
Electromagnetic Fields of Wireless Communications: Biological and Health Effects

EDITED BY
Dimitris J. Panagopoulos



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Electromagnetic Fields of Wireless Communications: Biological and Health Effects

This book reflects contributions from experts in the biological and health effects of Radio Frequency (RF)/Microwave and Extremely Low Frequency (ELF) Electromagnetic Fields (EMFs) used in wireless communications (WC) and other technological applications. Diverse topics related to physics, biology, pathology, epidemiology, and plausible biophysical and biochemical mechanisms of WC EMFs emitted by antennas and devices are included. Discussions on the possible consequences of fifth generation (5G) mobile telephony (MT) EMFs based on available data and correlation between anthropogenic EMF exposures and various pathological conditions such as infertility, cancer, electro-hypersensitivity, organic and viral diseases, and effects on animals, plants, trees, and environment are included. It further illustrates individual and public health protection and the setting of biologically- and epidemiologically-based exposure limits.

Features:

- Covers biological and health effects, including oxidative stress, DNA damage, reproductive effects of mobile phones/antennas (2G, 3G, 4G), cordless phones, Wi-Fi, etc.
- Describes effects induced by real-life exposures by commercially available devices/antennas.
- Illustrates biophysical and biochemical mechanisms that fill the gap between recorded experimental and epidemiological findings and their explanations.
- Explores experimental and epidemiological facts and mechanisms of action. Provides explanations and protection tips.
- Transcends across physical, biological, chemical, health, epidemiological, and environmental aspects of the topic.

This book is aimed at senior undergraduate/graduate students in physics, biology, medicine, bioelectromagnetics, electromagnetic biology, non-ionizing radiation biophysics, telecommunications, electromagnetism, bioengineering, and dosimetry.



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Contents

The Editor	vii
Contributors	ix
Foreword	xi

Introduction	1
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PART A Physical Properties of Wireless Communication Electromagnetic Fields

Chapter 1 Defining Wireless Communication (WC) Electromagnetic Fields (EMFs):	
A. Polarization Is a Principal Property of All Man-made EMFs	
B. Modulation, Pulsation, and Variability Are Inherent Parameters of WC EMFs	
C. Most Man-made EMF Exposures Are Non-thermal	
D. Measuring Incident EMFs Is More Relevant than Specific Absorption Rate (SAR)	
E. All Man-made EMFs Emit Continuous Waves, Not Photons	
F. Differences from Natural EMFs. Interaction with Matter	17
<i>Dimitris J. Panagopoulos, Andreas Karabarbounis, and Constantinos Liolios</i>	

PART B Biological and Health Effects of Wireless Communication Electromagnetic Fields

Chapter 2 Public Health Implications of Exposure to Wireless Communication Electromagnetic Fields	79
<i>Anthony B. Miller</i>	
Chapter 3 Oxidative Stress Induced by Wireless Communication Electromagnetic Fields	97
<i>Igor Yakymenko and Oleksandr Tsybulin</i>	
Chapter 4 Genotoxic Effects of Wireless Communication Electromagnetic Fields	137
<i>Ganesh Chandra Jagetia</i>	
Chapter 5 DNA and Chromosome Damage in Human and Animal Cells Induced by Mobile Telephony Electromagnetic Fields and Other Stressors	189
<i>Dimitris J. Panagopoulos</i>	

Chapter 6	The Impacts of Wireless Communication Electromagnetic Fields on Human Reproductive Biology	219
	<i>Kasey Miller, Kiara Harrison, Jacinta H. Martin, Brett Nixon, and Geoffry N. De Iuliis</i>	
Chapter 7	Effects of Wireless Communication Electromagnetic Fields on Human and Animal Brain Activity.....	275
	<i>Haitham S. Mohammed</i>	
Chapter 8	Electro-hypersensitivity as a Worldwide, Man-made Electromagnetic Pathology: A Review of the Medical Evidence.....	297
	<i>Dominique Belpomme and Philippe Irigaray</i>	
Chapter 9	Carcinogenic Effects of Non-thermal Exposure to Wireless Communication Electromagnetic Fields	369
	<i>Igor Yakymenko and Oleksandr Tsybulin</i>	
 PART C <i>Effects on Wildlife and Environment</i>		
Chapter 10	Effects of Man-made and Especially Wireless Communication Electromagnetic Fields on Wildlife.....	393
	<i>Alfonso Balmori</i>	
 PART D <i>Biophysical and Biochemical Mechanisms of Action</i>		
Chapter 11	Mechanism of Ion Forced-Oscillation and Voltage-Gated Ion Channel Dysfunction by Polarized and Coherent Electromagnetic Fields	449
	<i>Dimitris J. Panagopoulos</i>	
Chapter 12	Electromagnetic Field-induced Dysfunction of Voltage-Gated Ion Channels, Oxidative Stress, DNA Damage, and Related Pathologies	481
	<i>Dimitris J. Panagopoulos, Igor Yakymenko, and George P. Chrousos</i>	
Index		509

The Editor



Dr. Dimitris J. Panagopoulos (electromagnetic fields – biophysicist) was born in Athens, Greece, where he lives and works. He has a degree in Physics and a PhD in Biophysics both from the National and Kapodistrian University of Athens (NKUA). He completed his PhD on the Biological Effects of Electromagnetic Fields (EMFs) in 2001, and two post-doctoral studies on the biological effects of microwaves (2004) and on cell death induction by wireless communication (WC) EMFs (2006). He worked as a post-doctoral researcher and lecturer at the Department of Cell Biology and Biophysics, NKUA, (2002–2014), where he gave undergraduate and graduate lectures on radiation and EMF biophysics and performed research on the effects of various types of EMFs in experimental animals. From 2014 to 2018, he worked as a research associate at the National Centre for Scientific Research “Demokritos”, Laboratory of Health Physics, Radiobiology, and Cytogenetics, researching

effects of ionizing and non-ionizing radiation on human cells. Since 2018, he has been working as a researcher at the Choremeion Research Laboratory, Medical School, NKUA. His experiments were among the first that showed damaging effects of man-made EMFs on DNA and reproduction. He has also shown beneficial effects on reproduction of EMFs that mimic natural ones. His theory on the biophysical mechanism of action of EMFs on cells is considered the most valid amongst all proposed theories and is cited by more than 700 scientific publications. This theory has explained the sensing of upcoming earthquakes by animals and the sensing of upcoming thunderstorms by sensitive individuals through the action of the natural EMFs associated with these phenomena. The same theory has recently explained the induction of oxidative stress in cells by EMF exposure. Dr. Panagopoulos has shown why the specific absorption rate (SAR) is not a proper metric for non-thermal effects; why man-made (totally polarized and coherent) EMFs are damaging, while natural EMFs are vital; and why highly varying real-life exposures from mobile phones and other WC devices are significantly more damaging than simulated exposures with invariable parameters. He has also shown that genetic damage caused by WC EMFs occurs similarly in human and animal cells. Dr. Panagopoulos has also argued that photons are strictly wave-packets, not particles of light, and that man-made electromagnetic radiation does not consist of photons but of continuous “classical” polarized waves, in contrast to what has been postulated by quantum physicists for the past 100 years. He is the first or sole author in more than 40 peer-reviewed highly influential scientific publications, which have been referenced more than 1,800 times by other scientific publications and has been included in the Top 10 cited authors by the *Mutation Research* journals.

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† We regret to announce that our teacher, colleague, coworker and friend, Dr. Constantinos Lioliousis, Professor at the Department of Physics of the National and Kapodistrian University of Athens, who distinguished himself in the fields of applied physics, microwave electronics, telecommunications, and biological effects of electromagnetic fields, and contributed to this book as a coauthor in Chapter 1, a brilliant scientist and a man of ideals and integrity, passed away soon after the completion of the chapter, at his 82 years. Chapter 1 of this book, which represents his final contribution, is dedicated to his memory.

Foreword

Information and communication technology is an ever-evolving medium which has penetrated all aspects of life as we know it, accruing unprecedented societal benefits. But with those benefits come risks that need to be managed, and this book presents an exceptional, fact-based foundation for the latter.

Originally developed as a military tool, the wireless aspects of information and communication technology are complex and multi-faceted, with nuances unique to each type of mobile or cordless device, infrastructure platform, and exposure character, with effect metrics driven in large part by the sophisticated interplay of genetics and epigenetics.

To fully understand the depth and breadth of wireless technology and its health implications takes time, intelligence, and longitudinal effort. The growing scientific literature on wireless technology's biological activity alone includes thousands of peer-reviewed papers. The tasks of both learning this field and integrating the many strands of emerging knowledge portend multiple years of commitment.

In a time when opinions, informed and not, are readily available through multiple journalistic, entertainment, and social media platforms, the attainment of factual truth is elusive. But it is only factual truth that can ensure societal decision-making that is both reliable and actionable. Therein lies the value of this coalescence of professional factual thinking put forth here by Dr. Panagopoulos and his colleagues that represent a cross section of the world's top scientists and their work on the biological impacts of wireless communications technology.

This book effectively and efficiently presents the critically important science that leads to informed decisions about health, safety, and the environment. All the critical scientific aspects are considered in a learned fashion on these pages, presented by scientists who do the actual work, and who have done the heavy lifting of sorting and integrating these complexities for practical application.

This book is a necessary factual truth resource for scientists looking to informedly pursue wireless communications subject matter; for responsible employers looking to protect those in their workplaces; for regulators looking to protect health and the environment; for clinicians looking to do the best for their patients; for policy-makers looking to make informed changes to ensure public safety; and for consumers looking to balance the benefits of technology with protections for their children, families, and friends.

Read this book. Absorb its contents. Believe it. And be comfortable acting on this knowledge.

Dr. George L. Carlo
Washington, DC, USA
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Introduction

Abbreviations: B-field: magnetic field. E-field: electric field. EHS: electro-hypersensitivity. ELF: Extremely Low Frequency. EMF: electromagnetic field. EMR: electromagnetic radiation. LF: Low Frequency. MT: mobile telephony. MW: Microwaves. NR: New Radio. OS: oxidative stress. RF: Radio Frequency. ROS: reactive oxygen species. SAR: Specific Absorption Rate. ULF: Ultra Low Frequency. VGIC: voltage-gated ion channel. VLF: Very Low Frequency. WC: wireless communications. Wi-Fi: Wireless Fidelity. 1G/2G/3G/4G/5G: first/second/third/fourth/fifth generation of MT.

Static electric (E) fields are generated by (macroscopically) standing electric charges (actually nothing is “standing” at microscopic level), and static magnetic (B) fields are generated by direct and constant electric currents (directional movement of electric charge with a constant velocity). Only static (invariable in time) E- or B-fields can each exist alone without the coexistence of the other. But again, nothing is absolutely invariable in time, and, thus, totally static, and single E- and B-fields exist only approximately in certain occasions, such as electric fields of “isolated” charged objects or of electric batteries and magnetic fields of certain minerals (magnets).

When electric charges oscillate back and forth (as e.g., in alternating electric currents), both E- and B-fields are generated that also oscillate in phase with the charges. Thus, oscillating electric charges generate oscillating E- and B-fields simultaneously, and the frequency of the generated fields is the same as the frequency of the oscillating charges. The generated E-field oscillates in parallel to the direction of charge oscillation, while the generated B-field oscillates vertically to this direction. Due to this strong interrelation and coexistence between oscillating electric and magnetic fields, we talk about electromagnetic fields (EMFs). Oscillating electric and magnetic fields are not only generated simultaneously by oscillating electric charges but also the one reproduces the other each moment, and the two of them (vertical to each other) can propagate in space in the form of electromagnetic waves or electromagnetic radiation (EMR) vertically to both of them. Thus, electromagnetic waves are E- and B-fields oscillating with the same frequency vertically to each other and vertically to the direction of their propagation. The plane of oscillation of the E-field is called the polarization plane of the wave. The frequency of the emitted EMR is the same as the frequency of its oscillating fields and the oscillating charges that generate them. Thus, oscillating E-/B-fields not only create each other and always coexist, but they also have the unique property to reproduce and propagate themselves in the surrounding space, even in the absence of a material medium, i.e. in the vacuum. All electromagnetic waves propagate with the velocity of light, which is different in each medium. The velocity of light (and of any electromagnetic wave) in the vacuum or in the air (measured by the pioneer physicist H. Hertz to be approximately equal to (\approx) 3×10^8 m/s) represents an upper limit for all known velocities of any material or energetic entities (Tesla 1905; Alonso and Finn 1967; Jackson 1975).

In nature, all electric charges oscillate in all possible directions, and the generated EMFs/EMR have similarly random polarizations; in other words, they are not polarized, apart from specific occasions that are locally and partially polarized. Moreover, they do not oscillate with a unique frequency and in phase (coordinately). By contrast, electric charges in electric/electronic circuits oscillate in unique directions (determined by the geometry of the metallic conductors) and coordinately (with a unique frequency and phase), and, thus, the generated technical (man-made) EMFs/EMR are totally polarized and coherent (Panagopoulos et al. 2015a). All anthropogenic EMFs/EMR oscillate at subinfrared frequencies ($0-3 \times 10^{11}$ Hz) (Figure 0.1).

ELECTROMAGNETIC SPECTRUM

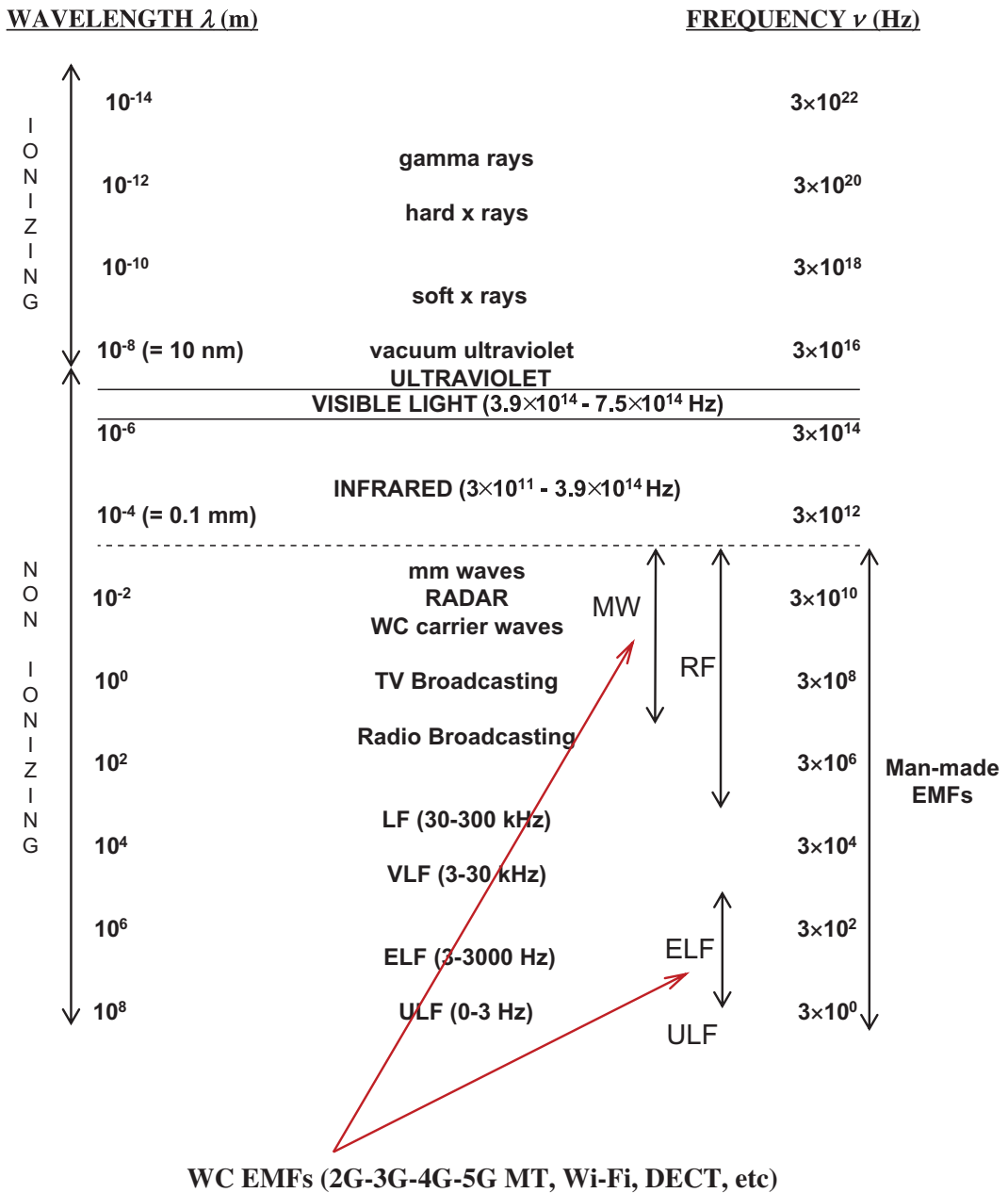


FIGURE 0.1 The electromagnetic spectrum with the ionizing, visible, infrared, and subinfrared parts. Man-made EMFs occupy the subinfrared frequency range ($0-3 \times 10^{11}$ Hz), and WC EMFs always combine MW carrier frequencies with ELF modulation and pulsation. Natural EMFs in the subinfrared part of the spectrum are cosmic microwaves, atmospheric EMFs due to lightning discharges (VLF, ELF), Schumann resonances (ELF), spontaneous ionic oscillations in cells (ULF), etc.

During the past five decades and beyond, a great amount of scientific knowledge has been accumulated regarding the biological and health effects of man-made EMFs and corresponding EMR. High-voltage power transmission lines and transformers operating at the Extremely Low Frequency (ELF) (3–3000 Hz) band, specifically at the so-called power frequency (50–60 Hz), radars, and various types of analog transmitters operating at the Radio Frequency (RF) (300 kHz–300 GHz) band and in its highest part called Microwave (MW) band (300 MHz–300 GHz) (Figure 0.1), were the first powerful man-made EMF/EMR sources that attracted the attention and concern of scientists and physicians for their biological/health effects (Persinger 1974; Presman 1977; Marino and Becker 1977; Adey 1981; 1993; Goodman et al. 1995; Puranen and Jokela 1996).

This accumulated knowledge is of particular importance today, as wireless communications (WC) have become an important part of daily life. In WC technologies, the information is conveyed by electromagnetic waves transmitted by devices and corresponding antennas. Today's digital WC technological products include mobile phones and corresponding mobile telephony (MT) base antennas; cordless domestic phones; wireless Internet connections called Wi-Fi (Wireless Fidelity); wireless connections among electronic devices (called "Bluetooth"), etc. All digital WC devices and corresponding antennas emit MW carrier waves that are necessarily modulated and pulsed by low frequency (mostly ELF) signals in order to carry variable information and provide simultaneous service to many users. The levels of EMF emissions from WC and other technologies have increased exponentially, especially during the past 25–30 years that digital WC are in use and, similarly, the human exposure to these EMF emissions. This tremendous increase of human exposure to EMFs is an unprecedented phenomenon throughout the billions of years of biological evolution. Most importantly, as explained already, all anthropogenic EMFs differ significantly from the natural EMFs in that they are totally polarized and coherent. Therefore, living organisms are not expected to have natural defenses against anthropogenic EMFs.

While the first-generation (1G) mobile phones in the 1980s were analog and of limited use, digital MT technology since the mid-1990s has evolved fast by producing the existing second, third, and fourth generations (2G/3G/4G) of devices/antennas with each next generation transmitting increasing amounts of information/data (voice, text, pictures, video, Internet). Today the massive deployment of the New Radio (NR) 5G (fifth generation) MT/WC system around the world by the telecommunications industry, which is expected to further increase considerably the existing ambient EMF levels, has already started and is rolling out, despite serious concerns expressed by scientists (Miller et al. 2018; 2019; Hardell and Nyberg 2020; Kostoff et al. 2020; Levitt et al. 2021). At the same time, during the past 2 years, humanity was suddenly confronted by a pandemic due to a new virus. As a result, a lot of concern has been raised among scientists and the general population regarding the health and environmental consequences of a vast technological expansion that is taking place uninvited to such an extent.

Natural EMFs/EMR in the terrestrial environment (geoelectric and geomagnetic fields, atmospheric discharges, Schumann resonances, solar light, cosmic microwaves, gamma radiation, etc.) are never totally polarized and maintain relatively constant average intensities. Those that are locally polarized, to a significant degree, are static with constant polarities, such as the geoelectric and geomagnetic fields (with average intensities approximately (~) 130 V/m and ~ 0.05 mT, respectively). Similarly, static and locally polarized are the cell membrane fields (~ 10⁷ V/m). During short-term changes of 20%–30% in the average constant intensities of both the environmental and the cell membrane natural EMFs, health problems and biological effects respectively are initiated (see Chapter 1 and Presman 1977; Dubrov 1978; Panagopoulos 2019). This fact suggests that the combination of polarization and variability provides a basis for EMF bioactivity (Panagopoulos 2019).

Now, all man-made EMFs produced by electric/electronic circuits are totally polarized and oscillating, and especially modern digital WC EMFs vary greatly and unpredictably at all times displaying, apart from the ELF pulsing and modulation mentioned already, significant random variability, mainly in the Ultra Low Frequency (ULF) (0–3 Hz) band, with intensity variations usually exceeding by more than 30% (and even by more than 100% in many instances) the average values because

of the varying information they transmit and many other factors (see Chapter 1 and Panagopoulos 2019). These significant physical differences between natural and man-made EMFs explain their corresponding differences in the induced biological/health effects.

Natural EMFs are necessary for maintaining the health and wellbeing of all living organisms on Earth. A characteristic example is the atmospheric “Schumann” resonances that attune the brain electrical activity in all animals (Persinger 1974; Wever 1979; Cherry 2002; 2003; Panagopoulos and Chrousos 2019). By contrast, man-made EMFs have been found to produce a great number of adverse biological and health effects. These include changes in key cellular functions; oxidative stress (OS); DNA and protein damage; cell death; infertility; cancer; effects on the immune system; changes in human/animal physiology, such as brain activity; pathological symptoms referred to as electro-hypersensitivity (EHS); etc. (Adey 1981; 1993; Liburdy 1992; Walleczek 1992; Goodman et al. 1995; Santini et al. 2005; Phillips et al. 2009; Hardell and Carlberg 2009; Khurana et al. 2009; De Iuliis et al. 2009; Johansson 2009; Szmigielski 2013; Houston et al. 2016; Yakymenko et al. 2011; 2016; 2018; Mohammed et al. 2013; Balmori 2015; 2021; Gulati et al. 2016; Zothansiana et al. 2017; Miller et al. 2018; 2019; Panagopoulos 2019; 2020; Irigaray et al. 2018; Belpomme and Irigaray 2020). From all anthropogenic EMF types, WC EMFs seem to be the most adversely bioactive, mainly because of their increased variability (Panagopoulos 2019).

Under the weight of accumulating scientific evidence, the International Agency for Research on Cancer (IARC), which is part of the World Health Organization (WHO), has categorized both ELF and RF (in fact WC) man-made EMFs as possibly carcinogenic to humans (IARC 2002; 2013). More recent updates on human cancer epidemiology and animal carcinogenicity studies argue that WC EMFs should be categorized as “probably carcinogenic” or “carcinogenic” (Miller et al. 2018; 2019; NTP 2018; Falcioni et al. 2018; Hardell and Nyberg 2020).

Significant scientific evidence shows that the bioactivity of WC EMFs is mainly due to their ELF/ULF components and that RF/microwave carrier signals alone, without modulation, pulsing, and variability, do not usually induce biological effects other than heating at adequately high intensities and frequencies (Bawin et al. 1975; 1978; Blackman et al. 1982; Frei et al. 1988; Walleczek 1992; Bolshakov and Alekseev 1992; Goodman et al. 1995; Penafiel et al. 1997; Creasey and Goldberg 2001; Huber et al. 2002; Betti et al. 2004; Goldsworthy 2006; Höytö et al. 2008; Franzellitti et al. 2010; Campisi et al. 2010; Mohammed et al. 2013; Panagopoulos 2019). As summarized by Goldsworthy (2006), “it is widely accepted that continuous unmodulated radio waves are of too high a frequency to give biological effects but they do become effective when pulsed or amplitude modulated at a low frequency”. All endogenous physiological EMFs discovered so far within living organisms, such as the intracellular spontaneous ionic oscillations, the endogenous electric currents that control all cellular and tissue functions, or the electromagnetic signals of brain and heart activities, oscillate at low frequencies (ELF/ULF). And then, like in all forms of matter, molecular oscillations and thermal noise have frequencies in the infrared band. RF EMFs have not been detected in living organisms (Alberts et al. 1994; McGaig and Zhao 1997; Huber et al. 2002; Nuccitelli 2003; Mohammed et al. 2013). It is, thus, absolutely expected for living organisms to be more responsive to external EMFs of similar frequencies. Although this notion for the principal role of ELFs in the bioactivity of WC EMFs has long been available and repeatedly verified, many studies focus exclusively on the RF part of the WC EMFs. A most common problem in published reports on the effects of WC EMFs is that many of them refer to these EMFs simply as “RF” or “microwave”, without assessing or even mentioning the inevitable coexistence of ELFs, which are actually the most bioactive (Pakhomov et al. 1998; Betskii and Lebedeva 2004; Belyaev 2005; EPRS 2020; 2021; Karipidis et al. 2021).

Recently, because of the highest microwave carrier frequencies (“mm-waves”) of the 5G, certain Russian studies reporting “non-thermal effects of microwave/mm-wave EMFs” came to light. These studies were written in Russian and became known mostly from reviews in English by other Russian scientists. Three such reviews are by Pakhomov et al. (1998), Betskii and Lebedeva (2004), and Belyaev (2005). In several studies reviewed in Pakhomov et al. (1998) and Belyaev (2005), ULF/ELF and Very Low Frequency (VLF) (3–30 kHz) components were present in the form of pulsing

and/or modulation/intermittence/variability, while no information on possible existence of such components was provided in the rest of the reviewed studies. Similarly, in the Betskii and Lebedeva (2004) review, information on possible existence of low-frequency components (ULF/ELF/VLF) is absent throughout the paper, but their presence was again not excluded. As it is unlikely that any microwave electronic circuit/generator is not turned on and off, even only for energy-saving reasons, the existence of ULF/ELF/VLF components, and the separate roles of the low and high frequencies in the biological effects, need to be carefully addressed in all experimental studies employing RF/microwave EMF exposures and in the related reviews in order to prevent misleading conclusions. This can be done easily and reliably in experimental studies by performing and reporting electric and magnetic field measurements in the ELF band by ELF field meters and/or spectrum analyzers. Thus, all experimental RF/microwave studies should necessarily include such measurements, and review studies should necessarily report the ELF components in the various exposures.

While one effect induced by high intensity ($>0.1 \text{ mW/cm}^2$) and frequency ($\geq 1 \text{ GHz}$) microwave EMFs is that of heating exposed materials and living tissues (as happens in microwave ovens with food) (“thermal effects”) (Metaxas 1991; Goodman et al. 1995; Creasey and Goldberg 2001), the vast majority of the recorded biological/health effects at lower – environmentally relevant – intensities (from either RF/WC or purely ELF EMFs) are not accompanied by any significant temperature increases and, thus, have been categorized as non-thermal effects (Goodman et al. 1995; Belyaev 2005; Panagopoulos et al. 2013; Yakymenko et al. 2016). Still, the metric for RF EMF bioactivity suggested by health agencies is the Specific Absorption Rate (SAR) (IARC 2013), which, apart from the fact that it is impractical because it cannot be measured directly but has to be calculated (usually by simplistic and inaccurate methods), actually accounts only for thermal effects because the only reliable way to estimate it is by measuring temperature increases (see Chapter 1 and Gandhi et al. 2012; Panagopoulos et al. 2013).

While man-made EMFs cannot directly break chemical bonds and, thus, cause direct ionization of molecules, they are capable of inducing such effects indirectly, by triggering production of free radicals and reactive oxygen species (ROS) in the cells (De Iuliis et al. 2009; Burlaka et al. 2013; Pall 2013; Houston et al. 2016; Yakymenko et al. 2016; 2018; Zothansiana et al. 2017; Panagopoulos et al. 2021). Such species can damage any critical biomolecules, including DNA. The (over)production of ROS in cells and the consequent OS that arises can be triggered by irregular gating of voltage-gated ion channels (VGICs) in the cell membranes due to purely ELF/VLF man-made EMFs or the ULF/ELF/VLF components of the complex WC EMFs (Creasey and Goldberg 2001; Panagopoulos et al. 2002; 2015a; 2021). Today, irregular gating of VGICs in cell membranes by man-made EMFs has been verified by many experimental studies (e.g., Liburdy 1992; Piacentini et al. 2008; Cecchetto et al. 2020; Zheng et al. 2021) and presented by reviews (Pall 2013; Bertagna et al. 2021). Thus, we are dealing with mechanisms that result in chemical changes of critical biomolecules without heating the exposed biological tissues.

Although the majority of peer-reviewed published studies (more than 60%–70%) indicate effects of purely ELF man-made EMFs for field intensities down to less than a few V/m or a few μT , or of pulsed/modulated RF/WC EMFs for RF intensities down to less than $1 \mu\text{W/cm}^2$ even for short-term exposures (Goodman et al. 1995; Santini et al. 2005; Phillips et al. 2009; Panagopoulos et al. 2010; Szmigielski 2013; Burlaka et al. 2013; Manna and Ghosh 2016; Yakymenko et al. 2011; 2016; Leach et al. 2018; Panagopoulos 2019), health authorities responsible for setting exposure guidelines in most countries have adopted limits that are thousands (and even millions, in some cases) of times higher, as set by a private, non-governmental organization (NGO) called the International Commission on Non-Ionizing Radiation Protection (ICNIRP 1998; 2010; 2020; Hardell and Carlberg 2021). These limits may provide limited protection against thermal RF effects, but certainly not against the non-thermal effects of the purely ELF man-made EMFs or the ELF components of the complex RF/WC EMFs, which actually constitute the vast majority of the reported biological and health effects.

Indicative threshold EMF/EMR intensity levels found to induce significant (non-thermal) biological/health effects and the corresponding ICNIRP (2010; 2020) limits for public exposure in the ELF and RF bands are shown in Table 0.1. It is evident that serious biological and health effects

TABLE 0.1
Threshold EMF/EMR Intensities for Indicative Biological/Health Effects and Corresponding ICNIRP Limits

Incident EMF	ICNIRP Intensity Limit (6 min Average, Local Exposure)	Threshold Intensity for Effect Initiation	Exposure Duration	Effect	References
ELF-E (CW or pulsed) (1–50 Hz)	5000 V/m	0.002 V/m 0.0021 V/m	12 h 4 days	Decrease in protein synthesis rate Increase in DNA synthesis rate	McLeod et al. (1987) Cleary et al. (1988)
ELF-B (50 Hz CW)	2 G (200 μ T)	10 V/m 0.002 G (0.2 μ T)	Years Years	Cancer (humans) Cancer (humans)	Coghill et al. (1996) Feychting and Ahlbom (1994)
Pulsed RF (GSM) 1800 MHz	3655.6 μ W/cm ²	<1 μ W/cm ²	6 min/day, 6 days	DNA damage, cell death (fruit fly ovarian cells)	Panagopoulos et al., (2010)
Pulsed RF (GSM) 900 MHz	2014.0 μ W/cm ²	0.25 μ W/cm ²	158–360 h intermittently	OS, DNA damage, embryonic death (bird embryos)	Burlaka et al. (2013)
Pulsed RF (GSM) 1800 MHz	3655.6 μ W/cm ²	0.32 μ W/cm ²	19 days (48 s On/12 s Off)	OS, DNA damage, embryonic death (bird embryos)	Yakymenko et al. (2018)

[ICNIRP (2020) limits calculated for 900 and 1800 MHz according to formula: $0.058f_{MHz}^{0.86}$, CW: continuous-wave, G: Gauss].

such as OS, DNA damage, cancer, etc. may occur from exposure to ELF EMFs or WC EMFs at levels thousands of times lower than the corresponding ICNIRP limits, while more subtle cellular effects may be initiated at ELF thresholds more than a million times lower than the corresponding ICNIRP limits (McLeod et al. 1987; Cleary et al. 1988; Feychting and Ahlbom 1994; Coghill et al. 1996; Panagopoulos et al. 2010; Burlaka et al. 2013; Yakymenko et al. 2018). Hence, these limits do not provide any health protection.

Because of these facts, and regardless of our remaining knowledge gaps, health complaints are increasing, especially among people residing close to antennas or high-voltage power lines, accompanied by increasing cancer rates and symptoms of unwellness (Kundi and Hutter 2009; Gulati et al. 2016; Zothansiana et al. 2017; Miller et al. 2018; 2019; Belpomme and Irigaray 2020; Lopez et al. 2021).

The situation may seem confusing with several other studies reporting no effects of ELF or pulsing/modulated RF/WC EMFs, especially studies that have employed simulated WC EMF exposures from generators, “exposure chambers”, or “test” mobile phones with invariable parameters (carrier frequency, intensity, pulsations) and no modulation (ICNIRP 1998; 2020; IARC 2002; 2013; EPRS 2020; 2021; Karipidis et al. 2021). Indeed, about 50% of the studies that employ simulated EMFs do not find effects. In contrast, among studies that employ real-life exposures from commercially available devices with high variability (such as mobile or cordless phones, Wi-Fi, etc.), more than 95% find effects (Panagopoulos et al. 2015b; Yakymenko et al. 2016; Leach et al. 2018; Panagopoulos 2019; Kostoff et al. 2020).

Bioelectromagnetics is a complex scientific field, featuring an equal combination of physics and biology. This is why collaboration among experts from different areas (e.g., physicists with biologists, or medical doctors with engineers) is necessary. EMF bioeffect experiments must necessarily be carried out by scientists/teams that combine adequate knowledge in both the physical and the biological parts; otherwise, the methodology may be flawed and the conclusions misleading. The use of any devices such as generators and exposure chambers provided by companies for exposure of biological samples to simulated EMFs without knowing and measuring the physical details of the generated EMFs is a major flaw in experimental studies.

Unfortunately, conflict of interest, corruption, results depending on funding, and misleading information in scientific papers have become usual phenomena in the field (Hardell and Carlberg 2021; Leach et al. 2018). Conflict of interest is not necessarily limited to economical/professional benefits but may also include other types of personal rewards (Panagopoulos and Karabarbounis 2020; Panagopoulos 2021). It is not unusual for important findings such as those reported above to be concealed or neglected in many publications, while their consideration is necessary for further developments.

At the same time, the massive deployment of the 5G MT/WC system in order to achieve ever increasing data transmission rates and the so-called Internet of Things (IoT) is well underway despite serious concerns expressed by many expert scientists who have asked for a moratorium in 5G deployment (Hardell and Nyberg 2020), as implied by the Precautionary Principle (Harremoes 2013; Read and O’Riordan 2017; Frank 2021). Indeed, the deployment of 5G will require a huge increase in the number of base antennas, combined with potential increases in transmission power/intensity, and thousands of satellites in the atmosphere to complement the base antennas. Moreover, the increased amount of variable data transmitted by this new WC EMR type make it even more variable in intensity, waveform, frequency, etc., with inclusion of ever more variable ELF pulsations than previous types of MT/WC EMFs (Rappaport et al. 2013; Dahlman et al. 2018). Thus, 5G is expected to significantly increase public exposure and consequent health problems (Panagopoulos 2019; Hardell and Nyberg 2020; Kostoff et al. 2020; Levitt et al. 2021).

Strangely, in 2020, the ICNIRP increased the general public exposure limit for WC EMFs (2–6 GHz) averaged over 6 minutes (min) from 1000 to 4000 $\mu\text{W}/\text{cm}^2$ (from 1 to 4 mW/cm^2) instead of decreasing it (ICNIRP 1998; 2020). Also strange were the technical reports and papers referring to the characteristics of 5G that do not provide any information on the ULF/ELF/VLF components of this new WC EMF type, as if their authors are not aware of their existence (EPRS 2020; 2021;

Karipidis et al. 2021). As already mentioned, carrying out studies involving WC EMF exposures without searching the low-frequency components and attributing any observed effects to the RF/MW carrier can be very misleading. Similarly, reviewing and evaluating other studies by looking only at the RF/MW part of their EMF exposures and ignoring the low-frequency part or not examining whether the exposures are from real-life WC devices/antennas or simulated signals with fixed parameters and, thus, significantly less bioactive, as in EPRS (2020; 2021) (EPRS: European Parliamentary Research Service) and Karipidis et al. (2021), is a flawed methodology. Thus, not only are WC EMFs dangerous to life, but the evaluation of their risks by certain reviews and organizations is flawed as well. In view of the fact that the ULF/ELF/VLF EMFs are actually the most bioactive, the low frequency (ULF/ELF/VLF) pulsations of the most recent generations of WC signals such as the 4G and 5G should be in the forefront of bioelectromagnetic research in order to allow the correct evaluation of their risks.

Because of the described confusion and misinformation, many people, especially among the general public, make careless use of WC devices, utilizing cordless domestic phones and Wi-Fi at homes and workplaces for convenience instead of using wired connections and attaching the mobile phones on their heads/bodies, subjecting themselves day and night to simultaneous telephone and Wi-Fi/Bluetooth EMF emissions from their “smart” devices. Unfortunately, they also give such devices in the hands of young children or even expose their embryos during pregnancy. So far, the authorities do nothing to educate them or protect them.

When, in many cases, people realize they have become hypersensitive to man-made EMFs, their efforts to restrict unbearable symptoms, especially from WC antennas, usually lead to risky solutions, such as metal shielding in their houses and even in their clothes. Any EMF-shielding attenuates not only the detrimental anthropogenic EMFs but also the natural and absolutely vital Schumann electromagnetic resonances, which actually attune our brain activity (Persinger 1974; 2014; Wever 1979; Cherry 2002; 2003; Panagopoulos and Chrousos 2019). Therefore, such solutions should be considered only when other ways of protection are not possible, and should be applied cautiously (after careful EMF measurements) and partially (e.g., only on certain wall(s) of a house), possibly in combination with earthing, and/or scientifically tested “Schumann generators” emitting very weak signals that mimic as closely as possible the Schumann oscillations (Panagopoulos and Chrousos 2019).

It seems that humanity and science are coming to realize that the price for the comfort provided by technology and the convenience in sharing information may be compromised health, wellbeing, and natural environment, when technology is not carefully designed to respect these values and health authorities do not set safe limits.

Another particularly worrying phenomenon is research on nanobiotechnology – magnetogenetics carried out during the past 10 years. Such research is crossing sensitive boundaries of bioethics by trying to control the cellular processes via magnetic nanoparticles injected in cells and manipulated by external electromagnetic signals (Monzel et al. 2017; He et al. 2021). Such methods can not only have unpredictable, adverse effects on the cell/organism, granted that such nanoparticles are unnatural and foreign to the cells, and are, thus, dangerous for many reasons and probably toxic, but can also violate the privacy and freedom of a treated individual, who could then be monitored and manipulated remotely by electromagnetic signals. It is questionable how such research is considered acceptable in the scientific community and compatible with bioethical principles.

This book on the Biological and Health Effects of WC EMFs includes contributions from top international experts on the various areas of this important subject and is published to increase scientific knowledge, awareness, and debate that would benefit science, public health, and the environment. Expert scientists were invited to submit specific chapters on the physics, biology, pathology, epidemiology, and plausible biophysical and biochemical mechanisms of action of WC EMFs. The invitations were specific. The contributors were invited to write on topics related to their previous publications and expertise so that the book covers a minimum number of the most important topics.

Because both RF and ELF EMFs are contained in all WC EMFs, studies on both frequency bands are examined in the chapters. Thus, the book describes effects from most types of man-made EMF exposures. In all chapters, the terms “EMF” and “EMR” (for example WC EMFs or WC EMR) are used interchangeably with equivalent meaning, as EMR is produced by temporally varying EMFs, and man-made (polarized and coherent) EMR carries net EMFs as well (Panagopoulos et al. 2015a). Moreover, because all types of WC EMFs commonly combine MW carrier waves with ELF modulation, pulsation, and ULF random variability, their biological/health effects are very similar, and, thus, they are treated similarly in the chapters, emphasizing though that newer generations of WC/MT EMFs (3G/4G/5G) are increasingly more variable and, thus, increasingly more bioactive. The terms “cell phone” and “cell tower” used occasionally in the book refer to digital mobile phones and base station antennas respectively. Thus, they have the same meaning as “mobile phones” and “MT base station antennas” (used in most cases) since all existing MT/WC systems (2G, 3G, 4G, 5G) today are digital. Digital MT uses the so called “cellular system” according to which the space is divided into areas called “cells” with one base station in each “cell”.

The chapters present cutting-edge knowledge on the effects of man-made EMFs on living systems and their mechanisms. It is evident that serious effects induced by man-made and especially WC EMFs, such as genetic damage, are well documented as resulting from OS. This explains other reported pathological conditions, such as infertility or cancer. It is also evident that a most plausible biophysical/biochemical mechanism for OS induction in the cells is the dysfunction of the VGICs in the cell membranes and that the low frequency (ELF/ULF/VLF) components (pulsation, modulation, etc.) of the WC EMFs play a major role. The chapters emphasize the need for setting much tighter exposure limits and recommend prudent avoidance of exposure to man-made and especially WC EMFs, a moratorium in 5G roll-out, and urgent application of the Precautionary Principle (Harremoes 2013; Read and O’Riordan 2017; Frank 2021). Moreover, the chapters underline the need for improvement and standardization of the experimental procedures, use of real-life EMFs, and better definition of the EMF exposures by measuring all their parameters, especially the low-frequency ones.

I thank all the distinguished scientists in this book for kindly accepting my invitation, for their high-quality contributions, and their collaboration during the editing process. Inviting the chapters, editing, and shaping this book was, for me, a unique experience and a great source of combined knowledge. I also thank Dr. G.L. Carlo for writing the Forward of the book, and Dr. G. Singh from CRC for his invitation and repeated reminders to submit a book proposal.

This book will have served its purpose if it contributes toward setting scientific research in this field on a better base, leaving behind conflicts of interest and misinformation; when evidence-based discussions on the consequences of WC EMFs and possible correlations between an EMF-polluted environment and viral and other diseases are unbiased and welcomed by scientists, concerned individuals, health authorities and governments; when suggestions on individual and public health protection, and the setting of biologically and epidemiologically based exposure limits are also welcomed.

Finally, this book will have served its purpose if it contributes toward a “*real and honest science*” as Dr. Neil J. Cherry (1946–2003) would say. A science that is applicable to life and works for the benefit of humanity, not for its destruction or enslavement. A science that increases awareness on the safety of our natural environment and our planet Earth, which is in great danger because of the uncontrolled expansion of human technology and the unrestricted use of the natural resources.

We are gifted to live on this beautiful planet. We should love and respect it and live in harmony with it without destroying it. We should not disturb its natural balance by destroying the forests, changing the weather, genetically modifying our food and the natural organisms, filling the sky with thousands of satellites, and polluting the atmosphere with chemicals and artificial polarized EMFs/EMR. Instead of trying to inhabit other planets unfriendly to life, we should rather protect our home Earth, which is unique in the known universe. The balance of our planet is very fragile, and so is our existence. We all share the same home and the same future. It is our duty to protect it.

Dr. Dimitris J. Panagopoulos (Editor)

REFERENCES

- Adey WR, (1981): Tissue interactions with non-ionizing electromagnetic fields. *Physiological Reviews*, 61(2), 435–514.
- Adey WR, (1993): Biological effects of electromagnetic fields. *Journal of Cellular Biochemistry*, 51(4), 410–416.
- Alberts B, Bray D, Lewis J, Raff M, Roberts K, Watson JD, (1994): *Molecular Biology of the Cell*. Garland Publishing, Inc., New York.
- Alonso M, Finn EJ, (1967): *Fundamental University Physics* (Vol. 2). Fields and Waves, Addison-Wesley.
- Balmori A, (2015): Anthropogenic radiofrequency electromagnetic fields as an emerging threat to wildlife orientation. *Science of the Total Environment*, 518–519, 58–60.
- Balmori A, (2021): Electromagnetic radiation as an emerging driver factor for the decline of insects. *Science of the Total Environment*, 767, 144913.
- Bawin SM, Kaczmarek LK, Adey WR, (1975): Effects of modulated VHF fields, on the central nervous system. *Annals of the New York Academy of Sciences*, 247, 74–81.
- Bawin SM, Adey WR, Sabbot IM, (1978): Ionic factors in release of $^{45}\text{Ca}^{2+}$ from chick cerebral tissue by electromagnetic fields. *Proceedings of the National Academy of Sciences of the United States of America*, 75(12), 6314–6318.
- Belpomme D, Irigaray P, (2020): Electrohypersensitivity as a newly identified and characterized neurologic pathological disorder: How to diagnose, treat, and prevent it. *International Journal of Molecular Sciences*, 21(6), 1915. <https://doi.org/10.3390/ijms21061915>.
- Belyaev I, (2005): Non-thermal biological effects of microwaves. *Microwave Review*, 11(2), 13–29.
- Bertagna F, Lewis R, Silva SRP, McFadden J, Jeevaratnam K, (2021): Effects of electromagnetic fields on neuronal ion channels: A systematic review. *Annals of the New York Academy of Sciences* May 4. <https://doi.org/10.1111/nyas.14597>.
- Betskii OV, Lebedeva NN, (2004): Low-intensity millimeter waves in biology and medicine. In *Clinical Application of Bioelectromagnetic Medicine* (Vol. 2004). Marcel Dekker, New York, 30–61.
- Betti L, Trebbi G, Lazzarato L, Brizzi M, Calzoni GL, et al, (2004): Nonthermal microwave radiations affect the hypersensitive response of tobacco to tobacco mosaic virus. *Journal of Alternative and Complementary Medicine*, 10(6), 947–957.
- Blackman CF, Benane SG, Kinney LS, Joines WT, House DE, (1982): Effects of ELF fields on calcium-ion efflux from brain tissue in vitro. *Radiation Research*, 92(3), 510–520.
- Bolshakov MA, Alekseev SI, (1992): Bursting responses of Lymnea neurons to microwave radiation. *Bioelectromagnetics*, 13(2), 119–129.
- Burlaka A, Tsybulin O, Sidorik E, Lukin S, Polishuk V, et al, (2013): Overproduction of free radical species in embryonic cells exposed to low intensity radiofrequency radiation. *Experimental Oncology*, 35(3), 219–225.
- Campisi A, Gulino M, Acquaviva R, Bellia P, Raciti G, et al, (2010): Reactive oxygen species levels and DNA fragmentation on astrocytes in primary culture after acute exposure to low intensity microwave electromagnetic field. *Neuroscience Letters*, 473(1), 52–55.
- Cecchetto C, Maschietto M, Boccaccio P, Vassanelli S, (2020): Electromagnetic field affects the voltage-dependent potassium channel Kv1.3. *Electromagnetic Biology and Medicine*, 39(4), 316–322.
- Cherry NJ, (2002): *Schumann Resonances, a Plausible Biophysical Mechanism for the Human Health Effects of Solar/Geomagnetic Activity*. https://researcharchive.lincoln.ac.nz/bitstream/handle/10182/3935/90_n1_EMR_Schumann_Resonance_paper_1.pdf?sequence=1.
- Cherry NJ, (2003): Human intelligence: The brain, an electromagnetic system synchronised by the Schumann Resonance signal. *Medical Hypotheses*, 60(6), 843–844.
- Cleary SF, Liu LM, Graham R, Diegelmann RF, (1988): Modulation of tendon fibroplasia by exogenous electric currents. *Bioelectromagnetics*, 9(2), 183–194.
- Coghill RW, Steward J, Phillips A, (1996): Extra low frequency electric and magnetic fields in the bed place of children diagnosed with leukaemia: A case-control study. *European Journal of Cancer Prevention*, 5(3), 153–158.
- Creasey WA, Goldberg RB, (2001): A new twist on an old mechanism for EMF bioeffects? *EMF Health Report*, 9(2), 1–11. <https://mdsafetech.files.wordpress.com/2021/07/creasey-wa-goldberg-rb-2001-a-new-twist-on-an-old-mechanism-for-emf-bioeffects.pdf>.
- Dahlman E, Parkvall S, Skoeld J, (2018): *5G NR: The Next Generation Wireless Access Technology*. Academic Press, Elsevier, London.

- De Iuliis GN, Newey RJ, King BV, Aitken RJ, (2009): Mobile phone radiation induces reactive oxygen species production and DNA damage in human spermatozoa in vitro. *PLOS ONE*, 4(7), e6446.
- Dubrov AP, (1978): *The Geomagnetic Field and Life*. Plenum Press, New York.
- EPRS, (2020): *Effects of 5G Wireless Communication on Human Health, European Parliamentary Research Service*. Scientific Foresight Unit (STOA), PE 646.172, March 2020.
- EPRS, (2021): *Environmental Impacts of 5G. A Literature Review of Effects of Radio-Frequency Electromagnetic Field Exposure of Non-human Vertebrates, Invertebrates and Plants*, Scientific Foresight Unit (STOA), PE 690.021, June 2021.
- Falcioni L, Bua L, Tibaldi E, Lauriola M, De Angelis L, et al, (2018): Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission. *Environmental Research*, 165, 496–503.
- Feychting M, Ahlbom A, (1994): Magnetic fields, leukemia and central nervous system tumors in Swedish adults residing near high - voltage power lines. *Epidemiology*, 5(5), 501–509.
- Frank JW, (2021): Electromagnetic fields, 5G and health: What about the precautionary principle? *Journal of Epidemiology and Community Health*, 75(6), 562–566.
- Franzellitti S, Valbonesi P, Ciancaglini N, Biondi C, Contin A, et al, (2010): Transient DNA damage induced by high-frequency electromagnetic fields (GSM 1.8 GHz) in the human trophoblast HTR-8/SVneo cell line evaluated with the alkaline comet assay. *Mutation Research*, 683(1–2), 35–42.
- Frei M, Jauchem J, Heinmets F, (1988): Physiological effects of 2.8 GHz radio-frequency radiation: A comparison of pulsed and continuous-wave radiation. *Journal of Microwave Power and Electromagnetic Energy*, 23(2), 2.
- Gandhi Om P, Morgan LL, De Salles AA, Han Y-Y, Herberman RB, Davis DL, (2012): Exposure limits: The underestimation of absorbed cell phone radiation, especially in children. *Electromagnetic Biology and Medicine*, 31(1), 34–51.
- Goldsworthy A, (2006): Effects of electrical and electromagnetic fields on plants and related topics. In AG Volkov (Ed.), *Plant Electrophysiology—Theory & Methods*. Springer-Verlag, Berlin Heidelberg, 247–267.
- Goodman EM, Greenebaum B, Marron MT, (1995): Effects of electro-magnetic fields on molecules and cells. *International Review of Cytology*, 158, 279–338.
- Gulati S, Yadav A, Kumar N, Kanupriya, Aggarwal NK, et al, (2016): Effect of GSTM1 and GSTT1 polymorphisms on genetic damage in humans populations exposed to radiation From mobile towers. *Archives of Environmental Contamination and Toxicology*, 70(3), 615–625.
- Hardell L, Carlberg M, (2009): Mobile phones, cordless phones and the risk for brain tumours. *International Journal of Oncology*, 35(1), 5–17.
- Hardell L, Nyberg R, (2020): Appeals that matter or not on a moratorium on the deployment of the fifth generation, 5G, for microwave radiation. *Molecular and Clinical Oncology*. <https://doi.org/10.3892/mco.2020.1984>.
- Hardell L, Carlberg M, (2021): Lost opportunities for cancer prevention: Historical evidence on early warnings with emphasis on radiofrequency radiation. *Reviews on Environmental Health*. <https://doi.org/10.1515/reveh-2020-0168>.
- Harremoes P, Gee D, MacGarvin M, Stirling A, Keys J, et al. (Eds.), (2013): *The Precautionary Principle in the 20th Century: Late Lessons from Early Warnings*. Routledge, London.
- He Y, Yi C, Zhang X, Zhao W, Yu D, (2021): Magnetic graphene oxide: Synthesis approaches, physicochemical characteristics, and biomedical applications. *TrAC Trends in Analytical Chemistry*, 136, 116191.
- Houston BJ, Nixon B, King BV, De Iuliis GN, Aitken RJ, (2016): The effects of radiofrequency electromagnetic radiation on sperm function. *Reproduction*, 152(6), R263–R276.
- Höytö A, Luukkonen J, Juutilainen J, Naarala J, (2008): Proliferation, oxidative stress and cell death in cells exposed to 872 MHz radiofrequency radiation and oxidants. *Radiation Research*, 170(2), 235–243.
- Huber R, Treyer V, Borbely AA, Schuderer J, Gottselig JM, et al, (2002): Electromagnetic fields, such as those from mobile phones, alter regional cerebral blood flow and sleep and waking EEG. *Journal of Sleep Research*, 11(4), 289–295.
- IARC, (2002): *Non-ionizing Radiation, Part 1: Static and Extremely Low-frequency (ELF) Electric and Magnetic Fields* (Vol. 80). International Agency for Research on Cancer, Lyon, France.
- IARC, (2013): *Non-ionizing Radiation, Part 2: Radiofrequency Electromagnetic Fields* (Vol. 102). International Agency for Research on Cancer, Lyon, France.
- ICNIRP, (1998): Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz). *Health Physics*, 74, 494–522.

- ICNIRP, (2010): Guidelines for limiting exposure to time-varying electric and magnetic fields (1 Hz to 100 kHz). *Health Physics*, 99(6), 818–836.
- ICNIRP, (2020): Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz). *Health Physics*, 118(5), 483–524.
- Irigaray P, Caccamo D, Belpomme D, (2018): Oxidative stress in electrohypersensitivity self-reporting patients: Results of a prospective *in vivo* investigation with comprehensive molecular analysis. *International Journal of Molecular Medicine*, 42(4), 1885–1898.
- Jackson JD, (1975): *Classical Electrodynamics*. John Wiley & Sons, Inc., New York.
- Johansson O, (2009): Disturbance of the immune system by electromagnetic fields—A potentially underlying cause for cellular damage and tissue repair reduction which could lead to disease and impairment. *Pathophysiology*, 16(2–3), 157–177.
- Karipidis K, Mate R, Urban D, Tinker R, Wood A, (2021): 5G mobile networks and health—A state-of-the-science review of the research into low-level RF fields above 6 GHz. *Journal of Exposure Science and Environmental Epidemiology*. <https://doi.org/10.1038/s41370-021-00307-7>.
- Khurana VG, Teo C, Kundi M, Hardell L, Carlberg M, (2009): Cell phones and brain tumors: A review including the long-term epidemiologic data. *Surgical Neurology*, 72(3), 205–214.
- Kostoff RN, Heroux P, Aschner M, Tsatsakis A, (2020): Adverse health effects of 5G mobile networking technology under real-life conditions. *Toxicology Letters*, 323, 35–40.
- Kundi M, Hutter HP, (2009): Mobile phone base stations—effects on wellbeing and health. *Pathophysiology*, 16(2–3), 123–135.
- Leach V, Weller S, Redmayne M, (2018): A novel database of bio-effects from non-ionizing radiation. *Reviews on Environmental Health*, 33(3), 1–8.
- Levitt BB, Lai HC, Manville AM, (2021): Effects of non-ionizing electromagnetic fields on flora and fauna, part 1. Rising ambient EMF levels in the environment. *Reviews on Environmental Health*. <https://doi.org/10.1515/reveh-2021-0026>.
- Liburdy RP, (1992): Calcium signalling in lymphocytes and ELF fields: Evidence for an electric field metric and a site of interaction involving the calcium ion channel. *FEBS Letters*, 301(1), 53–59.
- López I, Félix N, Rivera M, Alonso A, Maestú C, (2021): What is the radiation before 5G? A correlation study between measurements *in situ* and in real time and epidemiological indicators in Vallecas, Madrid. *Environmental Research*, 194, 110734.
- Manna D, Ghosh R, (2016): Effect of radiofrequency radiation in cultured mammalian cells: A review. *Electromagnetic Biology and Medicine*, 35(3), 265–301.
- Marino AA, Becker RO, (1977): Biological effects of extremely low frequency electric and magnetic fields: A review. *Physiological Chemistry and Physics*, 9(2), 131–147.
- McCaig CD, Zhao M, (1997): Physiological electric fields modify cell behaviour. *BioEssays*, 19(9), 819–826.
- McLeod KJ, Lee RC, Ehrlich HP, (1987): Frequency dependence of electric field modulation of fibroblast protein synthesis. *Science*, 236(4807), 1465–1469.
- Metaxas AC, (1991): Microwave heating. *Power Engineering Journal*, 5(5), 237–247.
- Miller AB, Morgan LL, Udasin I, Davis DL, (2018): Cancer epidemiology update, following the 2011 IARC evaluation of radiofrequency electromagnetic fields (Monograph 102). *Environmental Research*, 167, 673–683.
- Miller AB, Sears ME, Morgan LL, Davis DL, Hardell L, et al, (2019): Risks to health and well-being from radio-frequency radiation emitted by cell phones and other wireless devices. *Frontiers in Public Health*, 7, 223. <https://doi.org/10.3389/fpubh.2019.00223>.
- Mohammed HS, Fahmy HM, Radwan NM, Elsayed AA, (2013): Non-thermal continuous and modulated electromagnetic radiation fields effects on sleep EEG of rats. *Journal of Advanced Research*, 4(2), 181–187.
- Monzel C, Vicario C, Piehler J, Coppey M, Dahan M, (2017): Magnetic control of cellular processes using biofunctional nanoparticles. *Chemical Science*, 8(11), 7330.
- NTP (National Toxicology Program), (2018): Toxicology and Carcinogenesis studies in Hsd: Sprague Dawley SD rats exposed to whole-body radio frequency radiation at a frequency (900 MHz) and modulations (GSM and CDMA) used by cell phones. *NTP TR 595*, Department of Health and Human Services, USA.
- Nuccitelli R, (2003): Endogenous electric fields in embryos during development, regeneration and wound healing. *Radiation Protection Dosimetry*, 106(4), 375–383.
- Pakhomov AG, Akyel Y, Pakhomova ON, Stuck BE, Murphy MR, (1998): Current state and implications of research on biological effects of millimeter waves: A review of the literature. *Bioelectromagnetics*, 19(7), 393–413.
- Pall ML, (2013): Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects. *Journal of Cellular and Molecular Medicine*, 17(8), 958–965.

- Panagopoulos DJ, Karabarbounis A, Margaritis LH, (2002): Mechanism for action of electromagnetic fields on cells. *Biochemical and Biophysical Research Communications*, 298(1), 95–102.
- Panagopoulos DJ, Chavdoula ED, Margaritis LH, (2010): Bioeffects of mobile telephony radiation in relation to its intensity or distance from the antenna. *International Journal of Radiation Biology*, 86(5), 345–357.
- Panagopoulos DJ, Johansson O, Carlo GL, (2013): Evaluation of specific absorption rate as a dosimetric quantity for electromagnetic fields bioeffects. *PLOS ONE*, 8(6), e62663. <https://doi.org/10.1371/journal.pone.0062663>.
- Panagopoulos DJ, Johansson O, Carlo GL, (2015a): Polarization: A key difference between man-made and natural electromagnetic fields, in regard to biological activity. *Scientific Reports*, 5, 14914. <https://doi.org/10.1038/srep14914>.
- Panagopoulos DJ, Johansson O, Carlo GL, (2015b): Real versus simulated mobile phone exposures in experimental studies. *BioMed Research International*, 2015, 607053.
- Panagopoulos DJ, Chrousos GP, (2019): Shielding methods and products against man-made electromagnetic fields: Protection versus risk. *Science of the Total Environment*, 667C, 255–262.
- Panagopoulos DJ, (2019): Comparing DNA damage induced by mobile telephony and other types of man-made electromagnetic fields. *Mutation Research Reviews*, 781, 53–62.
- Panagopoulos DJ, (2020): Comparing chromosome damage induced by mobile telephony radiation and a high caffeine dose: Effect of combination and exposure duration. *General Physiology and Biophysics*, 39(6), 531–544.
- Panagopoulos DJ, Karabarbounis A, (2020): Comments on “diverse radiofrequency sensitivity and radiofrequency effects of mobile or cordless phone near fields exposure in *Drosophila melanogaster*”. *Advances in Environmental Studies*, 4(1), 271–276.
- Panagopoulos DJ, (2021): Comments on Pall’s “Millimeter (MM) wave and microwave frequency radiation produce deeply penetrating effects: the biology and the physics”. *Reviews on Environmental Health* 37(2), 295–297.
- Panagopoulos DJ, Karabarbounis A, Yakymenko I, Chrousos GP, (2021): Mechanism of DNA damage induced by human-made electromagnetic fields. *International Journal of Oncology*, 59: 92.
- Penafiel LM, Litovitz T, Krause D, Desta A, Mullins JM, (1997): Role of modulation on the effects of microwaves on ornithine decarboxylase activity in L929 cells. *Bioelectromagnetics*, 18(2), 132–141.
- Persinger MA, (1974): *ELF and VLF Electromagnetic Fields*. Plenum Press, New York.
- Persinger MA, (2014): Schumann Resonance frequencies found within quantitative electroencephalographic activity: Implications for earth-brain interactions. *International Letters of Chemistry, Physics and Astronomy*, 11(1), 24–32.
- Phillips JL, Singh NP, Lai H, (2009): Electromagnetic fields and DNA damage. *Pathophysiology*, 16(2–3), 79–88.
- Piacentini R, Ripoli C, Mezzogori D, Azzena GB, Grassi C, (2008): Extremely low-frequency electromagnetic fields promote in vitro neurogenesis via upregulation of Ca_v1-channel activity. *Journal of Cellular Physiology*, 215(1), 129–139.
- Presman AS, (1977): *Electromagnetic Fields and Life*. Plenum Press, New York.
- Puranen L, Jokela K, (1996): Radiation hazard assessment of pulsed microwave radars. *Journal of Microwave Power and Electromagnetic Energy*, 31(3), 165–177.
- Rappaport TS, Sun S, Mayzus R, Zhao H, Azar Y, et al, (2013): Millimeter wave mobile communications for 5G cellular: It will work! *IEEE Access*, 1, 335–349. <https://doi.org/10.1109/ACCESS.2013.2260813>.
- Read R, O’Riordan T, (2017): The precautionary principle under fire. *Environment: Science and Policy for Sustainable Development*, 59(5), 4–15.
- Santini MT, Ferrante A, Rainaldi G, Indovina P, Indovina PL, (2005): Extremely low frequency (ELF) magnetic fields and apoptosis: A review. *International Journal of Radiation Biology*, 81(1), 1–11.
- Szmigielski S, (2013): Reaction of the immune system to low-level RF/MW exposures. *Science of the Total Environment*, 454–455, 393–400.
- Tesla N, (1905): The transmission of electrical energy without wires as a means of furthering world peace. *Electrical World and Engineer*, 7, 21–24.
- Wallaczek J, (1992): Electromagnetic field effects on cells of the immune system: The role of calcium signaling. *FASEB Journal*, 6(13), 3177–3185.
- Wever R, (1979): *The Circadian System of Man: Results of Experiments under Temporal Isolation*. Springer-Verlag, New York.
- Yakymenko I, Sidorik E, Kyrylenko S, Chekhun V, (2011): Long-term exposure to microwave radiation provokes cancer growth: Evidences from radars and mobile communication systems. *Experimental Oncology*, 33(2), 62–70.

- Yakymenko I, Tsybulin O, Sidorik E, Henshel D, Kyrylenko O, et al, (2016): Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation. *Electromagnetic Biology and Medicine*, 35(2), 186–202.
- Yakymenko I, Burlaka A, Tsybulin I, Brieieva I, Buchynska L, et al, (2018): Oxidative and mutagenic effects of low intensity GSM 1800 MHz microwave radiation. *Experimental Oncology*, 40(4), 282–287.
- Zheng Y, Xia P, Dong L, Tian L, Xiong C, (2021): Effects of modulation on sodium and potassium channel currents by extremely low frequency electromagnetic fields stimulation on hippocampal CA1 pyramidal cells. *Electromagnetic Biology and Medicine*, 17, 1–12.
- Zothansiam, Zosangzuali M, Lalramdinpuii M, Jagetia GC, (2017): Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations. *Electromagnetic Biology and Medicine*, 36(3), 295–305.

Introduction

- Adey W.R. , (1981): Tissue interactions with non-ionizing electromagnetic fields. *Physiological Reviews*, 61(2), 435–514.
- Adey W.R. , (1993): Biological effects of electromagnetic fields. *Journal of Cellular Biochemistry*, 51(4), 410–416.
- Alberts B. , Bray D. , Lewis J. , Raff M. , Roberts K. , Watson J.D. , (1994): *Molecular Biology of the Cell*. Garland Publishing, Inc., New York.
- Alonso M. , Finn E.J. , (1967): *Fundamental University Physics (Vol. 2). Fields and Waves*, Addison-Wesley.
- Balmori A. , (2015): Anthropogenic radiofrequency electromagnetic fields as an emerging threat to wildlife orientation. *Science of the Total Environment*, 518–519, 58–60.
- Balmori A. , (2021): Electromagnetic radiation as an emerging driver factor for the decline of insects. *Science of the Total Environment*, 767, 144913.
- Bawin S.M. , Kaczmarek L.K. , Adey W.R. , (1975): Effects of modulated VHF fields, on the central nervous system. *Annals of the New York Academy of Sciences*, 247, 74–81.
- Bawin S.M. , Adey W.R. , Sabbot I.M. , (1978): Ionic factors in release of 45Ca^{2+} from chick cerebral tissue by electromagnetic fields. *Proceedings of the National Academy of Sciences of the United States of America*, 75(12), 6314–6318.
- Belpomme D. , Irigaray P. , (2020): Electrohypersensitivity as a newly identified and characterized neurologic pathological disorder: How to diagnose, treat, and prevent it. *International Journal of Molecular Sciences*, 21(6), 1915. <https://doi.org/10.3390/ijms21061915>.
- Belyaev I. , (2005): Non-thermal biological effects of microwaves. *Microwave Review*, 11(2), 13–29.
- Bertagna F. , Lewis R. , Silva S.R.P. , McFadden J. , Jeevaratnam K. , (2021): Effects of electromagnetic fields on neuronal ion channels: A systematic review. *Annals of the New York Academy of Sciences* May 4. <https://doi.org/10.1111/nyas.14597>.
- Betskii O.V. , Lebedeva N.N. , (2004): Low-intensity millimeter waves in biology and medicine. In *Clinical Application of Bioelectromagnetic Medicine (Vol. 2004)*. Marcel Dekker, New York, 30–61.
- Betti L. , Trebbi G. , Lazzarato L. , Brizzi M. , Calzoni G.L. , et al, (2004): Nonthermal microwave radiations affect the hypersensitive response of tobacco to tobacco mosaic virus. *Journal of Alternative and Complementary Medicine*, 10(6), 947–957.
- Blackman C.F. , Benane S.G. , Kinney L.S. , Joines W.T. , House D.E. , (1982): Effects of ELF fields on calcium-ion efflux from brain tissue in vitro. *Radiation Research*, 92(3), 510–520.
- Bolshakov M.A. , Alekseev S.I. , (1992): Bursting responses of Lymnea neurons to microwave radiation. *Bioelectromagnetics*, 13(2), 119–129.
- Burlaka A. , Tsybulin O. , Sidorik E. , Lukin S. , Polishuk V. , et al, (2013): Overproduction of free radical species in embryonic cells exposed to low intensity radiofrequency radiation. *Experimental Oncology*, 35(3), 219–225.
- Campisi A. , Gulino M. , Acquaviva R. , Bellia P. , Raciti G. , et al, (2010): Reactive oxygen species levels and DNA fragmentation on astrocytes in primary culture after acute exposure to low intensity microwave electromagnetic field. *Neuroscience Letters*, 473(1), 52–55.
- Cecchetto C. , Maschietto M. , Boccaccio P. , Vassanelli S. , (2020): Electromagnetic field affects the voltage-dependent potassium channel Kv1.3. *Electromagnetic Biology and Medicine*, 39(4), 316–322.
- Cherry N.J. , (2002): Schumann Resonances, a Plausible Biophysical Mechanism for the Human Health Effects of Solar/Geomagnetic Activity. https://researcharchive.lincoln.ac.nz/bitstream/handle/10182/3935/90_n1_EMR_Schumann_Resonance_paper_1.pdf?sequence=1.
- Cherry N.J. , (2003): Human intelligence: The brain, an electromagnetic system synchronised by the Schumann Resonance signal. *Medical Hypotheses*, 60(6), 843–844.
- Cleary S.F. , Liu L.M. , Graham R. , Diegelmann R.F. , (1988): Modulation of tendon fibroplasia by exogenous electric currents. *Bioelectromagnetics*, 9(2), 183–194.
- Coghill R.W. , Steward J. , Philips A. , (1996): Extra low frequency electric and magnetic fields in the bed place of children diagnosed with leukaemia: A case-control study. *European Journal of Cancer Prevention*, 5(3), 153–158.
- Creasey W.A. , Goldberg R.B. , (2001): A new twist on an old mechanism for EMF bioeffects? *EMF Health Report*, 9(2), 1–11. <https://midsafetech.files.wordpress.com/2021/07/creasey-wa-goldberg-rb-2001-a-new-twist-on-an-old-mechanism-for-emf-bioeffects.pdf>.
- Dahlman E. , Parkvall S. , Skoeld J. , (2018): *5G NR: The Next Generation Wireless Access Technology*. Academic Press, Elsevier, London.
- De Iulius G.N. , Newey R.J. , King B.V. , Aitken R.J. , (2009): Mobile phone radiation induces reactive oxygen species production and DNA damage in human spermatozoa in vitro. *PLOS ONE*, 4(7), e6446.
- Dubrov A.P. , (1978): *The Geomagnetic Field and Life*. Plenum Press, New York.
- EPRS , (2020): Effects of 5G Wireless Communication on Human Health, European Parliamentary Research Service. Scientific Foresight Unit (STOA), PE 646.172, March 2020.

EPRS , (2021): Environmental Impacts of 5G. A Literature Review of Effects of Radio-Frequency Electromagnetic Field Exposure of Non-human Vertebrates, Invertebrates and Plants, Scientific Foresight Unit (STOA), PE 690.021, June 2021.

Falcioni L. , Bua L. , Tibaldi E. , Lauriola M. , De Angelis L. , et al, (2018): Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission. *Environmental Research*, 165, 496–503.

Feychting M. , Ahlbom A. , (1994): Magnetic fields, leukemia and central nervous system tumors in Swedish adults residing near high - voltage power lines. *Epidemiology*, 5(5), 501–509.

Frank J.W. , (2021): Electromagnetic fields, 5G and health: What about the precautionary principle? *Journal of Epidemiology and Community Health*, 75(6), 562–566.

Franzellitti S. , Valbonesi P. , Ciancaglini N. , Biondi C. , Contin A. , et al, (2010): Transient DNA damage induced by high-frequency electromagnetic fields (GSM 1.8 GHz) in the human trophoblast HTR-8/SVneo cell line evaluated with the alkaline comet assay. *Mutation Research*, 683(1–2), 35–42.

Frei M. , Jauchem J. , Heinmets F. , (1988): Physiological effects of 2.8 GHz radio-frequency radiation: A comparison of pulsed and continuous-wave radiation. *Journal of Microwave Power and Electromagnetic Energy*, 23(2), 2.

Gandhi Om P. , Morgan L.L. , De Salles A.A. , Han Y-Y. , Herberman R.B. , Davis D.L. , (2012): Exposure limits: The underestimation of absorbed cell phone radiation, especially in children. *Electromagnetic Biology and Medicine*, 31(1), 34–51.

Goldsworthy A. , (2006): Effects of electrical and electromagnetic fields on plants and related topics. In A.G. Volkov (Ed.), *Plant Electrophysiology–Theory & Methods*. Springer-Verlag, Berlin Heidelberg, 247–267.

Goodman E.M. , Greenebaum B. , Marron M.T. , (1995): Effects of electro-magnetic fields on molecules and cells. *International Review of Cytology*, 158, 279–338.

Gulati S. , Yadav A. , Kumar N. , Kanupriya, Aggarwal N.K. , et al, (2016): Effect of GSTM1 and GSTT1 polymorphisms on genetic damage in humans populations exposed to radiation From mobile towers. *Archives of Environmental Contamination and Toxicology*, 70(3), 615–625.

Hardell L. , Carlberg M. , (2009): Mobile phones, cordless phones and the risk for brain tumours. *International Journal of Oncology*, 35(1), 5–17.

Hardell L. , Nyberg R. , (2020): Appeals that matter or not on a moratorium on the deployment of the fifth generation, 5G, for microwave radiation. *Molecular and Clinical Oncology*. <https://doi.org/10.3892/mco.2020.1984>.

Hardell L. , Carlberg M. , (2021): Lost opportunities for cancer prevention: Historical evidence on early warnings with emphasis on radiofrequency radiation. *Reviews on Environmental Health*. <https://doi.org/10.1515/revveh-2020-0168>.

Harremoens P. , Gee D. , MacGarvin M. , Stirling A. , Keys J. , et al. (Eds.), (2013): *The Precautionary Principle in the 20th Century: Late Lessons from Early Warnings*. Routledge, London.

He Y. , Yi C. , Zhang X. , Zhao W. , Yu D. , (2021): Magnetic graphene oxide: Synthesis approaches, physicochemical characteristics, and biomedical applications. *TrAC Trends in Analytical Chemistry*, 136, 116191.

Houston B.J. , Nixon B. , King B.V. , De luliis G.N. , Aitken R.J. , (2016): The effects of radiofrequency electromagnetic radiation on sperm function. *Reproduction*, 152(6), R263–R276.

Höytö A. , Luukkonen J. , Juutilainen J. , Naarala J. , (2008): Proliferation, oxidative stress and cell death in cells exposed to 872 MHz radiofrequency radiation and oxidants. *Radiation Research*, 170(2), 235–243.

Huber R. , Treyer V. , Borbely A.A. , Schuderer J. , Gottselig J.M. , et al, (2002): Electromagnetic fields, such as those from mobile phones, alter regional cerebral blood flow and sleep and waking EEG. *Journal of Sleep Research*, 11(4), 289–295.

IARC , (2002): *Non-ionizing Radiation, Part 1: Static and Extremely Low-frequency (ELF) Electric and Magnetic Fields (Vol. 80)*. International Agency for Research on Cancer, Lyon, France.

IARC , (2013): *Non-ionizing Radiation, Part 2: Radiofrequency Electromagnetic Fields (Vol. 102)*. International Agency for Research on Cancer, Lyon, France.

ICNIRP , (1998): Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz). *Health Physics*, 74, 494–522.

ICNIRP , (2010): Guidelines for limiting exposure to time-varying electric and magnetic fields (1 Hz to 100 kHz). *Health Physics*, 99(6), 818–836.

ICNIRP , (2020): Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz). *Health Physics*, 118(5), 483–524.

Irigaray P. , Caccamo D. , Belpomme D. , (2018): Oxidative stress in electrohypersensitivity self-reporting patients: Results of a prospective in vivo investigation with comprehensive molecular analysis. *International Journal of Molecular Medicine*, 42(4), 1885–1898.

Jackson J.D. , (1975): *Classical Electrodynamics*. John Wiley & Sons, Inc., New York.

Johansson O. , (2009): Disturbance of the immune system by electromagnetic fields-A potentially underlying cause for cellular damage and tissue repair reduction which could lead to disease and impairment. *Pathophysiology*, 16(2–3), 157–177.

Karipidis K. , Mate R. , Urban D. , Tinker R. , Wood A. , (2021): 5G mobile networks and health—A state-of-the-science review of the research into low-level RF fields above 6 GHz. *Journal of Exposure Science and Environmental Epidemiology*. <https://doi.org/10.1038/s41370-021-00307-7>.

Khurana V.G. , Teo C. , Kundi M. , Hardell L. , Carlberg M. , (2009): Cell phones and brain tumors: A review including the long-term epidemiologic data. *Surgical Neurology*, 72(3), 205–214.

Kostoff R.N. , Heroux P. , Aschner M. , Tsatsakis A. , (2020): Adverse health effects of 5G mobile networking technology under real-life conditions. *Toxicology Letters*, 323, 35–40.

Kundi M. , Hutter H.P. , (2009): Mobile phone base stations-effects on wellbeing and health. *Pathophysiology*, 16(2–3), 123–135.

Leach V. , Weller S. , Redmayne M. , (2018): A novel database of bio-effects from non-ionizing radiation. *Reviews on Environmental Health*, 33(3), 1–8.

Levitt B.B. , Lai H.C. , Manville A.M. , (2021): Effects of non-ionizing electromagnetic fields on flora and fauna, part 1. Rising ambient EMF levels in the environment. *Reviews on Environmental Health*. <https://doi.org/10.1515/reveh-2021-0026>.

Liburdy R.P. , (1992): Calcium signalling in lymphocytes and ELF fields: Evidence for an electric field metric and a site of interaction involving the calcium ion channel. *FEBS Letters*, 301(1), 53–59.

López I. , Félix N. , Rivera M. , Alonso A. , Maestú C. , (2021): What is the radiation before 5G? A correlation study between measurements in situ and in real time and epidemiological indicators in Vallecas, Madrid. *Environmental Research*, 194, 110734.

Manna D. , Ghosh R. , (2016): Effect of radiofrequency radiation in cultured mammalian cells: A review. *Electromagnetic Biology and Medicine*, 35(3), 265–301.

Marino A.A. , Becker R.O. , (1977): Biological effects of extremely low frequency electric and magnetic fields: A review. *Physiological Chemistry and Physics*, 9(2), 131–147.

McCaig C.D. , Zhao M. , (1997): Physiological electric fields modify cell behaviour. *BioEssays*, 19(9), 819–826.

McLeod K.J. , Lee R.C. , Ehrlich H.P. , (1987): Frequency dependence of electric field modulation of fibroblast protein synthesis. *Science*, 236(4807), 1465–1469.

Metaxas A.C. , (1991): Microwave heating. *Power Engineering Journal*, 5(5), 237–247.

Miller A.B. , Morgan L.L. , Udasin I. , Davis D.L. , (2018): Cancer epidemiology update, following the 2011 IARC evaluation of radiofrequency electromagnetic fields (Monograph 102). *Environmental Research*, 167, 673–683.

Miller A.B. , Sears M.E. , Morgan L.L. , Davis D.L. , Hardell L. , et al, (2019): Risks to health and well-being from radio-frequency radiation emitted by cell phones and other wireless devices. *Frontiers in Public Health*, 7, 223. <https://doi.org/10.3389/fpubh.2019.00223>.

Mohammed H.S. , Fahmy H.M. , Radwan N.M. , Elsayed A.A. , (2013): Non-thermal continuous and modulated electromagnetic radiation fields effects on sleep EEG of rats. *Journal of Advanced Research*, 4(2), 181–187.

Monzel C. , Vicario C. , Piehler J. , Coppey M. , Dahan M. , (2017): Magnetic control of cellular processes using biofunctional nanoparticles. *Chemical Science*, 8(11), 7330.

NTP (National Toxicology Program) , (2018): Toxicology and Carcinogenesis studies in Hsd: Sprague Dawley SD rats exposed to whole-body radio frequency radiation at a frequency (900 MHz) and modulations (GSM and CDMA) used by cell phones. NTP TR 595, Department of Health and Human Services, USA.

Nuccitelli R. , (2003): Endogenous electric fields in embryos during development, regeneration and wound healing. *Radiation Protection Dosimetry*, 106(4), 375–383.

Pakhomov A.G. , Akyel Y. , Pakhomova O.N. , Stuck B.E. , Murphy M.R. , (1998): Current state and implications of research on biological effects of millimeter waves: A review of the literature. *Bioelectromagnetics*, 19(7), 393–413.

Pall M.L. , (2013): Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects. *Journal of Cellular and Molecular Medicine*, 17(8), 958–965.

Panagopoulos D.J. , Karabarbounis A. , Margaritis L.H. , (2002): Mechanism for action of electromagnetic fields on cells. *Biochemical and Biophysical Research Communications*, 298(1), 95–102.

Panagopoulos D.J. , Chavdoula E.D. , Margaritis L.H. , (2010): Bioeffects of mobile telephony radiation in relation to its intensity or distance from the antenna. *International Journal of Radiation Biology*, 86(5), 345–357.

Panagopoulos D.J. , Johansson O. , Carlo G.L. , (2013): Evaluation of specific absorption rate as a dosimetric quantity for electromagnetic fields bioeffects. *PLOS ONE*, 8(6), e62663. <https://doi.org/10.1371/journal.pone.0062663>.

Panagopoulos D.J. , Johansson O. , Carlo G.L. , (2015a): Polarization: A key difference between man-made and natural electromagnetic fields, in regard to biological activity. *Scientific Reports*, 5, 14914. <https://doi.org/10.1038/srep14914>.

Panagopoulos D.J. , Johansson O. , Carlo G.L. , (2015b): Real versus simulated mobile phone exposures in experimental studies. *BioMed Research International*, 2015, 607053.

Panagopoulos D.J. , Chrousos G.P. , (2019): Shielding methods and products against man-made electromagnetic fields: Protection versus risk. *Science of the Total Environment*, 667C, 255–262.

Panagopoulos D.J. , (2019): Comparing DNA damage induced by mobile telephony and other types of man-made electromagnetic fields. *Mutation Research Reviews*, 781, 53–62.

Panagopoulos D.J. , (2020): Comparing chromosome damage induced by mobile telephony radiation and a high caffeine dose: Effect of combination and exposure duration. *General Physiology and Biophysics*, 39(6), 531–544.

Panagopoulos D.J. , Karabarounis A. , (2020): Comments on “diverse radiofrequency sensitivity and radiofrequency effects of mobile or cordless phone near fields exposure in *Drosophila melanogaster*”. *Advances in Environmental Studies*, 4(1), 271–276.

Panagopoulos D.J. , (2021): Comments on Pall's “Millimeter (MM) wave and microwave frequency radiation produce deeply penetrating effects: the biology and the physics”. *Reviews on Environmental Health* 37(2), 295–297.

Panagopoulos D.J. , Karabarounis A. , Yakymenko I. , Chrousos G.P. , (2021): Mechanism of DNA damage induced by human-made electromagnetic fields. *International Journal of Oncology*, 59: 92.

Penafiel L.M. , Litovitz T. , Krause D. , Desta A. , Mullins J.M. , (1997): Role of modulation on the effects of microwaves on ornithine decarboxylase activity in L929 cells. *Bioelectromagnetics*, 18(2), 132–141.

Persinger M.A. , (1974): *ELF and VLF Electromagnetic Fields*. Plenum Press, New York.

Persinger M.A. , (2014): Schumann Resonance frequencies found within quantitative electroencephalographic activity: Implications for earth-brain interactions. *International Letters of Chemistry, Physics and Astronomy*, 11(1), 24–32.

Phillips J.L. , Singh N.P. , Lai H. , (2009): Electromagnetic fields and DNA damage. *Pathophysiology*, 16(2–3), 79–88.

Piacentini R. , Ripoli C. , Mezzogori D. , Azzena G.B. , Grassi C. , (2008): Extremely low-frequency electromagnetic fields promote in vitro neurogenesis via upregulation of Cav1-channel activity. *Journal of Cellular Physiology*, 215(1), 129–139.

Presman A.S. , (1977): *Electromagnetic Fields and Life*. Plenum Press, New York.

Puranen L. , Jokela K. , (1996): Radiation hazard assessment of pulsed microwave radars. *Journal of Microwave Power and Electromagnetic Energy*, 31(3), 165–177.

Rappaport T.S. , Sun S. , Mayzus R. , Zhao H. , Azar Y. , et al, (2013): Millimeter wave mobile communications for 5G cellular: It will work! *IEEE Access*, 1, 335–349. <https://doi.org/10.1109/ACCESS.2013.2260813>.

Read R. , O'Riordan T. , (2017): The precautionary principle under fire. *Environment: Science and Policy for Sustainable Development*, 59(5), 4–15.

Santini M.T. , Ferrante A. , Rainaldi G. , Indovina P. , Indovina P.L. , (2005): Extremely low frequency (ELF) magnetic fields and apoptosis: A review. *International Journal of Radiation Biology*, 81(1), 1–11.

Szmigielski S. , (2013): Reaction of the immune system to low-level RF/MW exposures. *Science of the Total Environment*, 454–455, 393–400.

Tesla N. , (1905): The transmission of electrical energy without wires as a means of furthering world peace. *Electrical World and Engineer*, 7, 21–24.

Walleczek J. , (1992): Electromagnetic field effects on cells of the immune system: The role of calcium signaling. *FASEB Journal*, 6(13), 3177–3185.

Wever R. , (1979): *The Circadian System of Man: Results of Experiments under Temporal Isolation*. Springer-Verlag, New York.

Yakymenko I. , Sidorik E. , Kyrylenko S. , Chekhun V. , (2011): Long-term exposure to microwave radiation provokes cancer growth: Evidences from radars and mobile communication systems. *Experimental Oncology*, 33(2), 62–70.

Yakymenko I. , Tsybulin O. , Sidorik E. , Henshel D. , Kyrylenko O. , et al, (2016): Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation. *Electromagnetic Biology and Medicine*, 35(2), 186–202.

Yakymenko I. , Burlaka A. , Tsybulin I. , Brieieva I. , Buchynska L. , et al, (2018): Oxidative and mutagenic effects of low intensity GSM 1800 MHz microwave radiation. *Experimental Oncology*, 40(4), 282–287.

Zheng Y. , Xia P. , Dong L. , Tian L. , Xiong C. , (2021): Effects of modulation on sodium and potassium channel currents by extremely low frequency electromagnetic fields stimulation on hippocampal CA1 pyramidal cells. *Electromagnetic Biology and Medicine*, 17, 1–12.

Zothansiam, Zosangzuali M. , Lalramdinpuii M. , Jagetia G.C. , (2017): Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations. *Electromagnetic Biology and Medicine*, 36(3), 295–305.

Defining Wireless Communication (WC) Electromagnetic Fields (EMFs):

Adey W.R. , (1981). Tissue interactions with non-ionizing electromagnetic fields. *Physiol Rev*. 61: 435–514.

Adey W.R. , (1993). Biological effects of electromagnetic fields. *J Cell Biochem*. 51:410–416.

Alberts B. , Bray D. , Lewis J. , Raff M. , Roberts K. , Watson J.D. , (1994). *Molecular Biology of the Cell*. Garland Publishing, Inc., New York.

- Alexopoulos C.D. , (1962). Heat. Papazisis Publ., Athens [Αλεξόπουλος ΚΔ, Θερμότης, Εκδ. Παπαζήση, Αθήνα 1962].
- Alexopoulos C.D. , (1963). Atomic and Nuclear Physics. Papazisis Publ., Athens [Αλεξόπουλος ΚΔ, Ατομική και Πυρηνική φυσική, Εκδ. Παπαζήση, Αθήνα 1963].
- Alexopoulos C.D. , (1966). Optics. Papazisis Publ., Athens [Αλεξόπουλος ΚΔ, Οπτική, Εκδ. Παπαζήση, Αθήνα 1966].
- Alexopoulos C.D. , (1973). Electricity. Papazisis Publ., Athens [Αλεξόπουλος ΚΔ, Ηλεκτρισμός, Εκδ. Παπαζήση, Αθήνα 1973].
- Alonso M. , Finn E.J. , (1967). Fundamental University Physics, Vol. 2: Fields and Waves. Addison-Wesley, USA.
- Andersen J.B. , Pedersen G.F. , (1997). The technology of mobile telephone systems relevant for risk assessment. *Radiat Prot Dosimetry*. 3–4(72):249–257.
- Arago D.F.J. , Fresnel A.J. , (1819). On the action of rays of polarized light upon each other. *Ann Chim Phys*. 2:288–304.
- Azanza M.J. , Perez Bruzon R.N. , Lederer D. , et al, (2002). Reversibility of the effects induced on the spontaneous bioelectric activity of neurons under exposure to 8.3 and 217.0 Hz low intensity magnetic fields. 2nd Int. Workshop Biol. Effects of EMFs, Rhodes, Grece, 651–659.
- Baker K.B. , Tkach J.A. , Nyenhuis J.A. , Phillips M. , Shellock F.G. , et al, (2004). Evaluation of specific absorption rate as a dosimeter of MRI-related implant heating. *J Magn Reson Imaging*. 20:315–320.
- Balzano Q. , Sheppard A. , (2003). RF nonlinear interactions in living cells I: nonequilibrium thermodynamic theory. *Bioelectromagnetics*. 24:473–482.
- Bassett C.A.L. , Pawluk R.J. , Becker R.O. , (1964). Effect of electric currents on bone in vivo. *Nature*. 204:652–654.
- Bawin S.M. , Kaczmarek L.K. , Adey W.R. , (1975). Effects of modulated VMF fields, on the central nervous system. *Ann NY Acad Sci*. 247:74–81.
- Bawin S.M. , Adey W.R. , Sabbot I.M. , (1978). Ionic factors in release of 45Ca^{2+} from chick cerebral tissue by electromagnetic fields. *Proc Natl Acad Sci USA*. 75:6314–6318.
- Bawin S.M. , Adey W.R. , (1976). Sensitivity of calcium binding in cerebral tissue to weak environmental electric fields oscillating at low frequency. *Proc Natl Acad Sci USA*. 73:1999–2003.
- Behari J. , (2010). Biological responses of mobile phone frequency exposure. *Ind J Exp Biol*. 48:959–981.
- Beiser A. , (1987). Concepts of Modern Physics. McGraw-Hill, Inc., New York.
- Belpomme D. , Irigaray P. , (2020). Electrohypersensitivity as a newly identified and characterized neurologic pathological disorder: how to diagnose, treat, and prevent it. *Int J Mol Sci*. 21:1915; doi:10.3390/ijms21061915
- Belyaev I. , (2005). Non-thermal biological effects of microwaves. *Microwave Rev*. 11(2):13–29.
- Berger H. , (1929). Ueber das Elektrenkephalogramm des Menschen (On the human electroencephalogram). *Archiv f. Psychiatrie u. Nervenkrankheiten*. 87:527–570.
- Bertagna F. , Lewis R. , Silva S.R.P. , McFadden J. , Jeevaratnam K. , (2021). Effects of electromagnetic fields on neuronal ion channels: a systematic review. *Ann NY Acad Sci*. 1499(1):82–103.
- Betskii O.V. , Lebedeva N.N. , (2004). Low-intensity millimeter waves in biology and medicine. In *Clinical Application of Bioelectromagnetic Medicine*. Marcel Decker, New York, 30–61.
- Blackman C.F. , Benane S.G. , Elder J.A. , House D.E. , Lampe J.A. , Faulk J.M. , (1980). Induction of calcium-ion efflux from brain tissue by radiofrequency radiation: effect of sample number and modulation frequency on the power - density window. *Bioelectromagnetics*. 1:35–43.
- Blackman C.F. , Benane S.G. , Kinney L.S. , Joines W.T. , House D.E. , (1982). Effects of ELF fields on calcium-ion efflux from brain tissue in vitro. *Radiat Res*. 92(3):510–520.
- Blackman C. , (2009). Cell phone radiation: evidence from ELF and RF studies supporting more inclusive risk identification and assessment. *Pathophysiology*. 16:205–216.
- Bohr N. , (1913a). On the constitution of atoms and molecules, part I. *Philos Mag*. 26:1–24.
- Bohr N. , (1913b). On the constitution of atoms and molecules, part II systems containing only a single nucleus. *Philos Mag*. 26:476–502.
- Bohr N. , (1914). The spectra of helium and hydrogen. *Nature*. 92:231–232.
- Bohr N. , (1928). The quantum postulate and the recent development of atomic theory. *Nature* 121:580–590.
- Bolshakov M.A. , Alekseev S.I. , (1992). Bursting responses of Lymnea neurons to microwave radiation. *Bioelectromagnetics*. 13(2):119–129.
- Borgens R.B. , (1988). Stimulation of neuronal regeneration and development by steady electrical fields. *Advances in Neurology*. 47; *Functional Recovery in Neurological Disease*, S.G. Waxman (Ed), Raven Press, New York.
- Brighton C.T. , Friedenberz Z.B. , Black J. , (1979). Evaluation of the use of constant direct current in the treatment of non-union. In C.T. Brighton (Ed), *Electrical Properties of Bone and Cartilage*. Plenum Press, New York, 519–545.
- Brighton C.T. , McClusky W.P. , (1987). Response of cultured bone cells to capacitively coupled electrical field: inhibition of cAMP response to parathyroid hormone. *J Orthop Res*. 6:567–571.

Brighton C.T. , Jensen L. , Pollack S.R. , Tolin B.S. , Clark C.C. , (1989). Proliferative and synthetic response of bovine growth plate chondrocytes to various capacitively coupled electrical fields. *J Orthop Res.* 7:759–765.

Burcham W.E. , Jobes M. , (1995). *Nuclear and Particle Physics.* Prentice Hall, England.

Bush L.G. , Hill D.W. , Riazi A. , Stensaas L.J. , Partlow L.M. , Gandhi O.P. , (1981). Effects of millimeter wave radiation on monolayer cell cultures III: a search for frequency-specific effects on protein synthesis. *Bioelectromagnetics.* 2:151–160.

Byus C.V. , Lundak R.L. , Fletcher R.M. , Adey W.R. , (1984). Alterations in protein Kinase activity following exposure of cultured lymphocytes to modulated microwave fields. *Bioelectromagnetics (N.Y.).* 5:341–351.

Byus C.V. , Kartum K. , Pieper S.E. , Adey W.R. , (1988). Ornithine decarboxylase activity in liver cells is enhanced by low-level amplitude modulated microwave fields. *Cancer Res.* 48:4222–4226.

Campisi A. , Gulino M. , Acquaviva R. , Bellia P. , Raciti G. , et al., (2010). Reactive oxygen species levels and DNA fragmentation on astrocytes in primary culture after acute exposure to low intensity microwave electromagnetic field. *Neurosci Lett.* 473(1):52–55.

Carpenter R.L. , Livstone E.M. , (1968). Evidence for nonthermal effects of microwave radiation: abnormal development of irradiated insect pupae. *IEEE Trans Microwave Theory Tech.* 19(2):173–178.

Cecchetto C. , Maschietto M. , Boccaccio P. , Vassanelli S. , (2020). Electromagnetic field affects the voltage-dependent potassium channel Kv1.3. *Electromagn Biol Med.* 39(4):316–322.

Chandra A. , Bagchi B. , (2000). Frequency dependence of ionic conductivity of electrolyte solutions. *J Chem Phys.* 112:1876–1886.

Chavdoula E.D. , Panagopoulos D.J. , Margaritis L.H. , (2010). Comparison of biological effects between continuous and intermittent exposure to GSM-900 MHz mobile phone radiation. Detection of apoptotic cell death features. *Mut Res.* 700:51–61.

Chen H.S. , Rao C.R.N. , (1968). Polarization of light on reflection by some natural surfaces. *Brit J Appl Phys.* 1:1191–1200.

Christ A. , Gosselin M-C. , Christopoulou M. , et al. (2010). Age-dependent tissue-specific exposure of cell phone users. *Phys Med Biol.* 55:1767–1783.

Clark D.E. , Folz D.C. , West J.K. , (2000). Processing materials with microwave energy. *Adv Mater Sci Eng.* 287:153–158.

Clarke J. , Wilhelm F.K. , (2008). Superconducting quantum bits. *Nature.* 453:1031–1042.

Coggle J.E. , (1983). *Biological Effects of Radiation.* Taylor & Francis.

Creasey W.A. , Goldberg R.B. , (2001). A new twist on an old mechanism for EMF bioeffects?, *EMF Health Rep.* 9(2):1–11. <https://www.emfsa.co.za/research-and-studies/creasey-wa-goldberg-rb-2001-a-new-twist-on-an-old-mechanism-for-emf/>

Cronin T.W. , Warrant E.J. , Greiner B. , (2006). Celestial polarization patterns during twilight. *Applied Optics.* 22:5582–5589.

Curwen P. , Whalley J. , (2008). Mobile Communications in the 21st century, In A.C. Harper , R.V. Bures (Eds), *Mobile Telephones: Networks, Applications and Performance.* Nova Science Publishers, New York, 29–75.

Dahlman E. , Parkvall S. , Skoeld J. , (2018). *5G NR: The Next Generation Wireless Access Technology.* Academic Press, Elsevier, London.

Davisson C. , Germer L. , (1927). Reflection of electrons by a crystal of nickel. *Nature.* 119:558–560.

Dawe A.S. , Smith B. , Thomas D.W. , Greedy S. , Vasic N. , et al., (2006). A small temperature rise may contribute towards the apparent induction by microwaves of heat-shock gene expression in the nematode *Caenorhabditis elegans*. *Bioelectromagnetics.* 27(2):88–97.

De Broglie L. , (1924). *Recherches sur la théorie des quanta*, Doctoral thesis, Paris.

De Iulius G.N. , Newey R.J. , King B.V. , Aitken R.J. , (2009). Mobile phone radiation induces reactive oxygen species production and DNA damage in human spermatozoa in vitro. *PLoS One.* 4(7):e6446.

Diem E. , Schwarz C. , Adlkofer F. , Jahn O. , Rudiger H. , (2005). Non-thermal DNA breakage by mobile-phone radiation (1800 MHz) in human fibroblasts and in transformed GFSH-R17 rat granulosa cells in vitro. *Mutat Res.* 583(2):178–183.

Dirac P.A.M. . (1927). The quantum theory of the emission and absorption of radiation. *Proc R Soc London.* 114:243–256.

Dubrov A.P. , (1978). *The Geomagnetic Field and Life.* Plenum Press, New York.

Durrer R. , (2008). *The Cosmic Microwave Background.* Cambridge Univ. Press, Cambridge.

EPRS , (2021). Environmental impacts of 5G. A literature review of effects of radio-frequency electromagnetic field exposure of non-human vertebrates, invertebrates and plants. Scientific Foresight Unit (STOA), PE 690.021, June 2021.

Falcioni L. , Bua L. , Tibaldi E. , et al. (2018). Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8GHz GSM base station environmental emission. *Environ Res.* 165:496–503.

Fear E.C. , Stuchly M.A. , (1998). A novel equivalent circuit model for gap connected cells. *Phys Med Biol.* 43:1439–1448.

Feynman R.P. , (1950). Mathematical formulation of the quantum theory of electromagnetic interaction. *Phys Rev.* 80:440–457.

Flyckt V.M. , Raaymakers B.W. , Kroeze H. , Lagendijk J.J. , (2007). Calculation of SAR and temperature rise in a high-resolution vascularized model of the human eye and orbit when exposed to a dipole antenna at 900, 1500 and 1800 MHz. *Phys Med Biol.* 52(10):2691–2701.

Foster K.R. , Schwan H.P. , (1989). Dielectric properties of tissues and biological materials: a critical review, *Crit Rev Biomed Eng.* 17(1):25–103.

Franzellitti S. , Valbonesi P. , Ciancaglini N. , Biondi C. , Contini A. , et al., (2010). Transient DNA damage induced by high-frequency electromagnetic fields (GSM 1.8 GHz) in the human trophoblast HTR-8/SVneo cell line evaluated with the alkaline comet assay. *Mutat Res.* 683(1–2):35–42.

Frei M. , Jauchem J. , Heinmets F. , (1988). Physiological effects of 2.8 GHz radio-frequency radiation: a comparison of pulsed and continuous-wave radiation. *J Microwave Power Electromagn.* 23:2.

Furia L. , Hill D.W. , Gandhi O.P. , (1986). Effect of millimeter wave irradiation on growth of *saccharomyces cerevisiae*. *IEEE Trans Biomed Eng.* 33:993–999.

Gabriel S. , Lau R.W. , Gabriel C. , (1996a). The dielectric properties of biological tissues: II. measurements in the frequency range 10 Hz to 20 GHz. *Phys Med Biol.* 41:2251–2269.

Gabriel S. , Lau R.W. , Gabriel C. , (1996b). The dielectric properties of biological tissues: III. parametric models for the dielectric spectrum of tissues. *Phys Med Biol.* 41:2271–2293.

Gandhi O.P. , (1983). Some basic properties of biological tissues for potential biomedical applications of millimeter waves. *J Microwave Power.* 18:295–304.

Gandhi, O.P. , Morgan L.L. , de Salles A.A. , Han Y-Y. , Herberman R.B. , Davis D.L. , (2012). Exposure limits: the underestimation of absorbed cell phone radiation, especially in children. *Electromagn Biol Med.* 31(1):34–51.

Gautreau R. , Savin W. , (1978). *Theory and Problems of Modern Physics.* McGraw-Hill, New York.

Goldsworthy A. , (2006). Effects of electrical and electromagnetic fields on plants and related topics, In Volkov (Ed), *Plant Electrophysiology–Theory & Methods.* Springer-Verlag, Berlin Heidelberg.

Goodman E.M. , Greenebaum B. , Marron M.T. , (1995). Effects of electro- magnetic fields on molecules and cells. *Int Rev Cytol.* 158:279–338.

Gründler W. , (1992). Intensity- and frequency-dependent effects of microwaves on cell growth rates. *Bioelectrochem Bioenerg.* 27:361–365,

Gulati S. , Yadav A. , Kumar N. , Kanupriya A.N.K. , et al, (2016). Effect of GSTM1 and GSTT1 polymorphisms on genetic damage in humans populations exposed to radiation from mobile towers. *Arch Environ Contam Toxicol.* 70(3):615–625.

Gulyaev YuV. , Markov A.G. , Koreneva L.G. , Zakharov P.V. . (1995). Dynamical infrared thermography in humans. *Eng Med Biol Mag IEEE.* 14:766–771.

Haemmerich D. , Schutt D.J. , dos Santos I. , Webster J.G. , Mahvi D.M. , (2005). Measurement of temperature-dependent specific heat of biological tissues. *Physiol Meas.* 26(1):59–67.

Hardell L. , Carlberg M. , Söderqvist F. , Mild K.H. , Morgan L.L. . (2007). Long-term use of cellular phones and brain tumours: increased risk associated with use for > or =10 years. *Occup Environ Med.* 64(9):626–632. Review.

Hardell L. , Carlberg M. , Hansson Mild K. , (2013). Use of mobile phones and cordless phones is associated with increased risk for glioma and acoustic neuroma. *Pathophysiology.* 20:85–110.

Hardell L. , Nyberg R. , (2020). Appeals that matter or not on a moratorium on the deployment of the fifth generation, 5G, for microwave radiation. *Mol Clin Oncol.* doi:10.3892/mco.2020.1984

Hardell L. , Carlberg M. , (2021). Lost opportunities for cancer prevention: historical evidence on early warnings with emphasis on radiofrequency radiation. *Rev Environ Health.* doi:10.1515/reveh-2020-0168. Online ahead of print.

Herzberg G. , (1944). *Atomic Spectra and Atomic Structure.* Dover publications, USA.

Herzberg G. , (1950). *Molecular Spectra and Molecular Structure.* D Van Nostrand company Inc, USA.

High performance solutions for peak and average power measurements. <https://emin.com.mm/high-performance-solutions-for-peak-and-average-power-measurements-myanmar-83633/pr.html>.

Hinrikus H. , Bachmann M. , Lass J. , Tomson R. , Tuulik V. , (2008). Effect of 7, 14 and 21 Hz modulated 450 MHz microwave radiation on human electroencephalographic rhythms. *Int J Radiat Biol.* 84(1):69–79.

Holma H. , Toskala A. , (2004). WCDMA for UMTS, *Radio Access for Third Generation Mobile Communications.* John Wiley & Sons Inc, Chichester, England.

Houck A.A. , Schuster D.I. , Gambetta J.M. , Schreier J.A. , Johnson B.R. , Chow J.M. , Frunzio L. , Majer J. , Devoret M.H. , Girvin S.M. , Schoelkopf R.J. , (2007). Generating single microwave photons in a circuit. *Nature* 449:328–331.

Houston B.J. , Nixon B. , King B.V. , De Iulius G.N. , Aitken R.J. , (2016). The effects of radiofrequency electromagnetic radiation on sperm function. *Reproduction.* 152(6):R263–R276.

Höytö A. , Luukkonen J. , Juutilainen J. , Naarala J. , (2008). Proliferation, oxidative stress and cell death in cells exposed to 872 MHz radiofrequency radiation and oxidants. *Radiat Res.* 170(2):235–243.

Huber R. , Treyer V. , Borbely A.A. , Schuderer J. , Gottselig J.M. , Landolt H.P. , Werth E. , Berthold T. , Kuster N. , Buck A. , Achermann P. , (2002). Electromagnetic fields, such as those from mobile phones, alter regional cerebral blood flow and sleep and waking EEG. *J Sleep Res.* 11(4):289–295.

Hunter G. , Wadlinger R.L.P. , (1987). Physical photons: theory, experiment, interpretation. In *Quantum Uncertainties: Recent and Future Experiments and Interpretations: Proceedings of the NATO Workshop*, University of Bridgeport, CT, 1986, NATO ASI Series B, Vol.162, Plenum Press.

Hyland G.J. , (2000). Physics and biology of mobile telephony. *Lancet.* 356:1833–1836.

Hyland G.J. , (2008). Physical basis of adverse and therapeutic effects of low intensity microwave radiation. *Int J Exp Biol.* 46:403–419.

IARC , (2002). Non-ionizing radiation, part 1: static and extremely low-frequency (ELF) electric and magnetic fields. Vol. 80. World Health Organization.

IARC , (2013). Non-ionizing radiation, part 2: radiofrequency electromagnetic fields. Vol. 102. Lyon, France.

ICNIRP , (1998). Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300GHz). *Health Phys.* 74:494–522.

ICNIRP , (2020). Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300GHz). *Health Phys.* [Published ahead of print].

IEEE , (2002). IEEE recommended practice for measurements and computations of radio frequency electromagnetic fields with respect to human exposure to such fields, 100 kHz–300 GHz, IEEE Std C95.3™-2002 (R2008).

Inomata K. , Lin Z. , Koshino K. , Oliver W.D. , Tsai J.S. , Yamamoto T. , Nakamura Y. , (2016). Single microwave-photon detector using an artificial [Lambda]-type three-level system. *Nat Commun.* 7.

Ivancsits S. , Diem E. , Pilger A. , Rüdiger H.W. , Jahn, (2002). Induction of DNA strand breaks by intermittent exposure to extremely-low-frequency electromagnetic fields in human diploid fibroblasts. *Mutat Res.* 519(1–2):1–13.

Ivancsits S. , Diem E. , Jahn O. , Rüdiger H.W. , (2003). Intermittent extremely low frequency electromagnetic fields cause DNA damage in a dose-dependent way. *Int Arch Occup Environ Health.* 76(6):431–436.

Jackson J.D. , (1975). *Classical Electrodynamics.* John Wiley & Sons, Inc, New York .

Jaynes E.T. , (1966). Is QED necessary?. In L . Mandel , E. Wolf (Eds), *Proceedings of the Second Rochester Conference on Coherence and Quantum Optics.* Plenum, New York, 21.

Jaynes E.T. , (1978). *Electrodynamics today.* In L. Mandel , E . Wolf (Eds), *Coherence and Quantum Optics IV.* Plenum Press, New York, 495.

Jaynes E.T. , (1980). *Quantum Beats.* <http://bayes.wustl.edu/etj/articles/quantum.beats.pdf>.

Johansson O. , (2009). Disturbance of the immune system by electromagnetic fields-A potentially underlying cause for cellular damage and tissue repair reduction which could lead to disease and impairment. *Pathophysiology.* 16:157–177.

Karipidis K. , Mate R. , Urban D. , Tinker R. , Wood A. , (2021). 5G mobile networks and health—a state-of-the-science review of the research into low-level RF fields above 6 GHz. *J Exposure Sci Environ Epidemiol.* <https://doi.org/10.1038/s41370-021-00307-7>

Khurana V.G. , Teo C. , Kundi M. , Hardell L. , Carlberg M. , (2009). Cell phones and brain tumors: a review including the long-term epidemiologic data. *Surg Neurol.* 72(3):205–214.

Klimov A. , (1975). *Nuclear Physics and Nuclear Reactors.* Mir Publishers, Moscow.

Kostoff R.N. , Heroux P. , Aschner M. , Tsatsakis A. , (2020). Adverse health effects of 5G mobile networking technology under real-life conditions. *Toxicol Lett.* 323:35–40.

Kraus H. , Soltamov V.A. , Riedel D. , Vãth S. , Fuchs F. , Sperlich A. , Baranov P.G. , Dyakonov V. , Astakhov G.V. , (2014). Room-temperature quantum microwave emitters based on spin defects in silicon carbide. *Nat Phys.* 10:157–162.

Kwee S. , Raskmark P. , (1998). Changes in cell proliferation due to environmental non-ionizing radiation 2. Microwave radiation. *Bioelectrochem Bioenerg.* 44:251–255.

Lamb W.E. , Scully M.O. , (1969). The photoelectric effect without photons. In *Polarization, Matter and Radiation.* Presses Universitaires de France, Paris, 363–369.

Leach V. , Weller S. , Redmayne M. , (2018). A novel database of bio-effects from non-ionizing radiation. *Rev Environ Health.* 33(3):1–8.

Leonard J. , Foster K. , Athey T.W. , (1984). Thermal properties of tissue equivalent phantom materials. *IEEE Trans Biomed Eng.* 31:533–536.

Levitt B.B. , Lai H.C. , Manville A.M. , (2021). Effects of non-ionizing electromagnetic fields on flora and fauna, part 1. Rising ambient EMF levels in the environment. *Rev Environ Health.* doi.org/10.1515/reveh-2021-0026

Liboff A.R. , (2003). Ion cyclotron resonance in biological systems: experimental evidence. In Stavroulakis P. (Ed), *Biological Effects of Electromagnetic Fields,* Springer, Berlin, 76–113.

Liburdy R.P. , (1992). Calcium signalling in lymphocytes and ELF fields: Evidence for an electric field metric and a site of interaction involving the calcium ion channel. *FEBS Lett.* 301: 53–59.

Liman E.R. , Hess P. , Weaver F. , Koren G. , (1991). Voltage sensing residues in the S4 region of a mammalian K⁺ channel. *Nature.* 353:752–756.

Lin-Liu S. , Adey W.R. , (1982). Low frequency amplitude modulated microwave fields change calcium efflux rates from synaptosomes. *Bioelectromagnetics*. 3(3):309–22.6.

Lioliouis C. , (1979). *Microwaves*, Athens. [Λιολιούσης Κ, Μικροκύματα, Αθήνα 1979]

Lioliouis C. , (1997). *Biological Effects of Electromagnetic Radiation*. Diavlos, Athens. [Λιολιούσης Κ, Βιολογικές επιδράσεις της ηλεκτρομαγνητικής ακτινοβολίας, Δίαυλος, Αθήνα 1997]

Lioliouis C. , (2009). *Mobile Phone and Health*. Diavlos, Athens. [Λιολιούσης Κ, Κινητό τηλέφωνο και υγεία, Δίαυλος, Αθήνα 2009]

Litovitz T.A. , Krause D. , Penafiel M. , Elson E.C. , Mullins J.M. , (1993). The role of coherence time in the effect of microwaves on ornithine decarboxylase activity. *Bioelectromagnetics*. 14:395–403.

Ma T.H. , Chu K.C. . (1993). Effect of the extremely low frequency (ELF) electromagnetic field (EMF) on developing embryos of the fruit fly (*Drosophila melanogaster* L.). *Mutat Res*, 303(1):35–39.

Major F.G. , (2014). The classical atomic clocks. In *Quo Vadis: Evolution of Modern Navigation*. Springer, New York, NY, 151–180.

Manna D. , Ghosh R. , (2016). Effect of radiofrequency radiation in cultured mammalian cells: a review. *Electromagn Biol Med*. 35(3):265–301.

Mandel L. , Wolf E. . (1995). *Optical Coherence and Quantum Optics*. Cambridge University Press.

Mandl F. , (1988). *Statistical Physics*. Wiley, Chichester, 2nd edition.

Marino A.A. , Becker R.O. , (1977). Biological effects of extremely low frequency electric and magnetic fields: a review. *Physiol Chem Phys*. 9:131–147.

Marino A.A. , Kim P.Y. , Frilot C. , (2016). Trigeminal neurons detect cellphone radiation: thermal or nonthermal is not the question. *Electromagn Biol Med*. 36(2):123–131.

McCaig C.D. , Zhao M. , (1997). Physiological electric fields modify cell behaviour. *Bioessays*. 19(9):819–826.

Metaxas A.C. , (1991). Microwave heating. *Power Eng*. 5(5):237–2247.

Miller A.B. , Morgan L.L. , Udasin I. , Davis D.L. , (2018). Cancer epidemiology update, following the 2011 IARC evaluation of radiofrequency electromagnetic fields (Monograph 102). *Environ Res*. 167:673–683.

Miller A.B. , Sears M.E. , Morgan L.L. , Davis D.L. , Hardell L. , et al, (2019). Risks to health and well-being from radio-frequency radiation emitted by cell phones and other wireless devices. *Front Public Health*. 7:223. doi:10.3389/fpubh.2019.00223.

Mohammed H.S. , Fahmy H.M. , Radwan N.M. , Elsayed A.A. , (2013). Non-thermal continuous and modulated electromagnetic radiation fields effects on sleep EEG of rats. *J Adv Res*. 4(2):181–187.

Moulder J.E. , Erdreich L.S. , Malyapa R.S. , Merritt J. , Pickard W.F. et al, (1999). Cell phones and cancer. what is the evidence for a connection?. *Radiat Res*. 151:513–531. 60.

NCRP , (1986). Biological effects and exposure criteria for radiofrequency electromagnetic fields. Properties, quantities and units, biophysical interaction and measurements. National Council on Radiation Protection and Measurements, Report No 86, Bethesda, MD.

Neher E. , Sakmann B. , (1992). The patch clamp technique. *Sci Am*. 266: 28–35.

Neufeld E. , Kuster N. , (2018). Systematic derivation of safety limits for time-varying 5G radiofrequency exposure based on analytical models and thermal dose. *Health Phys*. 115(6):705–711.

NTP (National Toxicology Program) , (2018) Toxicology and carcinogenesis studies in HSD: sprague dawley SD rats exposed to whole-body radio frequency radiation at a frequency (900 MHz) and modulations (GSM and CDMA) used by cell phones. NTP TR 595, Department of Health and Human Services, USA.

Nuccitelli R. , (1992). Endogenous ionic currents and DC electric fields in multicellular animal tissues. *Bioelectromagnetics*. Suppl 1:147–157.

Nuccitelli R. , (2003). Endogenous electric fields in embryos during development, regeneration and wound healing. *Radiat Prot Dosimetry*.106(4):375–383.

Olaniyi I.J. , (2017). Microwave heating in food processing. *BAOJ Nutr*.3:027.

Pakhomov A.G. , Akyel Y. , Pakhomova O.N. , Stuck B.E. , Murphy M.R. , (1998). Current state and implications of research on biological effects of millimeter waves: a review of the literature. *Bioelectromagnetics*. 19:393–413.

Pall M.L. , (2013). Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects. *J Cell Mol Med*. 17(8):958–965.

Pall M.L. , (2018). Wi-Fi is an important threat to human health. *Environ Res*.164:405–416.

Palmer L.G. , (1986) *New Insights into Cell and Membrane Transport Processes*. G . Poste , S.T. Crooke , Eds., Plenum, New York, 331.

Panagopoulos D.J. , Messini N. , Karabarounis A. , Philippetis A.L. , Margaritis L.H. , (2000). A mechanism for action of oscillating electric fields on cells. *Biochem Biophys Res Commun*. 272:634–640.

Panagopoulos D.J. , Karabarounis A. , Margaritis L.H. , (2002). Mechanism for action of electromagnetic fields on cells. *Biochem Biophys Res Commun*. 298(1):95–102.

Panagopoulos D.J. , Margaritis L.H. , (2003). Theoretical considerations for the biological effects of electromagnetic fields. In P . Stavroulakis (Ed), *Biological Effects of Electromagnetic Fields*. Springer, Berlin, 5–33.

Panagopoulos D.J. , Karabarounis A. , Margaritis L.H. , (2004). Effect of GSM 900-MHz mobile phone radiation on the reproductive capacity of *drosophila melanogaster*. *Electromagn Biol Med*. 23(1):29–43.

Panagopoulos D.J. , Chavdoula E.D. , Nezis I.P. , Margaritis L.H. , (2007a). Cell death induced by GSM 900MHz and DCS 1800MHz mobile telephony radiation. *Mutat Res.* 626:69–78.

Panagopoulos D.J. , Chavdoula E.D. , Karabarounis A. , Margaritis L.H. , (2007b). Comparison of bioactivity between GSM 900 MHz and DCS 1800 MHz mobile telephony radiation. *Electromagn Biol Med.* 26(1):33–44.

Panagopoulos D.J. , Margaritis L.H. , (2009). Biological and health effects of mobile telephony radiations. *Int J Med Biol Front.* 15(1/2):33–76.

Panagopoulos D.J. , Chavdoula E.D. , Margaritis L.H. , (2010). Bioeffects of mobile telephony radiation in relation to its intensity or distance from the antenna. *Int J Radiat Biol.* 86(5):345–357.

Panagopoulos D.J. , Margaritis L.H. , (2010a). The effect of exposure duration on the biological activity of mobile telephony radiation. *Mutat Res.* 699(1/2):17–22.

Panagopoulos D.J. , Margaritis L.H. , (2010b). The identification of an intensity “window” on the bioeffects of mobile telephony radiation. *Int J Rad Biol.* 86(5):358–366.

Panagopoulos D.J. , (2011). Biological impacts, action mechanisms, dosimetry and protection issues of mobile telephony radiation. In M.C. Barnes , N.P. Meyers (Eds), *Mobile Phones: Technology, Networks and User Issues.* Nova Science Publishers, Inc., New York, 1–54.

Panagopoulos D.J. , (2013). Electromagnetic interaction between environmental fields and living systems determines health and well-being. In MH Kwang and SO Yoon (Eds), *Electromagnetic Fields: Principles, Engineering Applications and Biophysical Effects.* Nova Science Publishers, New York, 87–130.

Panagopoulos D.J. , Karabarounis A. , Lioliousis C. , (2013a). ELF alternating magnetic field decreases reproduction by DNA damage induction. *Cell Biochem Biophys.* 67:703–716.

Panagopoulos D.J. , Johansson O. , Carlo G.L. , (2013b). Evaluation of specific absorption rate as a dosimetric quantity for electromagnetic fields bioeffects. *PLoS One.* 8(6):e62663. doi:10.1371/journal.pone.0062663.

Panagopoulos D.J. , Johansson O. , Carlo G.L. , (2015a). Polarization: a key difference between man-made and natural electromagnetic fields, in regard to biological activity. *Sci Rep.* 5:14914

Panagopoulos D.J. , Johansson O. , Carlo G.L. , (2015b). Real versus simulated mobile phone exposures in experimental studies. *BioMed Res Int.* 2015:607053.

Panagopoulos D.J. , (2015). Considering photons as spatially confined wave-packets. In A. Reimer (Ed), *Horizons in World Physics.* Vol. 285, Nova Science Publishers, New York.

Panagopoulos D.J. , Cammaerts M.C. , Favre D. , Balmori A. , (2016). Comments on environmental impact of radiofrequency fields from mobile phone base stations. *Crit Rev Environ Sci Technol.* 46(9):885–903.

Panagopoulos D.J. , Balmori A. , (2017). On the biophysical mechanism of sensing atmospheric discharges by living organisms. *Sci Total Environ.* 599–600(2017):2026–2034.

Panagopoulos D.J. , (2017). Mobile telephony radiation effects on insect ovarian cells. the necessity for real exposures bioactivity assessment. the key role of polarization, and the ion forced-oscillation mechanism. In C.D. Geddes (Ed), *Microwave Effects on DNA and Proteins.* Springer, Cham, Switzerland, 1–48.

Panagopoulos D.J. , (2018). Man-made electromagnetic radiation is not quantized. In A. Reimer (Ed), *Horizons in World Physics.* Vol. 296, Nova Science Publishers, New York.

Panagopoulos D.J. , Chrousos G.P. , (2019). Shielding methods and products against man-made electromagnetic fields: protection versus risk. *Sci Total Environ.* 667C:255–262.

Panagopoulos D.J. , (2019a). Comparing DNA damage induced by mobile telephony and other types of man-made electromagnetic fields. *Mutat Res Rev.* 781:53–62.

Panagopoulos D.J. , (2019b). Chromosome damage in human cells induced by UMTS mobile telephony radiation. *Gen Physiol Biophys.* 38:445–454

Panagopoulos D.J. , (2020). Comparing chromosome damage induced by mobile telephony radiation and a high caffeine dose: effect of combination and exposure duration, *Gen Physiol Biophys.* 39:531–544.

Panagopoulos D.J. , Balmori A. , Chrousos G.P. , (2020). On the biophysical mechanism of sensing upcoming earthquakes by animals. *Sci Total Environ.* 717(2020):136989.

Panagopoulos D.J. , Karabarounis A. , (2020). Comments on “diverse radiofrequency sensitivity and radiofrequency effects of mobile or cordless phone near fields exposure in drosophila melanogaster. *Adv Environ Stud.* 4(1):271–276.

Panagopoulos D.J. , Karabarounis A. , Yakymenko I. , Chrousos G.P. , (2021). Human-made electromagnetic fields: ion forced-oscillation and voltage-gated ion channel dysfunction: oxidative stress and DNA damage. *Int J Oncol.* 59: 92.

Panarella E. , (2008). Single photons have not been detected: the alternative photon clump model. In C. Roychoudhuri , A.F. Kracklauer , K . Creath (Ed), *The Nature of Light. What Is a Photon?* CRC Press, Taylor & Francis, USA.

Parsons K.C. , (1993). *Human Thermal Environments.* Taylor and Francis, London.

Pedersen G.F. , (1997). Amplitude modulated RF fields stemming from a GSM/DCS-1800 phone. *Wireless Networks.* 3:489–498.

Penafiel L.M. , Litovitz T. , Krause D. , Desta A. , Mullins M.J. , (1997). Role of modulation on the effect of microwaves on ornithine decarboxylase activity in L929 cells. *Bioelectromagnetics.* 18(2):132–141.

Peyman A. , Rezazadeh A.A. , Gabriel C. , (2001). Changes in the dielectric properties of rat tissue as a function of age at microwave frequencies. *Phys Med Biol.* 46(6):1617–1629.

Phillips J.L. , Singh N.P. , Lai H. , (2009). Electromagnetic fields and DNA damage. *Pathophysiology*. 16(2–3):79–88.

Pirard W. , Vatoz B. . Study of pulsed character of radiation emitted by wireless telecommunication systems. Institut scientifique de service public, Liège, Belgium. https://www.issep.be/wp-content/uploads/7IWSBEEMF_B-Vatoz_W-Pirard.pdf.

Pohl R. , (1960). Discovery of interference by Thomas Young. *Am J Phys*. 28:530.

Prasad K.N. , (1995). *Handbook of Radiobiology*. CRC Press, Boca Raton, USA, 2nd edition.

Presman A.S. , (1977). *Electromagnetic Fields and Life*. Plenum Press, New York.

Puranen L. , Jokela K. , (1996). Radiation hazard assessment of pulsed microwave radars. *J Microwave Power Electromagn Energy*. 31(3):165–177.

Radebaugh R. , (2009). Cryocoolers: the state of the art and recent developments. *J Phys Condens Matt*. 21(16):164219.

Rappaport, T.S. , Sun, S. , Mayzus, R. , et al. (2013). Millimeter wave mobile communications for 5G cellular: it will work! *IEEE Access*. 1:335–349.

Reitz J.R. , Milford F.J. , (1967). *Foundations of Electromagnetic Theory*. Addison-Wesley Publishing Company, Inc, Boston, MA.

Roller W.L. , Goldman R.F. , (1968). Prediction of solar heat load on man. *J Appl Physiol*. 25:717–721.

Roychoudhuri C. , Kracklauer A.F. , Creath K. , (2008). *The Nature of Light. What Is a Photon?* CRC Press, Taylor & Francis, USA.

Roychoudhuri C. , Tirfessa N. , (2008). Do we count indivisible photons or discrete quantum events experienced by detectors?. In Roychoudhuri , Kracklauer , Creath (Eds), *The Nature of Light. What Is a Photon?*. CRC Press, Taylor & Francis, USA.

Roychoudhuri C. , (2014). *Causal Physics – Photon Model by Non-Interaction of Waves*. CRC Press, Taylor and Francis, Boca Raton, USA.

Sangeetha M. , Purushothaman B.M. , Suresh Babu S. , (2014). Estimating cell phone signal intensity and identifying radiation hotspot area for tirunel veli taluk using RS and GIS. *Int J Res Eng Technol*. 3:412–418.

Santini M.T. , Ferrante A. , Rainaldi G. , Indovina P. , Indovina P.L. , (2005). Extremely low frequency (ELF) magnetic fields and apoptosis: a review. *Int J Radiat Biol*. 81(1):1–11.

Sauter M. , (2011). *From GSM to LTE: An Introduction to Mobile Networks and Mobile Broadband*. John Wiley & Sons, Chichester, UK.

Schimmelpfeng J. , Dertinger H. , (1993). The action of 50Hz magnetic and electric fields upon cell proliferation and cyclic AMP content of cultured mammalian cells. *Bioelectrochem Bioenerg*. 30:143–150.

Schroedinger E. , (1926). An undulatory theory of the mechanics of atoms and molecules. *Physical Review*. 28(6):1049–1070.

Schumann W.O. , (1952). Über die strahlunglosen eigenschwingungen einer leitenden Kugel, die von einer Luftschicht und einer Ionosphärenhülle umgeben ist (On the characteristic oscillations of a conducting sphere which is surrounded by an air layer and an ionospheric shell). *Zeitschrift Naturforschung*. 7A:149–154.

Schuster D.I. , Houck A.A. , Schreier J.A. , Wallraff A. , Gambetta J.M. , Blais A. , Frunzio L. , Majer J. , Johnson B. , Devoret M.H. , Girvin S.M. , Schoelkopf R.J. , (2007). Resolving photon number states in a superconducting circuit. *Nature*. 445:515–518.

Schwan H.P. , (1957). Electrical properties of tissues and cell suspensions. *Adv Phys Med Biol*. 5:147–209.

Schwan H.P. , (1963). Determination of biological impedances. In Nastuk W.L. (Ed), *Physical Techniques in Biological Research*, Vol. 6. New York: Academic Press, 323–407.

Schwartz M. , (1990). *Information Transmission, Modulation, and Noise*, McGraw-Hill, New York, 4th edition.

Sesia S. , Toufik I. , Baker M. (Eds), (2011). *LTE – The UMTS Long Term Evolution*. John Wiley & Sons Ltd., West Sussex, UK.

Sheppard A.R. , Swicord M.L. , Balzano Q. , (2008). Quantitative evaluations of mechanisms of radiofrequency interactions with biological molecules and processes. *Health Phys*. 93(4):365–396.

Shim Y. , Lee I. , Park S. , (2013). The impact of LTE UE on audio devices. *ETRI J*. 35(2):332–335.

Sommerfeld A. , (1916). Zur Quantentheorie der Spektrallinien. *Ann D Phys*. 51:1.

Somosy Z. , Thuroczy G. , Kubasova T. , Kovacs J. , Szabo L.D. , (1991). Effects of modulated and continuous microwave irradiation on the morphology and cell surface negative charge of 3T3 fibroblasts. *Scanning Microsc*. 5(4):1145–1155.

Spiegel M.R. , (1974). *Fourier Analysis with Applications to Boundary Value Problems*. McGraw-Hill, New York.

Spottorno J. , Multigner M. , Rivero G. , Alvarez L. , de la Venta J. , Santos M. , (2008). Time dependence of electrical bioimpedance on porcine liver and kidney under a 50 Hz ac current. *Phys Med Biol*. 53:1701–1713.

Spottorno J. , Multigner M. , Rivero G. , Alvarez L. , de la Venta J. , Santos M. , (2012). In vivo measurements of electrical conductivity of porcine organs at low frequency: new method of measurement. *Bioelectromagnetics*. 33(7):612–619.

Stensaas L.J. , Partlow L.M. , Bush L.G. , Iversen P.L. , Hill D.W. , Hagmann M.J. , Gandhi O.P. , (1981). Effects of millimeter-wave radiation on monolayer cell cultures. II. Scanning and transmission electron microscopy. *Bioelectromagnetics*. 2(2):141–150.

Stephenson G. , (1973). *Mathematical Methods for Science Students*. Longman Group, London, 2nd edition.

Stryer L. , (1996). *Biochemistry*. W.H. Freeman and Co, New York, 4th edition.

Tarasov L.V. , (1980). *Basic Concepts of Quantum Mechanics*. Mir Publishers, Moscow.

Tesla N. , (1905). The transmission of electrical energy without wires as a means of furthering world peace. *Electrical World and Engineer*. 7:21–24.

Thielens A. , Bell D. , Mortimore D.B. , Greco M.K. , Martens L. , Joseph W. , (2018). Exposure of insects to radio-frequency electromagnetic fields from 2 to 120 GHz. *Sci Rep*. 8:3924. doi:10.1038/s41598-018-22271-3.

Thielens A. , Greco M.K. , Verloock L. , Martens L. , Joseph W. , (2020). Radio-frequency electromagnetic field exposure of western honey bees. *Sci Rep*. 10:461. doi:org/10.1038/s41598-019-56948-0.

Thuroczy G. , Kubinyi G. , Bodo M. , Bakos J. , Szabo L.D. , (1994). Simultaneous response of brain electrical activity (EEG) and cerebral circulation (REG) to microwave exposure in rats. *Rev Environ Health*. 10(2):135–148.

Tisal J. , (1998). *GSM Cellular Radio Telephony*. J.Wiley & Sons, West Sussex, England.

Trachanas S.L. , (1981). *Quantum Mechanics*. Athens. [Τραχανάς Σ.Λ., «Κβαντομηχανική», Εκδ. Σύγχρονες Επιστήμες, Αθήνα 1981].

Tuor M. , Ebert S. , Schuderer J. , Kuster N. , (2005). Assessment of ELF exposure from GSM handsets and development of an optimized RF/ELF exposure setup for studies of human volunteers. BAG Reg. No. 2.23.02.-18/02.001778, IT'IS Foundation.

Valberg P.A. , Kavet R. , Rafferty C.N. , (1997). Can low-level 50/60Hz electric and magnetic fields cause biological effects? *Rad Res*. 148:2–21.

Velizarov S. , Raskmark P. , Kwee S. , (1999). The effects of radiofrequency fields on cell proliferation are non-thermal. *Bioelectrochem Bioenerg*. 48:177–180.

Verschaeve L. , (2014). Environmental impact of radiofrequency fields from mobile phone base stations. *Crit Rev Environ Sci Technol*. 44:1313–1369.

Verschaeve L. , (2017). Misleading scientific papers on health effects from wireless communication devices. In C.D. Geddes (Ed), *Microwave Effects on DNA and Proteins*, Springer, Cham, Switzerland.

Veyret B. , Bouthet C. , Deschaux P. , de Seze R. , Geffard M. , et al., (1991). Antibody responses of mice exposed to low-power microwaves under combined, pulse-and-amplitude modulation. *Bioelectromagnetics*. 2(1):47–56.

Vistnes A.I. , Gjoetterud K. , (2001). Why arguments based on photon energy may be highly misleading for power line frequency electromagnetic fields. *Bioelectromagnetics*. 22: 200–204.

Walleczek J. , (1992). Electromagnetic field effects on cells of the immune system: the role of calcium signaling. *FASEB J*. 6: 3177–3185.

Walls D.F. , Milburn G.L. (2008). *Quantum Optics*, Springer.

Wang E.T. , Zhao M. , (2010). Regulation of tissue repair and regeneration by electric fields. *Chin J Traumatol*. 13(1):55–61.

Wang J. , Fujiwara O. , Kodera S. , Watanabe S. , (2006). FDTD calculation of whole-body average SAR in adult and child models for frequencies from 30 MHz to 3 GHz. *Phys Med Biol*. 51(17):4119–4127.

Weisenseel M.H. , (1983). Control of differentiation and growth by endogenous electric currents. In W. Hoppe , W. Lohmann , H. Markl , H. Ziegler (Eds), *Biophysics*, Springer–Verlag, Berlin, 460–465.

Wertheimer N. , Leeper E. , (1979). Electrical wiring configurations and childhood cancer. *Am J Epidemiol*. 109.

Wever R. , (1974). ELF effects on human circadian rhythms. In M.A. Persinger (Ed), *ELF and VLF Electromagnetic Fields*. Plenum Press, New York.

Wever R. , (1979). *The Circadian System of Man: Results of Experiments under Temporal Isolation*. Springer-Verlag, New York.

Wilson W. , (1915). The quantum theory of radiation and line spectra. *Phil Mag* 29: 795–802.

Wongkasem N. , (2021). Electromagnetic pollution alert: microwave radiation and absorption in human organs and tissues. *Electromag Biol Med*. Feb 10:1–18. doi:10.1080/15368378.2021.1874976. Online ahead of print.

Wood A. , Mate R. , Karipidis K. , (2021). Meta-analysis of in vitro and in vivo studies of the biological effects of low-level millimetre waves. *J Exposure Sci Environ Epidemiol*. <https://doi.org/10.1038/s41370-021-00307-7>.

Wust P. , Kortüm B. , Strauss U. , et al, (2020). Non-thermal effects of radiofrequency electromagnetic fields. *Sci Rep*. 10(1):13488. doi:10.1038/s41598-020-69561-3.

Wust P. , Stein U. , Ghadjar P. , (2021). Non-thermal membrane effects of electromagnetic fields and therapeutic applications in oncology. *Int J Hyperthermia*. 38(1):715–731.

Yakymenko I. , Sidorik E. , Kyrlyenko S. , Chekhun V. , (2011). Long-term exposure to microwave radiation provokes cancer growth: evidences from radars and mobile communication systems. *Exp Oncol*. 33(2):62–70.

Yakymenko I. , Tsybulin O. , Sidorik E. , Henshel D. , Kyrlyenko O. , et al, (2016). Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation. *Electromagn Biol Med*. 35(2):186–202.

Yakymenko I. , Burlaka A. , Tsybulin I. , Brieieva I. , Buchynska L. , et al, (2018). Oxidative and mutagenic effects of low intensity GSM 1800 MHz microwave radiation. *Exp Oncol*. 40(4):282–287.

Zheng Y. , Xia P. , Dong L. , Tian L. , Xiong C. , (2021). Effects of modulation on sodium and potassium channel currents by extremely low frequency electromagnetic fields stimulation on hippocampal CA1 pyramidal cells. *Electromagn Biol Med*. 17:1–12.

Zhou R. , Xiong Y. , Xing G. , Sun L. , Ma J. , (2010). Zifi: wireless LAN Discovery via ZigBee Interference Signatures MobiCom'10, September 20–24, Chicago, IL.

Zothansiam, Z.M. , Lalramdinpui M. , Jagetia G.C. , (2017). Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations. *Electromagn Biol Med.* 36(3):295–305.

Zwamborn A.P.M. , Vossen S.H.J.A. , van Leersum B.J.A.M. , Ouwens M.A. , Mäkel W.N. . (2003). Effects of global communication system radio-frequency fields on well being and cognitive functions of human subjects with and without subjective complaints. FEL-03-C148. TNO Physics and Electronics Laboratory, The Hague, the Netherlands.
http://home.tiscali.be/milieugezondheid/dossiers/gsm/TNO_rapport_Nederland_sept_2003.pdf.

Public Health Implications of Exposure to Wireless Communication Electromagnetic Fields

Adair, R.K. (2003). Biophysical limits on athermal effects of RF and microwave radiation. *Bioelectromagnetics* 24(1):39–48.

Adams, J.A. , Galloway, T.S. , Mondal, D. , Esteves, S.C. , Mathews, F. (2014). Effect of mobile telephones on sperm quality: A systematic review and meta-analysis. *Environ Int.* 70:106–112.

Agarwal, A. , Deepinder, F. , Sharma, R.K. , Ranga, G. , Li, J. (2008). Effect of cell phone usage on semen analysis in men attending infertility clinic: An observational study. *Fertil Steril.* 89(1):124–128.

Ahlbom, A. , Day, N. , Feychting, M. , et al. (2000). A pooled analysis of magnetic fields and childhood leukaemia. *Br. J. Cancer* 83(5):692–698.

Akdag, M. , Dasdag, S. , Canturk, F. , Akdag, M.Z. (2018). Exposure to non-ionizing electromagnetic fields emitted from mobile phones induced DNA damage in human ear canal hair follicle cells. *Electromagn Biol Med.* 37(2):66–75.

Aldad, T.S. , Gan, G. , Gao, X.B. , Taylor, H.S. (2012). Fetal radiofrequency radiation exposure from 800–1900 MHz-rated cellular telephones affects neurodevelopment and behavior in mice. *Sci Rep.* 2:312.
<https://doi.org/10.1038/srep00312>.

Alster, N. (2015). Captured agency: How the federal communications commission is dominated by the industries it presumably regulates. Edmond J. Safra Center for Ethics Harvard University, 124 Mount Auburn Street, Suite 520 N. Cambridge, MA 02138 USA.

Anonymous . (2018). LTE achieves 39% market share worldwide. *Microw J.*, June 25, 2018.
<http://www.microwavejournal.com/articles/30603-lte-achieves> (accessed September 29 2018).

Aydin, D. , Feychting, M. , Schüz, J. , et al. (2011). Mobile phone use and brain tumors in children and adolescents: A multicenter case-control study. *J Natl Cancer Inst.* 103(16):1264–1276.

Balmori, A. (2009). Electromagnetic pollution from phone masts: Effects on wildlife. *Pathophysiology* 16(2–3):191–199.

Balmori, A. (2014). Electrosmog and species conservation. *Sci Total Environ.* 496:314–316.

Barnes, F. , Greenebaum, B. (2016). Some effects of weak magnetic fields on biological systems: RF fields can change radical concentrations and cancer cell growth rates. *IEEE Power Electron Mag.* 3(1):60–68.

Belpomme, D. , Hardell, L. , Belyaev, I. , Burgio, E. , Carpenter, D.O. (2018). Thermal and non-thermal health effects of low intensity non-ionizing radiation: An international perspective. *Environ Pollut.*
<https://doi.org/10.1016/j.envpol.2018.07.019>.

Beltzalel, N. , Ben Ishai, P. , Feldman, Y. (2018). The human skin as a sub-THz receiver - Does 5G pose a danger to it or not? *Environ Res.* 163:208–216.

Belyaev, I. (2010). Dependence of non-thermal biological effects of microwaves on physical and biological variables: Implications for reproducibility and safety standards. In L. Giuliani , M. Soffritti (Eds.), *European J. Oncol.—Library non-thermal effects and mechanisms of interaction between electromagnetic fields and living matter*, 5, Ramazzini Institute, Bologna, Italy, pp. 187–218 (An ICEMS Monograph).

Belyaev, I. , Dean, A. , Eger, H. , et al. (2016). EUROPAEM EMF guideline. 2016 for the prevention, diagnosis and treatment of EMF-related health problems and illnesses. <https://doi.org/10.1515/reveh-2016-0011>.

Benson, V.S. , Pirie, K. , Schüz, J. , et al.; Million Women Study Collaborators . (2013). Mobile phone use and risk of brain neoplasms and other cancers: Prospective study. *Int J Epidemiol.* 42(3):792–802.

BioInitiative Working Group . (2012). A rationale for biologically-based exposure standards for low-intensity electromagnetic radiation. *BioInitiative.* <https://www.bioinitiative.org/>.

Brzozek, C. , Benke, K.K. , Zeleke, B.M. , et al. (2018). Radiofrequency electromagnetic radiation and memory performance: Sources of uncertainty in epidemiological cohort studies. *Int. J. Environ. Res. Public Health* 15(4):592. <https://doi.org/10.3390/ijerph15040592>.

Byun, Y.H. , Ha, M. , Kwon, H.J. , et al. (2013). Mobile phone use, blood lead levels, and attention deficit hyperactivity symptoms in children: A longitudinal study. *PLOS ONE* 8(3):e59742.
<https://doi.org/10.1371/journal.pone.0059742>.

- Carlberg, M. , Hardell, L. (2014). Decreased survival of glioma patients with astrocytoma grade IV (glioblastoma multiforme) associated with long-term use of mobile and cordless phones. *Int. J. Environ. Res. Public Health* 11(10):10790–10805.
- Carlberg, M. , Hardell, L. (2017). Evaluation of mobile phone and cordless phone use and glioma risk using the Bradford Hill viewpoints from 1965 on association or causation. *BioMed Res Int.* 2017:9218486.
- Carlberg, M. , Hedendahl, L. , Koppel, T. , Hardell, L. (2019). High ambient radiofrequency radiation in Stockholm city, Sweden. *Oncol Lett.* 17(2):1777–1783. <https://doi.org/10.3892/ol.2018.9789>.
- CDPH . (2017a). Connecticut department of public health: Cell phones: Questions and answers about safety. https://portal.ct.gov/-/media/Departments-and-Agencies/DPH/dph/environmental_health/eoha/Toxicology_Risk_Assessment/050815CellPhonesFINALpdf.pdf?la=en.
- CDPH . (2017b). Guidelines on how to reduce exposure to radio frequency energy from cell phones. <https://www.cdpb.ca.gov/Programs/OPA/Pages/NR17-086.aspx>.
- Choi, K.H. , Ha, M. , Ha, E.H. , et al. (2017). Neurodevelopment for the first three years following prenatal mobile phone use, radio frequency radiation and lead exposure. *Environ Res.* 156:810–817.
- Coghill, R.W. , Steward, J. , Philips, A. (1996). Extra low frequency electric and magnetic fields in the bed place of children diagnosed with leukaemia: A case-control study. *Eur J Cancer Prev.* 5(3):153–158.
- Coleman, M.P. , Bell, C.M. , Taylor, H.L. , Primitic-Zakelj, M. (1989). Leukaemia and residence near electricity transmission equipment: A case-control study. *Br. J. Cancer* 60(5):793–798.
- Corvi, R. , Madia, F. (2017). In vitro genotoxicity testing – Can the performance be enhanced? *Food Chem Toxicol.* 106(B):600–608.
- Coureau, G. , Bouvier, G. , Lebailly, P. , et al. (2014). Mobile phone use and brain tumours in the CERENAT case-control study. *Occup Environ Med.* 71(7):514–522.
- Czerninski, R. , Zini, A. , Sgan-Cohen, H.D. (2011). Risk of parotid malignant tumors in Israel (1970–2006). *Epidemiology* 22(1):130–131. <https://doi.org/10.1097/EDE.0b013e3181feb9f0>.
- De Iuliis, G.N. , Newey, R.J. , King, B.V. , Aitken, R.J. (2009). Mobile phone radiation induces reactive oxygen species production and DNA damage in human spermatozoa in vitro. *PLOS ONE* 4(7):e6446.
- Deniz, O.G. , Suleyman, K. , Mustafa, B.S. , et al. (2017). Effects of short and long term electromagnetic fields exposure on the human hippocampus. *J Microsc Ultrastruct.* 5(4):191–197. <https://doi.org/10.1016/j.jmau.2017.07.001>.
- De-Sola Gutiérrez, J. , Rodríguez de Fonseca, F. , Rubio, G. (2016). Cell-phone addiction: A review. *Front. Psychiatry* 7:175. <https://doi.org/10.3389/fpsy.2016.00175>; <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5076301/>.
- Divan, H.A. , Kheifets, L. , Obel, C. , Olsen, J. (2008). Prenatal and postnatal exposure to cell phone use and behavioral problems in children. *Epidemiology* 19(4):523–529. <https://doi.org/10.1097/EDE.0b013e318175dd47>.
- Eghlidospour, M. , Amir, G. , Seyyed, M.J.M. , Hassan, A. (2017). Effects of radiofrequency exposure emitted from a GSM mobile phone on proliferation, differentiation, and apoptosis of neural stem cells. *Anat Cell Biol.* 50(2):115–123.
- EMF-Portal of the RWTH Aachen University . (2018). <https://www.emf-portal.org/en>.
- Environmental Health Trust . (2018). Database of worldwide policies on cell phones, wireless and health. <https://ehtrust.org/policy/international-policy-actions-on-wireless/>.
- Falcioni, L. , Bua, L. , Tibaldi, E. , et al. (2018). Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission. *Environ Res.* 17(1):50. <https://doi.org/10.1186/s12940-018-0394-x>.
- Federal Communication Commission . (2013). Radio frequency safety 13–39 section 112, page 37 first report and order March 29, 2013. https://apps.fcc.gov/edocs_public/attachmatch/FCC-13-39A1.pdf.
- Fernández, C. , de Salles, A.A. , Sears, M.E. , Morris, R.D. , Davis, D.L. (2018). Absorption of wireless radiation in the child versus adult brain and eye from cell phone conversation or virtual reality. *Environ Res.* 167:694–699. <https://doi.org/10.1016/j.envres.2018.05.013>.
- Feychting, M. , Ahlbom, A. (1993). Magnetic fields and cancer in children residing near Swedish high - Voltage power lines. *Am J Epidemiol.* 138(7):467–481.
- Feychting, M. , Ahlbom, A. (1994). Magnetic fields, leukemia and central nervous system tumors in Swedish adults residing near high - Voltage power lines. *Epidemiology* 5(5):501–509.
- Feychting, M. , Ahlbom, A. (1995). Childhood leukemia and residential exposure to weak extremely low frequency magnetic fields. *Environ Health Perspect.* 103(suppl 2):59–62.
- Foerster, M. , Thielens, A. , Joseph, W. , Eeftens, M. , Rössli, M. (2018). A prospective cohort study of adolescents' memory performance and individual brain dose of microwave radiation from wireless communication. *Environ Health Perspect.* 126(7):077007. <https://doi.org/10.1289/EHP2427>.
- Gautam, R. , Singh, K.V. , Nirala, J. , et al. (2019). Oxidative stress-mediated alterations on sperm parameters in male Wistar rats exposed to 3G mobile phone radiation. *Andrologia* 51(3):e13201. <https://doi.org/10.1111/and.13201>.
- Gittleman, H.R. , Ostrom, Q.T. , Rouse, C.D. , et al. (2015). Trends in central nervous system tumor incidence relative to other common cancers in adults, adolescents, and children in the United States, 2000 to 2010.

Cancer 121(1):102–112. <https://doi.org/10.1002/cncr.29015>.

Goedhart, G. , van Wel, L. , Langer, C.E. , et al. (2018). Recall of mobile phone usage and laterality in young people: The multinational mobi-expo study. *Environ Res.* 165:150–157. <https://doi.org/10.1016/j.envres.2018.04.018>.

Green, L.M. , Miller, A.B. , Villeneuve, P. , et al. (1999a). A case-control study of childhood leukemia in Southern Ontario, Canada, and exposure to magnetic fields in residences. *Int. J. Cancer* 82(2):161–170.

Green, L.M. , Miller, A.B. , Agnew, D.A. , et al. (1999b). Childhood leukemia and personal monitoring of residential exposures to electric and magnetic fields in Ontario Canada. *Cancer Causes Control* 10(3):233–243.

Greenland, S. , Sheppard, A.R. , Kaune, W.T. , Poole, C. , Kelsh, M.A. (2000). A pooled analysis of magnetic fields, wire codes, and childhood leukemia: Childhood leukemia-EMF Study Group. *Epidemiology* 11(6):624–634.

Halgamuge, M.N. (2017). Review: Weak radiofrequency radiation exposure from mobile phone radiation on plants. *Electromagn Biol Med.* 36(2):213–235.

Hardell, L. , Carlberg, M. , Söderqvist, F. , Kjell, H.M. (2013a). Pooled analysis of case-control studies on acoustic neuroma diagnosed 1997–2003 and 2007–2009 and use of mobile and cordless phones. *Int J Oncol.* 43(4):1036–1044.

Hardell, L. , Carlberg, M. , Gee, D. (2013b). Mobile phone use and brain tumour risk: Early warnings, early actions? Chapter 21. In *Late lessons from early warnings, part 2*. European Environment Agency, Copenhagen, Denmark. <https://www.eea.europa.eu/publications/late-lessons-2/late-lessons-chapters/late-lessons-ii-chapter-21/view>.

Hardell, L. , Carlberg, M. (2015). Mobile phone and cordless phone use and the risk for glioma - Analysis of pooled case-control studies in Sweden, 1997–2003 and 2007–2009. *Pathophysiology* 22(1):1–13.

Hardell, L. , Carlberg, M. , Hedendahl, L.K. (2018). Radiofrequency radiation from nearby base stations gives high levels in an apartment in Stockholm, Sweden: A case report. *Oncol Lett.* 15(5):7871–7883. <https://doi.org/10.3892/ol.2018.8285>.

Hardell, L. , Nyberg, R. (2020). Appeals that matter or not on a moratorium on the deployment of the fifth generation, 5G, for microwave radiation. *Mol Clin Oncol.* <https://doi.org/10.3892/mco.2020.1984>.

Hardell, L. , Carlberg, M. (2020). Health risks from radiofrequency radiation, including 5G, should be assessed by experts with no conflicts of interest. *Oncol Lett.* 20(4):15.

Hardell, L. , Carlberg, M. (2021). Lost opportunities for cancer prevention: Historical evidence on early warnings with emphasis on radiofrequency radiation. *Rev. Environ. Health.* <https://doi.org/10.1515/reveh-2020-0168>.

Heuser, G. , Heuser, S.A. (2017). Functional brain MRI in patients complaining of electrohypersensitivity after long term exposure to electromagnetic fields. *Rev. Environ. Health* 32(3):291–299. <https://doi.org/10.1515/reveh-2017-0014>.

Houston, B.J. , Nixon, B. , King, B.V. , De luliis, G.N. , Aitken, R.J. (2016). The effects of radiofrequency electromagnetic radiation on sperm function. *Reproduction* 152(6):R263–R276.

Huber, R. , Treyer, V. , Borbély, A.A. , et al. (2002). Electromagnetic fields, such as those from mobile phones, alter regional cerebral blood flow and sleep and waking EEG. *J Sleep Res.* 11(4):289–295.

Huber, R. , Treyer, V. , Schuderer, J. , et al. (2005). Exposure to pulse-modulated radio frequency electromagnetic fields affects regional cerebral blood flow. *Eur J Neurosci.* 21(4):1000–1006.

Huss, A. , Egger, M. , Hug, K. , Huwiler-Müntener, K. , Rössli, M. (2007). Source of funding and results of studies of health effects of mobile phone use: Systematic review of experimental studies. *Environ Health Perspect.* 115(1):1–4.

Hyland, G.J. (2000). Physics and biology of mobile telephony. *Lancet* 356(9244):1833–1836.

Hyland, G.J. (2008). Physical basis of adverse and therapeutic effects of low intensity microwave radiation. *Indian J Exp Biol.* 46(5):403–419.

IARC . (2002). Non-ionizing radiation, Part 1: Static and extremely low-frequency (ELF) electric and magnetic fields. *IARC Monogr Eval Carcinog Risks Hum.*80:1–395 .

IARC . (2013). IARC Monographs on the evaluation of carcinogenic risks to humans. Non-ionizing radiation, Part 2: Radiofrequency Electromagnetic fields. *IARC Monogr Eval Carcinog Risks Hum.* 102(Pt 2):1–460.

IARC . (2021). Cancer incidence in five continents, Volume XI. International Agency for Research on Cancer, Lyon, France.

ICNIRP . (1998). Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). International commission on non-ionizing radiation protection. *Health Phys.* 74(4):494–522.

ICNIRP . (2018). ICNIRP note on recent animal carcinogenesis studies. Munich, Germany. https://www.icnirp.org/cms/upload/publications/ICNIRP_note.pdf.

ICNIRP . (2020). Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300GHz). *Health Phys.* [Published ahead of print].

IEEE . (1991). IEEE c95.1 IEEE standard for safety levels with respect to human exposure to radio frequency electromagnetic fields, 3 kHz to 300 GHz. <https://ieeexplore.ieee.org/document/1626482/>.

Interphone Study Group . (2010). Brain tumour risk in relation to mobile telephone use: Results of the INTERPHONE international case-control study. *Int J Epidemiol.* 39(3):675–694.

Karipidis, K. , Elwood, M. , Benke, G. , et al. (2018). Mobile phone use and incidence of brain tumour histological types, grading or anatomical location: A population-based ecological study. *BMJ Open* 8(12):e024489. <https://doi.org/10.1136/bmjopen-2018-024489>.

Kesari, K.K. , Agarwal, A. , Henkel, R. (2018). Radiations and male fertility. *Reprod Biol Endocrinol.* 16(1):118. <https://doi.org/10.1186/s12958-018-0431-1>.

Kostoff, R.N. , Lau, C.G.Y. (2013). Combined biological and health effects of electromagnetic fields and other agents in the published literature. *Technol. Forecast Soc. Change* 80(7):1331–1349.

Leach, V. , Weller, S. , Redmayne, M. (2018). Database of bio-effects from non-ionizing radiation: A novel database of bio-effects from non-ionizing radiation. *Rev. Environ. Health* 33(3):273–280. <https://doi.org/10.1515/reveh-2018-0017>; <https://www.ncbi.nlm.nih.gov/pubmed/29874195>.

Lerchl, A. , Kloese, M. , Grote, K. , et al. (2015). Tumor promotion by exposure to radiofrequency electromagnetic fields below exposure limits for humans. *Biochem Biophys Res Commun.* 459(4):585–590. Massachusetts, United States of America . (2017). Legislative update on bills on wireless and health. <https://ehtrust.org/massachusetts-2017-bills-wireless-health/>.

Melnick, R.L. (2019). Commentary on the utility of the national toxicology program study on cellphone radiofrequency radiation data for assessing human health risks despite unfounded criticisms aimed at minimizing the findings of adverse health effects. *Environ Res.* 168:1–6.

Meo, S.A. , Almahmoud, M. , Alsultan, Q. , et al. (2018). Mobile phone base station tower settings adjacent to school buildings: Impact on students' cognitive health. *Am. J. Mens Health.* 7:1557988318816914. <https://doi.org/10.1177/1557988318816914>.

Miller, A.B. , To, T. , Agnew, D.A. , Wall, C. , Green, L.M. (1996). Leukemia following occupational exposure to 60-Hz electric and magnetic fields among Ontario electric utility workers. *Am J Epidemiol.* 144(2):150–160.

Miller, A.B. , Morgan, L.L. , Udasin, I. , Davis, D.L. (2018). Cancer epidemiology update, following the 2011 IARC evaluation of radiofrequency electromagnetic fields (monograph 102). *Environ Res.* 167:673–683.

Miller, A.B. , Sears, M.E. , Morgan, L.L. , et al. (2019). Risks to health and well-being from radio-frequency radiation emitted by cell phones and other wireless devices. *Front. Public Health* 7:223. <https://doi.org/10.3389/fpubh.2019.00223>.

Moon, I.S. , Kim, B.G. , Kim, J. , Lee, J.D. , Lee, W.S. (2014). Association between vestibular schwannomas and mobile phone use. *Tumour Biol.* 35(1):581–587. <https://doi.org/10.1007/s13277-013-1081-8>.

Moulder, J.E. , Erdreich, L.S. , Malyapa, R.S. , et al. (1999). Cell phones and cancer: What is the evidence for a connection? *Radiat Res.* 151(5):513–531.

Moulder, J.E. , Foster, K.R. , Erdreich, L.S. , McNamee, J.P. (2005). Mobile phones mobile phone base stations and cancer: A review. *Int J Radiat Biol.* 81(3):189–203.

National Toxicology Program . (2018a). NTP technical report on the toxicology and carcinogenesis studies in Hsd:Sprague-Dawley SD rats exposed to whole-body radio frequency radiation at a frequency (900 MHz) and modulations (GSM and CDMA) used by cell phones. NTP TR 595.

National Toxicology Program . (2018b). NTP technical report on the toxicology and carcinogenesis studies in B6C3F1/N mice exposed to whole-body radio frequency radiation at a frequency (1800 MHz) and modulations (GSM and CDMA) used by cell phones. NTP TR 596. https://ntp.niehs.nih.gov/ntp/about_ntp/trpanel/2018/march/tr596peerdraft.pdf.

Nilsson, J. , Järås, J. , Henriksson, R. , et al. (2019). No evidence for increased brain tumour incidence in the Swedish national cancer register between years 1980–2012. *Anticancer Res.* 39(2):791–796. <https://doi.org/10.21873/anticancer.13176>.

Odemer, R. , Odemer, F. (2019). Effects of radiofrequency electromagnetic radiation (RF-EMF) on honey bee queen development and mating success. *Sci Total Environ.* 661:553–562. <https://doi.org/10.1016/j.scitotenv.2019.01.154>.

Olsson, A. , Bouaoun, L. , Auvinen, A. , et al. (2019). Survival of glioma patients in relation to mobile phone use in Denmark, Finland and Sweden. *J Neurooncol.* 141(1):139–149. <https://doi.org/10.1007/s11060-018-03019-5>.

Ostrom, Q.T. , Gittleman, H. , de Blank, P.M. , et al. (2016). Adolescent and young adult primary brain and central nervous system tumors diagnosed in the United States in 2008–2012. *Neuro-Oncology* 18(suppl_1):1–50. <https://doi.org/10.1093/neuonc/nov297>.

Ostrom, Q.T. , Gittleman, H. , Truitt, G. , et al. (2018). CBTRUS statistical report: Primary brain and other central nervous system tumors diagnosed in the United States in 2011–2015. *Neuro-Oncology* 20(suppl 4):1–86. <https://doi.org/10.1093/neuonc/noy131>.

Ostrom, Q.T. , Patil, N. , Cioffi, G. , et al. (2020). CBTRUS statistical report. Primary brain and other central nervous system tumors diagnosed in the United States in 2013–2017. *Neuro-Oncology* 22(12 suppl 2):iv1–iv96. <https://doi.org/10.1093/neuonc/noaa200>.

Pall, M.L. (2016). Microwave frequency electromagnetic fields (EMFs) produce widespread neuropsychiatric effects including depression. *J Chem Neuroanat.* 75(Pt B):43–51. <https://doi.org/10.1016/j.jchemneu.2015.08.001>.

Panagopoulos, D.J. , Karabarbounis, A. , Margaritis, L.H. (2004). Effect of GSM 900-MHz mobile phone radiation on the reproductive capacity of *Drosophila melanogaster*. *Electromagn Biol Med.* 23(1):29–43.

Panagopoulos, D.J. , Johansson, O. , Carlo, G.L. (2013). Evaluation of specific absorption rate as a dosimetric quantity for electromagnetic fields bioeffects. *PLOS ONE* 8(6):e62663.

<https://doi.org/10.1371/journal.pone.0062663>.

Panagopoulos, D.J. , Johansson, O. , Carlo, G.L. (2015). Polarization: A key difference between man-made and natural electromagnetic fields, in regard to biological activity. *Sci Rep.* 5:14914.

<https://doi.org/10.1038/srep14914>.

Panagopoulos, D.J. (2019). Comparing DNA damage induced by mobile telephony and other types of man-made electromagnetic fields. *Mutat Res Rev Mutat Res.* 781:53–62.

Philips, A. , Henshaw, D.L. , Lamburn, G. , O'Carroll, L.M.J. (2018). Brain tumours: Rise in Glioblastoma multiforme incidence in England 1995–2015 suggests an adverse environmental or lifestyle factor. *J Public Health Environ.*:7910754. <https://doi.org/10.1155/2018/7910754>.

Rago, R. , Salacone, P. , Caponecchia, L. , et al. (2013). The semen quality of the mobile phone users. *J Endocrinol Invest.* 36(11):970–974. <https://doi.org/10.3275/8996>.

Rappaport, T.S. , Sun, S. , Mayzus, R. , et al. (2013). Millimeter wave mobile communications for 5G cellular: It will work! *IEEE Access* 1:335–349. <https://doi.org/10.1109/ACCESS.2013.2260813>.

Redmayne, M. , Smith, E. , Abramson, M.J. (2013). The relationship between adolescents' well-being and their wireless phone use: A cross-sectional study. *Environ. Health* 12:90. <https://doi.org/10.1186/1476-069X-12-90>.

Röösli, M. , Lagorio, S. , Schoemaker, M.J. , Schüz, J. , Feychting, M. (2019). Brain and salivary gland tumors and mobile phone use: Evaluating the evidence from various epidemiological study designs. *Annu. Rev. Public Health*; January 11. <https://doi.org/10.1146/annurev-publhealth-040218-044037>.

Russell, C.L. (2018). 5G wireless telecommunications expansion: Public health and environmental implications. *Environ Res.* 165:484–495.

Sage, C. , Burgio, E. (2018). Electromagnetic fields, pulsed radiofrequency radiation, and epigenetics: How wireless technologies may affect childhood development. *Child Dev.* 89(1):129–136.

<https://doi.org/10.1111/cdev.12824>.

Salford, L.G. , Brun, A.E. , Eberhardt, J.L. , Marmgren, L. , Persson, B.R. (2003). Nerve cell damage in mammalian brain after exposure to microwaves from GSM mobile phones. *Environ Health Perspect.* 111(7):881–883.

Samuel, H. (2018). The telegraph. France to impose total ban on mobile phones in schools.

<https://www.telegraph.co.uk/news/2017/12/11/france-impose-total-ban-mobile-phones-schools/>.

Savitz, D.A. , Wachtel, H. , Barnes, F. , John, E.M. , Tvrdik, J.G. (1988). Case-control study of childhood cancer and exposure to 60Hz magnetic fields. *Am J Epidemiol.* 128(1):21–38.

Sharma, V.P. , Kumar, N.R. (2010). Changes in honeybee behaviour and biology under the influence of cellphone radiations. *Curr Sci.* 98:1376–1378.

Szmigielski, S. (2013). Reaction of the immune system to low-level RF/MW exposures. *Sci Total Environ.* 454–455:393–400.

Söderqvist, F. , Carlberg, M. , Hardell, L. (2012). Review of four publications on the Danish cohort study on mobile phone subscribers and risk of brain tumours. *Rev. Environ. Health* 27(1):51–58.

Soffritti, M. , Giuliani, L. (2019). The carcinogenic potential of non-ionizing radiations: The cases of S-50 Hz MF and 1.8 GHz GSM radiofrequency radiation. *Basic Clin Pharmacol Toxicol.* February 24.

<https://doi.org/10.1111/bcpt.13215>.

Sudan, M. , Olsen, J. , Arah, O.A. , Obel, C. , Kheifets, L. (2016). Prospective cohort analysis of cellphone use and emotional and behavioural difficulties in children. *J. Epidemiol. Community Health.*

<https://doi.org/10.1136/jech-2016-207419>.

Tuor, M. , Ebert, S. , Schuderer, J. , Kuster, N. (2005). Assessment of ELF exposure from GSM handsets and development of an optimized RF/ELF exposure setup for studies of human volunteers, BAG Reg. No. 2.23.02.-18/02.001778, IT'IS Foundation.

Vijayalaxmi, Prihoda, T.J. (2019). Comprehensive review of quality of publications and meta-analysis of genetic damage in mammalian cells exposed to non-ionizing radiofrequency fields. *Radiat Res.* 191(1):20–30.

<https://doi.org/10.1667/RR15117.1>.

Villeneuve, P.J. , Agnew, D.A. , Miller, A.B. , Corey, P.N. (2000a). Non-Hodgkin's lymphoma among electric utility workers in Ontario: The evaluation of alternate indices of exposure to 60 Hz electric and magnetic fields. *Occup Environ Med.* 57(4):249–257.

Villeneuve, P.J. , Agnew, D.A. , Miller, A.B. , Corey, P.N. , Purdham, J.T. (2000b). Leukemia in electric utility workers: The evaluation of alternative indices of exposure to 60 Hz electric and magnetic fields. *Am J Ind Med.* 37(6):607–617.

Volkow, N.D. , Tomasi, D. , Wang, G.-J. , et al. (2011). Effects of cell phone radiofrequency signal exposure on brain glucose metabolism. *JAMA* 305(8):808–813.

Vrijheid, M. , Deltour, I. , Krewski, D. , Sanchez, M. , Cardis, E. (2006). The effects of recall errors and of selection bias in epidemiologic studies of mobile phone use and cancer risk. *J Expo Sci Environ Epidemiol.*:1–14. <https://doi.org/10.1038/sj.jes.7500509>.

Waldmann-Selsam, C. , Balmori-de la Plante, A. , Breunig, H. , Balmori, A. (2016). Radiofrequency radiation injures trees around mobile phone base stations. *Sci Total Environ.* 572:554–569.

<https://doi.org/10.1016/j.scitotenv.2016.08.045>.

Walsh, J.J. , Barnes, J.D. , Cameron, J.D. , et al. (2018). Associations between 24 hour movement behaviours and global cognition in US children: A cross-sectional observational study. *The Lancet Child Adolesc. Health,*

September 27, 2018. [https://doi.org/10.1016/S2352-4642\(18\)30278-5](https://doi.org/10.1016/S2352-4642(18)30278-5) (accessed September 29, 2018).

Wdowiak, A. , Wdowiak, L. , Wiktor, H. (2007). Evaluation of the effect of using mobile phones on male fertility. *Ann Agric Environ Med.* 14(1):169–172.

Wertheimer, N. , Leeper, E. (1979). Electrical wiring configurations and childhood cancer. *Am J Epidemiol.* 109(3):273–284.

West, J.G. , Kapoor, N.S. , Liao, S.-Y. , et al. (2013). Multifocal breast cancer in young women with prolonged contact between their breasts and their cellular phones. *Case Rep Med.* 2013:354682.

Worcester Massachusetts Public Schools . (2017). Worcester school committee precautionary option on radiofrequency exposure. http://wpsweb.com/sites/default/files/www/school_safety/radio_frequency.pdf.

Ying, L. , Héroux, P. (2014). Extra-low-frequency magnetic fields alter cancer cells through metabolic restriction. *Electromagn Biol Med.* 33(4):264–275. <https://doi.org/10.3109/15368378.2013.817334>.

Yakymenko, I. , Tsybulin, O. , Sidorik, E. , et al. (2016). Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation. *Electromagn Biol Med.* 35(2):186–202.

Zhang, G. , Yan, H. , Chen, Q. , et al. (2016). Effects of cell phone use on semen parameters: Results from the MARHCS cohort study in Chongqing, China. *Environ Int.* 91:116–121. <https://doi.org/10.1016/j.envint.2016.02.028>.

Zwamborn, A.P.M. , Vossen, S.H.J.A. , van Leersum, B.J.A.M. , et al. (2003). Effects of global communication system radio-frequency fields on well being and cognitive functions of human subjects with and without subjective complaints. FEL-03-C148. The Hague, the Netherlands: TNO Physics and Electronics Laboratory. http://home.tiscali.be/milieugezondheid/dossiers/gsm/TNO_rapport_Nederland_sept_2003.pdf.

Oxidative Stress Induced by Wireless Communication Electromagnetic Fields

Abdel-Rassoul, G. , El-Fateh, O. A. , Salem, M. A. , et al. (2007). Neurobehavioral effects among inhabitants around mobile phone base stations. *Neurotoxicology* 28(2):434–440.

Abu Khadra, K. M. , Khalil, A. M. , Abu Samak, M. , et al. (2014). Evaluation of selected biochemical parameters in the saliva of young males using mobile phones. *Electromagnetic Biology and Medicine*, 34(1):1–5.

Abyaneh, E. B. (2018). Low frequency electromagnetic field induced oxidative stress in *Lepidium sativum* L. *Iranian Journal of Science and Technology, Transactions A: Science* 42(3):1419–1426.

Agarwal, A. , Desai, N. R. , Makker, K. , et al. (2009). Effects of radiofrequency electromagnetic waves (RF-EMW) from cellular phones on human ejaculated semen: An in vitro pilot study. *Fertility and Sterility* 92(4):1318–1325.

Ahmed, N. A. , Radwan, N. M. , Aboul Ezz, H. S. , Salama, N. A. (2017). The antioxidant effect of green tea mega EGCG against electromagnetic radiation-induced oxidative stress in the hippocampus and striatum of rats. *Electromagnetic Biology and Medicine* 36(1):63–73.

Akbari, A. , Jelodar, G. , Nazifi, S. (2014). Vitamin C protects rat cerebellum and encephalon from oxidative stress following exposure to radiofrequency wave generated by BTS antenna mobile. *Toxicology Mechanisms and Methods* , 24(5):347–352.

Akdag, M. Z. , Dasdag, S. , Ulukaya, E. , et al. (2010). Effects of extremely low-frequency magnetic field on caspase activities and oxidative stress values in rat brain. *Biological Trace Element Research* 138(1):238–249.

Akdag, M. Z. , Dasdag, S. , Uzunlar, A. K. , et al. (2013). Can safe and long-term exposure to extremely low frequency (50 Hz) magnetic fields affect apoptosis, reproduction, and oxidative stress? *International Journal of Radiation Biology* 89(12):1053–1060.

Akefe, I. O. , Yusuf, I. L. , Adegoke, V. A. (2019). C-glycosyl flavonoid orientin alleviates learning and memory impairment by radiofrequency electromagnetic radiation in mice via improving antioxidant defence mechanism. *Asian Pacific Journal of Tropical Biomedicine* 9(12):518.

Akkam, Y. , A Al-Taani, A. , Ayasreh, S. , Akkam, N. (2020). Correlation of blood oxidative stress parameters to indoor radiofrequency radiation: A cross sectional study in Jordan. *International Journal of Environmental Research and Public Health* 17(13):4673.

Al-Damegh, M. A. (2012). Rat testicular impairment induced by electromagnetic radiation from a conventional cellular telephone and the protective effects of the antioxidants vitamins C and E. *Clinics* 67(7):785–792.

Alkis, M. E. , Bilgin, H. M. , Akpolat, V. , et al. (2019). Effect of 900-, 1800-, and 2100-MHz radiofrequency radiation on DNA and oxidative stress in brain. *Electromagnetic Biology and Medicine* 38(1):32–47.

Asl, J. F. , Goudarzi, M. , Shoghi, H. (2020). The radio-protective effect of rosmarinic acid against mobile phone and wi-fi radiation-induced oxidative stress in the brains of rats. *Pharmacological Reports* 72(4):857–866.

Avci, B. , Akar, A. , Bilgici, B. , et al. (2012). Oxidative stress induced by 1.8 GHz radio frequency electromagnetic radiation and effects of garlic extract in rats. *International Journal of Radiation Biology* 88(11):799–805.

Ayata, A. , Mollaoglu, H. , Yilmaz, H. R. , et al. (2004). Oxidative stress-mediated skin damage in an experimental mobile phone model can be prevented by melatonin. *Journal of Dermatology* 31(11):878–883.

- Aynali, G. , Naziroglu, M. , Celik, O. , et al. (2013). Modulation of wireless (2.45 GHz)-induced oxidative toxicity in laryngotracheal mucosa of rat by melatonin. *European Archives of Oto-Rhino-Laryngology: Official Journal of the European Federation of Oto-Rhino-Laryngological Societies* 270(5):1695–1700.
- Bagheri Hosseinabadi, M. , Khanjani, N. , Ebrahimi, M. H. , Haji, B. , Abdolahfard, M. (2019). The effect of chronic exposure to extremely low-frequency electromagnetic fields on sleep quality, stress, depression and anxiety. *Electromagnetic Biology and Medicine* 38(1):96–101.
- Bagheri Hosseinabadi, M. , Khanjani, N. , Norouzi, P. , et al. (2021). Oxidative stress associated with long term occupational exposure to extremely low frequency electric and magnetic fields. *Work* 68(2), 379–386.
- Bahreyni Toossi, M. H. , Sadeghnia, H. R. , Mohammad Mahdizadeh Feyzabadi, M. , et al. (2018). Exposure to mobile phone (900–1800 MHz) during pregnancy: Tissue oxidative stress after childbirth. *The Journal of Maternal-Fetal and Neonatal Medicine* 31(10):1298–1303.
- Balci, M. , Devrim, E. , Durak, I. (2007). Effects of mobile phones on oxidant/antioxidant balance in cornea and lens of rats. *Current Eye Research* 32(1):21–25.
- Baohong, W. , Jiliang, H. , Lifan, J. , et al. (2005). Studying the synergistic damage effects induced by 1.8 GHz radiofrequency field radiation (RFR) with four chemical mutagens on human lymphocyte DNA using comet assay in vitro. *Mutation Research* 578(1–2):149–157.
- Belpomme, D. , Irigaray, P. (2020). Electrohypersensitivity as a newly identified and characterized neurologic pathological disorder: How to diagnose, treat, and prevent it. *International Journal of Molecular Sciences* 21(6):1915.
- Belyaev, I. (2010). Dependence of non-thermal biological effects of microwaves on physical and biological variables: Implications for reproducibility and safety standards. *European Journal of Oncology Library* 5:187–217.
- Belyaev, I. Y. , Koch, C. B. , Terenius, O. , et al. (2006). Exposure of rat brain to 915 MHz GSM microwaves induces changes in gene expression but not double stranded DNA breaks or effects on chromatin conformation. *Bioelectromagnetics* 27(4):295–306.
- Bilgici, B. , Akar, A. , Avci, B. , et al. (2013). Effect of 900 MHz radiofrequency radiation on oxidative stress in rat brain and serum. *Electromagnetic Biology and Medicine* 32(1):20–29.
- Blank, M. , Soo, L. (2001). Electromagnetic acceleration of electron transfer reactions. *Journal of Cellular Biochemistry* 81(2):278–283.
- Blank, M. , Soo, L. (2003). Electromagnetic acceleration of the Belousov-Zhabotinski reaction. *Bioelectrochemistry* 61(1–2):93–97.
- Bodera, P. , Stankiewicz, W. , Zawada, K. , et al. (2013). Changes in antioxidant capacity of blood due to mutual action of electromagnetic field (1800 MHz) and opioid drug (tramadol) in animal model of persistent inflammatory state. *Pharmacological Reports: PR* 65(2):421–428.
- Bohr, H. , Bohr, J. (2000a). Microwave-enhanced folding and denaturation of globular proteins. *Physical Review: Part E* 61(4):4310–4314.
- Bohr, H. , Bohr, J. (2000b). Microwave enhanced kinetics observed in ORD studies of a protein. *Bioelectromagnetics* 21(1):68–72.
- Boldogh, I. , Bacsi, A. , Choudhury, B. K. , et al. (2005). ROS generated by pollen NADPH oxidase provide a signal that augments antigen-induced allergic airway inflammation. *The Journal of Clinical Investigation* 115(8):2169–2179.
- Brocklehurst, B. , McLauchlan, K. A. (1996). Free radical mechanism for the effects of environmental electromagnetic fields on biological systems. *International Journal of Radiation Biology* 69(1):3–24.
- Buchner, K. , Eger, H. (2011). Changes of clinically important neurotransmitters under the influence of modulated RF fields—A long-term study under real-life conditions. *Umwelt - Medizin-Gesellschaft* 24(1):44–57.
- Budi, A. , Legge, F. S. , Treutlein, H. , Yarovsky, I. (2007). Effect of frequency on insulin response to electric field stress. *The Journal of Physical Chemistry: Part B* 111(20):5748–5756.
- Budziosz, J. , Stanek, A. , Sieroń, A. , et al. (2018). Effects of low-frequency electromagnetic field on oxidative stress in selected structures of the central nervous system. *Oxidative Medicine and Cellular Longevity*, 2018, 1427412.
- Burlaka, A. , Tsybulin, O. , Sidorik, E. , et al. (2013). Overproduction of free radical species in embryonic cells exposed to low intensity radiofrequency radiation. *Experimental Oncology* 35(3):219–225.
- Burlaka, A. , Selyuk, M. , Gafurov, M. , et al. (2014). Changes in mitochondrial functioning with electromagnetic radiation of ultra high frequency as revealed by electron paramagnetic resonance methods. *International Journal of Radiation Biology* 90(5):357–362.
- Byus, C. V. , Kartun, K. , Pieper, S. , Adey, W. R. (1988). Increased ornithine decarboxylase activity in cultured cells exposed to low energy modulated microwave fields and phorbol ester tumor promoters. *Cancer Research* 48(15):4222–4226.
- Calabrese, E. J. (2008). Hormesis: Why it is important to toxicology and toxicologists. *Environmental Toxicology and Chemistry* 27(7):1451–1474.
- Campisi, A. , Gulino, M. , Acquaviva, R. , et al. (2010). Reactive oxygen species levels and DNA fragmentation on astrocytes in primary culture after acute exposure to low intensity microwave electromagnetic field. *Neuroscience Letters* 473(1):52–55.

- Canseven, A. G. , Coskun, S. , Seyhan, N. (2008). Effects of various extremely low frequency magnetic fields on the free radical processes, natural antioxidant system and respiratory burst system activities in the heart and liver tissues, *Indian Journal of Biochemistry & Biophysics*, 45:326–331.
- Caraglia, M. , Marra, M. , Mancinelli, F. , et al. (2005). Electromagnetic fields at mobile phone frequency induce apoptosis and inactivation of the multi-chaperone complex in human epidermoid cancer cells. *Journal of Cellular Physiology* 204(2):539–548.
- Cardis, E. , Deltour, I. , Vrijheid, M. , et al. (2010). Brain tumour risk in relation to mobile telephone use: Results of the INTERPHONE international case-control study. *International Journal of Epidemiology* 39(3):675–694.
- Carpenter, D. O. (2013). Human disease resulting from exposure to electromagnetic fields. *Reviews on Environmental Health* 28(4):159–172.
- Çenesiz, M. , Atakışi, O. , Akar, A. , et al. (2011). Effects of 900 and 1800 MHz electromagnetic field application on electrocardiogram, nitric oxide, total antioxidant capacity, total oxidant capacity, total protein, albumin and globulin levels in guinea pigs. *Kafkas Üniversitesi Veteriner Fakültesi Dergisi* 17(3):357–362.
- Céspedes, O. , Ueno, S. (2009). Effects of radio frequency magnetic fields on iron release from cage proteins. *Bioelectromagnetics* 30(5):336–342.
- Çetin, H. , Naziroglu, M. , Çelik, Ö. , et al. (2014). Liver antioxidant stores protect the brain from electromagnetic radiation (900 and 1800 MHz)-induced oxidative stress in rats during pregnancy and the development of offspring. *The Journal of Maternal-Fetal and Neonatal Medicine (Published online)*:1–6.
- Chavdoula, E. D. , Panagopoulos, D. J. , Margaritis, L. H. (2010). Comparison of biological effects between continuous and intermittent exposure to GSM-900 MHz mobile phone radiation: Detection of apoptotic cell death features. *Mutation Research* 700(1–2):51–61.
- Chekhun, V. , Yakymenko, I. , Sidorik, E. , et al. (2014). Current state of international and national public safety limits for radiofrequency radiation. *Scientific Journal of the Ministry of Health of Ukraine* 1:57–64.
- Cho, S. I. , Nam, Y. S. , Chu, L. Y. , et al. (2012). Extremely low-frequency magnetic fields modulate nitric oxide signaling in rat brain. *Bioelectromagnetics* 33(7):568–574.
- Chou, C. K. , Guy, A. W. , Kunz, L. L. , et al. (1992). Long-term, low-level microwave irradiation of rats. *Bioelectromagnetics* 13(6):469–496.
- Christ, A. , Gosselin, M. C. , Christopoulou, M. , Kühn, S. , Kuster, N. (2010). Age-dependent tissue-specific exposure of cell phone users. *Physics in Medicine and Biology* 55(7):1767–1783.
- Chu, L. Y. , Lee, J. H. , Nam, Y. S. , et al. (2011). Extremely low frequency magnetic field induces oxidative stress in mouse cerebellum. *General Physiology and Biophysics* 30(4):415–421.
- Chu, M. K. , Song, H. G. , Kim, C. , Lee, B. C. (2011). Clinical features of headache associated with mobile phone use: A cross-sectional study in university students. *BMC Neurology* 11:115.
- Ciejka, E. , Kleniewska, P. , Skibska, B. , Goraca, A. (2011). Effects of extremely low frequency magnetic field on oxidative balance in brain of rats. *Journal of Physiology and Pharmacology* 62(6):657.
- Clifford, A. , Morgan, D. , Yuspa, S. H. , Soler, A. P. , Gilmour, S. (1995). Role of ornithine decarboxylase in epidermal tumorigenesis. *Cancer Research* 55(8):1680–1686.
- Consales, C. , Merla, C. , Marino, C. , Benassi, B. (2012). Electromagnetic fields, oxidative stress, and neurodegeneration. *International Journal of Cell Biology* 2012:683897.
- Cui, Y. , Ge, Z. , Rizak, J. D. , et al. (2012). Deficits in water maze performance and oxidative stress in the hippocampus and striatum induced by extremely low frequency magnetic field exposure. *PLOS ONE* 7(5):e32196.
- Dasdag, S. , Zulkuf Akdag, M. , Aksen, F. , et al. (2003). Whole body exposure of rats to microwaves emitted from a cell phone does not affect the testes. *Bioelectromagnetics* 24(3):182–188.
- Dasdag, S. , Bilgin, H. , Akdag, M. Z. , Celik, H. , Aksen, F. (2008). Effect of long term mobile phone exposure on oxidative-antioxidative processes and nitric oxide in rats. *Biotechnology and Biotechnological Equipment* 22(4):992–997.
- Dasdag, S. , Akdag, M. Z. , Ulukaya, E. , Uzunlar, A. K. , Ocak, A. R. (2009). Effect of mobile phone exposure on apoptotic glial cells and status of oxidative stress in rat brain. *Electromagnetic Biology and Medicine* 28(4):342–354.
- Dasdag, S. , Akdag, M. Z. , Kizil, G. , et al. (2012). Effect of 900 MHz radio frequency radiation on beta amyloid protein, protein carbonyl, and malondialdehyde in the brain. *Electromagnetic Biology and Medicine* 31(1):67–74.
- De Iullis, G. N. , Newey, R. J. , King, B. V. , Aitken, R. J. (2009). Mobile phone radiation induces reactive oxygen species production and DNA damage in human spermatozoa in vitro. *PLOS ONE* 4(7):e6446.
- De Salles, A. A. , Bulla, G. , Rodriguez, C. E. (2006). Electromagnetic absorption in the head of adults and children due to mobile phone operation close to the head. *Electromagnetic Biology and Medicine* 25(4):349–360.
- De Souza, F. T. , Silva, J. F. , Ferreira, E. F. , et al. (2014). Cell phone use and parotid salivary gland alterations: No molecular evidence. *Cancer Epidemiology, Biomarkers and Prevention (Published online)*:1357.
- Demirel, S. , Doganay, S. , Turkoz, Y. , et al. (2012). Effects of third generation mobile phone-emitted electromagnetic radiation on oxidative stress parameters in eye tissue and blood of rats. *Cutaneous and Ocular Toxicology* 31(2):89–94.

- Deng, Y. , Zhang, Y. , Jia, S. , et al. (2013). Effects of aluminum and extremely low frequency electromagnetic radiation on oxidative stress and memory in brain of mice. *Biological Trace Element Research* 156(1):243–252.
- Desai, N. R. , Kesari, K. K. , Agarwal, A. (2009). Pathophysiology of cell phone radiation: Oxidative stress and carcinogenesis with focus on male reproductive system. *Reproductive Biology and Endocrinology: RB and E* 7:114.
- Deshmukh, P. S. , Banerjee, B. D. , Abegaonkar, M. P. , et al. (2013). Effect of low level microwave radiation exposure on cognitive function and oxidative stress in rats. *Indian Journal of Biochemistry and Biophysics* 50(2):114–119.
- Diem, E. , Schwarz, C. , Adlkofer, F. , Jahn, O. , Rüdiger, H. (2005). Non-thermal DNA breakage by mobile-phone radiation (1800MHz) in human fibroblasts and in transformed GFSH-R17 rat granulosa cells in vitro. *Mutation Research/Genetic Toxicology and Environmental Mutagenesis* 583(2):178–183.
- Ding, S.-S. , Sun, P. , Zhang, Z. , et al. (2018). Moderate dose of trolox preventing the deleterious effects of wi-fi radiation on spermatozoa in vitro through reduction of oxidative stress damage. *Chinese Medical Journal (English Edition)* 131(4):402.
- Duan, Y. , Wang, Z. , Zhang, H. , et al. (2013). The preventive effect of lotus seedpod procyanidins on cognitive impairment and oxidative damage induced by extremely low frequency electromagnetic field exposure. *Food and Function* 4(8):1252–1262. <https://doi.org/10.1039/C3FO60116A>.
- Dutta, S. K. , Ghosh, B. , Blackman, C. F. (1989). Radiofrequency radiation-induced calcium ion efflux enhancement from human and other neuroblastoma cells in culture. *Bioelectromagnetics* 10(2):197–202.
- Eger, H. , Hagen, K. , Lucas, B. , et al. (2004). Influence of the proximity of mobile phone base stations on the incidence of cancer. *Environmental Medicine Society* 17:273–356.
- Emre, M. , Cetiner, S. , Zencir, S. , et al. (2011). Oxidative stress and apoptosis in relation to exposure to magnetic field. *Cell Biochemistry and Biophysics* 59(2):71–77.
- Enyedí, B. , Niethammer, P. (2013). H₂O₂: A chemoattractant? *Methods in Enzymology* 528:237–255.
- Erdal, N. , Gürgül, S. , Tamer, L. , Ayaz, L. (2008). Effects of long-term exposure of extremely low frequency magnetic field on oxidative/nitrosative stress in rat liver. *Journal of Radiation Research* 49(2):181–187.
- Ericsson , (2009). LTE – an introduction. White Paper. 2009.
- Ertilav, K. , Uslusoy, F. , Ataizi, S. , Nazıroğlu, M. (2018). Long term exposure to cell phone frequencies (900 and 1800 MHz) induces apoptosis, mitochondrial oxidative stress and TRPV1 channel activation in the hippocampus and dorsal root ganglion of rats. *Metabolic Brain Disease* 33(3):753–763.
- Esmekaya, M. A. , Ozer, C. , Seyhan, N. (2011). 900 MHz pulse-modulated radiofrequency radiation induces oxidative stress on heart, lung, testis and liver tissues. *General Physiology and Biophysics* 30(1):84–89.
- Falone, S. , Grossi, M. R. , Cinque, B. , et al. (2007). Fifty hertz extremely low-frequency electromagnetic field causes changes in redox and differentiative status in neuroblastoma cells. *The International Journal of Biochemistry and Cell Biology* 39(11):2093–2106.
- Ferreira, A. R. , Bonatto, F. , de Bittencourt Pasquali, M. A. , et al. (2006). Oxidative stress effects on the central nervous system of rats after acute exposure to ultra high frequency electromagnetic fields. *Bioelectromagnetics* 27(6):487–493.
- Forman, H. J. , Ursini, F. , Maiorino, M. (2014). An overview of mechanisms of redox signaling. *Journal of Molecular and Cellular Cardiology*, 73:2–9.
- Frank, J. W. (2021). Electromagnetic fields, 5G and health: What about the precautionary principle? *Journal of Epidemiology and Community Health* 75(6):562–566.
- Friedman, J. , Kraus, S. , Hauptman, Y. , Schiff, Y. , Seger, R. (2007). Mechanism of short-term ERK activation by electromagnetic fields at mobile phone frequencies. *Biochemical Journal* 405(3):559–568.
- Gandhi, O. , Lazzi, G. , Furse, C. (1996). Electromagnetic absorption in the human head and neck for mobile telephones at 835 and 1900 MHz. *IEEE Transactions on Microwave Theory and Techniques* 44(10):1884–1897.
- Gao, Q.-H. , Cai, Q. , Fan, Y. (2017). Beneficial effect of catechin and epicatechin on cognitive impairment and oxidative stress induced by extremely low frequency electromagnetic field. *Journal of Food Biochemistry* 41(6):e12416.
- Garaj-Vrhovac, V. , Fucic, A. , Horvat, D. (1992). The correlation between the frequency of micronuclei and specific chromosome aberrations in human lymphocytes exposed to microwave radiation in vitro. *Mutation Research* 281(3):181–186.
- Garaj-Vrhovac, V. , Gajski, G. , Pažanin, S. , et al. (2011). Assessment of cytogenetic damage and oxidative stress in personnel occupationally exposed to the pulsed microwave radiation of marine radar equipment. *International Journal of Hygiene and Environmental Health* 214(1):59–65.
- Garson, O. M. , McRobert, T. L. , Campbell, L. J. , Hocking, B. A. , Gordon, I. (1991). A chromosomal study of workers with long-term exposure to radio-frequency radiation. *The Medical Journal of Australia* 155(5):289–292.
- Gautam, R. , Singh, K. V. , Nirala, J. , et al. (2019). Oxidative stress-mediated alterations on sperm parameters in male Wistar rats exposed to 3G mobile phone radiation. *Andrologia* 51(3):e13201.
- Georgiou, C. D. (2010). Oxidative stress-induced biological damage by low-level EMFs: Mechanism of free radical pair electron spin-polarization and biochemical amplification. *European Journal of Oncology - Library* 5:63–113.

- Goodman, E. M. , Greenebaum, B. , Marron, M. T. (1995). Effects of electro-magnetic fields on molecules and cells. *International Review of Cytology* 158:279–338.
- Goodman, R. , Blank, M. (2002). Insights into electromagnetic interaction mechanisms. *Journal of Cellular Physiology* 192(1):16–22.
- Goraca, A. , Ciejka, E. , Piechota, A. (2010). Effects of extremely low frequency magnetic field on the parameters of oxidative stress in heart. *Journal of Physiology and Pharmacology* 61(3):333.
- Griendling, K. K. , Sorescu, D. , Ushio-Fukai, M. (2000). NAD(P)H oxidase: Role in cardiovascular biology and disease. *Circulation Research* 86(5):494–501.
- Guleken, Z. (2021). Chronic low-frequency electromagnetic field exposure before and after neonatal life induces changes on blood oxidative parameters of rat offspring. *Annals of Medical Research* 28(2):361–365.
- Guler, G. , Tomruk, A. , Ozgur, E. , et al. (2012). The effect of radiofrequency radiation on DNA and lipid damage in female and male infant rabbits. *International Journal of Radiation Biology* 88(4):367–373.
- Gunes, M. , Ates, K. , Yalcin, B. , et al. (2021). An evaluation of the genotoxic effects of electromagnetic radiation at 900 MHz, 1800 MHz, and 2100 MHz frequencies with a SMART assay in *Drosophila melanogaster*. *Electromagnetic Biology and Medicine*, 40(2):254-263.
- Guney, M. , Ozguner, F. , Oral, B. , Karahan, N. , Mungan, T. (2007). 900 MHz radiofrequency-induced histopathologic changes and oxidative stress in rat endometrium: Protection by vitamins E and C. *Toxicology and Industrial Health* 23(7):411–420.
- Gürler, H. Ş. , Bilgici, B. , Akar, A. K. , et al. (2014). Increased DNA oxidation (8-OHdG) and protein oxidation (AOPP) by low level electromagnetic field (2.45 GHz) in rat brain and protective effect of garlic. *International Journal of Radiation Biology*, 90(10):892-896. .
- Guzy, R. D. , Schumacker, P. T. (2006). Oxygen sensing by mitochondria at complex III: The paradox of increased reactive oxygen species during hypoxia. *Experimental Physiology* 91(5):807–819.
- Hallberg, O. , Oberfeld, G. (2006). Letter to the editor: Will we all become electrosensitive? [Letter]. *Electromagnetic Biology and Medicine* 25(3):189–191.
- Halliwell, B. (1991). Reactive oxygen species in living systems: Source, biochemistry, and role in human disease [Review]. *American Journal of Medicine* 91(3C):14S–22S.
- Halliwell, B. , Whiteman, M. (2004). Measuring reactive species and oxidative damage in vivo and in cell culture: How should you do it and what do the results mean? *British Journal of Pharmacology* 142(2):231–255.
- Halliwell, B. (2007). Biochemistry of oxidative stress [Review]. *Biochemical Society Transactions* 35(Pt 5):1147–1150.
- Hamzany, Y. , Feinmesser, R. , Shpitzer, T. , et al. (2013). Is human saliva an indicator of the adverse health effects of using mobile phones? *Antioxidants and Redox Signaling* 18(6):622–627.
- Hancı, H. , Kerimoğlu, G. , Mercantepe, T. , Odacı, E. (2018). Changes in testicular morphology and oxidative stress biomarkers in 60-day-old Sprague Dawley rats following exposure to continuous 900-MHz electromagnetic field for 1 ha day throughout adolescence. *Reproductive Toxicology* 81:71–78.
- Hardell, L. , Carlberg, M. , Hansson Mild, K. (2005). Case-control study on cellular and cordless telephones and the risk for acoustic neuroma or meningioma in patients diagnosed 2000–2003. *Neuroepidemiology* 25(3):120–128.
- Hardell, L. , Eriksson, M. , Carlberg, M. , Sundström, C. , Mild, K. H. (2005). Use of cellular or cordless telephones and the risk for non-Hodgkin's lymphoma. *International Archives of Occupational and Environmental Health* 78(8):625–632.
- Hardell, L. , Carlberg, M. , Ohlson, C. G. , et al. (2007). Use of cellular and cordless telephones and risk of testicular cancer. *International Journal of Andrology* 30(2):115–122.
- Hardell, L. , Carlberg, M. , Soderqvist, F. , Mild, K. H. , Morgan, L. L. (2007). Long-term use of cellular phones and brain tumours: Increased risk associated with use for > or =10 years. *Occupational and Environmental Medicine* 64(9):626–632.
- Hardell, L. , Carlberg, M. (2009). Mobile phones, cordless phones and the risk for brain tumours. *International Journal of Oncology* 35(1):5–17.
- Hardell, L. , Carlberg, M. , Hansson Mild, K. , Eriksson, M. (2011). Case-control study on the use of mobile and cordless phones and the risk for malignant melanoma in the head and neck region. *Pathophysiology* 18(4):325–333.
- Hashish, A. H. , El-Missiry, M. A. , Abdelkader, H. I. , Abou-Saleh, R. H. (2008). Assessment of biological changes of continuous whole body exposure to static magnetic field and extremely low frequency electromagnetic fields in mice. *Ecotoxicology and Environment Safety* 71(3):895–902.
- Hayden, M. S. , Ghosh, S. (2011). NF-kappa B in immunobiology. *Cell Research* 21(2):223–244.
- Hedendahl, L. , Carlberg, M. , Hardell, L. (2015). Electromagnetic hypersensitivity—an increasing challenge to the medical profession. *Reviews on Environmental Health* 30(4):209–215.
- Hong, M.-N. , Han, N.-K. , Lee, H.-C. , et al. (2012). Extremely low frequency magnetic fields do not elicit oxidative stress in MCF10A cells. *Journal of Radiation Research* 53(1):79–86.
- Hong, M. N. , Kim, B. C. , Ko, Y. G. , et al. (2012). Effects of 837 and 1950 MHz radiofrequency radiation exposure alone or combined on oxidative stress in MCF10A cells. *Bioelectromagnetics* 33(7):604–611.

- Hook, G. J. , Spitz, D. R. , Sim, J. E. , et al. (2004). Evaluation of parameters of oxidative stress after in vitro exposure to FMCW- and CDMA-modulated radiofrequency radiation fields. *Radiation Research* 162(5):497–504.
- Hosseinabadi, M. B. , Khanjani, N. , Ebrahimi, M. H. , Mousavi, S. H. , Nazarkhani, F. (2020). Investigating the effects of exposure to extremely low frequency electromagnetic fields on job burnout syndrome and the severity of depression; the role of oxidative stress. *Journal of Occupational Health* 62(1):e12136.
- Hou, Q. , Wang, M. , Wu, S. , et al. (2014). Oxidative changes and apoptosis induced by 1800-MHz electromagnetic radiation in NIH/3T3 cells. *Electromagnetic Biology and Medicine* (Published online):1–8.
- Houston, B. J. , Nixon, B. , King, B. V. , Aitken, R. J. , De Luliis, G. N. (2018). Probing the origins of 1,800 MHz radio frequency electromagnetic radiation induced damage in mouse immortalized germ cells and spermatozoa in vitro. *Frontiers in Public Health* 6:270.
- Hoyto, A. , Juutilainen, J. , Naarala, J. (2007). Ornithine decarboxylase activity is affected in primary astrocytes but not in secondary cell lines exposed to 872 MHz RF radiation. *International Journal of Radiation Biology* 83(6):367–374.
- Hyland, G. J. (2000). Physics and biology of mobile telephony. *Lancet* 356(9244):1833–1836.
- Hyland, G. J. (2008). Physical basis of adverse and therapeutic effects of low intensity microwave radiation. *Indian Journal of Experimental Biology* 46(5):403–419.
- ICNIRP . (1998). Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz). *Health Physics* 74(4):494–522.
- ICNIRP . (2010). Guidelines for limiting exposure to time-varying electric and magnetic fields (1 Hz to 100 kHz). *Health Physics* 99(6):818–836.
- ICNIRP . (2020). Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz). *Health Physics* 118(5):483–524.
- Ilhan, A. , Gurel, A. , Armutcu, F. , et al. (2004). Ginkgo biloba prevents mobile phone-induced oxidative stress in rat brain. *Clinica Chimica Acta* 340(1–2):153–162.
- Inoue, M. , Sato, E. F. , Nishikawa, M. , et al. (2003). Mitochondrial generation of reactive oxygen species and its role in aerobic life. *Current Medicinal Chemistry* 10(23):2495–2505.
- Irigaray, P. , Caccamo, D. , Belpomme, D. (2018). Oxidative stress in electrohypersensitivity selfreporting patients: Results of a prospective in vivo investigation with comprehensive molecular analysis. *International Journal of Molecular Medicine* 42(4):1885–1898.
- Ismail, L. A. , Joumaa, W. H. , Moustafa, M. E. (2019). The impact of exposure of diabetic rats to 900 MHz electromagnetic radiation emitted from mobile phone antenna on hepatic oxidative stress. *Electromagnetic Biology and Medicine* 38(4):287–296.
- Jelenković, A. , Janać, B. , Pešić, V. , et al. (2006). Effects of extremely low-frequency magnetic field in the brain of rats. *Brain Research Bulletin* 68(5):355–360.
- Jelodar, G. , Akbari, A. , Nazifi, S. (2013a). The prophylactic effect of vitamin C on oxidative stress indexes in rat eyes following exposure to radiofrequency wave generated by a BTS antenna model. *International Journal of Radiation Biology* 89(2):128–131.
- Jelodar, G. , Nazifi, S. , Akbari, A. (2013b). The prophylactic effect of vitamin C on induced oxidative stress in rat testis following exposure to 900 MHz radio frequency wave generated by a BTS antenna model. *Electromagnetic Biology and Medicine* 32(3):409–416.
- Jeong, Y. J. , Son, Y. , Han, N.-K. , et al. (2018). Impact of long-term RF-EMF on oxidative stress and neuroinflammation in aging brains of C57BL/6 mice. *International Journal of Molecular Sciences* 19(7):2103.
- Jing, J. , Yuhua, Z. , Xiao-qian, Y. , et al. (2012). The influence of microwave radiation from cellular phone on fetal rat brain. *Electromagnetic Biology and Medicine* 31(1):57–66.
- Johansson, O. (2006). Electrohypersensitivity: State-of-the-art of a functional impairment. *Electromagnetic Biology and Medicine* 25(4):245–258.
- Johansson, O. , Gangi, S. , Liang, Y. , et al. (2001). Cutaneous mast cells are altered in normal healthy volunteers sitting in front of ordinary TVs/PCs – Results from open-field provocation experiments. *Journal of Cutaneous Pathology* 28(10):513–519.
- Kahya, M. C. , Nazıroğlu, M. , Çiğ, B. (2014). Selenium reduces mobile phone (900 MHz)-induced oxidative stress, mitochondrial function, and apoptosis in breast cancer cells. *Biological Trace Element Research* 160(2):285–293.
- Kamali, K. , Taravati, A. , Sayyadi, S. , Gharib, F. Z. , Maftoon, H. (2018). Evidence of oxidative stress after continuous exposure to wi-fi radiation in rat model. *Environmental Science and Pollution Research International* 25(35):35396–35403.
- Kang, K. A. , Lee, H. C. , Lee, J. J. , et al. (2013). Effects of combined radiofrequency radiation exposure on levels of reactive oxygen species in neuronal cells. *Journal of Radiation Research*, 55(2):265–276.
- Karimi, S. A. , Salehi, I. , Shykhi, T. , Zare, S. , Komaki, A. (2019). Effects of exposure to extremely low-frequency electromagnetic fields on spatial and passive avoidance learning and memory, anxiety-like behavior and oxidative stress in male rats. *Behavioural Brain Research* 359:630–638.
- Kerbacher, J. J. , Meltz, M. L. , Erwin, D. N. (1990). Influence of radiofrequency radiation on chromosome aberrations in CHO cells and its interaction with DNA-damaging agents. *Radiation Research* 123(3):311–319.

- Kerman, M. , Senol, N. (2012). Oxidative stress in hippocampus induced by 900 MHz electromagnetic field emitting mobile phone: Protection by melatonin. *Biomedical Research* 23(1):147–151.
- Kesari, K. K. , Kumar, S. , Behari, J. (2010). Mobile phone usage and male infertility in Wistar rats. *Indian Journal of Experimental Biology* 48(10):987–992.
- Kesari, K. K. , Kumar, S. , Behari, J. (2011). 900-MHz microwave radiation promotes oxidation in rat brain. *Electromagnetic Biology and Medicine* 30(4):219–234.
- Kesari, K. K. , Meena, R. , Nirala, J. , Kumar, J. , Verma, H. N. (2014). Effect of 3G cell phone exposure with computer controlled 2-D stepper motor on non-thermal activation of the hsp27/p38MAPK stress pathway in rat brain. *Cell Biochemistry and Biophysics* 68(2):347–358.
- Khalil, A. M. , Gagaa, M. H. , Alshamali, A. M. (2012). 8-Oxo-7, 8-dihydro-2'-deoxyguanosine as a biomarker of DNA damage by mobile phone radiation. *Human and Experimental Toxicology* 31(7):734–740.
- Khalil, A. M. , Abu Khadra, K. M. , Aljaberi, A. M. , Gagaa, M. H. , Issa, H. S. (2013). Assessment of oxidant/antioxidant status in saliva of cell phone users. *Electromagnetic Biology and Medicine*, 33(2):92–97.
- Kim, J. Y. , Hong, S. Y. , Lee, Y. M. , et al. (2008). In vitro assessment of clastogenicity of mobile-phone radiation (835 MHz) using the alkaline comet assay and chromosomal aberration test. *Environmental Toxicology* 23(3):319–327.
- Kismali, G. , Ozgur, E. , Guler, G. , et al. (2012). The influence of 1800 MHz GSM-like signals on blood chemistry and oxidative stress in non-pregnant and pregnant rabbits. *International Journal of Radiation Biology* 88(5):414–419.
- Koc, A. , Unal, D. , Cimentepe, E. (2013). The effects of antioxidants on testicular apoptosis and oxidative stress produced by cell phones. *Turkish Journal of Medical Sciences* 43:131–137.
- Koohestani, N. V. , Zavareh, S. , Lashkarbolouki, T. , Azimpour, F. (2019). Exposure to cell phone induce oxidative stress in mice preantral follicles during in vitro cultivation: An experimental study. *International Journal of Reproductive Biomedicine* 17(9):637.
- Koylu, H. , Mollaoglu, H. , Ozguner, F. , Naziroglu, M. , Delibas, N. (2006). Melatonin modulates 900 MHz microwave-induced lipid peroxidation changes in rat brain. *Toxicology and Industrial Health* 22(5):211–216.
- Koyu, A. , Ozguner, F. , Yilmaz, H. , et al. (2009). The protective effect of caffeic acid phenethyl ester (CAPE) on oxidative stress in rat liver exposed to the 900 MHz electromagnetic field. *Toxicology and Industrial Health* 25(6):429–434.
- Kumar, S. , Nirala, J. P. , Behari, J. , Paulraj, R. (2014). Effect of electromagnetic irradiation produced by 3G mobile phone on male rat reproductive system in a simulated scenario. *Indian Journal of Experimental Biology* 52(9):890–897.
- Kunt, H. , Şentürk, İ. , Gönül, Y. , et al. (2016). Effects of electromagnetic radiation exposure on bone mineral density, thyroid, and oxidative stress index in electrical workers. *Oncotargets and Therapy* 9:745.
- Lai, H. , Singh, N. P. (1996). Single- and double-strand DNA breaks in rat brain cells after acute exposure to radiofrequency electromagnetic radiation. *International Journal of Radiation Biology* 69(4):513–521.
- Lai, H. , Singh, N. P. (1997). Melatonin and a spin-trap compound block radiofrequency electromagnetic radiation-induced DNA strand breaks in rat brain cells. *Bioelectromagnetics* 18(6):446–454.
- Lantow, M. , Lupke, M. , Frahm, J. , et al. (2006). ROS release and Hsp70 expression after exposure to 1,800 MHz radiofrequency electromagnetic fields in primary human monocytes and lymphocytes. *Radiation and Environmental Biophysics* 45(1):55–62.
- Lantow, M. , Schuderer, J. , Hartwig, C. , Simkó, M. (2006). Free radical release and HSP70 expression in two human immune-relevant cell lines after exposure to 1800 MHz radiofrequency radiation. *Radiation Research* 165(1):88–94.
- Lee, B.-C. , Johng, H.-M. , Lim, J.-K. , et al. (2004). Effects of extremely low frequency magnetic field on the antioxidant defense system in mouse brain: A chemiluminescence study. *Journal of Photochemistry and Photobiology, Part B: Biology* 73(1):43–48.
- Litovitz, T. A. , Krause, D. , Penafiel, M. , Elson, E. C. , Mullins, J. M. (1993). The role of coherence time in the effect of microwaves on ornithine decarboxylase activity. *Bioelectromagnetics* 14(5):395–403.
- Litovitz, T. A. , Penafiel, L. M. , Farrel, J. M. , et al. (1997). Bioeffects induced by exposure to microwaves are mitigated by superposition of ELF noise. *Bioelectromagnetics* 18(6):422–430.
- Liu, C. , Duan, W. , Xu, S. , et al. (2013a). Exposure to 1800 MHz radiofrequency electromagnetic radiation induces oxidative DNA base damage in a mouse spermatocyte-derived cell line. *Toxicology Letters* 218(1):2–9.
- Liu, C. , Gao, P. , Xu, S.-C. , et al. (2013b). Mobile phone radiation induces mode-dependent DNA damage in a mouse spermatocyte-derived cell line: A protective role of melatonin. *International Journal of Radiation Biology* 89(11):993–1001.
- Liu, Y. , Fiskum, G. , Schubert, D. (2002). Generation of reactive oxygen species by the mitochondrial electron transport chain. *Journal of Neurochemistry* 80(5):780–787.
- Low, H. , Crane, F. L. , Morre, D. J. (2012). Putting together a plasma membrane NADH oxidase: A tale of three laboratories. *International Journal of Biochemistry and Cell Biology* 44(11):1834–1838.
- Luo, X. , Chen, M. , Duan, Y. , et al. (2016). Chemoprotective action of lotus seedpod procyanidins on oxidative stress in mice induced by extremely low-frequency electromagnetic field exposure. *Biomedicine and Pharmacotherapy* 82:640–648.

- Lu, Y. S. , Huang, B. T. , Huang, Y. X. (2012). Reactive oxygen species formation and apoptosis in human peripheral blood mononuclear cell induced by 900 MHz mobile phone radiation. *Oxidative Medicine and Cellular Longevity* 2012:740280.
- Luo, Y.-P. , Ma, H.-R. , Chen, J.-W. , Li, J. J. , Li, C. X. (2014). Effect of American ginseng Capsule on the liver oxidative injury and the Nrf2 protein expression in rats exposed by electromagnetic radiation of frequency of cell phone. *Zhongguo Zhong Xi Yi Jie He Za Zhi Zhongguo Zhongxiyi Jiehe Zazhi = Chinese Journal of Integrated Traditional and Western Medicine / Zhongguo Zhong Xi Yi Jie He Xue Hui, Zhongguo Zhong Yi Yan Jiu Yuan Zhu Ban* 34(5):575–580.
- Luukkonen, J. , Hakulinen, P. , Maki-Paakkanen, J. , Juutilainen, J. , Naarala, J. (2009). Enhancement of chemically induced reactive oxygen species production and DNA damage in human SH-SY5Y neuroblastoma cells by 872 MHz radiofrequency radiation. *Mutation Research* 662(1–2):54–58.
- Maes, A. , Collier, M. , Verschaeve, L. (2000). Cytogenetic investigations on microwaves emitted by a 455.7 MHz car phone. *Folia Biologica* 46(5):175–180.
- Mailankot, M. , Kunnath, A. P. , Jayalekshmi, H. , Koduru, B. , Valsalan, R. (2009). Radio frequency electromagnetic radiation (RF-EMR) from GSM (0.9/1.8GHz) mobile phones induces oxidative stress and reduces sperm motility in rats. *Clinics* 64(6):561–565.
- Manikonda, P. K. , Rajendra, P. , Devendranath, D. , et al. (2014). Extremely low frequency magnetic fields induce oxidative stress in rat brain. *General Physiology and Biophysics* 33(1):81–90.
- Manta, A. K. , Stravopodis, D. J. , Papassideri, I. S. , Margaritis, L. H. (2013). Reactive oxygen species elevation and recovery in *Drosophila* bodies and ovaries following short-term and long-term exposure to DECT base EMF. *Electromagnetic Biology and Medicine* 33(2):118–131.
- Marino, A. A. , Carrubba, S. , Frilot, C. , Chesson, A. L. (2009). Evidence that transduction of electromagnetic field is mediated by a force receptor. *Neuroscience Letters* 452(2):119–123.
- Marjanovic, A. M. , Pavicic, I. , Trosic, I. (2014). Cell oxidation–reduction imbalance after modulated radiofrequency radiation. *Electromagnetic Biology and Medicine* (Published online):1–6.
- Marjanovic, A. M. , Pavicic, I. , Trosic, I. (2018). Oxidative stress response in SH-SY5Y cells exposed to short-term 1800 MHz radiofrequency radiation. *Journal of Environmental Science and Health, Part A* 53(2):132–138.
- Martínez-Sámamo, J. , Torres-Durán, P. V. , Juárez-Oropeza, M. A. , Verdugo-Díaz, L. (2012). Effect of acute extremely low frequency electromagnetic field exposure on the antioxidant status and lipid levels in rat brain. *Archives of Medical Research* 43(3):183–189.
- Marzook, E. A. , Abd El Moneim, A. E. , Elhadary, A. A. (2014). Protective role of sesame oil against mobile base station-induced oxidative stress. *Journal of Radiation Research and Applied Sciences* 7(1):1–6.
- Masoumi, A. , Karbalaeei, N. , Mortazavi, S. , Shabani, M. (2018). Radiofrequency radiation emitted from wi-fi (2.4 GHz) causes impaired insulin secretion and increased oxidative stress in rat pancreatic islets. *International Journal of Radiation Biology* 94(9):850–857.
- Meena, R. , Kumari, K. , Kumar, J. , et al. (2013). Therapeutic approaches of melatonin in microwave radiations-induced oxidative stress-mediated toxicity on male fertility pattern of Wistar rats. *Electromagnetic Biology and Medicine* 33(2):81–91.
- Megha, K. , Deshmukh, P. S. , Banerjee, B. D. , Tripathi, A. K. , Abegaonkar, M. P. (2012). Microwave radiation induced oxidative stress, cognitive impairment and inflammation in brain of Fischer rats. *Indian Journal of Experimental Biology* 50(12):889–896.
- Meral, I. , Mert, H. , Mert, N. , et al. (2007). Effects of 900-MHz electromagnetic field emitted from cellular phone on brain oxidative stress and some vitamin levels of guinea pigs. *Brain Research* 1169:120–124.
- Miller, A. B. , Sears, M. , Hardell, L. , et al. (2019). Risks to health and well-being from radio-frequency radiation emitted by cell phones and other wireless devices. *Frontiers in Public Health* 7:223.
- Moloney, J. N. , Cotter, T. G. (2018). ROS signalling in the biology of cancer. *Seminars in cell & developmental biology* 80:50–64.
- Morabito, C. , Rovetta, F. , Bizzarri, M. , et al. (2010). Modulation of redox status and calcium handling by extremely low frequency electromagnetic fields in C2C12 muscle cells: A real-time, single-cell approach. *Free Radical Biology and Medicine* 48(4):579–589.
- Motawi, T. , Darwish, H. , Moustafa, Y. , Labib, M. M. (2014). Biochemical modifications and neuronal damage in brain of young and adult rats after long-term exposure to mobile phone radiations. *Cell Biochemistry and Biophysics* 70(2):845–855.
- Moustafa, Y. M. , Moustafa, R. M. , Belacy, A. , Abou-El-Ela, S. H. , Ali, F. M. (2001). Effects of acute exposure to the radiofrequency fields of cellular phones on plasma lipid peroxide and antioxidant activities in human erythrocytes. *Journal of Pharmaceutical and Biomedical Analysis* 26(4):605–608.
- Nagata, M. (2005). Inflammatory cells and oxygen radicals. *Current Drug Targets: Inflammation and Allergy* 4(4):503–504.
- Naziroglu, M. , Celik, O. , Ozgul, C. , et al. (2012). Melatonin modulates wireless (2.45 GHz)-induced oxidative injury through TRPM2 and voltage gated Ca(2+) channels in brain and dorsal root ganglion in rat. *Physiology and Behavior* 105(3):683–692.
- Naziroglu, M. , Cig, B. , Dogan, S. , et al. (2012). 2.45-Gz wireless devices induce oxidative stress and proliferation through cytosolic Ca(2+)(+) influx in human leukemia cancer cells. *International Journal of Radiation Biology* 88(6):449–456.

Nguyen, H. L. , Zucker, S. , Zarrabi, K. , et al. (2011). Oxidative stress and prostate cancer progression are elicited by membrane-type 1 matrix metalloproteinase. *Molecular Cancer Research* 9(10):1305–1318.

Ni, S. , Yu, Y. , Zhang, Y. , et al. (2013). Study of oxidative stress in human lens epithelial cells exposed to 1.8 GHz radiofrequency fields. *PLOS ONE* 8(8):e72370.

Okayama, Y. (2005). Oxidative stress in allergic and inflammatory skin diseases. *Current Drug Targets: Inflammation and Allergy* 4(4):517–519.

Oksay, T. , Nazıroğlu, M. , Doğan, S. , et al. (2014). Protective effects of melatonin against oxidative injury in rat testis induced by wireless (2.45 GHz) devices. *Andrologia* 46(1):65–72.

Oktem, F. , Ozguner, F. , Mollaoglu, H. , Koyu, A. , Uz, E. (2005). Oxidative damage in the kidney induced by 900-MHz-emitted mobile phone: Protection by melatonin. *Archives of Medical Research* 36(4):350–355.

Oral, B. , Guney, M. , Ozguner, F. , et al. (2006). Endometrial apoptosis induced by a 900-MHz mobile phone: Preventive effects of vitamins E and C. *Advances in Therapy* 23(6):957–973.

Oshino, N. , Jamieson, D. , Sugano, T. , Chance, B. (1975). Optical measurement of catalase-hydrogen peroxide intermediate (Compound-I) in liver of anesthetized rats and its implication to hydrogen-peroxide production insitu. *Biochemical Journal* 146(1):67–77.

Ott, M. , Gogvadze, V. , Orrenius, S. , Zhivotovsky, B. (2007). Mitochondria, oxidative stress and cell death. *Apoptosis* 12(5):913–922.

Oyewopo, A. , Olaniyi, S. , Oyewopo, C. , Jimoh, A. T. (2017). Radiofrequency electromagnetic radiation from cell phone causes defective testicular function in male Wistar rats. *Andrologia* 49(10):e12772.

Ozel, H. B. , Cetin, M. , Sevik, H. , et al. (2021). The effects of base station as an electromagnetic radiation source on flower and cone yield and germination percentage in *Pinus brutia* Ten. *Biologia Futura*, 72(3):359-365.

Ozguner, F. , Altınbas, A. , Ozaydin, M. , et al. (2005a). Mobile phone-induced myocardial oxidative stress: Protection by a novel antioxidant agent caffeic acid phenethyl ester. *Toxicology and Industrial Health* 21(9):223–230.

Ozguner, F. , Oktem, F. , Ayata, A. , Koyu, A. , Yilmaz, H. R. (2005b). A novel antioxidant agent caffeic acid phenethyl ester prevents long-term mobile phone exposure-induced renal impairment in rat. Prognostic value of malondialdehyde, N-acetyl-beta-D-glucosaminidase and nitric oxide determination. *Molecular and Cellular Biochemistry* 277(1–2):73–80.

Ozguner, F. , Bardak, Y. , Comlekci, S. (2006). Protective effects of melatonin and caffeic acid phenethyl ester against retinal oxidative stress in long-term use of mobile phone: A comparative study. *Molecular and Cellular Biochemistry* 282(1–2):83–88.

Ozguner, F. , Kismali, G. , Guler, G. , et al. (2013). Effects of prenatal and postnatal exposure to GSM-like radiofrequency on blood chemistry and oxidative stress in infant rabbits, an experimental study. *Cell Biochemistry and Biophysics* 67(2):743–751.

Özorak, A. , Nazıroğlu, M. , Çelik, Ö. , et al. (2013). Wi-fi (2.45 GHz)- and mobile phone (900 and 1800 MHz)-induced risks on oxidative stress and elements in kidney and testis of rats during pregnancy and the development of offspring. *Biological Trace Element Research* 156(1–3):221–229.

Özsobacı, N. P. , Ergün, D. D. , Durmuş, S. , et al. (2018). Selenium supplementation ameliorates electromagnetic field-induced oxidative stress in the HEK293 cells. *Journal of Trace Elements in Medicine and Biology: Organ of the Society for Minerals and Trace Elements* 50:572–579.

Özsobacı, N. P. , Ergün, D. D. , Tunçdemir, M. , Özçelik, D. (2020). Protective effects of zinc on 2.45 GHz electromagnetic radiation-induced oxidative stress and apoptosis in HEK293 cells. *Biological Trace Element Research* 194(2):368–378.

Panagopoulos, D. J. , Messini, N. , Karabarbounis, A. , Philippetis, A. L. , Margaritis, L. H. (2000). A mechanism for action of oscillating electric fields on cells. *Biochemical and Biophysical Research Communications* 272(3):634–640.

Panagopoulos, D. J. , Karabarbounis, A. , Margaritis, L. H. (2002). Mechanism for action of electromagnetic fields on cells. *Biochemical and Biophysical Research Communications* 298(1):95–102.

Panagopoulos, D. J. , Chavdoula, E. D. , Nezis, I. P. , Margaritis, L. H. (2007). Cell death induced by GSM 900-MHz and DCS 1800-MHz mobile telephony radiation. *Mutation Research/Genetic Toxicology and Environmental Mutagenesis* 626(1–2):69–78.

Panagopoulos, D. J. , Chavdoula, E. D. , Margaritis, L. H. (2010). Bioeffects of mobile telephony radiation in relation to its intensity or distance from the antenna. *International Journal of Radiation Biology* 86(5):345–357.

Panagopoulos, D. J. (2012). Effect of microwave exposure on the ovarian development of *Drosophila melanogaster*. *Cell Biochemistry and Biophysics* 63(2):121–132.

Panagopoulos, D. , Johansson, O. , Carlo, G. (2013). Evaluation of specific absorption rate as a dosimetric quantity for electromagnetic fields bioeffects. *PLOS ONE* 8(6):e62663.

Panagopoulos, D. , Johansson, O. , Carlo, G. (2015). Polarization: A key difference between man-made and natural electromagnetic fields, in regard to biological activity. *Scientific Reports* 5(1):1–10.

Panagopoulos, D. J. (2019). Comparing DNA damage induced by mobile telephony and other types of man-made electromagnetic fields. *Mutation Research Reviews* 781:53–62.

Panagopoulos, D. J. (2020). Comparing chromosome damage induced by mobile telephony radiation and a high caffeine dose: Effect of combination and exposure Duration. *General Physiology and Biophysics*

39(6):531–544.

- Panagopoulos, D. J. , Karabarbounis, A. , Yakymenko, I. , Chrousos, G. P. (2021). Mechanism of DNA damage induced by human-made electromagnetic fields. *International Journal of Oncology* 59(5):92.
- Pandey, N. , Giri, S. (2018). Melatonin attenuates radiofrequency radiation (900 MHz)-induced oxidative stress, DNA damage and cell cycle arrest in germ cells of male Swiss albino mice. *Toxicology and Industrial Health* 34(5):315–327.
- Patruno, A. , Amerio, P. , Pesce, M. , et al. (2010). Extremely low frequency electromagnetic fields modulate expression of inducible nitric oxide synthase, endothelial nitric oxide synthase and cyclooxygenase-2 in the human keratinocyte cell line HaCat: Potential therapeutic effects in wound healing. *British Journal of Dermatology* 162(2):258–266.
- Paulraj, R. , Behari, J. , Rao, A. R. (1999). Effect of amplitude modulated RF radiation on calcium ion efflux and ODC activity in chronically exposed rat brain. *Indian Journal of Biochemistry and Biophysics* 36(5):337–340.
- Pavicic, I. , Trosic, I. (2010). Interaction of GSM modulated RF radiation and macromolecular cytoskeleton structures. Paper presented at the 6th International Workshop on Biological Effects of Electromagnetic Fields.
- Pedersen, G. F. (1997). Amplitude modulated RF fields stemming from a GSM/DCS1800 phone. *Wireless Networks* 3(6):489–498.
- Penafiel, L. M. , Litovitz, T. , Krause, D. , et al. (1997). Role of modulation on the effect of microwaves on ornithine decarboxylase activity in L929 cells. *Bioelectromagnetics: Journal of the Bioelectromagnetics Society, The Society for Physical Regulation in Biology and Medicine, The European Bioelectromagnetics Association* 18(2):132–141.
- Phillips, J. L. , Singh, N. P. , Lai, H. (2009). Electromagnetic fields and DNA damage. *Pathophysiology* 16(2–3):79–88.
- Pilla, A. A. (2012). Electromagnetic fields instantaneously modulate nitric oxide signaling in challenged biological systems. *Biochemical and Biophysical Research Communications* 426(3):330–333.
- Pourabadian, S. , Golshiri, P. , Habibi, E. (2009). Anxiety disorder in exposed employment to extremely low frequency electromagnetic fields (ELF-EMF) in steel industry. *Journal of Military Medicine* 10(4):299–302.
- Qin, F. , Yuan, H. , Nie, J. , Cao, Y. , Tong, J. (2014). Effects of nano-selenium on cognition performance of mice exposed in 1800 MHz radiofrequency fields. *Wei Sheng Yan Jiu = Journal of Hygiene Research* 43(1):16–21.
- Ragy, M. M. (2014). Effect of exposure and withdrawal of 900-MHz-electromagnetic waves on brain, kidney and liver oxidative stress and some biochemical parameters in male rats. *Electromagnetic Biology and Medicine* (Published online):1–6.
- Ralph, S. J. , Rodríguez-Enríquez, S. , Neuzil, J. , Saavedra, E. , Moreno-Sánchez, R. (2010). The causes of cancer revisited: “mitochondrial malignancy” and ROS-induced oncogenic transformation – Why mitochondria are targets for cancer therapy. *Molecular Aspects of Medicine* 31(2):145–170.
- Rao, V. S. , Titushkin, I. A. , Moros, E. G. , et al. (2008). Nonthermal effects of radiofrequency-field exposure on calcium dynamics in stem cell-derived neuronal cells: Elucidation of calcium pathways. *Radiation Research* 169(3):319–329.
- Rauš Balind, S. , Selaković, V. , Radenović, L. , Prolić, Z. , Janać, B. (2014). Extremely low frequency magnetic field (50 Hz, 0.5 mT) reduces oxidative stress in the brain of gerbils submitted to global cerebral ischemia. *PLOS ONE* 9(2):e88921.
- Read, R. , O’Riordan, T. (2017). The precautionary principle under fire. *Environment: Science and Policy for Sustainable Development* 59(5):4–15.
- Reale, M. , Kamal, M. A. , Patruno, A. , et al. (2014). Neuronal cellular responses to extremely low frequency electromagnetic field exposure: Implications regarding oxidative stress and neurodegeneration. *PLOS ONE* 9(8):e104973.
- Regoli, F. , Gorbi, S. , Machella, N. , et al. (2005). Pro-oxidant effects of extremely low frequency electromagnetic fields in the land snail *Helix aspersa*. *Free Radical Biology and Medicine* 39(12):1620–1628.
- Repacholi, M. H. , Basten, A. , Gebiski, V. , et al. (1997). Lymphomas in E mu-Pim1 transgenic mice exposed to pulsed 900 MHz electromagnetic fields. *Radiation Research* 147(5):631–640.
- Ruediger, H. W. (2009). Genotoxic effects of radiofrequency electromagnetic fields. *Pathophysiology* 16(2–3):89–102.
- Sadetzki, S. , Chetrit, A. , Jarus-Hakak, A. , et al. (2008). Cellular phone use and risk of benign and malignant parotid gland tumors—A nationwide case-control study. *American Journal of Epidemiology* 167(4):457–467.
- Saikhedkar, N. , Bhatnagar, M. , Jain, A. , et al. (2014). Effects of mobile phone radiation (900 MHz radiofrequency) on structure and functions of rat brain. *Neurological Research* 36(12):1072–1079.
- Santini, R. , Santini, P. , Danze, J. M. , Le Ruz, P. , Seigne, M. (2002). Study of the health of people living in the vicinity of mobile phone base stations: 1. Influences of distance and sex. *Pathologie biologique* 50(6):369–373.
- Sato, Y. , Akiba, S. , Kubo, O. , Yamaguchi, N. (2011). A case-case study of mobile phone use and acoustic neuroma risk in Japan. *Bioelectromagnetics* 32(2):85–93.
- Saygin, M. , Ozmen, O. , Erol, O. , et al. (2018). The impact of electromagnetic radiation (2.45 GHz, wi-fi) on the female reproductive system: The role of vitamin C. *Toxicology and Industrial Health* 34(9):620–630.
- Sefidbakht, Y. , Moosavi-Movahedi, A. A. , Hosseinkhani, S. , et al. (2014). Effects of 940 MHz EMF on bioluminescence and oxidative response of stable luciferase producing HEK cells. *Photochemical and*

Photobiological Sciences 13(7):1082–1092. <https://doi.org/10.1039/C3PP50451D>.

- Seif, F. , Reza Bayatiani, M. , Ansarihadipour, H. , Habibi, G. , Sadelaji, S. (2019). Protective properties of Myrtus communis extract against oxidative effects of extremely low-frequency magnetic fields on rat plasma and hemoglobin. *International Journal of Radiation Biology* 95(2):215–224.
- Selaković, V. , Rauš Balind, S. , Radenović, L. , Prolić, Z. , Janać, B. (2013). Age-dependent effects of ELF-MF on oxidative stress in the brain of Mongolian gerbils. *Cell Biochemistry and Biophysics* 66(3):513–521.
- Seomun, G. , Lee, J. , Park, J. (2021). Exposure to extremely low-frequency magnetic fields and childhood cancer: A systematic review and meta-analysis. *PLOS ONE* 16(5):e0251628.
- Sert, C. , Deniz, M. (2011). Total antioxidant capacity, total oxidant status and oxidative stress index in rats exposed to extremely low frequency magnetic field. *Asian Journal of Chemistry* 23(5):1925.
- Shaheen, W. , Amer, N. M. , Hafez, S. F. , et al. (2021). Effect of antioxidants intake on oxidative stress among mobile phone users. *Egyptian Journal of Chemistry* 64(7):3903–3912.
- Shahin, S. , Singh, V. P. , Shukla, R. K. , et al. (2013). 2.45 GHz microwave irradiation-induced oxidative stress affects implantation or pregnancy in mice, *Mus musculus*. *Applied Biochemistry and Biotechnology* 169(5):1727–1751.
- Sharma, A. , Shrivastava, S. , Shukla, S. (2020). Exposure of radiofrequency electromagnetic radiation on biochemical and pathological alterations. *Neurology India* 68(5):1092.
- Sharma, S. , Shukla, S. (2020). Effect of electromagnetic radiation on redox status, acetylcholine esterase activity and cellular damage contributing to the diminution of the brain working memory in rats. *Journal of Chemical Neuroanatomy* 106:101784.
- Sharma, V. P. , Singh, H. P. , Kohli, R. K. , Batish, D. R. (2009). Mobile phone radiation inhibits *Vigna radiata* (mung bean) root growth by inducing oxidative stress. *The Science of the Total Environment* 407(21):5543–5547.
- Shedid, S. M. , El-Tawill, G. A. , Algeda, F. R. , El-Fatih, N. , Eltahawy, N. (2019). The impact of 950 MHz electromagnetic radiation on the brain and liver of rats and the role of garlic treatment. *Egyptian Journal of Radiation Sciences and Applications* 32(1):51–60.
- Shim, Y. , Lee, I. , Park, S. (2013). The impact of LTE UE on audio devices. *ETRI Journal* 35(2):332–335.
- Sies, H. (2014). Role of metabolic H₂O₂ generation: Redox signalling and oxidative stress. *Journal of Biological Chemistry*, 289(13):8735–8741.
- Sies, H. , Jones, D. P. (2020). Reactive oxygen species (ROS) as pleiotropic physiological signalling agents. *Nature Reviews. Molecular Cell Biology* 21(7):363–383.
- Singh, H. P. , Sharma, V. P. , Batish, D. R. , Kohli, R. K. (2012). Cell phone electromagnetic field radiations affect rhizogenesis through impairment of biochemical processes. *Environmental Monitoring and Assessment* 184(4):1813–1821.
- Sokolovic, D. , Djindjic, B. , Nikolic, J. , et al. (2008). Melatonin reduces oxidative stress induced by chronic exposure of microwave radiation from mobile phones in rat brain. *Journal of Radiation Research (Tokyo)* 49(6):579–586.
- Sokolovic, D. , Djordjevic, B. , Kocic, G. , et al. (2013). Melatonin protects rat thymus against oxidative stress caused by exposure to microwaves and modulates proliferation/apoptosis of thymocytes. *General Physiology and Biophysics* 32(1):79–90.
- Suleyman, D. , Zulkuf, M. , A. , Feyzan, A. , Buyukbayram, H. (2004). Does 900 MHz GSM mobile phone exposure affect rat brain? *Electromagnetic Biology and Medicine* 23(3):201–214.
- Sun, Y.-Y. , Wang, Y.-H. , Li, Z.-H. , et al. (2019). Extremely low frequency electromagnetic radiation enhanced energy metabolism and induced oxidative stress in *Caenorhabditis elegans*. *Sheng Li Xue Bao: [Acta Physiologica Sinica]* 71(3):388–394.
- Sun, Y. , Shi, Z. , Wang, Y. , et al. (2018). Coupling of oxidative stress responses to tricarboxylic acid cycle and prostaglandin E₂ alterations in *Caenorhabditis elegans* under extremely low-frequency electromagnetic field. *International Journal of Radiation Biology* 94(12):1159–1166.
- Szmigielski, S. , Szudzinski, A. , Pietraszek, A. , et al. (1982). Accelerated development of spontaneous and benzopyrene-induced skin cancer in mice exposed to 2450-MHz microwave radiation. *Bioelectromagnetics* 3(2):179–191.
- Tice, R. R. , Hook, G. G. , Donner, M. , McRee, D. I. , Guy, A. W. (2002). Genotoxicity of radiofrequency signals. I. Investigation of DNA damage and micronuclei induction in cultured human blood cells. *Bioelectromagnetics* 23(2):113–126.
- Tiwari, R. , Lakshmi, N. , Bhargava, S. , Ahuja, Y. R. (2015). Epinephrine, DNA integrity and oxidative stress in workers exposed to extremely low-frequency electromagnetic fields (ELF-EMFs) at 132 kV substations. *Electromagnetic Biology and Medicine* 34(1):56–62.
- Tkalec, M. , Malaric, K. , Pevalek-Kozlina, B. (2007). Exposure to radiofrequency radiation induces oxidative stress in duckweed *Lemna minor* L. *Science of the Total Environment* 388(1–3):78–89.
- Tkalec, M. , Stambuk, A. , Srut, M. , et al. (2013). Oxidative and genotoxic effects of 900 MHz electromagnetic fields in the earthworm *Eisenia fetida*. *Ecotoxicology and Environment Safety* 90:7–12.
- Tök, L. , Nazıroğlu, M. , Doğan, S. , Kahya, M. C. , Tök, O. (2014). Effects of melatonin on wi-fi-induced oxidative stress in lens of rats. *Indian Journal of Ophthalmology* 62(1):12–15.

Toler, J. C. , Shelton, W. W. , Frei, M. R. , Merritt, J. H. , Stedham, M. A. (1997). Long-term, low-level exposure of mice prone to mammary tumors to 435 MHz radiofrequency radiation. *Radiation Research* 148(3):227–234.

Tomruk, A. , Guler, G. , Dincel, A. S. (2010). The influence of 1800 MHz GSM-like signals on hepatic oxidative DNA and lipid damage in nonpregnant, pregnant, and newly born rabbits. *Cell Biochemistry and Biophysics* 56(1):39–47.

Topsakal, S. , Ozmen, O. , Cicek, E. , Comlekci, S. (2017). The ameliorative effect of gallic acid on pancreas lesions induced by 2.45 GHz electromagnetic radiation (wi-fi) in young rats. *Journal of Radiation Research and Applied Sciences* 10(3):233–240.

Torrieri, D. (2018). *Principles of spread-spectrum communication systems*, 4th ed. Springer.

Tsybulin, O. , Sidorik, E. , Kyrylenko, S. , Henshel, D. , Yakymenko, I. (2012). GSM 900 MHz microwave radiation affects embryo development of Japanese quails. *Electromagnetic Biology and Medicine* 31(1):75–86.

Tsybulin, O. , Sidorik, E. , Brieieva, O. , et al. (2013). GSM 900 MHz cellular phone radiation can either stimulate or depress early embryogenesis in Japanese quails depending on the duration of exposure. *International Journal of Radiation Biology* 89(9):756–763.

Tsybulin, O. , Sidorik, E. , Kyrylenko, S. , Yakymenko, I. (2016). Monochromatic red light of LED protects embryonic cells from oxidative stress caused by radiofrequency radiation. *Oxidants and Antioxidants in Medical Science* 5(1):21–27.

Türedi, S. , Hanci, H. , Topal, Z. , et al. (2014). The effects of prenatal exposure to a 900-MHz electromagnetic field on the 21-day-old male rat heart. *Electromagnetic Biology and Medicine* (Published online):1–8.

Turker, Y. , Naziroglu, M. , Gumral, N. , et al. (2011). Selenium and L-carnitine reduce oxidative stress in the heart of rat induced by 2.45-GHz radiation from wireless devices. *Biological Trace Element Research* 143(3):1640–1650.

Usman, J. D. , Isyaku, U. M. , Magaji, R. A. , et al. (2020). Assessment of electromagnetic fields, vibration and sound exposure effects from multiple transceiver mobile phones on oxidative stress levels in serum, brain and heart tissue. *Scientific African* 7:e00271.

Vaks, V. L. , Domrachev, G. A. , Rodygin, Y. L. , Selivanovskii, D. A. , Spivak, E. I. (1994). Dissociation of water by microwave radiation. *Radiophysics and Quantum Electronics* 37(1):85–88.

Valko, M. , Rhodes, C. J. , Moncol, J. , Izakovic, M. , Mazur, M. (2006). Free radicals, metals and antioxidants in oxidative stress-induced cancer. *Chemico-Biological Interactions* 160(1):1–40.

Valko, M. , Leibfritz, D. , Moncol, J. , et al. (2007). Free radicals and antioxidants in normal physiological functions and human disease. *International Journal of Biochemistry and Cell Biology* 39(1):44–84.

Wang, C. , Liu, Y. , Wang, Y. , et al. (2019). Lowfrequency pulsed electromagnetic field promotes functional recovery, reduces inflammation and oxidative stress, and enhances HSP70 expression following spinal cord injury. *Molecular Medicine Reports* 19(3):1687–1693.

Wang, M. , Yang, G. , Li, Y. , et al. (2020). Protective role of vitamin C in wi-fi induced oxidative stress in MC3T3-E1 cells in vitro. *Applied Computational Electromagnetics Society Journal*, 35(5):587–94.

Wang, X. , Sharma, R. K. , Gupta, A. , et al. (2003). Alterations in mitochondria membrane potential and oxidative stress in infertile men: A prospective observational study. *Fertility and Sterility* 80:844–850.

Wertheimer, N. , Leeper, E. (1979). Electrical wiring configurations and childhood cancer. *American Journal of Epidemiology* 109(3):273–284.

Wertheimer, N. , Leeper, E. (1982). Adult cancer related to electrical wires near the home. *International Journal of Epidemiology* 11(4):345–355.

WHO . (2007). *Electromagnetic fields and public health*. <https://www.who.int/teams/environment-climate-change-and-health/radiation-and-health/non-ionizing/elff>.

Wolf, R. , Wolf, D. (2007). Increased incidence of cancer near a cell-phone transmitted station. In F. Columbus (Ed.), *Trends in cancer prevention* (pp. 1–8). Nova Science Publishers, Inc., New York, USA.

Xu, S. , Zhou, Z. , Zhang, L. , et al. (2010). Exposure to 1800 MHz radiofrequency radiation induces oxidative damage to mitochondrial DNA in primary cultured neurons. *Brain Research* 1311:189–196.

Yakymenko, I. , Sidorik, E. , Kyrylenko, S. , Chekhun, V. (2011). Long-term exposure to microwave radiation provokes cancer growth: Evidences from radars and mobile communication systems. *Experimental Oncology* 33(2):62–70.

Yakymenko, I. , Sidorik, E. , Tsybulin, O. , et al. (2011). Potential risks of microwaves from mobile phones for youth health. *Environmental and Health* 56(1):48–51.

Yakymenko, I. , Tsybulin, O. , Sidorik, E. , et al. (2016). Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation. *Electromagnetic Biology and Medicine* 35(2):186–202.

Yakymenko, I. , Burlaka, A. , Tsybulin, I. , et al. (2018). Oxidative and mutagenic effects of low intensity GSM 1800 MHz microwave radiation. *Experimental Oncology* 40(4):282–287.

Yang, M. L. , Ye, Z. M. (2015). Extremely low frequency electromagnetic field induces apoptosis of osteosarcoma cells via oxidative stress. *Journal of Zhejiang University (Medical Sciences)* 44(3):323–328.

Yokus, B. , Cakir, D. U. , Akdag, M. Z. , Sert, C. , Mete, N. (2005). Oxidative DNA damage in rats exposed to extremely low frequency electro magnetic fields. *Free Radical Research* 39(3):317–323.

Yokus, B. , Akdag, M. Z. , Dasdag, S. , Cakir, D. U. , Kizil, M. (2008). Extremely low frequency magnetic fields cause oxidative DNA damage in rats. *International Journal of Radiation Biology* 84(10):789–795.

Yurekli, A. I. , Ozkan, M. , Kalkan, T. , et al. (2006). GSM base station electromagnetic radiation and oxidative stress in rats. *Electromagnetic Biology and Medicine* 25(3):177–188.

Zhao, T. Y. , Zou, S. P. , Knapp, P. E. (2007). Exposure to cell phone radiation up-regulates apoptosis genes in primary cultures of neurons and astrocytes. *Neuroscience Letters* 412(1):34–38.

Zmyślony, M. , Politański, P. , Rajkowska, E. , Szymczak, W. , Jajte, J. (2004). Acute exposure to 930 MHz CW electromagnetic radiation in vitro affects reactive oxygen species level in rat lymphocytes treated by iron ions. *Bioelectromagnetics* 25(5):324–328.

Zosangzuali, M. , Lalremruati, M. , Lalmuansangi, C. , et al. (2021). Effects of radiofrequency electromagnetic radiation emitted from a mobile phone base station on the redox homeostasis in different organs of Swiss albino mice. *Electromagnetic Biology and Medicine*, 40(3): 393–407.

Zotti-Martelli, L. , Peccatori, M. , Maggini, V. , Ballardini, M. , Barale, R. (2005). Individual responsiveness to induction of micronuclei in human lymphocytes after exposure in vitro to 1800-MHz microwave radiation. *Mutation Research* 582(1–2):42–52.

Genotoxic Effects of Wireless Communication Electromagnetic Fields

Abdel-Rassoul G. , El-Fateh O.A. , Salem M.A. , et al (2007) Neurobehavioral effects among inhabitants around mobile phone base stations. *Neurotoxicology* 28(2):434–440. <https://doi.org/10.1016/j.neuro.2006.07.012>.

Agarwal A. , Desai N.R. , Makker K. , et al (2009) Effects of radiofrequency electromagnetic waves (RF-EMW) from cellular phones on human ejaculated semen: An in vitro pilot study. *Fertil Steril* 92(4):1318–1325. <https://doi.org/10.1016/j.fertnstert.2008.08.022>.

Ahuja Y.R. , Bhargava A. , Sircar S. , et al (1997) Comet assay to evaluate DNA damage caused by magnetic fields. *Proc Int Conf Electromagn Interf Compat* 273–276. <https://doi.org/10.1109/icemic.1997.669812>.

Ahuja Y.R. , Vijayashree B. , Saran R. , et al (1999) In vitro effects of low-level, low-frequency electromagnetic fields on DNA damage in human leucocytes by comet assay. *Indian J Biochem Biophys* 36(5):318–322.

Aitken R.J. , Bennetts L.E. , Sawyer D. , Wiklendt A.M. , King B.V. (2005) Impact of radio frequency electromagnetic radiation on DNA integrity in the male germline. *Int J Androl* 28(3):171–179. <https://doi.org/10.1111/j.1365-2605.2005.00531.x>.

Akbarnejad Z. , Eskandary H. , Vergallo C. , et al (2017) Effects of extremely low-frequency pulsed electromagnetic fields (ELF-PEMFs) on glioblastoma cells (U87). *Electromagn Biol Med* 36(3):238–247. <https://doi.org/10.1080/15368378.2016.1251452>.

Akdag M. , Dasdag S. , Canturk F. , Akdag M.Z. (2018) Exposure to non-ionizing electromagnetic fields emitted from mobile phones induced DNA damage in human ear canal hair follicle cells. *Electromagn Biol Med* 37(2):66–75. <https://doi.org/10.1080/15368378.2018.1463246>.

Al-Khlaiwi T.M. , Habib S.S. , Meo S.A. , Alqhtani M.S. , Ogailan A.A. (2020) The association of smart mobile phone usage with cognitive function impairment in Saudi adult population. *Pak J Med Sci* 36(7):1628–1633. <https://doi.org/10.12669/PJMS.36.7.2826>.

Al-Serori H. , Ferk F. , Kundi M. , et al (2018) Mobile phone specific electromagnetic fields induce transient DNA damage and nucleotide excision repair in serum-deprived human glioblastoma cells. *PLOS ONE* 13(4):e0193677. <https://doi.org/10.1371/journal.pone.0193677>.

Alcaraz M. , Olmos E. , Alcaraz-Saura M. , Achel D.G. , Castillo J. (2014) Effect of long-term 50 Hz magnetic field exposure on the micronucleated polychromatic erythrocytes of mice. *Electromagn Biol Med* 33(1):51–57. <https://doi.org/10.3109/15368378.2013.783851>.

Alchalabi A.S.H. , Aklilu E. , Aziz A.R. , et al (2016) Different periods of intrauterine exposure to electromagnetic field: Influence on female rats' fertility, prenatal and postnatal development. *Asian Pac J Reprod* 5(1):14–23. <https://doi.org/10.1016/J.APJR.2015.12.003>.

Alchalabi A.S.H. , Rahim H. , AbdulMalek M.F. , et al (2017) Micronuclei formation and 8-hydroxy-2-deoxyguanosine enzyme detection in ovarian tissues after radiofrequency exposure at 1800 MHz in adult Sprague-Dawley Rats. *HAYATI J Biosci* 24:79–79. <https://doi.org/10.4308/hjb.24.2.79>.

Alekperov S. , Suetov A. , Efremov V. , Kimstach A.N. , Lavrenenok L.V. (2019) The effect of electromagnetic fields of extremely low frequency 30 Hz on rat ovaries. *Bull Exp Biol Med* 166(5):704–707. <https://doi.org/10.1007/S10517-019-0442-2>.

Alkis M.E. , Bilgin H.M. , Akpolat V. , et al (2019) Effect of 900-, 1800-, and 2100-MHz radiofrequency radiation on DNA and oxidative stress in brain. *Electromagn Biol Med* 38(1):32–47. <https://doi.org/10.1080/15368378.2019.1567526>.

Alkis M.E. , Akdag M.Z. , Dasdag S. (2021) Effects of low-intensity microwave radiation on oxidant-antioxidant parameters and DNA damage in the liver of rats. *Bioelectromagnetics* 42(1):76–85. <https://doi.org/10.1002/bem.22315>.

Aly A. , Crum R. (2016) Research review for possible relation between mobile phone radiation and brain tumor. *Int J Inf Technol Converg Serv* 6:1–16. <https://doi.org/10.5121/ijitcs.2016.6401>.

Amara S. , Abdelmelek H. , Garrel C. , et al (2006) Effects of subchronic exposure to static magnetic field on testicular function in rats. *Arch Med Res* 37(8):947–952. <https://doi.org/10.1016/j.arcmed.2006.06.004>.

Amjad F. , Farooq M.N. , Batool R. , Irshad A. (2020) Frequency of wrist pain and its associated risk factors in students using mobile phones. *Pak J Med Sci* 36(4):746–749.

Anonymous (2022) How many smartphones are in the world? <https://www.bankmycell.com/blog/how-many-phones-are-in-the-world#sources>

Antonopoulos A. , Yang B. , Stamm A. , Heller W.D. , Obe G. (1995) Cytological effects of 50 Hz electromagnetic fields on human lymphocytes in vitro. *Mutat Res Lett* 346(3):151–157. [https://doi.org/10.1016/0165-7992\(95\)90047-0](https://doi.org/10.1016/0165-7992(95)90047-0).

Antonopoulos A. , Eisenbrandt H. , Obe G. (1997) Effects of high-frequency electromagnetic fields on human lymphocytes in vitro. *Mutat Res - Genet Toxicol Environ Mutagen* 395(2–3):209–214. [https://doi.org/10.1016/S1383-5718\(97\)00173-3](https://doi.org/10.1016/S1383-5718(97)00173-3).

Augner C. , Florian M. , Pauser G. , Oberfeld G. , Hacker G.W. (2009) GSM base stations: Short-term effects on well-being. *Bioelectromagnetics* 30(1):73–80. <https://doi.org/10.1002/bem.20447>.

Avenidaño C. , Mata A. , Sanchez Sarmiento C. , Doncel G. (2012) Use of laptop computers connected to internet through Wi-fi decreases human sperm motility and increases sperm DNA fragmentation. *Fertil Steril* 97(1):39–45.e2. <https://doi.org/10.1016/J.FERTNSTERT.2011.10.012>.

Aweda M.A. , Usikalu M.R. , Wan J.H. , et al (2010) Genotoxic effects of low 2.45 GHz microwave radiation exposures on Sprague Dawley rats. *Int J Genet Mol Biol* 2:189–197. <https://doi.org/10.5897/IJGMB.9000028>.

Baker K.B. , Tkach J.A. , Nyenhuis J.A. , et al (2004) Evaluation of specific absorption rate as a dosimeter of MRI-related implant heating. *J Magn Reson Imaging* 20(2):315–320. <https://doi.org/10.1002/jmri.20103>.

Balode Z. (1996) Assessment of radio-frequency electromagnetic radiation by the micronucleus test in bovine peripheral erythrocytes. *Sci Total Environ* 180(1):81–85. [https://doi.org/10.1016/0048-9697\(95\)04923-1](https://doi.org/10.1016/0048-9697(95)04923-1).

Banerjee S. , Singh N.N. , Sreedhar G. , Mukherjee S. (2016) Analysis of the genotoxic effects of mobile phone radiation using buccal micronucleus assay: A comparative evaluation. *J Clin Diagn Res* 10(3):82–85. <https://doi.org/10.7860/JCDR/2016/17592.7505>.

Belpomme D. , Irigaray P. (2020) Electrohypersensitivity as a newly identified and characterized neurologic pathological disorder: How to diagnose, treat, and prevent it. *Int J Mol Sci* 21(6):1915. <https://doi.org/10.3390/ijms21061915>.

Belyaev I.Y. , Hillert L. , Protopopova M. , et al (2005) 915 MHz microwaves and 50 Hz magnetic field affect chromatin conformation and 53BP1 foci in human lymphocytes from hypersensitive and healthy persons. *Bioelectromagnetics* 26(3):173–184. <https://doi.org/10.1002/bem.20103>.

Belyaev I.Y. , Markova E. , Hillert L. , Malmgren L.O. , Persson B.R. (2009) Microwaves from UMTS/GSM mobile phones induce long-lasting inhibition of 53BP1/γ-H2AX DNARepair foci in human lymphocytes. *Bioelectromagnetics* 30(2):129–141. <https://doi.org/10.1002/bem.20445>.

Bento N. (2016) Calling for change? Innovation, diffusion, and the energy impacts of global mobile telephony. *Energy Res Soc Sci* 21:84–100. <https://doi.org/10.1016/j.erss.2016.06.016>.

Bisht K. , Moros E. , Straube W. , Baty J.D. , Roti Roti J.L. (2002) The effect of 835.62 MHz FDMA or 847.74 MHz CDMA modulated radiofrequency radiation on the induction of micronuclei in C3H 10T(1/2) cells. *Radiat Res* 157(5):506–515. [https://doi.org/10.1667/0033-7587\(2002\)157\[0506:teomfo\]2.0.co;2](https://doi.org/10.1667/0033-7587(2002)157[0506:teomfo]2.0.co;2).

Blank M. , Goodman R. (2009) Electromagnetic fields stress living cells. *Pathophysiology* 16(2–3):71–78. <https://doi.org/10.1016/j.pathophys.2009.01.006>.

Blank M. , Goodman R. (2011) DNA is a fractal antenna in electromagnetic fields. *Int J Radiat Biol* 87(4):409–415. <https://doi.org/10.3109/09553002.2011.538130>.

Boileau N. , Marguerite F. , Gauthier T. , et al (2020) Mobile phone use during pregnancy: Which association with fetal growth? *J Gynecol Obstet Hum Reprod* 49(8):101852. <https://doi.org/10.1016/J.JOGOH.2020.101852>.

Bourthoumieu S. , Joubert V. , Marin B. , et al (2010) Cytogenetic studies in human cells exposed in vitro to GSM-900 MHz radiofrequency radiation using R-banded karyotyping. *Radiat Res* 174(6):712–718. <https://doi.org/10.1667/RR2137.1>.

Brech A. , Kubinyi G. , Németh Z. , et al (2019) Genotoxic effects of intermediate frequency magnetic fields on blood leukocytes in vitro. *Mutat Res - Genet Toxicol Environ Mutagen* 845:403060. <https://doi.org/10.1016/j.mrgentox.2019.05.016>.

Bryant P.A. (2021) Communicating radiation risk: The role of public engagement in reaching ALARA. *J Radiol Prot* 41(2):S1–S8. <https://doi.org/10.1088/1361-6498/abd348>.

Burlaka A. , Tsybulin O. , Sidorik E. , et al (2013) Overproduction of free radical species in embryonic cells exposed to low intensity radiofrequency radiation. *Exp Oncol* 35(3):219–225.

Çam S.T. , Seyhan N. (2012) Single-strand DNA breaks in human hair root cells exposed to mobile phone radiation. *Int J Radiat Biol* 88(5):420–424. <https://doi.org/10.3109/09553002.2012.666005>.

Campisi A. , Gulino M. , Acquaviva R. , et al (2010) Reactive oxygen species levels and DNA fragmentation on astrocytes in primary culture after acute exposure to low intensity microwave electromagnetic field. *Neurosci Lett* 473(1):52–55. <https://doi.org/10.1016/j.neulet.2010.02.018>.

Carpenter D.O. (2013) Human disease resulting from exposure to electromagnetic fields. *Rev Environ Health* 28(4):159–172. <https://doi.org/10.1515/reveh-2013-0016>.

- Cecconi S. , Gualtieri G. , Di Bartolomeo A. , et al (2000) Evaluation of the effects of extremely low frequency electromagnetic fields on mammalian follicle development. *Hum Reprod* 15(11):2319–2325. <https://doi.org/10.1093/HUMREP/15.11.2319>.
- Chavdoula E.D. , Panagopoulos D.J. , Margaritis L.H. (2010) Comparison of biological effects between continuous and intermittent exposure to GSM-900-MHz mobile phone radiation: Detection of apoptotic cell-death features. *Mutat Res - Genet Toxicol Environ Mutagen* 700(1–2):51–61. <https://doi.org/10.1016/j.mrgentox.2010.05.008>.
- Coghill R.W. , Steward J. , Phillips A. (1996) Extra low frequency electric and magnetic fields in the bedplace of children diagnosed with leukaemia: A case-control study. *Eur J Cancer Prev* 5(3):153–158. <https://doi.org/10.1097/00008469-199606000-0000>.
- D'Ambrosio G. , Lioi M.B. , Massa R. , Scarfi M.R. , Zeni O. (1995) Genotoxic effects of amplitude-modulated microwaves on human lymphocytes exposed in vitro under controlled conditions. *Electromagn Biol Med* 14(3):157–164. <https://doi.org/10.3109/15368379509030726>.
- D'Ambrosio G. , Massa R. , Scarfi M.R. , Zeni O. (2002) Cytogenetic damage in human lymphocytes following GMSK phase modulated microwave exposure. *Bioelectromagnetics* 23(1):7–13. <https://doi.org/10.1002/bem.93>.
- D'Silva M.H. , Swer R.T. , Anbalagan J. , Rajesh B. (2017) Effect of radiofrequency radiation emitted from 2G and 3G cell phone on developing liver of chick embryo – A comparative study. *J Clin Diagn Res* 11(7):AC05–AC09. <https://doi.org/10.7860/JCDR/2017/26360.10275>.
- D'Silva M.H. , Swer R.T. , Anbalagan J. , Bhargavan R. (2021) Assessment of DNA damage in chick embryo brains exposed to 2G and 3G cell phone radiation using alkaline comet assay technique. *J Clin Diagn Res* 15:AC01–AC04. <https://doi.org/10.7860/jcdr/2021/47115.14441>.
- Daroit N.B. , Visioli F. , Magnusson A.S. , Vieira G.R. , Rados P.V. (2015) Cell phone radiation effects on cytogenetic abnormalities of oral mucosal cells. *Braz Oral Res* 29:1–8. <https://doi.org/10.1590/1807-3107BOR-2015.vol29.0114>.
- De Iulius G.N. , Newey R.J. , King B.V. , Aitken R.J. (2009) Mobile phone radiation induces reactive oxygen species production and DNA damage in human spermatozoa in vitro. *PLOS ONE* 4(7):e6446. <https://doi.org/10.1371/journal.pone.0006446>.
- de Oliveira F.M. , Carmona A.M. , Ladeira C. (2017) Is mobile phone radiation genotoxic? An analysis of micronucleus frequency in exfoliated buccal cells. *Mutat Res - Genet Toxicol Environ Mutagen* 822:41–46. <https://doi.org/10.1016/j.mrgentox.2017.08.001>.
- Delimaris J. , Tsilimigaki S. , Messini-Nicolaki N. , Ziros E. , Piperakis S.M. (2006) Effects of pulsed electric fields on DNA of human lymphocytes. *Cell Biol Toxicol* 22(6):409–415. <https://doi.org/10.1007/s10565-006-0105-1>.
- Demsia G. , Vlastos D. , Matthopoulos D.P. (2004) Effect of 910-MHz electromagnetic field on rat bone marrow. *Sci World J* 4(Suppl 2):48–54. <https://doi.org/10.1100/tsw.2004.178>.
- Deniz O. , Kaplan S. , Selçuk M. , et al (2017) Effects of short and long term electromagnetic fields exposure on the human hippocampus. *J Microsc Ultrastruct* 5(4):191–197. <https://doi.org/10.1016/J.JMAU.2017.07.001>.
- Deshmukh P.S. , Megha K. , Banerjee B.D. , et al (2013) Detection of low level microwave radiation induced deoxyribonucleic acid damage vis-à-vis genotoxicity in brain of Fischer rats. *Toxicol Int* 20(1):19–24. <https://doi.org/10.4103/0971-6580.111549>.
- Diem E. , Schwarz C. , Adlkofer F. , Jahn O. , Rüdiger H. (2005) Non-thermal DNA breakage by mobile-phone radiation (1800 MHz) in human fibroblasts and in digested GFSH-R17 rat granulosa cells in vitro. *Mutat Res - Genet Toxicol Environ Mutagen* 583(2):178–183. <https://doi.org/10.1016/j.mrgentox.2005.03.006>.
- Dilli R. (2021) Implications of mmWave radiation on human health: State of the art threshold levels. *IEEE Access* 9:13009–13021. <https://doi.org/10.1109/ACCESS.2021.3052387>.
- Duan W. , Liu C. , Zhang L. , et al (2015) Comparison of the genotoxic effects induced by 50 Hz extremely low-frequency electromagnetic fields and 1800 MHz radiofrequency electromagnetic fields in GC-2 cells. *Radiat Res* 183(3):305–314. <https://doi.org/10.1667/RR13851.1>.
- Erdal N. , Gürgül S. , Çelik A. (2007) Cytogenetic effects of extremely low frequency magnetic field on Wistar rat bone marrow. *Mutat Res - Genet Toxicol Environ Mutagen* 630(1–2):69–77. <https://doi.org/10.1016/j.mrgentox.2007.03.001>.
- Erogul O. , Oztas E. , Yildirim I. , et al (2006) Effects of electromagnetic radiation from a cellular phone on human sperm motility: An in vitro study. *Arch Med Res* 37(7):840–843. <https://doi.org/10.1016/J.ARCMED.2006.05.003>.
- Ferreira A.R. , Knakiewicz T. , de Bittencourt Pasquali M.A. , et al (2006) Ultra high frequency-electromagnetic field irradiation during pregnancy leads to an increase in erythrocytes micronuclei incidence in rat offspring. *Life Sci* 80(1):43–50. <https://doi.org/10.1016/j.lfs.2006.08.018>.
- Focke F. , Schuermann D. , Kuster N. , Schär P. (2010) DNA fragmentation in human fibroblasts under extremely low frequency electromagnetic field exposure. *Mutat Res - Fundam Mol Mech Mutagen* 683(1–2):74–83. <https://doi.org/10.1016/j.mrfmmm.2009.10.012>.
- Frei P. , Mohler E. , Bürgi A. , et al (2009) A prediction model for personal radio frequency electromagnetic field exposure. *Sci Total Environ* 408(1):102–108. <https://doi.org/10.1016/j.scitotenv.2009.09.023>.

- Fučić A. , Garaj-Vrhovac V. , Škara M. , Dimitrović B. (1992) X-rays, microwaves and vinyl chloride monomer: Their clastogenic and aneugenic activity, using the micronucleus assay on human lymphocytes. *Mutat Res Lett* 282(4):265–271. [https://doi.org/10.1016/0165-7992\(92\)90133-3](https://doi.org/10.1016/0165-7992(92)90133-3).
- Gadhia P.K. , Shah T. , Mistry A. , Pithawala M. , Tamakuwala D. (2003) A preliminary study to assess possible chromosomal damage among users of digital mobile phones. *Electromagn Biol Med* 22(2–3):149–159. <https://doi.org/10.1081/JBC-120024624>.
- Gandhi G. , Anita (2005) Genetic damage in mobile phone users: Some preliminary findings. *Indian J Hum Genet* 11(2):99–104. <https://doi.org/10.4103/0971-6866.16810>.
- Garaj-Vrhovac V. , Horvat D. , Koren Z. (1990) The effect of microwave radiation on the cell genome. *Mutat Res Lett* 243(2):87–93. [https://doi.org/10.1016/0165-7992\(90\)90028-1](https://doi.org/10.1016/0165-7992(90)90028-1).
- Garaj-Vrhovac V. , Horvat D. , Koren Z. (1991) The relationship between colony-forming ability, chromosome aberrations and incidence of micronuclei in V79 Chinese hamster cells exposed to microwave radiation. *Mutat Res Lett* 263(3):143–149. [https://doi.org/10.1016/0165-7992\(91\)90054-8](https://doi.org/10.1016/0165-7992(91)90054-8).
- Garaj-Vrhovac V. , Fučić A. , Horvat D. (1992) The correlation between the frequency of micronuclei and specific chromosome aberrations in human lymphocytes exposed to microwave radiation in vitro. *Mutat Res Lett* 281(3):181–186. [https://doi.org/10.1016/0165-7992\(92\)90006-4](https://doi.org/10.1016/0165-7992(92)90006-4).
- Garaj-Vrhovac V. (1999) Micronucleus assay and lymphocyte mitotic activity in risk assessment of occupational exposure to microwave radiation. *Chemosphere* 39(13):2301–2312. [https://doi.org/10.1016/S0045-6535\(99\)00139-3](https://doi.org/10.1016/S0045-6535(99)00139-3).
- Garaj-Vrhovac V. , Orescanin V. (2009) Assessment of DNA sensitivity in peripheral blood leukocytes after occupational exposure to microwave radiation: The alkaline comet assay and chromatid breakage assay. *Cell Biol Toxicol* 25(1):33–43. <https://doi.org/10.1007/s10565-008-9060-3>.
- Garson O. , McRobert T. , Campbell L. , Hocking B.A. , Gordon I. (1991) A chromosomal study of workers with long-term exposure to radio-frequency radiation. *Med J Aust* 155(5):289–292. <https://doi.org/10.5694/J.1326-5377.1991.TB142282.X>.
- Görlitz B. , Müller M. , Ebert S. , et al (2005) Effects of 1-week and 6-week exposure to GSM/DCS radiofrequency radiation on micronucleus formation in B6C3F1 mice. *Radiat Res* 164(4 Pt 1):431–439. <https://doi.org/10.1667/RR3440.1>.
- Goodman E.M. , Greenebaum B. , Marron M.T. , (1995): Effects of electromagnetic fields on molecules and cells, *International Rev Cytol*. 158, 279–338.
- Gosselin M-C. , Kühn S. , Kuster N. (2013) Experimental and numerical assessment of low-frequency current distributions from UMTS and GSM mobile phones. *Phys Med Biol* 58(23):8339. <https://doi.org/10.1088/0031-9155/58/23/8339>.
- Gul A. , Celebi H. , Uğraş S. (2009) The effects of microwave emitted by cellular phones on ovarian follicles in rats. *Arch Gynecol Obstet* 280(5):729–733. <https://doi.org/10.1007/s00404-009-0972-9>.
- Gulati S. , Yadav A. , Kumar N. , et al (2016) Effect of GSTM1 and GSTT1 polymorphisms on genetic damage in humans populations exposed to radiation from mobile towers. *Arch Environ Contam Toxicol* 70(3):615–625. <https://doi.org/10.1007/s00244-015-0195-y>.
- Gulati S. , Yadav A. , Kumar N. , et al (2018) Phenotypic and genotypic characterization of antioxidant enzyme system in human population exposed to radiation from mobile towers. *Mol Cell Biochem* 440(1–2):1–9. <https://doi.org/10.1007/s11010-017-3150-6>.
- Gulati S. , Kosik P. , Durdik M. , et al (2020) Effects of different mobile phone UMTS signals on DNA, apoptosis and oxidative stress in human lymphocytes. *Environ Pollut* 267:115632. <https://doi.org/10.1016/j.envpol.2020.115632>.
- Guler G. , Tomruk A. , Ozgur E. , Seyhan N. (2010) The effect of radiofrequency radiation on DNA and lipid damage in non-pregnant and pregnant rabbits and their newborns. *Gen Physiol Biophys* 29(1):59–66. https://doi.org/10.4149/gpb_2010_01_59.
- Guler G. , Ozgur E. , Keles H. , et al (2011) Apoptosis resulted from radiofrequency radiation exposure of pregnant rabbits and their infants. *Bull Vet Inst Pulawy* 55:127–134.
- Güler G. , Tomruk A. , Ozgur E. , et al (2012) The effect of radiofrequency radiation on DNA and lipid damage in female and male infant rabbits. *Int J Radiat Biol* 88(4):367–373. doi.org/10.3109/09553002.2012.646349.
- Guo L. , Lin J. , Xue Y. , et al (2019) Effects of 220 MHz pulsed modulated radiofrequency field on the sperm quality in rats. *Int J Environ Res Public Health* 16(7):1286. <https://doi.org/10.3390/IJERPH16071286>.
- Gurbuz N. , Sirav B. , Yuvaci H. , et al (2010) Is there any possible genotoxic effect in exfoliated bladder cells of rat under the exposure of 1800 MHz GSM-like modulated radio frequency radiation (RFR)? *Electromagn Biol Med* 29(3):98–104. <https://doi.org/10.3109/15368378.2010.482498>.
- Gurbuz N. , Sirav B. , Colbay M. , Yetkin I. , Seyhan N. (2014) No genotoxic effect in exfoliated bladder cells of rat under the exposure of 1800 and 2100 MHz radio frequency radiation. *Electromagn Biol Med* 33(4):296–301.
- Gurbuz N. , Sirav B. , Kuzay D. , Ozer C. , Seyhan N. , et al (2015) Does radio frequency radiation induce micronuclei frequency in exfoliated bladder cells of diabetic rats? *Endocr Regul* 49:126–130. https://doi.org/10.4149/ENDO_2015_03_126.
- Gürler H. , Bilgici B. , Akar A.K. , Tomak L. , Bedir A. (2014) Increased DNA oxidation (8-OHdG) and protein oxidation (AOPP) by low level electromagnetic field (2.45 GHz) in rat brain and protective effect of garlic. *Int J Radiat Biol* 90(10):892–896. <https://doi.org/10.3109/09553002.2014.922717>.

Hanci H. , Odaci E. , Kaya H. , et al (2013) The effect of prenatal exposure to 900-MHz electromagnetic field on the 21-old-day rat testicle. *Reprod Toxicol* 42:203–209. <https://doi.org/10.1016/j.reprotox.2013.09.006>.

Hardell L. , Hallquist A. , Mild K.H. , et al (2002) Cellular and cordless telephones and the risk for brain tumours. *Eur J Cancer Prev* 11(4):377–386. <https://doi.org/10.1097/00008469-200208000-00010>.

Hardell L. , Carlberg M. , Söderqvist F. , Mild K.H. , Morgan L.L. (2007) Long-term use of cellular phones and brain tumours: Increased risk associated with use for ≥ 10 years. *Occup Environ Med* 64(9):626–632. <https://doi.org/10.1136/oem.2006.029751>.

Hardell L. , Carlberg M. (2009) Mobile phones, cordless phones and the risk for brain tumours. *Int J Oncol* 35(1):5–17. https://doi.org/10.3892/ijo_00000307.

Hardell L. , Carlberg M. , Söderqvist F. , Mild K.H. (2013) Case-control study of the association between malignant brain tumours diagnosed between 2007 and 2009 and mobile and cordless phone use. *Int J Oncol* 43(6):1833–1845. <https://doi.org/10.3892/ijo.2013.2111>.

Hardell L. , Carlberg M. (2020) Health risks from radiofrequency radiation, including 5G, should be assessed by experts with no conflicts of interest. *Oncol Lett* 20(4):15. <https://doi.org/10.3892/ol.2020.11876>.

Hardell L. , Carlberg M. (2021) Lost opportunities for cancer prevention: Historical evidence on early warnings with emphasis on radiofrequency radiation. *Rev Environ Health* 36(4):585–597. <https://doi.org/10.1515/reveh-2020-0168>.

Harremoes P. , Gee D. , MacGarvin M. , et al. (Eds.). (2013). *The precautionary principle in the 20th century: Late lessons from early warnings*. London: Routledge.

Harris A. , Cooper M. (2019) Mobile phones: Impacts, challenges, and predictions. *Hum Behav Emerg Technol* 1(1):15–17. <https://doi.org/10.1002/hbe2.112>.

Hatch E. , Willis S. , Wesselink A. , et al (2021) Male cellular telephone exposure, fecundability, and semen quality: Results from two preconception cohort studies. *Hum Reprod* 36(5):1395–1404. <https://doi.org/10.1093/HUMREP/DEAB001>.

Haumann T. , Münzenberg U.W.E. , Maes W. , Sierck P. (2002) HF-radiation levels of GSM cellular phone towers in residential areas. *Proc 2nd Int Work Biol Eff EMFS* 1:327–333.

Herrala M. , Mustafa E. , Naarala J. , Juutilainen J. (2018) Assessment of genotoxicity and genomic instability in rat primary astrocytes exposed to 872 MHz radiofrequency radiation and chemicals. *Int J Radiat Biol* 94(10):883–889. <https://doi.org/10.1080/09553002.2018.1450534>.

Hook G.J. , Zhang P. , Lagroye I. , et al (2004) Measurement of DNA damage and apoptosis in Molt-4 cells after in vitro exposure to radiofrequency radiation. *Radiat Res* 161(2):193–200. <https://doi.org/10.1667/RR3127>.

Houston B.J. , Nixon B. , King B.V. , Aitken R.J. , De luliis G.N. (2018) Probing the origins of 1,800 MHz radio frequency electromagnetic radiation induced damage in mouse immortalized germ cells and spermatozoa in vitro. *Front Public Health* 6:270. <https://doi.org/10.3389/fpubh.2018.00270>.

Houston B.J. , Nixon B. , McEwan K.E. , et al (2019) Whole-body exposures to radiofrequency-electromagnetic energy can cause DNA damage in mouse spermatozoa via an oxidative mechanism. *Sci Rep* 9(1):17478. <https://doi.org/10.1038/s41598-019-53983-9>.

Huang C-Y. , Chang C-W. , Chen C-R. , Chuang C-Y. , Chiang C-S. , et al (2014) Extremely low-frequency electromagnetic fields cause G1 phase arrest through the activation of the ATM-Chk2-p21 pathway. *PLoS ONE* 9(8): e104732. <https://doi.org/10.1371/journal.pone.0104732>.

Hui W. , Xu Y.S. , Miao Lin W. , et al (2017) Protective effect of naringin against the LPS-induced apoptosis of PC12 cells: Implications for the treatment of neurodegenerative disorders. *Int J Mol Med* 39(4):819–830. <https://doi.org/10.3892/ijmm.2017.2904>.

Hutter H.P. , Moshammer H. , Wallner P. , Kundi M. (2006) Subjective symptoms, sleeping problems, and cognitive performance in subjects living near mobile phone base stations. *Occup Environ Med* 63(5):307–313. <https://doi.org/10.1136/oem.2005.020784>.

Hyland G.J. (2000) Physics and biology of mobile telephony. *Lancet* 356(9244):1833–1836. [https://doi.org/10.1016/s0140-6736\(00\)03243-8](https://doi.org/10.1016/s0140-6736(00)03243-8).

Hyland G.J. (2008) Physical basis of adverse and therapeutic effects of low intensity microwave radiation. *Indian J Exp Biol* 46(5):403–419.

ICNIRP . (1998) Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). *Health Phys* 74(4):494–521.

ICNIRP . (2010) Guidelines for limiting exposure to time-varying electric and magnetic fields (1 Hz to 100 kHz). *Health Phys* 99(6):818–836. <https://doi.org/10.1097/HP.0b013e3181f06c86>.

ICNIRP . (2020) Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz). *Health Phys* 118(5):483–524. <https://doi.org/10.1097/HP.0000000000001210>.

Ivancsits S. , Diem E. , Pilger A. , Rüdiger H.W. , Jahn O. (2002) Induction of DNA strand breaks by intermittent exposure to extremely-low-frequency electromagnetic fields in human diploid fibroblasts. *Mutat Res - Genet Toxicol Environ Mutagen* 519(1–2):1–13. [https://doi.org/10.1016/S1383-5718\(02\)00109-2](https://doi.org/10.1016/S1383-5718(02)00109-2).

Ivancsits S. , Diem E. , Jahn O. , Rüdiger H.W. (2003) Intermittent extremely low frequency electromagnetic fields cause DNA damage in a dose-dependent way. *Int Arch Occup Environ Health* 76(6):431–436. <https://doi.org/10.1007/s00420-003-0446-5>.

Ivancsits S. , Pilger A. , Diem E. , Jahn O. , Rüdiger H.W. (2005) Cell type-specific genotoxic effects of intermittent extremely low-frequency electromagnetic fields. *Mutat Res - Genet Toxicol Environ Mutagen*

583(2):184–188. <https://doi.org/10.1016/j.mrgentox.2005.03.011>.

Jeong Y.J. , Son Y. , Han N.K. , et al (2018) Impact of long-term RF-EMF on oxidative stress and neuroinflammation in aging brains of C57BL/6 mice. *Int J Mol Sci* 19(7):2103. <https://doi.org/10.3390/ijms19072103>.

Juutilainen J. , Heikkinen P. , Soikkeli H. , Mäki-Paakkanen J. (2007) Micronucleus frequency in erythrocytes of mice after long-term exposure to radiofrequency radiation. *Int J Radiat Biol* 83(4):213–220. <https://doi.org/10.1080/09553000601169800>.

Karaca E. , Durmaz B. , Altug H. , et al (2012) The genotoxic effect of radiofrequency waves on mouse brain. *J Neurooncol* 106(1):53–58. <https://doi.org/10.1007/s11060-011-0644-z>.

Kerbacher J.J. , Meltz M.L. , Erwin D.N. (1990) Influence of radiofrequency radiation on chromosome aberrations in CHO cells and its interaction with DNA-damaging agents. *Radiat Res* 123(3):311–319. <https://doi.org/10.2307/3577738>.

Kesari K.K. , Luukkonen J. , Juutilainen J. , Naarala J. (2015) Genomic instability induced by 50Hz magnetic fields is a dynamically evolving process not blocked by antioxidant treatment. *Mutat Res - Genet Toxicol Environ Mutagen* 794:46–51. <https://doi.org/10.1016/j.mrgentox.2015.10.004>.

Khalil A.M. , Gagaa M.H. , Alshamali A.M. (2012) 8-Oxo-7, 8-dihydro-2'-deoxyguanosine as a biomarker of DNA damage by mobile phone radiation. *Hum Exp Toxicol* 31(7):734–740. <https://doi.org/10.1177/0960327111433184>.

Khalil A.M. , Alemam I.F. , Al-Qaoud K.M. (2020) Association between mobile phone using and DNA damage of epithelial cells of the oral mucosa. *J Biotechnol Biomed* 3(2):50–66. <https://doi.org/10.26502/jbb.2642-91280027>.

Kim J. , Ha C.S. , Lee H.J. , Song K. (2010) Repetitive exposure to a 60-Hz time-varying magnetic field induces DNA double-strand breaks and apoptosis in human cells. *Biochem Biophys Res Commun* 400(4):739–744. <https://doi.org/10.1016/j.bbrc.2010.08.140>.

Kim J. , Yoon Y. , Yun S. , et al (2012) Time-varying magnetic fields of 60Hz at 7mT induce DNA double-strand breaks and activate DNA damage checkpoints without apoptosis. *Bioelectromagnetics* 33(5):383–393. <https://doi.org/10.1002/bem.21697>.

Komatsubara Y. , Hirose H. , Sakurai T. , et al (2005) Effect of high-frequency electromagnetic fields with a wide range of SARs on chromosomal aberrations in murine m5S cells. *Mutat Res* 587(1–2):114–119. <https://doi.org/10.1016/J.MRGENTOX.2005.08.010>.

Koyama S. , Nakahara T. , Wake K. , et al (2003) Effects of high frequency electromagnetic fields on micronucleus formation in CHO-K1 cells. *Mutat Res - Genet Toxicol Environ Mutagen* 541(1–2):81–89. <https://doi.org/10.1016/j.mrgentox.2003.07.009>.

Koyama S. , Isozumi Y. , Suzuki Y. , Taki M. , Miyakoshi J. (2004) Effects of 2.45-GHz electromagnetic fields with a wide range of SARs on micronucleus formation in CHO-K1 cells. *Sci World J* 4(Suppl 2):29–40. <https://doi.org/10.1100/tsw.2004.176>.

Koyama S. , Narita E. , Shimizu Y. , et al (2016) Effects of long-term exposure to 60 GHz millimeter-wavelength radiation on the genotoxicity and heat shock protein (HSP) expression of cells derived from human eye. *Int J Environ Res Public Health* 13(8):802. <https://doi.org/10.3390/ijerph13080802>.

Koyama S. , Narita E. , Suzuki Y. , et al (2019) Long-term exposure to a 40-GHz electromagnetic field does not affect genotoxicity or heat shock protein expression in HCE-T or SRA01/04 cells. *J Radiat Res* 60(4):417–423. <https://doi.org/10.1093/jrr/rrz017>.

Kumar G. , McIntosh R.L. , Anderson V. , McKenzie R.J. , Wood A.W. (2015) A genotoxic analysis of the hematopoietic system after mobile phone type radiation exposure in rats. *Int J Radiat Biol* 91(8):664–672. <https://doi.org/10.3109/09553002.2015.1047988>.

Kumar S. , Kesari K.K. , Behari J. (2010) Evaluation of genotoxic effects in male Wistar rats following microwave exposure. *Indian J Exp Biol* 48(6):586–592. <https://pubmed.ncbi.nlm.nih.gov/20882761/>.

Lagroye I. , Anane R. , Wettring B.A. , et al (2004a) Measurement of DNA damage after acute exposure to pulsed-wave 2450 MHz microwaves in rat brain cells by two alkaline comet assay methods. *Int J Radiat Biol* 80(1):11–20. <https://doi.org/10.1080/09553000310001642911>.

Lagroye I. , Hook G. , Wettring B. , et al (2004b) Measurements of alkali-labile DNA damage and protein-DNA crosslinks after 2450 MHz microwave and low-dose gamma irradiation in vitro. *Radiat Res* 161(2):201–214. <https://doi.org/10.1667/RR3122>.

Lai H. , Singh N.P. (1995) Acute low-intensity microwave exposure increases DNA single-strand breaks in rat brain cells. *Bioelectromagnetics* 16(3):207–210. <https://doi.org/10.1002/bem.2250160309>.

Lai H. , Singh N.P. (1996) Single- and double-strand DNA breaks in rat brain cells after acute exposure to radiofrequency electromagnetic radiation. *Int J Radiat Biol* 69(4):513–521. <https://doi.org/10.1080/095530096145814>.

Lai H. , Singh N.P. (1997) Acute exposure to a 60 Hz magnetic field increases DNA strand breaks in rat brain cells. *Bioelectromagnetics* 18(2):156–165. [https://doi.org/10.1002/\(sici\)1521-186x\(1997\)18:2<156::aid-bem8>3.0.co;2-1](https://doi.org/10.1002/(sici)1521-186x(1997)18:2<156::aid-bem8>3.0.co;2-1).

Lai H. , Singh N.P. (2004) Magnetic field-induced DNA strand breaks in brain cells of the rat. *Environ Health Perspect* 112(6):687–694. <https://doi.org/10.1289/ehp.6355>.

Leach V. , Weller S. , Redmayne M. (2018) A novel database of bio-effects from non-ionizing radiation. *Rev Environ Health* 33(3):273–280. <https://doi.org/10.1515/reveh-2018-0017>.

Lee J.W. , Kim M.S. , Kim Y.J. , et al (2011) Genotoxic effects of 3T magnetic resonance imaging in cultured human lymphocytes. *Bioelectromagnetics* 32(7):535–542. <https://doi.org/10.1002/bem.20664>.

Li L. , Bisht K. , LaGroye I. , et al (2001) Measurement of DNA damage in mammalian cells exposed in vitro to radiofrequency fields at SARs of 3–5 W/kg. *Radiat Res* 156(3):328–332. [https://doi.org/10.1667/0033-7587\(2001\)156\[0328:moddim\]2.0.co;2](https://doi.org/10.1667/0033-7587(2001)156[0328:moddim]2.0.co;2).

Li R. , Ma M. , Li L. , et al (2018) The protective effect of autophagy on DNA damage in mouse spermatocyte-derived cells exposed to 1800 MHz radiofrequency electromagnetic fields. *Cell Physiol Biochem* 48(1):29–41. <https://doi.org/10.1159/000491660>.

Liu C. , Duan W. , Xu S. , et al (2013a) Exposure to 1800 MHz radiofrequency electromagnetic radiation induces oxidative DNA base damage in a mouse spermatocyte-derived cell line. *Toxicol Lett* 218(1):2–9. <https://doi.org/10.1016/j.toxlet.2013.01.003>.

Liu C. , Gao P. , Xu S.C. , et al (2013b) Mobile phone radiation induces mode-dependent DNA damage in a mouse spermatocyte-derived cell line: A protective role of melatonin. *Int J Radiat Biol* 89(11):993–1001. <https://doi.org/10.3109/09553002.2013.811309>.

Liu C. , Guo H. , Chen J. , Guo H. , Chen J. (2019) Research on pulse response characteristics of wireless ultraviolet communication in mobile scene. *Opt Express* 27(8):10670–10683. <https://doi.org/10.1364/OE.27.010670>.

Liu Y. , Bin W.B. , Liu K.J. , et al (2015) Effect of 50 Hz extremely low-frequency electromagnetic fields on the DNA methylation and DNA methyltransferases in mouse spermatocyte-derived cell line GC-2. *BioMed Res Int* 2015:237183. <https://doi.org/10.1155/2015/237183>.

Lloyd D.C. , Saunders R.D. , Finnon P. , Kowalczyk C.I. (1984) No clastogenic effect from in vitro microwave irradiation of G0 human lymphocytes. *Int J Radiat Biol* 46(2):135–141. <https://doi.org/10.1080/09553008414551211>.

López-Furelos A. , Salas-Sánchez A.A. , Ares-Pena F.J. , Leiro-Vidal J.M. , López-Martín E. (2018) Exposure to radiation from single or combined radio frequencies provokes macrophage dysfunction in the RAW 264.7 cell line. *Int J Radiat Biol* 94(6):607–618. <https://doi.org/10.1080/09553002.2018.1465610>.

López I. , Félix N. , Rivera M. , Alonso A. , Maestú C. (2021) What is the radiation before 5G? A correlation study between measurements in situ and in real time and epidemiological indicators in Vallecas, Madrid. *Environ Res* 194:110734. <https://doi.org/10.1016/J.ENVRES.2021.110734>.

Lu X. , Oda M. , Ohba T. , et al (2017) Association of excessive mobile phone use during pregnancy with birth weight: An adjunct study in Kumamoto of Japan environment and children's study. *Environ Health Prev Med* 22(1):52. <https://doi.org/10.1186/S12199-017-0656-1>.

Luukkonen J. , Liimatainen A. , Juutilainen J. , Naarala J. (2014) Induction of genomic instability, oxidative processes, and mitochondrial activity by 50 Hz magnetic fields in human SH-SY5Y neuroblastoma cells. *Mutat Res - Fundam Mol Mech Mutagen* 760:33–41. <https://doi.org/10.1016/j.mrfmmm.2013.12.002>.

Lv Y. , Chen S. , Zhu B. , et al (2021) Exposure to 50 Hz extremely-low-frequency magnetic fields induces no DNA damage in cells by gamma H2AX technology. *BioMed Res Int* 2021:8510315. <https://doi.org/10.1155/2021/8510315>.

Maes A. , Verschaeve L. , Arroyo A. , De Wagter C. , Vercruyssen L. (1993) In vitro cytogenetic effects of 2450 MHz waves on human peripheral blood lymphocytes. *Bioelectromagnetics* 14(6):495–501. <https://doi.org/10.1002/BEM.2250140602>

Maes A. , Collier M. , Van Gorp U. , Vandoninck S. , Verschaeve L. (1997) Cytogenetic effects of 935.2-MHz (GSM) microwaves alone and in combination with Mitomycin C. *Mutat Res - Genet Toxicol Environ Mutagen* 393(1–2):151–156. [https://doi.org/10.1016/S1383-5718\(97\)00100-9](https://doi.org/10.1016/S1383-5718(97)00100-9).

Maes A. , Collier M. , Slaets D. , Verschaeve L. (2000a) Cytogenetic investigations on microwaves emitted by a 455.7 MHz car phone. *Folia Biol* 46(5):175–180.

Maes A. , Collier M. , Vandoninck S. , Scarpa P. , Verschaeve L. (2000b) Cytogenetic effects of 50 Hz magnetic fields of different magnetic flux densities. *Bioelectromagnetics* 21(8):589–596.

Maes A. , Collier M. , Verschaeve L. (2001) Cytogenetic effects of 900 MHz (GSM) microwaves on human lymphocytes. *Bioelectromagnetics* 22(2):91–96.

Maes A. , Van Gorp U. , Verschaeve L. (2006) Cytogenetic investigation of subjects professionally exposed to radiofrequency radiation. *Mutagenesis* 21(2):139–142. <https://doi.org/10.1093/MUTAGE/GEL008>.

Mahmoudabadi F. , Ziaei S. , Firoozabadi M. , Kazemnejad A. (2015) Use of mobile phone during pregnancy and the risk of spontaneous abortion. *J Environ Heal Sci Eng* 13:34. <https://doi.org/10.1186/S40201-015-0193-Z>.

Mailankot M. , Kunnath A.P. , Jayalekshmi H. , Koduru B. , Valsalan R. (2009) Radio frequency electromagnetic radiation (RF-EMR) from GSM (0.9/1.8GHz) mobile phones induces oxidative stress and reduces sperm motility in rats. *Clin (Sao Paulo)* 64(6):561–565. <https://doi.org/10.1590/s1807-59322009000600011>.

Malyapa R.S. , Ahern E.W. , Straube W.L. , et al (1997a) Measurement of DNA damage after exposure to 2450 MHz electromagnetic radiation. *Radiat Res* 148(6):608–617. <https://doi.org/10.2307/3579737>.

Malyapa R.S. , Ahern E.W. , Straube W.L. , et al (1997b) Measurement of DNA damage after exposure to electromagnetic radiation in the cellular phone communication frequency band (835.62 and 847.74 MHz).

Radiat Res 148(6):618–627. <https://doi.org/10.2307/3579738>.

Manikowska-Czerska E. , Czerski P. , Leach W.M. (1985) Effects of 2.45 GHz microwaves on meiotic chromosomes of male CBA/CAy mice. *J Hered* 76(1):71–73. <https://doi.org/10.1093/oxfordjournals.jhered.a110027>.

Manna D. , Ghosh R. (2016) Effect of radiofrequency radiation in cultured mammalian cells: A review. *Electromagn Biol Med* 35(3):265–301. <https://doi.org/10.3109/15368378.2015.1092158>.

Manti L. , Braselmann H. , Calabrese M.L. , et al (2008) Effects of modulated microwave radiation at cellular telephone frequency (1.95 GHz) on X-ray-induced chromosome aberrations in human lymphocytes in vitro. *Radiat Res* 169(5):575–583. <https://doi.org/10.1667/RR1044.1>.

Mariucci G. , Villarini M. , Moretti M. , et al (2010) Brain DNA damage and 70-kDa heat shock protein expression in CD1 mice exposed to extremely low frequency magnetic fields. *Int J Radiat Biol* 86(8):701–710. <https://doi.org/10.3109/09553001003789588>.

Marková E. , Hillert L. , Malmgren L. , Persson B.R. , Belyaev I.Y. (2005) Microwaves from GSM mobile telephones affect 53BP1 and γ -H2AX foci in human lymphocytes from hypersensitive and healthy persons. *Environ Health Perspect* 113(9):1172–1177. <https://doi.org/10.1289/ehp.7561>.

Martynyuk V. , Melnyk M. , Artemenko A. (2016) Comparison of biological effects of electromagnetic fields with pulse frequencies of 8 and 50 Hz on gastric smooth muscles. *Electromagn Biol Med* 35(2):143–151. <https://doi.org/10.3109/15368378.2015.1028072>.

Mashevich M. , Folkman D. , Kesar A. , et al (2003) Exposure of human peripheral blood lymphocytes to electromagnetic fields associated with cellular phones leads to chromosomal instability. *Bioelectromagnetics* 24(2):82–90. <https://doi.org/10.1002/bem.10086>.

Mazor R. , Korenstein-Ilan A. , Barbul A. , et al (2008) Increased levels of numerical chromosome aberrations after in vitro exposure of human peripheral blood lymphocytes to radiofrequency electromagnetic fields for 72 hours. *Radiat Res* 169(1):28–37. <https://doi.org/10.1667/RR0872.1>.

McNamee J. , Bellier P. , Gajda G.B. , et al (2002a) DNA damage in human leukocytes after acute in vitro exposure to a 1.9 GHz pulse-modulated radiofrequency field. *Radiat Res* 158(4):534–537. [https://doi.org/10.1667/0033-7587\(2002\)158\[0534:DDIHLA\]2.0.CO;2](https://doi.org/10.1667/0033-7587(2002)158[0534:DDIHLA]2.0.CO;2).

McNamee J.P. , Bellier P.V. , Gajda G.B. , et al (2002b) DNA damage and micronucleus induction in human leukocytes after acute in vitro exposure to a 1.9 GHz continuous-wave radiofrequency field. *Radiat Res* 158(4):523–533. [https://doi.org/10.1667/0033-7587\(2002\)158\[0523:DDAMII\]2.0.CO;2](https://doi.org/10.1667/0033-7587(2002)158[0523:DDAMII]2.0.CO;2).

McNamee J.P. , Bellier P.V. , Gajda G.B. , et al (2003) No evidence for genotoxic effects from 24 h exposure of human leukocytes to 1.9 GHz radiofrequency fields. *Radiat Res* 159(5):693–697. [https://doi.org/10.1667/0033-7587\(2003\)159\[0693:NEFGFJ\]2.0.CO;2](https://doi.org/10.1667/0033-7587(2003)159[0693:NEFGFJ]2.0.CO;2).

Meena R. , Kumari K. , Kumar J. , et al (2014) Therapeutic approaches of melatonin in microwave radiations-induced oxidative stress-mediated toxicity on male fertility pattern of Wistar rats. *Electromagn Biol Med* 33(2):81–91. <https://doi.org/10.3109/15368378.2013.781035>.

Meral O. , Ozgur E. , Kismali G. , et al (2016) GSM-like radiofrequency exposure induces apoptosis via caspase-dependent pathway in infant rabbits. *Bratisl Med J* 117(11):672–676. https://doi.org/10.4149/BLL_2016_129.

Miller A.B. , Morgan L.L. , Udasin I. , Davis D.L. (2018) Cancer epidemiology update, following the 2011 IARC evaluation of radiofrequency electromagnetic fields (Monograph 102). *Environ Res* 167:673–683. <https://doi.org/10.1016/j.envres.2018.06.043>.

Miller A. , Sears M. , Morgan L. , et al (2019) Risks to health and well-being from radio-frequency radiation emitted by cell phones and other wireless devices. *Front Public Health* 7:223. <https://doi.org/10.3389/FPUBH.2019.00223>.

Mizuno K. , Shinohara N. , Miyakoshi J. (2015) In vitro evaluation of genotoxic effects under magnetic resonant coupling wireless power transfer. *Int J Environ Res Public Health* 12(4):3853–3863. <https://doi.org/10.3390/ijerph120403853>.

Moon J. (2020) Health effects of electromagnetic fields on children. *Clin Exp Pediatr* 63(11):422–428. <https://doi.org/10.3345/CEP.2019.01494>.

Nakayama M. , Nakamura A. , Hondou T. , Miyata H. (2016) Evaluation of cell viability, DNA single-strand breaks, and nitric oxide production in LPS-stimulated macrophage RAW264 exposed to a 50-Hz magnetic field. *Int J Radiat Biol* 92(10):583–589. <https://doi.org/10.1080/09553002.2016.1206224>.

Navarro E.A. , Segura J. , Portolés M. , Gómez-Perretta C. (2003) The microwave syndrome: A preliminary study in Spain. *Electromagn Biol Med* 22(2–3):161–169. <https://doi.org/10.1081/JBC-120024625>.

Nordenson I. , Mild K.H. , Andersson G. , Sandström M. (1994) Chromosomal aberrations in human amniotic cells after intermittent exposure to fifty hertz magnetic fields. *Bioelectromagnetics* 15(4):293–301. <https://doi.org/10.1002/bem.2250150404>.

Okechukwu C. (2020) Does the use of mobile phone affect male fertility? A mini-review. *J Hum Reprod Sci* 13(3):174–183. https://doi.org/10.4103/JHRS.JHRS_126_19.

Ono T. , Saito Y. , Komura J.I. , et al (2004) Absence of mutagenic effects of 2.45 GHz radiofrequency exposure in spleen, liver, brain, and testis of lacZ-transgenic mouse exposed in utero. *Tohoku J Exp Med* 202(2):93–103. <https://doi.org/10.1620/tjem.202.93>.

Othman O.E. , Aly M.S. , El Nahas S.M. , Mohamed H.M. (2003) Mutagenic potential of radio-frequency electromagnetic fields. *Cytol (Tokyo)* 68(1):35–43. <https://doi.org/10.1508/cytologia.68.35>.

Pall M.L. (2013) Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects. *J Cell Mol Med* 17(8):958–965. <https://doi.org/10.1111/jcmm.12088>.

Panagopoulos D.J. , Messini N. , Karabarbounis A. , Philippetis A.L. , Margaritis L.H. (2000) A mechanism for action of oscillating electric fields on cells. *Biochem Biophys Res Commun* 272(3):634–640. <https://doi.org/10.1006/bbrc.2000.2746>.

Panagopoulos D.J. , Karabarbounis A. , Margaritis L.H. (2002) Mechanism for action of electromagnetic fields on cells. *Biochem Biophys Res Commun* 298(1):95–102. [https://doi.org/10.1016/S0006-291X\(02\)02393-8](https://doi.org/10.1016/S0006-291X(02)02393-8).

Panagopoulos D.J. , Chavdoula E.D. , Nezis I.P. , Margaritis L.H. (2007) Cell death induced by GSM 900-MHz and DCS 1800-MHz mobile telephony radiation. *Mutat Res - Genet Toxicol Environ Mutagen* 626(1–2):69–78. <https://doi.org/10.1016/j.mrgentox.2006.08.008>.

Panagopoulos D.J. , Chavdoula E.D. , Margaritis L.H. (2010) Bioeffects of mobile telephony radiation in relation to its intensity or distance from the antenna. *Int J Radiat Biol* 86(5):345–357.

Panagopoulos D.J. (2012) Effect of microwave exposure on the ovarian development of *Drosophila melanogaster*. *Cell Biochem Biophys* 63(2):121–132. <https://doi.org/10.1007/s12013-012-9347-0>.

Panagopoulos D.J. , Johansson O. , Carlo G.L. (2013a) Evaluation of specific absorption rate as a dosimetric quantity for electromagnetic fields bioeffects. *PLOS ONE* 8(6):e62663. <https://doi.org/10.1371/journal.pone.0062663>.

Panagopoulos D.J. , Karabarbounis A. , Lioliouis C. (2013b) ELF alternating magnetic field decreases reproduction by DNA damage induction. *Cell Biochem Biophys* 67(2):703–716. <https://doi.org/10.1007/s12013-013-9560-5>.

Panagopoulos D.J. , Johansson O. , Carlo G.L. (2015) Polarization: A key difference between man-made and natural electromagnetic fields, in regard to biological activity. *Sci Rep* 5:14914. <https://doi.org/10.1038/srep14914>.

Panagopoulos D. (2019a) Comparing DNA damage induced by mobile telephony and other types of man-made electromagnetic fields. *Mutat Res* 781:53–62. <https://doi.org/10.1016/J.MRREV.2019.03.003>.

Panagopoulos D.J. (2019b) Chromosome damage in human cells induced by UMTS mobile telephony radiation. *Gen Physiol Biophys* 38(5):445–454. https://doi.org/10.4149/gpb_2019032.

Panagopoulos D.J. (2020) Comparing chromosome damage induced by mobile telephony radiation and a high caffeine dose: Effect of combination and exposure duration. *Gen Physiol Biophys* 39(6):531–544. https://doi.org/10.4149/gpb_2020036.

Panagopoulos D. , Karabarbounis A. , Yakymenko I. , Chrousos G. (2021) Human-made electromagnetic fields: Ion forced oscillation and voltage-gated ion channel dysfunction, oxidative stress and DNA damage (Review). *Int J Oncol* 59(5):92. <https://doi.org/10.3892/ijo.2021.5272>.

Pandey N. , Giri S. (2018) Melatonin attenuates radiofrequency radiation (900 MHz)-induced oxidative stress, DNA damage and cell cycle arrest in germ cells of male Swiss albino mice. *Toxicol Ind Health* 34(5):315–327. <https://doi.org/10.1177/0748233718758092>.

Paolucci T. , Pezzi L. , Centra A. , et al (2020) Electromagnetic field therapy: A rehabilitative perspective in the management of musculoskeletal pain - A systematic review. *J Pain Res* 13:1385–1400. <https://doi.org/10.2147/JPR.S231778>.

Parasuraman S. , Sam A. , Yee S.K. , Chuon B.L.C. , Ren L.Y. (2017) Smartphone usage and increased risk of mobile phone addiction: A concurrent study. *Int J Pharm Investig* 7(3):125–131. https://doi.org/10.4103/jphi.jphi_56_17.

Pedersen G.F. (1997) Amplitude modulated RF fields stemming from a GSM/DCS-1800 phone. *Wirel Netw* 3(6):489–498. <https://doi.org/10.1023/A:1019158712657>.

Phillips J.L. , Ivaschuk O. , Ishida-Jones T. , et al (1998) DNA damage in molt-4 T-lymphoblastoid cells exposed to cellular telephone radiofrequency fields in vitro. *Bioelectrochem Bioenerg* 45(1):103–110. [https://doi.org/10.1016/S0302-4598\(98\)00074-9](https://doi.org/10.1016/S0302-4598(98)00074-9).

Popov V. , Shevchenko A. (2019) Analysis of standards and norms of electromagnetic irradiation levels in wireless communication systems on railway transport. *Proced Comp Sci* 149:239–245. <https://doi.org/10.1016/j.procs.2019.01.129>.

Port M. , Abend M. , Römer B. , Van Beuningen D. (2003) Influence of high-frequency electromagnetic fields on different modes of cell death and gene expression. *Int J Radiat Biol* 79(9):701–708. <https://doi.org/10.1080/09553000310001606803>.

Rageh M.M. , El-Gebaly R.H. , El-Bialy N.S. (2012) Assessment of genotoxic and cytotoxic hazards in brain and bone marrow cells of newborn rats exposed to extremely low-frequency magnetic field. *J Biomed Biotechnol* 2012:716023. <https://doi.org/10.1155/2012/716023>.

Rashmi B. , Chinna S. , Rodrigues C. , et al (2020) Occurrence of micronuclei in exfoliated buccal mucosal cells in mobile phone users: A case-control study. *Indian J Dent Res* 31(5):734–737. https://doi.org/10.4103/ijdr.IJDR_634_18.

Reddy S.B. , Weller J. , Desjardins-Holmes D. , et al (2010) Micronuclei in the blood and bone marrow cells of mice exposed to specific complex time-varying pulsed magnetic fields. *Bioelectromagnetics* 31(6):445–453. <https://doi.org/10.1002/bem.20576>.

Regalbuto E. , Anselmo A. , De Sanctis S. , et al (2020) Human fibroblasts in vitro exposed to 2.45 GHz continuous and pulsed wave signals: Evaluation of biological effects with a multimethodological approach. *Int J Mol Sci* 21(19):1–24. <https://doi.org/10.3390/ijms21197069>.

Rezaie-Tavirani M. , Hasanzadeh H. , Seyyedi S. , Zali H. (2017) Proteomic analysis of the effect of extremely low-frequency electromagnetic fields (ELF-EMF) with different intensities in SH-SY5Y Neuroblastoma cell line. *J Lasers Med Sci* 8(2):79–83. <https://doi.org/10.15171/jlms.2017.14>.

Ros-Llor I. , Sanchez-Siles M. , Camacho-Alonso F. , Lopez-Jornet P. (2012) Effect of mobile phones on micronucleus frequency in human exfoliated oral mucosal cells. *Oral Dis* 18(8):786–792. <https://doi.org/10.1111/j.1601-0825.2012.01946.x>.

Ross C.L. , Pettenati M.J. , Procita J. , et al (2018) Evaluation of cytotoxic and genotoxic effects of extremely low-frequency electromagnetic field on mesenchymal stromal cells. *Glob Adv Heal Med* 7:216495611877747. <https://doi.org/10.1177/2164956118777472>.

Russell C.L. (2018) 5 G wireless telecommunications expansion: Public health and environmental implications. *Environ Res* 165:484–495. <https://doi.org/10.1016/j.envres.2018.01.016>.

Sakuma N. , Komatsubara Y. , Takeda H. , et al (2006) DNA strand breaks are not induced in human cells exposed to 2.1425 GHz band CW and W-CDMA modulated radiofrequency fields allocated to mobile radio base stations. *Bioelectromagnetics* 27(1):51–57. <https://doi.org/10.1002/BEM.20179>.

Salford L.G. , Brun A.E. , Eberhardt J.L. , Malmgren L. , Persson B.R. (2003) Nerve cell damage in mammalian brain after exposure to microwaves from GSM mobile phones. *Environ Health Perspect* 111(7):881–883. <https://doi.org/10.1289/ehp.6039>.

Sanie-Jahromi F. , Saadat I. , Saadat M. (2016) Effects of extremely low frequency electromagnetic field and cisplatin on mRNA levels of some DNA repair genes. *Life Sci* 166:41–45. <https://doi.org/10.1016/j.lfs.2016.10.006>.

Sannino A. , Calabrese M.L. , D'Ambrosio G. , Massa R. , Petraglia G. , Mita P. , et al (2006). Evaluation of cytotoxic and genotoxic effects in human peripheral blood leukocytes following exposure to 1950-MHz modulated signal. *IEEE Trans Plasma Sci*.34:1441–1448. <https://doi.org/10.1109/TPS.2006.878379>.

Santini R. , Santini P. , Danze J.M. , Le Ruz P. , Seigne M. (2002) Enquête sur la santé de riverains de stations relais de téléphonie mobile: l'Incidence de la distance et du sexe. *Pathol Biol* 50(6):369–373. [https://doi.org/10.1016/S0369-8114\(02\)00311-5](https://doi.org/10.1016/S0369-8114(02)00311-5).

Sarimov R. , Malmgren L.O.G. , Marková E. , Persson B. , Belyaev I.Y. (2004) Nonthermal GSM microwaves affect chromatin conformation in human lymphocytes similar to heat shock. *IEEE Trans Plasma Sci* 32(4):1600–1608. <https://doi.org/10.1109/TPS.2004.832613>.

Sarkar S. , Ali S. , Behari J. (1994) Effect of low power microwave on the mouse genome: A direct DNA analysis. *Mutat Res Toxicol* 320(1–2):141–147. [https://doi.org/10.1016/0165-1218\(94\)90066-3](https://doi.org/10.1016/0165-1218(94)90066-3).

Scarfì M.R. , Fresegna A.M. , Villani P. , Pinto R. , Marino C. , Sarti M. , et al (2006) Exposure to radiofrequency radiation (900 MHz, GSM signal) does not affect micronucleus frequency and cell proliferation in human peripheral blood lymphocytes: An interlaboratory study. *Radiat Res*. 165:655–663; <https://doi.org/10.1667/RR3570.1>.

Schmitz C. , Keller E. , Freuding T. , Silny J. , Korr H. (2004) 50-Hz magnetic field exposure influences DNA repair and mitochondrial DNA synthesis of distinct cell types in brain and kidney of adult mice. *Acta Neuropathol* 107(3):257–264. <https://doi.org/10.1007/s00401-003-0799-6>.

Şekeroğlu V. , Akar A. , Şekeroğlu Z.A. (2012) Cytotoxic and genotoxic effects of high-frequency electromagnetic fields (GSM 1800 MHz) on immature and mature rats. *Ecotoxicol Environ Saf* 80:140–144. <https://doi.org/10.1016/j.ecoenv.2012.02.028>.

Şekeroğlu Z.A. , Akar A. , Şekeroğlu V. (2013) Evaluation of the cytogenotoxic damage in immature and mature rats exposed to 900 MHz radiofrequency electromagnetic fields. *Int J Radiat Biol* 89(11):985–992. <https://doi.org/10.3109/09553002.2013.809170>.

Sesia S. , Toufik I. , Baker M. (2011). LTE-the UMTS long term evolution: From theory to practice. John Wiley & Sons.

Shah C. , Anu N. , Mehl N. , Sonal B. (2015) Cell phone radiation and genomic damage: In vitro exposure and assessment. *Int J Innov Res Sci Eng Technol* 4:401–405. <https://doi.org/10.15680/ijrset.2015.0402025>.

Sharma A. , Shrivastava S. , Shukla S. (2020) Exposure of radiofrequency electromagnetic radiation on biochemical and pathological alterations. *Neurol India* 68(5):1092–1100. <https://doi.org/10.4103/0028-3886.294554>.

Shen Y. , Xia R. , Jiang H. , et al (2016) Exposure to 50 Hz-sinusoidal electromagnetic field induces DNA damage-independent autophagy. *Int J Biochem Cell Biol* 77(A):72–79. <https://doi.org/10.1016/j.biocel.2016.05.009>.

Singh K. , Prakash C. , Nirala J. , et al (2020) Acute radiofrequency electromagnetic radiation exposures cause neuronal DNA damage and impair neurogenesis in the young adolescent rat brain. *bioRxiv*. <https://doi.org/10.1101/2020.11.07.370627>.

Singh N. , Lai H. (1998) 60 Hz magnetic field exposure induces DNA crosslinks in rat brain cells. *Mutat Res - Fundam Mol Mech Mutagen* 400(1–2):313–320. [https://doi.org/10.1016/S0027-5107\(98\)00017-7](https://doi.org/10.1016/S0027-5107(98)00017-7).

Skamrova G.B. , Lantushenko A.O. , Shckorbatov Y.G. , Evstigneev M.P. (2013) Influence of mobile phone radiation on membrane permeability and chromatin state of human buccal epithelium cells. *Biochem Biophys*

- Smith-Roe S.L. , Wyde M.E. , Stout M.D. , et al (2020) Evaluation of the genotoxicity of cell phone radiofrequency radiation in male and female rats and mice following subchronic exposure. *Environ Mol Mutagen* 61(2):276–290. <https://doi.org/10.1002/em.22343>.
- Solek P. , Majchrowicz L. , Bloniarz D. , Krotoszynska E. , Koziowski M. (2017) Pulsed or continuous electromagnetic field induce p53/p21-mediated apoptotic signaling pathway in mouse spermatogenic cells in vitro and thus may affect male fertility. *Toxicology* 382:84–92. <https://doi.org/10.1016/j.tox.2017.03.015>.
- Speit G. , Schütz P. , Hoffmann H. (2007) Genotoxic effects of exposure to radiofrequency electromagnetic fields (RF-EMF) in cultured mammalian cells are not independently reproducible. *Mutat Res* 626(1–2):42–47. <https://doi.org/10.1016/J.MRGENTOX.2006.08.003>.
- Stronati L. , Testa A. , Villani P. , et al (2004) Absence of genotoxicity in human blood cells exposed to 50 Hz magnetic fields as assessed by comet assay, chromosome aberration, micronucleus, and sister chromatid exchange analyses. *Bioelectromagnetics* 25(1):41–48. <https://doi.org/10.1002/BEM.10141>.
- Stronati L. , Testa A. , Moquet J. , et al (2006) 935 MHz cellular phone radiation. An in vitro study of genotoxicity in human lymphocytes. *Int J Radiat Biol* 82(5):339–346. <https://doi.org/10.1080/09553000600739173>.
- Su L. , Yimaer A. , Wei X. , Xu Z. , Chen G. (2017) The effects of 50 Hz magnetic field exposure on DNA damage and cellular functions in various neurogenic cells. *J Radiat Res* 58(4):488–500. <https://doi.org/10.1093/jrr/rrx012>.
- Su L. , Yimaer A. , Xu Z. , Chen G. (2018) Effects of 1800 MHz RF-EMF exposure on DNA damage and cellular functions in primary cultured neurogenic cells. *Int J Radiat Biol* 94(3):295–305. <https://doi.org/10.1080/09553002.2018.1432913>.
- Sun C. , Wei X. , Yimaer A. , Xu Z. , Chen G. (2018) Ataxia telangiectasia mutated deficiency does not result in genetic susceptibility to 50 Hz magnetic fields exposure in mouse embryonic fibroblasts. *Bioelectromagnetics* 39(6):476–484. <https://doi.org/10.1002/bem.22140>.
- Sun Y. , Zong L. , Gao Z. , et al (2017) Mitochondrial DNA damage and oxidative damage in HL-60 cells exposed to 900 MHz radiofrequency fields. *Mutat Res - Fundam Mol Mech Mutagen* 797–799:7–14. <https://doi.org/10.1016/j.mrfmmm.2017.03.001>.
- Svedenstål B.M. , Johanson K.J. (1998) Leukocytes and micronucleated erythrocytes in peripheral blood from mice exposed to 50-Hz or 20-kHz magnetic fields. *Electro- and Magnetobiol* 17(2):127–143. <https://doi.org/10.3109/15368379809022558>.
- Svedenstål B.M. , Johanson K.J. , Mattsson M.O. , Paulsson L.E. (1999) DNA damage, cell kinetics and ODC activities studied in CBA mice exposed to electromagnetic fields generated by transmission lines. *In Vivo (Brooklyn)* 13(6):507–513. <https://pubmed.ncbi.nlm.nih.gov/10757046/>.
- Sykes P.J. , McCallum B.D. , Bangay M.J. , Hooker A.M. , Morley A.A. (2001) Effect of exposure to 900 MHz radiofrequency radiation on intrachromosomal recombination in pKZ1 mice. *Radiat Res* 156:495–502. [https://doi.org/10.1667/0033-7587\(2001\)156\[0495:EOETMR\]2.0.CO;2](https://doi.org/10.1667/0033-7587(2001)156[0495:EOETMR]2.0.CO;2).
- Szmigielski S. (2013) Reaction of the immune system to low-level RF/MW exposures. *Sci Total Environ* 454–455:393–400. <https://doi.org/10.1016/j.scitotenv.2013.03.034>.
- Testa A. , Cordelli E. , Stronati L. , et al (2004) Evaluation of genotoxic effect of low level 50 Hz magnetic fields on human blood cells using different cytogenetic assays. *Bioelectromagnetics* 25(8):613–619. <https://doi.org/10.1002/bem.20048>.
- Thamilselvan S. , Behera A. , Nair S.K. , et al (2021) Micronuclei analysis in people residing within 25 m of radiation-exposed areas around mobile towers in Chennai, India: An observational study. *J Int Oral Heal* 13:350–355. <https://doi.org/10.4103/JIOH.JIOH-358-20>.
- Tice R. , Hook G. , Donner M. , McRee D.I. , Guy A.W. (2002) Genotoxicity of radiofrequency signals. I. Investigation of DNA damage and micronuclei induction in cultured human blood cells. *Bioelectromagnetics* 23(2):113–126. <https://doi.org/10.1002/BEM.104>.
- Trosic I. , Busljeta I. , Kasuba V. , Rozgaj R. (2002) Micronucleus induction after whole-body microwave irradiation of rats. *Mutat Res - Genet Toxicol Environ Mutagen* 521(1–2):73–79. [https://doi.org/10.1016/S1383-5718\(02\)00214-0](https://doi.org/10.1016/S1383-5718(02)00214-0).
- Trosic I. , Busljeta I. , Modlic B. (2004) Investigation of the genotoxic effect of microwave irradiation in rat bone marrow cells: In vivo exposure. *Mutagenesis* 19(5):361–364. <https://doi.org/10.1093/mutage/geh042>.
- Tsarna E. , Reedijk M. , Birks L. , et al (2019) Associations of maternal cell-phone use during pregnancy with pregnancy duration and fetal growth in 4 birth cohorts. *Am J Epidemiol* 188(7):1270–1280. <https://doi.org/10.1093/AJE/KWZ092>.
- Udroiu I. , Antoccia A. , Tanzarella C. , et al (2015) Genotoxicity induced by foetal and infant exposure to magnetic fields and modulation of ionising radiation effects. *PLOS ONE* 10(11):e0142259. <https://doi.org/10.1371/journal.pone.0142259>.
- Udroiu I. , Cristaldi M. , Ieradi L.A. , et al (2008) Genotoxic and haematotoxic damage induced by ELF magnetic fields. *Eur J Oncol* 13:239–244.
- Ullrich V. , Apell H-J. (2021) Electromagnetic fields and calcium signaling by the voltage dependent anion channel. *Open J Vet Med* 11(1):57–86. <https://doi.org/10.4236/ojvm.2021.111004>.

Uslu N. , Demirhan O. , Emre M. , Seydaoğlu G. (2019) The chromosomal effects of GSM-like electromagnetic radiation exposure on human fetal cells. *Biomed Res Clin Pract* 4(4). <https://doi.org/10.15761/brcp.1000192>.

Vijayalaxmi F.M.R. , Dusch S.J. , Dusch S.J. , et al (1997) Frequency of micronuclei in the peripheral blood and bone marrow of cancer-prone mice chronically exposed to 2450 MHz radiofrequency radiation. *Radiat Res* 147(4):495–500.

Vijayalaxmi , Seaman R.L. , Belt M.L. , Doyle J.M. , Mathur S.P. , Prihoda T.J. , et al (1999) Frequency of micronuclei in the blood and bone marrow cells of mice exposed to ultra-wideband electromagnetic radiation. *Int J Radiat Biol* 75(1):115–120. <https://doi.org/10.1080/095530099140870>.

Vijayalaxmi , Pickard W. , Bisht K. , Bisht K.S. , et al (2001) Micronuclei in the peripheral blood and bone marrow cells of rats exposed to 2450 MHz radiofrequency radiation. *Int J Radiat Biol* 77(11):1109–1115. <https://doi.org/10.1080/09553000110069100>.

Vijayalaxmi , Logani M.K. , Bhanushali A. , Bhanushali A. , Ziskin M.C. , Prihoda T.J. (2004) Micronuclei in peripheral blood and bone marrow cells of mice exposed to 42 GHz electromagnetic millimeter waves. *Radiat Res* 161(3):341–345. <https://doi.org/10.1667/RR3121>.

Villarini M. , Ambrosini M.V. , Moretti M. , et al (2013) Brain hsp70 expression and DNA damage in mice exposed to extremely low frequency magnetic fields: A dose-response study. *Int J Radiat Biol* 89(7):562–570. <https://doi.org/10.3109/09553002.2013.782449>.

Veerachari S.B. , Vasana S.S. (2012) Mobile phone electromagnetic waves and its effect on human ejaculated semen: An in vitro study. *Int J Infertil Fetal Med* 3(1):15–21.

Waldmann P. , Bohnenberger S. , Greinert R. , et al (2013) Influence of GSM signals on human peripheral lymphocytes: Study of genotoxicity. *Radiat Res* 179(2):243–253. <https://doi.org/10.1667/RR2914.1>.

Wang X. , Liu C. , Ma Q. , et al (2015) 8-oxoG DNA glycosylase-1 inhibition sensitizes Neuro-2a cells to oxidative DNA base damage induced by 900 MHz radiofrequency electromagnetic radiation. *Cell Physiol Biochem* 37(3):1075–1088. <https://doi.org/10.1159/000430233>.

Wang Y. , Liu X. , Zhang Y. , et al (2019) Exposure to a 50 Hz magnetic field at 100 μ T exerts no DNA damage in cardiomyocytes. *Biol Open* 8(8):bio041293. <https://doi.org/10.1242/bio.041293>.

Winker R. , Ivancsits S. , Pilger A. , Adlkofer F. , Rüdiger H.W. (2005) Chromosomal damage in human diploid fibroblasts by intermittent exposure to extremely low-frequency electromagnetic fields. *Mutat Res - Genet Toxicol Environ Mutagen* 585(1–2):43–49. <https://doi.org/10.1016/j.mrgentox.2005.04.013>.

Wolf F.I. , Torsello A. , Tedesco B. , et al (2005) 50-Hz extremely low frequency electromagnetic fields enhance cell proliferation and DNA damage: Possible involvement of a redox mechanism. *Biochim Biophys Acta - Mol Cell Res* 1743(1–2):120–129. <https://doi.org/10.1016/j.bbamcr.2004.09.005>.

Xu S. , Chen G. , Chen C. , et al (2013) Cell type-dependent induction of DNA damage by 1800 MHz radiofrequency electromagnetic fields does not result in significant cellular dysfunctions. *PLOS ONE* 8(1):e54906. <https://doi.org/10.1371/journal.pone.0054906>.

Xu S. , Zhou Z. , Zhang L. , et al (2010) Exposure to 1800 MHz radiofrequency radiation induces oxidative damage to mitochondrial DNA in primary cultured neurons. *Brain Res* 1311:189–196. <https://doi.org/10.1016/j.brainres.2009.10.062>.

Yadav A.S. , Sharma M.K. (2008) Increased frequency of micronucleated exfoliated cells among humans exposed in vivo to mobile telephone radiations. *Mutat Res - Genet Toxicol Environ Mutagen* 650(2):175–180. <https://doi.org/10.1016/j.mrgentox.2007.11.005>.

Yaguchi H. , Yoshida M. , Ejima Y. , Miyakoshi J. (1999) Effect of high-density extremely low frequency magnetic field on sister chromatid exchanges in mouse m5S cells. *Mutat Res - Genet Toxicol Environ Mutagen* 440(2):189–194. [https://doi.org/10.1016/S1383-5718\(99\)00027-3](https://doi.org/10.1016/S1383-5718(99)00027-3).

Yakymenko I. , Tsybulin O. , Sidorik E. , et al (2016) Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation. *Electromagn Biol Med* 35(2):186–202. <https://doi.org/10.3109/15368378.2015.1043557>.

Yakymenko I. , Burlaka A. , Tsybulin O. , et al (2018) Oxidative and mutagenic effects of low intensity GSM 1800 MHz microwave radiation. *Exp Oncol* 40(4):282–287. [https://doi.org/10.31768/2312-8852.2018.40\(4\):282-287](https://doi.org/10.31768/2312-8852.2018.40(4):282-287).

Yan J. , Agresti M. , Bruce T. , et al (2007) Effects of cellular phone emissions on sperm motility in rats. *Fertil Steril* 88(4):957–964. <https://doi.org/10.1016/J.FERTNSTERT.2006.12.022>.

Yao K. , Wu W. , Wang K.J. , et al (2008) Electromagnetic noise inhibits radiofrequency radiation-induced DNA damage and reactive oxygen species increase in human lens epithelial cells. *Mol Vis* 14:964–969.

Yao K.T.S. (1982) Cytogenetic consequences of microwave irradiation on mammalian cells incubated in vitro. *J Hered* 73(2):133–138. <https://doi.org/10.1093/oxfordjournals.jhered.a109596>.

Yeung A.W.K. (2019) The 'as low as reasonably achievable' (ALARA) principle: A brief historical overview and a bibliometric analysis of the most cited publications. *Radioprotection* 54(2):103–109. <https://doi.org/10.1051/radiopro/2019016>.

Yokus B. , Cakir D.U. , Akdag M.Z. , Sert C. , Mete N. (2005) Oxidative DNA damage in rats exposed to extremely low frequency electro magnetic fields. *Free Radic Res* 39(3):317–323. <https://doi.org/10.1080/10715760500043603>.

Yuan L.Q. , Wang C. , Lu D.F. , et al (2020) Induction of apoptosis and ferroptosis by a tumor suppressing magnetic field through ROS-mediated DNA damage. *Aging (Albany NY)* 12(4):3662–3681.

<https://doi.org/10.18632/aging.102836>.

Zendehdel R. , Yu I.J. , Hajipour-Verdom B. , Panjali Z. (2019) DNA effects of low level occupational exposure to extremely low frequency electromagnetic fields (50/60 Hz). *Toxicol Ind Health* 35(6):424–430.

<https://doi.org/10.1177/0748233719851697>.

Zeni O. , Chiavoni A. , Sannino A. , et al (2003) Lack of genotoxic effects (micronucleus induction) in human lymphocytes exposed in vitro to 900 MHz electromagnetic fields. *Radiat Res* 160(2):152–158.

<https://doi.org/10.1667/RR3014>.

Zeni O. , Romanò M. , Perrotta A. , et al (2005) Evaluation of genotoxic effects in human peripheral blood leukocytes following an acute in vitro exposure to 900 MHz radiofrequency fields. *Bioelectromagnetics* 26(4):258–265. <https://doi.org/10.1002/BEM.20078>.

Zeni O. , Gallerano G. , Romanò M. , et al (2007) Cytogenetic observations in human peripheral blood leukocytes following in vitro exposure to THz radiation: A pilot study. *Health Phys* 92(4):349–357.

<https://doi.org/10.1097/01.HP.0000251248.23991.35>.

Zeni O. , Schiavoni A. , Perrotta A. , et al (2008) Evaluation of genotoxic effects in human leukocytes after in vitro exposure to 1950 MHz UMTS radiofrequency field. *Bioelectromagnetics* 29(3):177–184.

<https://doi.org/10.1002/BEM.20378>.

Zhu K. , Lv Y. , Cheng Q. , Hua J. , Zeng Q. (2016) Extremely low frequency magnetic fields do not induce DNA damage in human lens epithelial cells in vitro. *Anat Rec (Hoboken)* 299(5):688–697.

<https://doi.org/10.1002/ar.23312>.

Ziemann C. , Brockmeyer H. , Reddy S.B. , et al (2009) Absence of genotoxic potential of 902 MHz (GSM) and 1747MHz (DCS) wireless communication signals: In vivo two-year bioassay in B6C3F1 mice. *Int J Radiat Biol* 85(5):454–464. <https://doi.org/10.1080/09553000902818907>.

Zothansiam, Z.M. , Lalramdinpui M. , Jagetia G.C. , Jagetia G.C. (2017) Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations. *Electromagn Biol Med* 36(3):295–305. <https://doi.org/10.1080/15368378.2017.1350584>.

Zotti-Martelli L. , Peccatori M. , Scarpato R. , Migliore L. (2000) Induction of micronuclei in human lymphocytes exposed in vitro to microwave radiation. *Mutat Res - Genet Toxicol Environ Mutagen* 472(1–2):51–58.

[https://doi.org/10.1016/S1383-5718\(00\)00112-1](https://doi.org/10.1016/S1383-5718(00)00112-1).

Zotti-Martelli L. , Peccatori M. , Maggini V. , Ballardini M. , Barale R. (2005) Individual responsiveness to induction of micronuclei in human lymphocytes after exposure in vitro to 1800-MHz microwave radiation. *Mutat Res - Genet Toxicol Environ Mutagen* 582(1–2):42–52. <https://doi.org/10.1016/j.mrgentox.2004.12.014>.

Zuo H. , Lin T. , Wang D. , et al (2014) Neural cell apoptosis induced by microwave exposure through mitochondria-dependent caspase-3 pathway. *Int J Med Sci* 11(5):426–435. <https://doi.org/10.7150/ijms.6540>.

Zwamborn A. , Vossen S. , van Leersum B. , et al (2003) Effects of global communication system radio-frequency fields on well being and cognitive functions of human subjects with and without subjective complaints. *TNO Rep FEL-03-C148*:1–89.

DNA and Chromosome Damage in Human and Animal Cells Induced by Mobile Telephony Electromagnetic Fields and Other Stressors

Agiwal M. , Jin H. , (2018): Directional paging for 5G communications based on partitioned user ID. *Sensors*, 18(6), 1845. <https://doi.org/10.3390/s18061845>.

Alberts B. , Bray D. , Lewis J. , Raff M. , Roberts K. , Watson J.D. , (1994): *Molecular biology of the cell*. Garland Publishing, Inc., New York.

Ardoino L. , Lopresto V. , Mancini S. , Marino C. , Pinto R. , Lovisolo G.A. , (2005): A radiofrequency system for in vivo pilot experiments aimed at the studies on biological effects of electromagnetic fields. *Physics in Medicine and Biology*, 50(15), 3643–3654.

Atli E. , Unlü H. , (2006): The effects of microwave frequency electromagnetic fields on the development of *Drosophila melanogaster*. *International Journal of Radiation Biology*, 82(6), 435–441.

Baan R. , Grosse Y. , LaubySecretan B. , El Ghissassi F. , Bouvard V. , Benbrahim-Tallaa L. , Guha N. , Islami F. , Galichet L. , Straif K. ; WHO International Agency for Research on Cancer Monograph Working Group , (2011): Carcinogenicity of radiofrequency electromagnetic fields. *Lancet Oncology*, 12(7), 624–626.

Baohong W. , Jiliang H. , Lifan J. , Deqiang L. , Wei Z. , Jianlin L. , Hongping D. , (2005): Studying the synergistic damage effects induced by 1.8 GHz radiofrequency field radiation (RFR) with four chemical mutagens on human lymphocyte DNA using comet assay in vitro. *Mutation Research*, 578(1–2), 149–157.

Baohong W. , Lifan J. , Lanjuan L. , Jianlin L. , Deqiang L. , Wei Z. , Jiliang H. , (2007): Evaluating the combinative effects on human lymphocyte DNA damage induced by ultraviolet ray C plus 1.8 GHz microwaves using comet assay in vitro. *Toxicology*, 232(3), 311–316.

Baum J.S. , St George J.P. , McCall K. , (2005): Programmed cell death in the germline. *Seminars in Cell and Development Biology*, 16(2), 245–259.

Belyaev I.Y., Hillert L., Protopopova M., Tamm C., Malmgren L.O., Persson B.R., Selivanova G., Harms-Ringdahl M., (2005): 915 MHz microwaves and 50 Hz magnetic field affect chromatin conformation and 53BP1 foci in human lymphocytes from hypersensitive and healthy persons. *Bioelectromagnetics*, 26(3), 173–184.

Belyaev I.Y., Markovà E., Hillert L., Malmgren L.O.G., Persson B.R.R., (2009): Microwaves from UMTS/GSM mobile phones induce longlasting inhibition of 53BP1/γH2AX DNA repair foci in human lymphocytes. *Bioelectromagnetics*, 30(2), 129–141.

Bertagna F., Lewis R., Silva S.R.P., McFadden J., Jeevaratnam K., (2021): Effects of electromagnetic fields on neuronal ion channels: A systematic review. *Annals of the New York Academy of Sciences*, 1499(1), 82–103.

Brecher S., (1977): Ultra-structural observations of x-ray induced chromatid gaps. *Mutation Research*, 42(2), 249–268.

Burlaka A., Tsybulin O., Sidorik E., Lukin S., Polishuk V., Tsehmistrenko S., Yakymenko I., (2013): Overproduction of free radical species in embryonic cells exposed to low intensity radiofrequency radiation. *Experimental Oncology*, 35(3), 219–225.

Calabrese E.J., (2008): Hormesis: Why it is important to toxicology and toxicologists. *Environmental Toxicology and Chemistry*, 27(7), 1451–1474.

Carlberg M., Hardell L., (2017): Evaluation of mobile phone and cordless phone use and glioma risk using the Bradford Hill viewpoints form 1965 on association or causation. *BioMed Research International*, 2017, 9218486.

Chavdoula E.D., Panagopoulos D.J., Margaritis L.H., (2010): Comparison of biological effects between continuous and intermittent exposure to GSM-900 MHz mobile phone radiation: Detection of apoptotic cell death features. *Mutation Research*, 700(1–2), 51–61.

Clark D.E., Folz D.C., West J.K., (2000): Processing materials with microwave energy. *Materials Science and Engineering, Part A*, 287(2), 153–158.

Conger A.D., (1967): Real chromatid deletions versus gaps. *Mutation Research*, 4(4), 449–459.

Cook D.G., Peacock J.L., Feyerabend C., Carey I.M., Jarvis M.J., Anderson H.R., Bland J.M., (1996): Relation of caffeine intake and blood caffeine concentrations during pregnancy to fetal growth: Prospective population based study. *BMJ*, 313(7069), 1358–1362.

Dahlman E., Parkvall S., Skoeld J., (2018): 5G NR: The next generation wireless access technology. Academic Press, Elsevier, London.

Danese E., Lippi G., Buonocore R., Benati M., Bovo C., Bonaguri C., Salvagno G.L., Brocco G., Roggenbuck D., Montagnana M., (2017): Mobile phone radiofrequency exposure has no effect on DNA double strand breaks (DSB) in human lymphocytes. *Annals of Translational Medicine*, 5(13), 272.

De Iulius G.N., Newey R.J., King B.V., Aitken R.J., (2009): Mobile phone radiation induces reactive oxygen species production and DNA damage in human spermatozoa in vitro. *PLOS ONE*, 4(7), e6446.

Delgado J.M.R., (1985): Biological effects of extremely low frequency electromagnetic fields. *Journal of Bioelectricity*, 4(1), 75–91.

Draper G., Vincent T., Kroll M.E., Swanson J., (2005): Childhood cancer in relation to distance from high voltage power lines in England and Wales: A case-control study. *BMJ*, 330(7503), 1290.

Drummond-Barbosa D., Spradling A.C., (2001): Stem cells and their progeny respond to nutritional changes during *Drosophila* oogenesis. *Developments in Biologicals*, 231(1), 265–278.

D'Silva M.H., Swer R.T., Anbalagan J., Rajesh B., (2017): Effect of radiofrequency radiation emitted from 2G and 3G cell phone on developing liver of chick embryo - A comparative study. *Journal of Clinical and Diagnostic Research*, 11(7), 5–9.

D'Silva M.H., Swer R.T., Anbalagan J., Bhargavan R., (2021): Assessment of DNA damage in chick embryo brains exposed to 2G and 3G cell phone radiation using alkaline comet assay technique. *Journal of Clinical and Diagnostic Research*, 15:AC01–AC04. <https://doi.org/10.7860/jcdr/2021/47115.14441>.

Duan W., Liu C., Zhang L., He M., Xu S., Chen C., Pi H., Gao P., Zhang Y., Zhong M., Yu Z., Zhou Z., (2015): Comparison of the genotoxic effects induced by 50 Hz extremely low-frequency electromagnetic fields and 1800 MHz radiofrequency electromagnetic fields in GC-2 cells. *Radiation Research*, 183(3), 305–314.

Dubrov A.P., (1978): The geomagnetic field and life. Plenum Press, New York.

EFSA (European Food Safety Authority), (2015): Scientific opinion on the safety of caffeine. *EFSA Journal*, 13(5), 4102.

El-Abd S.F., Eltoweissy M.Y., (2012): Cytogenetic alterations in human lymphocyte culture following exposure to radiofrequency field of mobile phone. *Journal of Applied Pharmaceutical Science*, 2(2), 16–20.

Falcioni L., Bua L., Tibaldi E., Lauriola M., De Angelis L., Gnudi F., Mandrioli D., Manservigi M., Manservigi F., Manzoli I., Menghetti I., Montella R., Panzacchi S., Sgargi D., Strollo V., Vornoli A., Belpoggi F., (2018): Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission. *Environmental Research*, 165, 496–503.

Gavrieli Y., Sherman Y., Ben-Sasson S.A., (1992): Identification of programmed cell death in situ via specific labeling of nuclear DNA fragmentation. *Journal of Cell Biology*, 119(3), 493–501.

Goodman E.M., Greenebaum B., Marron M.T., (1995): Effects of electro-magnetic fields on molecules and cells. *International Review of Cytology*, 158, 279–338.

Gulati S. , Yadav A. , Kumar N. , Kanupriya, A.N.K. , Kumar R. , Gupta R. , Gupta R. , (2016): Effect of GSTM1 and GSTT1 polymorphisms on genetic damage in humans populations exposed to radiation from mobile towers. *Archives of Environmental Contamination and Toxicology*, 70(3), 615–625.

Gunes M. , Ates K. , Yalcin B. , Akkurt S. , Ozen S. , Kaya B. , (2021): An evaluation of the genotoxic effects of electromagnetic radiation at 900 MHz, 1800 MHz, and 2100 MHz frequencies with a SMART assay in *Drosophila melanogaster*. *Electromagnetic Biology and Medicine*, 40(2), 254–263.

Hallberg O. , Johansson O. , (2002): Melanoma incidence and frequency modulation (FM) broadcasting. *Archives of Environmental Health*, 57(1), 32–40.

Hardell L. , Carlberg M. , Hansson Mild K. , (2013): Use of mobile phones and cordless phones is associated with increased risk for glioma and acoustic neuroma. *Pathophysiology*, 20(2), 85–110.

Hardell L. , (2017): World Health Organization, radiofrequency radiation and health - A hard nut to crack (Review). *International Journal of Oncology*, 51(2), 405–413.

Hardell L. , (2019): Notes on parliament hearing in Tallinn, Estonia June 4, 2019 as regards the deployment of the fifth generation, 5G, of wireless communication. *World Academy of Sciences Journal*, 1, 275–282.

Hardell L. , Carlberg M. , (2020): Health risks from radiofrequency radiation, including 5G, should be assessed by experts with no conflicts of interest. *Oncology Letters*, 20(4), 15.

Hardell L. , Nyberg R. , (2020): Appeals that matter or not on a moratorium on the deployment of the fifth generation, 5G, for microwave radiation. *Molecular and Clinical Oncology*.
<https://doi.org/10.3892/mco.2020.1984>.

Hatzi V.I. , Karakosta M. , Barszczewska K. , Karachristou I. , Pantelias G. , Terzoudi G.I. , (2015): Low concentrations of caffeine induce asymmetric cell division as observed in vitro by means of the CBMN-assay and iFISH. *Mutation Research/Genetic Toxicology and Environmental Mutagenesis*, 793, 71–78.

Higdon J.V. , Frei B. , (2006): Coffee and health: A review of recent human research. *Critical Reviews in Food Science and Nutrition*, 46(2), 101–123.

Holma H. , Toskala A. , (2004): WCDMA for UMTS, radio access for third generation mobile communications. John Wiley & Sons Ltd., Chichester, England

IAEA , (2011): Cytogenetic dosimetry: Applications in preparedness for and response to radiation emergencies. International Atomic Energy Agency, Vienna.

IARC , (1991): Coffee, tea, mate, methylxanthines, and methylglyoxal, Vol. 51. International Agency for Research on Cancer, World Health Organization, Lyon.

IARC , (2002): Non-ionizing radiation, part 1: Static and extremely low-frequency (ELF) electric and magnetic fields, Vol. 80. International Agency for Research on Cancer, Lyon.

IARC , (2013): Non-Ionizing radiation, part 2: Radiofrequency electromagnetic fields, Vol. 102. International Agency for Research on Cancer, Lyon.

IARC , (2016): Coffee, mate and very hot beverages, Vol. 116. International Agency for Research on Cancer, Lyon.

ICNIRP , (1998): Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz). *Health Physics*, 74, 494–522.

ICNIRP , (2020): Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz). *Health Physics*, 118(5), 483–524.

Ji S. , Oh E. , Sul D. , Choi J.W. , Park H. , Lee E. , (2004): DNA Damage of lymphocytes in volunteers after 4 hours use of mobile phone. *Journal of Preventive Medicine and Public Health*, 37(4), 373–380.

Kikuchi T. , Ogawa M. , Otaka Y. , Furuta M. , (1998): Multigeneration exposure test of *Drosophila melanogaster* to ELF magnetic fields. *Bioelectromagnetics*, 19(6), 335–340.

King R.C. , (1970): Ovarian development in *Drosophila melanogaster*. Academic Press, New York.

Koana T. , Okada M.O. , Takashima Y. , Ikehata M. , Miyakoshi J. , (2001): Involvement of eddy currents in the mutagenicity of ELF magnetic fields. *Mutation Research*, 476(1–2), 55–62.

Kostoff R.N. , Heroux P. , Aschner M. , Tsatsakis A. , (2020): Adverse health effects of 5G mobile networking technology under real-life conditions. *Toxicology Letters*, 323, 35–40.

Kuhlmann W. , Fromme H.G. , Heege E.M. , Ostertag W. , (1968): The mutagenic action of caffeine in higher organisms. *Cancer Research*, 28(11), 2375–2389.

Lai H. , (2021): Genetic effects of non-ionizing electromagnetic fields. *Electromagnetic Biology and Medicine*, 40(2), 264–273.

Leach V. , Weller S. , Redmayne M. , (2018): A novel database of bio-effects from non-ionizing radiation. *Reviews on Environmental Health*, 33(3), 1–8.

Liman E.R. , Hess P. , Weaver F. , Koren G. , (1991): Voltage-sensing residues in the S4 region of a mammalian K⁺ channel. *Nature*, 353(6346), 752–756.

López I. , Félix N. , Rivera M. , Alonso A. , Maestú C. , (2021): What is the radiation before 5G? A correlation study between measurements in situ and in real time and epidemiological indicators in Vallecas, Madrid. *Environmental Research*, 194, 110734.

Ma T.H. , Chu K.C. , (1993): Effect of the extremely low frequency (ELF) electromagnetic field (EMF) on developing embryos of the fruit fly (*Drosophila melanogaster* L). *Mutation Research*, 303(1), 35–39.

Maber J. , (1999): Data analysis for biomolecular sciences. Longman, Harlow, England.

Manta A.K. , Stravopodis D.J. , Papassideri I.S. , Margaritis L.H. , (2014): Reactive oxygen species elevation and recovery in *Drosophila* bodies and ovaries following short-term and long-term exposure to DECT base EMF. *Electromagnetic Biology and Medicine*, 33(2), 118–131.

Manti L. , Braselmann H. , Calabrese M.L. , Massa R. , Pugliese M. , Scampoli P. , Sicignano G. , Grossi G. , (2008): Effects of modulated microwave radiation at cellular telephone frequency (1.95 GHz) on X-ray-induced chromosome aberrations in human lymphocytes in vitro. *Radiation Research*, 169(5), 575–583.

Margaritis L.H. , Kafatos F.C. , Petri W.H. , (1980): The eggshell of *Drosophila melanogaster*; fine structure of the layers and regions of the wild-type eggshell. *Journal of Cell Science*, 43, 1–35.

Margaritis L.H. , Manta A.K. , Kokkaliaris K.D. , Schiza D. , Alimisis K. , Georgiou E. , Giannakopoulou O. , Kollia I. , Kontogianni G. , Kourouzidou A. , Myari A. , Roumelioti F. , Skouropoulou A. , Sykioti V. , Varda G. , Xenos K. , Ziomas K. , (2014): *Drosophila* oogenesis as a bio-marker responding to EMF sources. *Electromagnetic Biology and Medicine*, 33(3), 165–189.

Markova E. , Hillert L. , Malmgren L. , Persson B.R. , Belyaev I.Y. , (2005): Microwaves from GSM mobile telephones affect 53BP1 and gamma-H2AX foci in human lymphocytes from hypersensitive and healthy persons. *Environmental Health Perspectives*, 113(9), 1172–1177.

McCall K. , (2004): Eggs over easy: Cell death in the *Drosophila* ovary. *Developmental Biology*, 274(1), 3–14.

McClelland S. , Jaboin J.J. , (2018): The radiation safety of 5G wi-fi: Reassuring or Russian roulette? *International Journal of Radiation Oncology Biology Physics*, 101(5), 1274–1275.

Melnick R.L. , (2019): Commentary on the utility of the national toxicology program study on cell phone radiofrequency radiation data for assessing human health risks despite unfounded criticisms aimed at minimizing the findings of adverse health effects. *Environmental Research*, 168, 1–6.

Mendelsohn J. , Hudic D. , Castagnola J. , (1981): DNA synthesis and proliferation of human lymphocytes in vitro: III. Fate of cycling cells in aging cultures of phytohemagglutinin stimulated human lymphocytes. *Journal of Cellular Physiology*, 106(1), 13–22.

Miller A.B. , To T. , Agnew D.A. , Wall C. , Green L.M. , (1996): Leukemia following occupational exposure to 60-Hz electric and magnetic fields among Ontario electric utility workers. *American Journal of Epidemiology*, 144(2), 150–160.

Miller A.B. , Morgan L.L. , Udasin I. , Davis D.L. , (2018): Cancer epidemiology update, following the 2011 IARC evaluation of radiofrequency electromagnetic fields (Monograph 102). *Environmental Research*, 167, 673–683.

Miller A.B. , Sears M.E. , Morgan L.L. , Davis D.L. , Hardell L. , Oremus M. , Soskolne C.L. , (2019): Risks to health and well-being From radio-frequency radiation emitted by cell phones and other wireless devices. *Frontiers in Public Health*, 7, 223. <https://doi.org/10.3389/fpubh.2019.00223>.

Mirabolghasemi G. , Azarnia M. , (2002): Developmental changes in *Drosophila melanogaster* following exposure to alternating electromagnetic fields. *Bioelectromagnetics*, 23(6), 416–420.

Neufeld E. , Kuster N. , (2018): Systematic derivation of safety limits for time-varying 5G radiofrequency exposure based on analytical models and thermal dose. *Health Physics*, 115(6), 705–711.

Nezis I.P. , Stravopodis D.J. , Papassideri I. , Robert-Nicoud M. , Margaritis L.H. , (2000): Stage-specific apoptotic patterns during *Drosophila* oogenesis. *European Journal of Cell Biology*, 79(9), 610–620.

Nias A.H.W. , (1998): An introduction to radiobiology. J.Wiley & Sons, Chichester, England.

NTP (National Toxicology Program) , (2018): Toxicology and carcinogenesis studies in Hsd: Sprague Dawley SD rats exposed to whole-body radio frequency radiation at a frequency (900 MHz) and modulations (GSM and CDMA) used by cell phones, NTP TR 595, Department of Health and Human Services, USA.

Pall M.L. , (2013): Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects. *Journal of Cellular and Molecular Medicine*, 17(8), 958–965.

Pall M.L. , (2018): Wi-fi is an important threat to human health. *Environmental Research*, 164, 405–416.

Panagopoulos D.J. , Messini N. , Karabarounis A. , Filippidis A.L. , Margaritis L.H. , (2000): A mechanism for action of oscillating electric fields on cells. *Biochemical and Biophysical Research Communications*, 272(3), 634–640.

Panagopoulos D.J. , Karabarounis A. , Margaritis L.H. , (2002): Mechanism for action of electromagnetic fields on cells. *Biochemical and Biophysical Research Communications*, 298(1), 95–102.

Panagopoulos D.J. , Karabarounis A. , Margaritis L.H. , (2004): Effect of GSM 900-MHz mobile phone radiation on the reproductive capacity of *Drosophila melanogaster*. *Electromagnetic Biology and Medicine*, 23(1), 29–43.

Panagopoulos D.J. , Chavdoula E.D. , Nezis I.P. , Margaritis L.H. , (2007a): Cell death induced by GSM 900 MHz and DCS 1800 MHz mobile telephony radiation. *Mutation Research*, 626(1–2), 69–78.

Panagopoulos D.J. , Chavdoula E.D. , Karabarounis A. , Margaritis L.H. , (2007b): Comparison of bioactivity between GSM 900 MHz and DCS 1800 MHz mobile telephony radiation. *Electromagnetic Biology and Medicine*, 26(1), 33–44.

Panagopoulos D.J. , Chavdoula E.D. , Margaritis L.H. , (2010): Bioeffects of mobile telephony radiation in relation to its intensity or distance from the antenna. *International Journal of Radiation Biology*, 86(5), 345–357.

Panagopoulos D.J. , Margaritis L.H. , (2010): The effect of exposure duration on the biological activity of mobile telephony radiation. *Mutation Research*, 699(1/2), 17–22.

- Panagopoulos D.J. , (2011): Analyzing the health impacts of modern telecommunications microwaves. In: L.V. Berhardt (Ed.), *Advances in medicine and biology*, Vol. 17. Nova Science Publishers, Inc., New York, 1–55.
- Panagopoulos D.J. , (2012a): Gametogenesis, embryonic and post-embryonic development of *Drosophila melanogaster*, as a model system for the assessment of radiation and environmental genotoxicity. In: M. Spindler-Barth (Ed.), *Drosophila melanogaster: Life cycle, genetics and development*. Nova Science Publishers, New York, 1–38.
- Panagopoulos D.J. , (2012b): Effect of microwave exposure on the ovarian development of *Drosophila melanogaster*. *Cell Biochemistry and Biophysics*, 63(2), 121–132.
- Panagopoulos D.J. , (2013): Electromagnetic interaction between environmental fields and living systems determines health and well-being. In: MH Kwang and SO Yoon (Eds), *Electromagnetic fields: Principles, engineering applications and biophysical effects*. Nova Science Publishers, New York, 87–130.
- Panagopoulos D.J. , Karabarounis A. , Lioliousis C. , (2013): ELF alternating magnetic field decreases reproduction by DNA damage induction. *Cell Biochemistry and Biophysics*, 67(2), 703–716.
- Panagopoulos D.J. , Johansson O. , Carlo G.L. , (2015a): Real versus simulated mobile phone exposures in experimental studies. *BioMed Research International*, 2015, 607053.
- Panagopoulos D.J. , Johansson O. , Carlo G.L. , (2015b): Polarization: A key difference between man-made and natural electromagnetic fields, in regard to biological activity. *Scientific Reports*, 5, 14914. <https://doi.org/10.1038/srep14914>.
- Panagopoulos D.J. , (2016): Pulsed electric field increases reproduction. *International Journal of Radiation Biology*, 92(2), 94–106.
- Panagopoulos D.J. , (2017): Mobile telephony radiation effects on insect ovarian cells: The necessity for real exposures bioactivity assessment. The key role of polarization, and the “ion forced-oscillation mechanism”. In: C.D. Geddes (Ed.), *Microwave effects on DNA and proteins*. Springer, Cham, Switzerland, 1–48.
- Panagopoulos D.J. , Balmori A. , (2017): On the biophysical mechanism of sensing atmospheric discharges by living organisms. *Science of the Total Environment*, 599–600, 2026–2034.
- Panagopoulos D.J. , (2019a): Comparing DNA damage induced by mobile telephony and other types of man-made electromagnetic fields. *Mutation Research Reviews*, 781, 53–62.
- Panagopoulos D.J. , (2019b): Chromosome damage in human cells induced by UMTS mobile telephony radiation. *General Physiology and Biophysics*, 38(5), 445–454.
- Panagopoulos D.J. , Chrousos G.P. , (2019): Shielding methods and products against man-made electromagnetic fields: Protection versus risk. *Science of the Total Environment*, 667C, 255–262.
- Panagopoulos D.J. , (2020): Comparing chromosome damage induced by mobile telephony radiation and a high caffeine dose: Effect of combination and exposure duration. *General Physiology and Biophysics*, 39(6), 531–544.
- Panagopoulos D.J. , Karabarounis A. , (2020): Comments on “diverse radiofrequency sensitivity and radiofrequency effects of mobile or cordless phone near fields exposure in *Drosophila melanogaster*”. *Advances in Environmental Studies*, 4(1), 271–276.
- Panagopoulos D.J. , Karabarounis A. , Yakymenko I. , Chrousos G.P. , (2021): Mechanism of DNA damage induced by human-made electromagnetic fields. *International Journal of Oncology*, 59(5), 92.
- Panagopoulos D.J. , (2021): Comments on Pall's “Millimeter (MM) wave and microwave frequency radiation produce deeply penetrating effects: The biology and the physics”. *Reviews on Environmental Health*. <https://doi.org/10.1515/REVEH-2021-0090>.
- Pantelias G.E. , Terzoudi G.I. , (2010): Functional cell-cycle chromatin conformation changes in the presence of DNA damage result into chromatid breaks: A new insight in the formation of radiation-induced chromosomal aberrations based on the direct observation of interphase chromatin. *Mutation Research*, 701(1), 27–37.
- Pantelias G.E. , Terzoudi G.I. , (2011): A standardized G2-assay for the prediction of individual radiosensitivity. *Radiotherapy and Oncology*, 101(1), 28–34.
- Pay T.L. , Andersen F.A. , Jessup G.L. , (1978): A comparative study of the effects of microwave radiation and conventional heating on the reproductive capacity of *Drosophila melanogaster*. *Radiation Research*, 76(2), 271–282.
- Pedersen G.F. , (1997): Amplitude modulated RF fields stemming from a GSM/DCS-1800 phone. *Wireless Networks*, 3(6), 489–498.
- Persinger M.A. , (2014): Schumann resonance frequencies found within quantitative electroencephalographic activity: Implications for earth-brain interactions. *International Letters of Chemistry, Physics and Astronomy*, 11(1), 24–32.
- Phillips J.L. , Singh N.P. , Lai H. , (2009): Electromagnetic fields and DNA damage. *Pathophysiology*, 16(2–3), 79–88.
- Pincheira J. , López-Sáez J.F. , (1991): Effects of caffeine and cycloheximide during G2 prophase in control and X-ray-irradiated human lymphocytes. *Mutation Research*, 251(1), 71–77.
- Pirard W. , Vatozvez B. : Study of pulsed character of radiation emitted by wireless telecommunication systems. Institut scientifique de service public, Liège, Belgium. https://www.issep.be/wp-content/uploads/7IWSBEEMF_B-Vatozvez_W-Pirard.pdf.
- Presman A.S. , (1977): *Electromagnetic fields and life*. Plenum Press, New York.

Pritchett T.L. , Tanner E.A. , McCall K. , (2009): Cracking open cell death in the *Drosophila* ovary. *Apoptosis*, 14(8), 969–979.

Ramirez E. , Montegudo J.L. , Garcia-Gracia M. , Delgado J.M.R. , (1983): Oviposition and development of *Drosophila* modified by magnetic fields. *Bioelectromagnetics*, 4(4), 315–326.

Sagioglou N.E. , Manta A.K. , Giannarakis I.K. , Skouroliakou A.S. , Margaritis L.H. , (2016): Apoptotic cell death during *Drosophila* oogenesis is differentially increased by electromagnetic radiation depending on modulation, intensity and duration of exposure. *Electromagnetic Biology and Medicine*, 35(1), 40–53.

Santini R. , Santini P. , Danze J.M. , Le Ruz P. , Seigne M. , (2002): Study of the health of people living in the vicinity of mobile phone base stations: I. Influences of distance and sex. *Pathologie biologique*, 50(6), 369–373.

Sauter M. , (2011): From GSM to LTE: An introduction to mobile networks and mobile broadband, John Wiley & Sons, Chichester, UK.

Schumann W.O. , (1952): Über die strahlunglosen eigenschwingungen einer leitenden Kugel, die von einer Luftschicht und einer Ionosphärenhülle umgeben ist (On the characteristic oscillations of a conducting sphere which is surrounded by an air layer and an ionospheric shell). *Zeitschrift für Naturforschung*, 7A, 149–154.

Schwarz C. , Kratochvil E. , Pilger A. , Kuster N. , Adlkofer F. , Ruediger H.W. , (2008): Radiofrequency electromagnetic fields (UMTS, 1,950 MHz) induce genotoxic effects in vitro in human fibroblasts but not in lymphocytes. *International Archives of Occupational and Environmental Health*, 81(6), 755–767.

Sesia S. , Toufik I. , Baker M. (Eds.), (2011): LTE – The UMTS long term evolution. John Wiley & Sons Ltd., West Sussex.

Smith-Roe S.L. , Wyde M.E. , Stout M.D. , Winters J.W. , Hobbs C.A. , Shepard K.G. , Green A.S. , Kissling G.E. , Shockley K.R. , Tice R.R. , Bucher J.R. , Witt K.L. , (2020): Evaluation of the genotoxicity of cell phone radiofrequency radiation in male and female rats and mice following subchronic exposure. *Environmental and Molecular Mutagenesis*, 1(2), 276–290.

Stronati L. , Testa A. , Moquet J. , Edwards A. , Cordelli E. , Villani P. , Marino C. , Fresegna A.M. , Appolloni M. , Lloyd D. , (2006): 935 MHz cellular phone radiation. An in vitro study of genotoxicity in human lymphocytes. *International Journal of Radiation Biology*, 82(5), 339–346.

Stryer L. , (1996): *Biochemistry*, 4th ed. W.H. Freeman and Co, New York.

Terzoudi G.I. , Pantelias G.E. , (2006): Cytogenetic methods for biodosimetry and risk individualization after exposure to ionizing radiation. *Radiation Protection Dosimetry*, 122(1–4), 513–520.

Terzoudi G.I. , Hatzi V.I. , Donta-Bakoyianni C. , Pantelias G.E. , (2011): Chromatin dynamics during cell cycle mediate conversion of DNA damage into chromatid breaks and affect formation of chromosomal aberrations: Biological and clinical significance. *Mutation Research*, 711(1–2), 174–186.

Thielens A. , Bell D. , Mortimore D.B. , Greco M.K. , Martens L. , Joseph W. , (2018): Exposure of insects to radio-frequency electromagnetic fields from 2 to 120 GHz. *Scientific Reports*, 8(1), 3924.
<https://doi.org/10.1038/s41598-018-22271-3>.

Thielens A. , Greco M.K. , Verloock L. , Martens L. , Joseph W. , (2020): Radio-frequency electromagnetic field exposure of western honey bees. *Scientific Reports*, 10(1), 461. <https://doi.org/10.1038/s41598-019-56948-0>.

Tian X.L. , Lu X. , Feng J.B. , Cai T.J. , Li S. , Tian M. , Liu Q.J. , (2018): Alterations in histone acetylation following exposure to 60Co γ -rays and their relationship with chromosome damage in human lymphoblastoid cells. *Radiation and Environmental Biophysics*, 57(3), 215–222.

Wertheimer N. , Leeper E. , (1979): Electrical wiring configurations and childhood cancer. *American Journal of Epidemiology*, 109(3), 273–284.

Wertheimer N. , Leeper E. , (1982): Adult cancer related to electrical wires near the home. *International Journal of Epidemiology*, 11(4), 345–355.

Wu G.W. , Liu X.X. , Wu M.X. , Zhao J.Y. , Chen W.L. , Lin R.H. , Lin J.M. , (2009): Experimental study of millimeter wave-induced differentiation of bone marrow mesenchymal stem cells into chondrocytes. *International Journal of Molecular Medicine*, 23(4), 461–467.

Yakymenko I. , Tsybulin O. , Sidorik E. , Henshel D. , Kyrylenko O. , Kyrylenko S. , (2016): Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation. *Electromagnetic Biology and Medicine*, 35(2), 186–202.

Yakymenko I. , Burlaka A. , Tsybulin I. , Brieieva I. , Buchynska L. , Tsehmistrenko I. , Chekhun F. , (2018): Oxidative and mutagenic effects of low intensity GSM 1800 MHz microwave radiation. *Experimental Oncology*, 40(4), 282–287.

Yanagawa A. , Tomaru M. , Kajiwara A. , Nakajima, Quemener E.D. , Steyer J.P. , Mitani T. , (2020): Impact of 2.45 GHz microwave irradiation on the fruit fly, *Drosophila melanogaster*. *Insects*, 11(9), 598.

Zeni O. , Chiavoni A.S. , Sannino A. , Antolini A. , Forigo D. , Bersani F. , Scarfi M.R. , (2003): Lack of genotoxic effects (micronucleus induction) in human lymphocytes exposed in vitro to 900 MHz electromagnetic fields. *Radiation Research*, 160(2), 152–158.

Zeni O. , Sannino A. , Romeo S. , Massa R. , Sarti M. , Reddy A.B. , Prihoda T.J. , Vijayalaxmi, Scarfi M.R. , (2012): Induction of an adaptive response in human blood lymphocytes exposed to radiofrequency fields: Influence of the universal mobile telecommunication system (UMTS) signal and the specific absorption rate. *Mutation Research*, 747(1), 29–35.

Zhukova M.V. , Kiseleva E.V. , (2011): Effects of starvation on the lifespan and apoptosis in the ovarian cells of *Drosophila melanogaster*. *Russian Journal of Genetics: Applied Research*, 1(4), 315–320.

Zothansiana, Zosangzuali M., Lalramdinpui M., Jagetia G.C., (2017): Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations. *Electromagnetic Biology and Medicine*, 36(3), 295–305.

The Impacts of Wireless Communication Electromagnetic Fields on Human Reproductive Biology

Adams J.A., Galloway T.S., Mondal D., Esteves S.C., Mathews F. (2014) "Effect of mobile telephones on sperm quality: A systematic review and meta-analysis." *Environ Int* 70:106–112. <https://doi.org/10.1016/j.envint.2014.04.015>.

Adey W.R. (1981) "Tissue interactions with nonionizing electromagnetic fields." *Physiol Rev* 61(2):435–514. <https://doi.org/10.1152/physrev.1981.61.2.435>.

Adey W.R. (1993) "Biological effects of electromagnetic fields." *J Cell Biochem* 51(4):410–416. <https://doi.org/10.1002/jcb.2400510405>.

Agarwal A., Gupta S., Sharma R.K. (2005) "Role of oxidative stress in female reproduction." *Reprod Biol Endocrinol* 3(1):28. <https://doi.org/10.1186/1477-7827-3-28>.

Agarwal A., Deepinder F., Sharma R.K., Ranga G., Li J. (2008) "Effect of cell phone usage on semen analysis in men attending infertility clinic: An observational study." *Fertil Steril* 89(1):124–128. <https://doi.org/10.1016/j.fertnstert.2007.01.166>.

Agarwal A., Desai N.R., Makker K., Varghese A., Mouradi R., et al (2009) "Effects of radiofrequency electromagnetic waves (RF-EMW) from cellular phones on human ejaculated semen: An in vitro pilot study." *Fertil Steril* 92(4):1318–1325. <https://doi.org/10.1016/j.fertnstert.2008.08.022>.

Agarwal A., Singh A., Hamada A., Kesari K. (2011) "Cell phones and male infertility: A review of recent innovations in technology and consequences." *Int Braz J Urol* 37(4):432–454. <https://doi.org/10.1590/s1677-55382011000400002>.

Agarwal A., Virk G., Ong C., du Plessis S.S. (2014) "Effect of oxidative stress on male reproduction." *World J Mens Health* 32(1):1–17. <https://doi.org/10.5534/wjmh.2014.32.1.1>.

Agarwal A., Mulgund A., Hamada A., Chyatte M.R. (2015) "A unique view on male infertility around the globe." *Reprod Biol Endocrinol* 13(1):37. <https://doi.org/10.1186/s12958-015-0032-1>.

Agarwal A., Baskaran S., Parekh N., Cho C.L., Henkel R., et al (2021) "Male infertility." *Lancet* 397(10271):319–333. [https://doi.org/10.1016/s0140-6736\(20\):32667-2](https://doi.org/10.1016/s0140-6736(20):32667-2).

Ahlbom A., Bridges J., de Seze R., Hillert L., Juutilainen J., et al (2008) "Possible effects of electromagnetic fields (EMF) on human health—Opinion of the scientific committee on emerging and newly identified health risks (SCENIHR)." *Toxicology* 246(2–3):248–250. <https://doi.org/10.1016/j.tox.2008.02.004>.

Ahmadi S., Bashiri R., Ghadiri-Anari A., Nadjarzadeh A. (2016) "Antioxidant supplements and semen parameters: An evidence based review." *Int J Reprod Biomed* 14(12):729–736.

Ahmed A.S., Sheng M.H., Wasnik S., Baylink D.J., Lau K.W. (2017) "Effect of aging on stem cells." *World J Exp Med* 7(1):1–10. <https://doi.org/10.5493/wjem.v7.i1.1>.

AIHW (2020): Australian Institute of Health and Welfare, Cancer data in Australia, Web report 2020. Edited by Cancer series no. 122. Canberra, Australia.

Aitken R.J., Clarkson J.S. (1987) "Cellular basis of defective sperm function and its association with the genesis of reactive oxygen species by human spermatozoa." *J Reprod Fertil* 81(2):459–469. <https://doi.org/10.1530/jrf.0.0810459>.

Aitken R.J., Gordon E., Harkiss D., Twigg J.P., Milne P., et al (1998) "Relative impact of oxidative stress on the functional competence and genomic integrity of human Spermatozoa1." *Biol Reprod* 59(5):1037–1046. <https://doi.org/10.1095/biolreprod59.5.1037>.

Aitken R.J., Koopman P., Lewis S.E. (2004) "Seeds of concern." *Nature* 432(7013):48–52. <https://doi.org/10.1038/432048a>.

Aitken R.J., Bennetts L.E., Sawyer D., Wiklendt A.M., King B.V. (2005) "Impact of radio frequency electromagnetic radiation on DNA integrity in the male germline." *Int J Androl* 28(3):171–179. <https://doi.org/10.1111/j.1365-2605.2005.00531.x>.

Aitken R.J., De Luliis G.N. (2007) "Origins and consequences of DNA damage in male germ cells." *Reprod Biomed Online* 14(6):727–733. [https://doi.org/10.1016/S1472-6483\(10\):60676-1](https://doi.org/10.1016/S1472-6483(10):60676-1).

Aitken R.J., De Luliis G.N. (2009) "On the possible origins of DNA damage in human spermatozoa." *Mol Hum Reprod* 16(1):3–13. <https://doi.org/10.1093/molehr/gap059>.

Aitken R.J., De Luliis G.N., Finnie J.M., Hedges A., McLachlan R.I. (2010) "Analysis of the relationships between oxidative stress, DNA damage and sperm vitality in a patient population: Development of diagnostic criteria." *Hum Reprod* 25(10):2415–2426. <https://doi.org/10.1093/humrep/deq214>.

Aitken R.J., De Luliis G.N., Gibb Z., Baker M.A. (2012a) "The Simmet lecture: New horizons on an old landscape—Oxidative stress, DNA damage and apoptosis in the male germ line." *Reprod Domest Anim* 47(Suppl 4):7–14. <https://doi.org/10.1111/j.1439-0531.2012.02049.x>.

- Aitken R.J. , Whiting S. , De Luliis G.N. , McClymont S. , Mitchell L.A. , Baker M.A. (2012b) "Electrophilic aldehydes generated by sperm metabolism activate mitochondrial reactive oxygen species generation and apoptosis by targeting succinate dehydrogenase." *J Biol Chem* 287(39):33048–33060. <https://doi.org/10.1074/jbc.M112.366690>.
- Aitken R.J. , Smith T.B. , Lord T. , Kuczera L. , Koppers A.J. , et al (2013) "On methods for the detection of reactive oxygen species generation by human spermatozoa: Analysis of the cellular responses to catechol oestrogen, lipid aldehyde, menadione and arachidonic acid." *Andrology* 1(2):192–205. <https://doi.org/10.1111/j.2047-2927.2012.00056.x>.
- Aitken R.J. , Smith T.B. , Jobling M.S. , Baker M.A. , De Luliis G.N. (2014) "Oxidative stress and male reproductive health." *Asian J Androl* 16(1):31–38. <https://doi.org/10.4103/1008-682x.122203>.
- Aitken R.J. , Gibb Z. , Baker M.A. , Drevet J. , Gharagozloo P. (2015) "Causes and consequences of oxidative stress in spermatozoa." *Reprod Fertil Dev* 28(1–2):1–10. <https://doi.org/10.1071/rd15325>.
- Aitken R.J. (2018) "Not every sperm is sacred; a perspective on male infertility." *Mol Hum Reprod* 24(6):287–298. <https://doi.org/10.1093/molehr/gay010>.
- Aitken R.J. (2020) "Impact of oxidative stress on male and female germ cells: Implications for fertility." *Reproduction* 159(4):R189–R201. <https://doi.org/10.1530/rep-19-0452>.
- Aitken R.J. , Baker M.A. (2020) "The role of genetics and oxidative stress in the etiology of male infertility—A unifying hypothesis?" *Front Endocrinol* 11. <https://doi.org/10.3389/fendo.2020.581838>.
- Aitken R.J. , De Luliis G.N. , Nixon B. (2020) "The sins of our forefathers: Paternal impacts on de novo mutation rate and development." *Annu Rev Genet* 54(1):1–24. <https://doi.org/10.1146/annurev-genet-112618-043617>.
- Alchalabi A.S.H. , Akliu E. , Aziz A.R. , Malek F. , Ronald S.H. , Khan M.A. (2016a) "Different periods of intrauterine exposure to electromagnetic field: Influence on female rats' fertility, prenatal and postnatal development." *Asian Pac J Reprod* 5(1):14–23. <https://doi.org/10.1016/j.apjr.2015.12.003>.
- Alchalabi A.S.H. , Rahim H. , Akliu E. , Al-Sultan I.I. , Aziz A.R. , et al (2016b) "Histopathological changes associated with oxidative stress induced by electromagnetic waves in rats' ovarian and uterine tissues." *Asian Pac J Reprod* 5(4):301–310. <https://doi.org/10.1016/j.apjr.2016.06.008>.
- Aldad T.S. , Gan G. , Gao X-B. , Taylor H.S. (2012) "Fetal radiofrequency radiation exposure from 800–1900 MHz-rated cellular telephones affects neurodevelopment and behavior in mice." *Sci Rep* 2(1):312. <https://doi.org/10.1038/srep00312>.
- Al-Damegh M.A. (2012) "Rat testicular impairment induced by electromagnetic radiation from a conventional cellular telephone and the protective effects of the antioxidants vitamins C and E." *Clin (Sao Paulo)* 67(7):785–792. [https://doi.org/10.6061/clinics/2012\(07\):14](https://doi.org/10.6061/clinics/2012(07):14).
- Ali M. , Martinez M. , Parekh N. (2021) "Are antioxidants a viable treatment option for male infertility?" *Andrologia* 53(1):e13644. <https://doi.org/10.1111/and.13644>.
- Altun G. , Deniz Ö.G. , Yurt K.K. , Davis D. , Kaplan S. (2018) "Effects of mobile phone exposure on metabolomics in the male and female reproductive systems." *Environ Res* 167:700–707. <https://doi.org/10.1016/j.envres.2018.02.031>.
- ARPANSA (2014) "Report by the ARPANSA radiofrequency expert panel on review of radiofrequency health effects research – Scientific literature 2000–2012." Edited by ARPANSA, Technical Report No. 164.
- Authority (2015) Communications report: 2013–14 series. Australian communications and media authority. Australian Government, Canberra.
- Avci B. , Akar A. , Bilgici B. , Tunçel Ö.K. (2012) "Oxidative stress induced by 1.8 GHz radio frequency electromagnetic radiation and effects of garlic extract in rats." *Int J Radiat Biol* 88(11):799–805. <https://doi.org/10.3109/09553002.2012.711504>.
- Aydin M. , Cevik A. , Kandemir F.M. , Yuksel M. , Apaydin A.M. (2009) "Evaluation of hormonal change, biochemical parameters, and histopathological status of uterus in rats exposed to 50-Hz electromagnetic field." *Toxicol Ind Health* 25(3):153–158. <https://doi.org/10.1177/0748233709102717>.
- Baan R. , Grosse Y. , Lauby-Secretan B. , El Ghissassi F. , Bouvard V. , et al (2011) "Carcinogenicity of radiofrequency electromagnetic fields." *Lancet Oncol* 12(7):624–626. [https://doi.org/10.1016/s1470-2045\(11\):70147-4](https://doi.org/10.1016/s1470-2045(11):70147-4).
- Bakacak M. , Bostancı M.S. , Attar R. , Yıldırım Ö.K. , Yıldırım G. , et al (2015) "The effects of electromagnetic fields on the number of ovarian primordial follicles: An experimental study." *Kaohsiung J Med Sci* 31(6):287–292. <https://doi.org/10.1016/j.kjms.2015.03.004>.
- Baker K.B. , Tkach J.A. , Nyenhuis J.A. , Phillips M. , Shellock F.G. , et al (2004) "Evaluation of specific absorption rate as a dosimeter of MRI-related implant heating." *J Magn Reson Imaging* 20(2):315–320. <https://doi.org/10.1002/jmri.20103>.
- Balmori A. (2005) "Possible effects of electromagnetic fields from phone masts on a population of white stork (*Ciconia ciconia*)." *Electromagn Biol Med* 24(2):109–119. <https://doi.org/10.1080/15368370500205472>.
- Balmori A. (2006) "The incidence of electromagnetic pollution on the amphibian decline: Is this an important piece of the puzzle?" *Toxicol Environ Chem* 88(2):287–299. <https://doi.org/10.1080/02772240600687200>.
- Bansal A.K. , Bilaspuri G.S. (2011) "Impacts of oxidative stress and antioxidants on semen functions." *Vet Med Int* 2011:686137. <https://doi.org/10.4061/2011/686137>.
- Barbieri R.L. (2019) "Chapter 22 - Female infertility." In: J.F. Strauss , R.L. Barbieri (Eds.), *Yen and Jaffe's reproductive endocrinology* (eighth edition). Philadelphia: Elsevier, 556–581.e7.

- Barratt C.L.R. , De Jonge C.J. , Sharpe R.M. (2018) "Man up: The importance and strategy for placing male reproductive health centre stage in the political and research agenda." *Hum Reprod* 33(4):541–545. <https://doi.org/10.1093/humrep/dey020>.
- Batellier F. , Couty I. , Picard D. , Brillard J.P. (2008) "Effects of exposing chicken eggs to a cell phone in 'call position over the entire incubation period." *Theriogenology* 69(6):737–745. <https://doi.org/10.1016/j.theriogenology.2007.12.006>.
- Belva F. , Bonduelle M. , Roelants M. , Michielsen D. , Van Steirteghem A. , et al (2016) "Semen quality of young adult ICSI offspring: The first results." *Hum Reprod* 31(12):2811–2820. <https://doi.org/10.1093/humrep/dew245>.
- Belyaev I. (2005) "Non-thermal biological effects of microwaves." *Microw Rev* 11, 13–29.
- Belyaev I. (2010) "Dependence of non-thermal biological effects of microwaves on physical and biological variables: Implications for reproducibility and safety standards." *Eur J Oncol (Library)* 5:187–218.
- Bergh C. , Wennerholm U.B. (2020) "Long-term health of children conceived after assisted reproductive technology." *Ups J Med Sci* 125(2):152–157. <https://doi.org/10.1080/03009734.2020.1729904>.
- Bergqvist U.O. (1984) "Video display terminals and health: A technical and medical appraisal of the state of the art." *Scand J Work Environ Health* 10(Suppl 2):1–87.
- Bernabò N. , Tettamanti E. , Russo V. , Martelli A. , Turriani M. , et al (2010) "Extremely low frequency electromagnetic field exposure affects fertilization outcome in swine animal model." *Theriogenology* 73(9):1293–1305. <https://doi.org/10.1016/j.theriogenology.2009.12.010>.
- Bertagna F. , Lewis R. , Silva S.R.P. , McFadden J. , Jeevaratnam K. (2021) "Effects of electromagnetic fields on neuronal ion channels: A systematic review." *Ann N Y Acad Sci* 1499(1):82–103. <https://doi.org/10.1111/nyas.14597>.
- Björkgren I. , Sipilä P. (2019) "The impact of epididymal proteins on sperm function." *Reproduction* 158(5):R155–R167. <https://doi.org/10.1530/rep-18-0589>.
- Blackman C. (2009) "Cell phone radiation: Evidence from ELF and RF studies supporting more inclusive risk identification and assessment." *Pathophysiology* 16(2–3):205–216. <https://doi.org/10.1016/j.pathophys.2009.02.001>.
- Boileau N. , Marguerite F. , Gauthier T. , Boukeffa N. , Preux P-M. , et al (2020) "Mobile phone use during pregnancy: Which association with fetal growth?" *J Gynecol Obstet Hum Reprod* 49(8):101852. <https://doi.org/10.1016/j.jogoh.2020.101852>.
- Bonde J.P. , Flachs E.M. , Rimborg S. , Glazer C.H. , Giwercman A. , et al (2016) "The epidemiologic evidence linking prenatal and postnatal exposure to endocrine disrupting chemicals with male reproductive disorders: A systematic review and meta-analysis." *Hum Reprod Update* 23(1):104–125. <https://doi.org/10.1093/humupd/dmw036>.
- Borhani N. , Rajaei F. , Salehi Z. , Javadi A. (2011) "Analysis of DNA fragmentation in mouse embryos exposed to an extremely low-frequency electromagnetic field." *Electromagn Biol Med* 30(4):246–252. <https://doi.org/10.3109/15368378.2011.589556>.
- Bortkiewicz A. (2019) "Health effects of radiofrequency electromagnetic fields (RF EMF)." *Ind Health* 57(4):403–405. https://doi.org/10.2486/indhealth.57_400.
- Brown J. , Daya S. , Matson P. (2016) "Day three versus day two embryo transfer following in vitro fertilization or intracytoplasmic sperm injection." *Cochrane Database Syst Rev* 12. <https://doi.org/10.1002/14651858.CD004378.pub3>.
- Brugh V.M., 3rd. , Lipshultz L.I. (2004) "Male factor infertility: Evaluation and management." *Med Clin North Am* 88(2):367–385. [https://doi.org/10.1016/s0025-7125\(03\)00150-0](https://doi.org/10.1016/s0025-7125(03)00150-0).
- Bryant H.E. , Love E.J. (1989) "Video display terminal use and spontaneous abortion risk." *Int J Epidemiol* 18(1):132–138. <https://doi.org/10.1093/ije/18.1.132>.
- Burch J.B. , Reif J.S. , Noonan C.W. , Ichinose T. , Bachand A.M. , et al (2002) "Melatonin metabolite excretion among cellular telephone users." *Int J Radiat Biol* 78(11):1029–1036. <https://doi.org/10.1080/09553000210166561>.
- Burlaka A. , Tsybulin O. , Sidorik E. , Lukin S. , Polishuk V. , et al (2013) "Overproduction of free radical species in embryonal cells exposed to low intensity radiofrequency radiation." *Exp Oncol* 35(3):219–225.
- Cafe S.L. , Nixon B. , Ecroyd H. , Martin J.H. , Skerrett-Byrne D.A. , Bromfield E.G. (2021) "Proteostasis in the male and female germline: A new outlook on the maintenance of reproductive health." *Front Cell Dev Biol* 9. <https://doi.org/10.3389/fcell.2021.660626>.
- Cairnie A.B. , Harding R.K. (1981) "Cytological studies in mouse testis irradiated with 2.45-GHz continuous-wave microwaves." *Radiat Res* 87(1):100–108. <https://doi.org/10.2307/3575544>.
- Carlsen E. , Giwercman A. , Keiding N. , Skakkebaek N.E. (1992) "Evidence for decreasing quality of semen during past 50 years." *Br Med J* 305(6854):609–613. <https://doi.org/10.1136/bmj.305.6854.609>.
- Carolan M. , Frankowska D. (2011) "Advanced maternal age and adverse perinatal outcome: A review of the evidence." *Midwifery* 27(6):793–801. <https://doi.org/10.1016/j.midw.2010.07.006>.
- Cecconi S. , Gualtieri G. , Di Bartolomeo A. , Troiani G. , Cifone M.G. , Canipari R. (2000) "Evaluation of the effects of extremely low frequency electromagnetic fields on mammalian follicle development." *Hum Reprod* 15(11):2319–2325. <https://doi.org/10.1093/humrep/15.11.2319>.

Challis L.J. (2005) "Mechanisms for interaction between RF fields and biological tissue." *Bioelectromagnetics* 26(S7):S98–S106. <https://doi.org/10.1002/bem.20119>.

Chambers G.M. , Paul R.C. , Harris K. , Fitzgerald O. , Boothroyd C.V. , et al (2017) "Assisted reproductive technology in Australia and New Zealand: Cumulative live birth rates as measures of success." *Med J Aust* 207(3):114–118. <https://doi.org/10.5694/mja16.01435>.

Chavdoula E.D. , Panagopoulos D.J. , Margaritis L.H. (2010) "Comparison of biological effects between continuous and intermittent exposure to GSM-900-MHz mobile phone radiation: Detection of apoptotic cell-death features." *Mutat Res Genet Toxicol Environ Mutagen* 700(1):51–61. <https://doi.org/10.1016/j.mrgentox.2010.05.008>.

Chen M. , Heilbronn L.K. (2017) "The health outcomes of human offspring conceived by assisted reproductive technologies (ART)." *J Dev Orig Health Dis* 8(4):388–402. <https://doi.org/10.1017/s2040174417000228>.

Chernoff N. , Rogers J.M. , Kavet R. (1992) "A review of the literature on potential reproductive and developmental toxicity of electric and magnetic fields." *Toxicology* 74(2):91–126. [https://doi.org/10.1016/0300-483X\(92\)90132-X](https://doi.org/10.1016/0300-483X(92)90132-X).

Collins J. , Burrows E. , Willan A. (1993) "Infertile couples and their treatment in Canadian academic infertility clinics." Royal Commission on New Reproductive Technologies. *Treatment of Infertility: Current Practices and Psychosocial Implications* 10:233–329.

Creasey W.A. , Goldberg R.B. (2001) "A new twist on an old mechanism for EMF bioeffects?" *EMF Health Report* 9(2):1–11. <https://www.emfsa.co.za/research-and-studies/creasey-wa-goldberg-rb-2001-a-new-twist-on-an-old-mechanism-for-emf/>.

Dahal K.P. (2013) "Mobile communication and its adverse effects." *Himalayan Phys* 4(0):51–59. <https://doi.org/10.3126/hj.v4i0.9429>.

Dawe A.S. , Smith B. , Thomas D.W. , Greedy S. , Vasic N. , et al (2006) "A small temperature rise may contribute towards the apparent induction by microwaves of heat-shock gene expression in the nematode *Caenorhabditis elegans*." *Bioelectromagnetics* 27(2):88–97. <https://doi.org/10.1002/bem.20192>.

Dawson B.V. , Robertson I.G. , Wilson W.R. , Zwi L.J. , Boys J.T. , et al (1998) "Evaluation of potential health effects of 10 kHz magnetic fields: A rodent reproductive study." *Bioelectromagnetics* 19(3):162–171. [https://doi.org/10.1002/\(sici\)1521-186x\(1998\)19:3<162::aid-bem4>3.0.co;2-#](https://doi.org/10.1002/(sici)1521-186x(1998)19:3<162::aid-bem4>3.0.co;2-#).

De Iulius G.N. , Newey R.J. , King B.V. , Aitken R.J. (2009a) "Mobile phone radiation induces reactive oxygen species production and DNA damage in human spermatozoa in vitro." *PLOS ONE* 4(7):e6446. <https://doi.org/10.1371/journal.pone.0006446>.

De Iulius G.N. , Thomson L.K. , Mitchell L.A. , Finnie J.M. , Koppers A.J. , et al (2009b) "DNA damage in human spermatozoa is highly correlated with the efficiency of chromatin remodeling and the formation of 8-hydroxy-2'-deoxyguanosine, a marker of oxidative stress." *Biol Reprod* 81(3):517–524. <https://doi.org/10.1095/biolreprod.109.076836>.

Deepinder F. , Makker K. , Agarwal A. (2007) "Cell phones and male infertility: Dissecting the relationship." *Reprod Biomed Online* 15(3):266–270. [https://doi.org/10.1016/s1472-6483\(10\)60338-0](https://doi.org/10.1016/s1472-6483(10)60338-0).

Delimaris J. , Tsilimigaki S. , Messini-Nicolaki N. , Ziros E. , Piperakis S.M. (2006) "Effects of pulsed electric fields on DNA of human lymphocytes." *Cell Biol Toxicol* 22(6):409–415. <https://doi.org/10.1007/s10565-006-0105-1>.

Diem E. , Schwarz C. , Adlkofer F. , Jahn O. , Rüdiger H. (2005) "Non-thermal DNA breakage by mobile-phone radiation (1800 MHz) in human fibroblasts and in transformed GFSH-R17 rat granulosa cells in vitro." *Mutat Res* 583(2):178–183. <https://doi.org/10.1016/j.mrgentox.2005.03.006>.

Divan H.A. , Kheifets L. , Obel C. , Olsen J. (2008) "Prenatal and postnatal exposure to cell phone use and behavioral problems in children." *Epidemiology* 19(4):523–529. <https://doi.org/10.1097/EDE.0b013e318175dd47>.

Drevet J.R. (2006) "The antioxidant glutathione peroxidase family and spermatozoa: A complex story." *Mol Cell Endocrinol* 250(1–2):70–79. <https://doi.org/10.1016/j.mce.2005.12.027>.

Drevet J.R. , Aitken R.J. (2020) "Oxidation of sperm nucleus in mammals: A physiological necessity to some extent with adverse impacts on oocyte and offspring." *Antioxidants (Basel, Switzerland)* 9(2):95. <https://doi.org/10.3390/antiox9020095>.

Dun M. , Aitken R. , Nixon B. (2012) "The role of molecular chaperones in spermatogenesis and the post-testicular maturation of mammalian spermatozoa." *Hum Reprod Update* 18(4):420–435. <https://doi.org/10.1093/humupd/dms009>.

Dundar B. , Cesur G. , Comlekci S. , Songur A. , Gokcimen A. , et al (2009) "The effect of the prenatal and post-natal long-term exposure to 50 Hz electric field on growth, pubertal development and IGF-1 levels in female Wistar rats." *Toxicol Ind Health* 25(7):479–487. <https://doi.org/10.1177/0748233709345942>.

Eisenberg M.L. , Li S. , Behr B. , Cullen M.R. , Galusha D. , et al (2014) "Semen quality, infertility and mortality in the USA." *Hum Reprod* 29(7):1567–1574. <https://doi.org/10.1093/humrep/deu106>.

Eisenberg M.L. , Li S. , Behr B. , Pera R.R. , Cullen M.R. (2015a) "Relationship between semen production and medical comorbidity." *Fertil Steril* 103(1):66–71. <https://doi.org/10.1016/j.fertnstert.2014.10.017>.

Eisenberg M.L. , Li S. , Brooks J.D. , Cullen M.R. , Baker L.C. (2015b) "Increased risk of cancer in infertile men: Analysis of U.S. claims data." *J Urol* 193(5):1596–1601. <https://doi.org/10.1016/j.juro.2014.11.080>.

- El-Helaly M. , Abu-Hashem E. (2010) "Oxidative stress, melatonin level, and sleep insufficiency among electronic equipment repairers." *Indian J Occup Environ Med* 14(3):66–70. <https://doi.org/10.4103/0019-5278.75692>.
- Elmussareh M. , Mahrous A. , Kayes O. (2015) "Antioxidant therapy for male subfertility: Myth or evidence-based?" *Trends Urol Men's Health* 6(1). <https://doi.org/10.1002/tre.439>.
- Erogul O. , Oztas E. , Yildirim I. , Kir T. , Aydur E. , et al (2006) "Effects of electromagnetic radiation from a cellular phone on human sperm motility: An in vitro study." *Arch Med Res* 37(7):840–843. <https://doi.org/10.1016/j.arcmed.2006.05.003>.
- Faddy M.J. , Gosden R.G. , Gougeon A. , Richardson S.J. , Nelson J.F. (1992) "Accelerated disappearance of ovarian follicles in mid-life: Implications for forecasting menopause." *Hum Reprod* 7(10):1342–1346. <https://doi.org/10.1093/oxfordjournals.humrep.a137570>.
- Falzone N. , Huyser C. , Fourie F. , Toivo T. , Leszczynski D. , Franken D. (2008) "In vitro effect of pulsed 900 MHz GSM radiation on mitochondrial membrane potential and motility of human spermatozoa." *Bioelectromagnetics* 29(4):268–276. <https://doi.org/10.1002/bem.20390>.
- Falzone N. , Huyser C. , Becker P. , Leszczynski D. , Franken D.R. (2011) "The effect of pulsed 900-MHz GSM mobile phone radiation on the acrosome reaction, head morphometry and zona binding of human spermatozoa." *Int J Androl* 34(1):20–26. <https://doi.org/10.1111/j.1365-2605.2010.01054.x>.
- Farquhar C. , Marjoribanks J. (2018) "Assisted reproductive technology: An overview of cochrane reviews." *Cochrane Database Syst Rev* 8(8):Cd010537. <https://doi.org/10.1002/14651858.CD010537.pub5>.
- Fejes I. , Závaczki Z. , Szöllösi J. , Koloszá S. , Daru J. , et al (2005) "Is there a relationship between cell phone use and semen quality?" *Arch Androl* 51(5):385–393. <https://doi.org/10.1080/014850190924520>.
- Foster K.R. , Glaser R. (2007) "Thermal mechanisms of interaction of radiofrequency energy with biological systems with relevance to exposure guidelines." *Health Phys* 92(6):609–620. <https://doi.org/10.1097/01.Hp.0000262572.64418.38>.
- Fragouli E. , Alfawati S. , Goodall N. , Sánchez-García J. , Colls P. , Wells D. (2011) "The cytogenetics of polar bodies: Insights into female meiosis and the diagnosis of aneuploidy." *Mol Hum Reprod* 17(5):286–295.
- Friedman J. , Kraus S. , Hauptman Y. , Schiff Y. , Seger R. (2007) "Mechanism of short-term ERK activation by electromagnetic fields at mobile phone frequencies." *Biochem J* 405(3):559–568. <https://doi.org/10.1042/bj20061653>.
- Furtado-Filho O.V. , Borba J.B. , Dallegrave A. , Pizzolato T.M. , Henriques J.A. , et al (2014) "Effect of 950 MHz UHF electromagnetic radiation on biomarkers of oxidative damage, metabolism of UFA and antioxidants in the livers of young rats of different ages." *Int J Radiat Biol* 90(2):159–168. <https://doi.org/10.3109/09553002.2013.817697>.
- Gabriel S. , Lau R.W. , Gabriel C. (1996) "The dielectric properties of biological tissues: III. Parametric models for the dielectric spectrum of tissues." *Phys Med Biol* 41(11):2271–2293. <https://doi.org/10.1088/0031-9155/41/11/003>.
- Gajda G.B. , McNamee J.P. , Thansandote A. , Boonpanyarak S. , Lemay E. , Bellier P.V. (2002) "Cylindrical waveguide applicator for in vitro exposure of cell culture samples to 1.9-GHz radiofrequency fields." *Bioelectromagnetics* 23(8):592–598. <https://doi.org/10.1002/bem.10055>.
- Gandhi O.P. , Kang G. (2001) "Calculation of induced current densities for humans by magnetic fields from electronic article surveillance devices." *Phys Med Biol* 46(11):2759–2771. <https://doi.org/10.1088/0031-9155/46/11/301>.
- Gandhi O.P. , Morgan L.L. , de Salles A.A. , Han Y.Y. , Herberman R.B. , Davis D.L. (2012) "Exposure limits: The underestimation of absorbed cell phone radiation, especially in children." *Electromagn Biol Med* 31(1):34–51. <https://doi.org/10.3109/15368378.2011.622827>.
- George K. , Kamath M.S. (2010) "Fertility and age." *J Hum Reprod Sci* 3(3):121–123. <https://doi.org/10.4103/0974-1208.74152>.
- Gerner C. , Haudek V. , Schandl U. , Bayer E. , Gundacker N. , et al (2010) "Increased protein synthesis by cells exposed to a 1800-MHz radio-frequency mobile phone electromagnetic field, detected by proteome profiling." *Int Arch Occup Environ Health* 83(6):691–702. <https://doi.org/10.1007/s00420-010-0513-7>.
- Gervasi M.G. , Visconti P.E. (2017) "Molecular changes and signaling events occurring in spermatozoa during epididymal maturation." *Andrology* 5(2):204–218. <https://doi.org/10.1111/andr.12320>.
- Ghanbari M. , Mortazavi S.B. , Khavanin A. , Khazaei M. (2013) "The effects of cell phone waves (900 MHz-GSM band) on sperm parameters and total antioxidant capacity in rats." *Int J Fertil Steril* 7(1):21–28.
- Glazer C.H. , Bonde J.P. , Eisenberg M.L. , Giwercman A. , Hærvig K.K. , et al (2017) "Male infertility and risk of nonmalignant chronic diseases: A systematic review of the epidemiological evidence." *Semin Reprod Med* 35(3):282–290. <https://doi.org/10.1055/s-0037-1603568>.
- Goldhaber M.K. , Polen M.R. , Hiatt R.A. (1988) "The risk of miscarriage and birth defects among women who use visual display terminals during pregnancy." *Am J Ind Med* 13(6):695–706. <https://doi.org/10.1002/ajim.4700130608>.
- Goodman E. , Greenebaum B. , Marron M. (1995) "Effects of electromagnetic fields on molecules and cells." *Int Rev Cytol* 158:279–338. [https://doi.org/10.1016/S0074-7696\(08\):62489-4](https://doi.org/10.1016/S0074-7696(08):62489-4).
- Gorpinchenko I. , Nikitin O. , Banyra O. , Shulyak A. (2014) "The influence of direct mobile phone radiation on sperm quality." *Cent Eur J Urol* 67(1):65–71. <https://doi.org/10.5173/cej.2014.01.art14>.

- Gul A. , Celebi H. , Uğraş S. (2009) "The effects of microwave emitted by cellular phones on ovarian follicles in rats." *Arch Gynecol Obstet* 280(5):729–733. <https://doi.org/10.1007/s00404-009-0972-9>.
- Güler G. , Tomruk A. , Ozgur E. , Sahin D. , Sepici A. , et al (2012) "The effect of radiofrequency radiation on DNA and lipid damage in female and male infant rabbits." *Int J Radiat Biol* 88(4):367–373. <https://doi.org/10.3109/09553002.2012.646349>.
- Guney M. , Ozguner F. , Oral B. , Karahan N. , Mungan T. (2007) "900 MHz radiofrequency-induced histopathologic changes and oxidative stress in rat endometrium: Protection by vitamins E and C." *Toxicol Ind Health* 23(7):411–420. <https://doi.org/10.1177/0748233707080906>.
- Gutsch T. , Mohamad Al-Ali B. , Shamloul R. , Pummer K. , Trummer H. (2011) "Impact of cell phone use on men's semen parameters." *Andrologia* 43(5):312–316. <https://doi.org/10.1111/j.1439-0272.2011.01075.x>.
- Gye M.C. , Park C.J. (2012) "Effect of electromagnetic field exposure on the reproductive system." *Clin Exp Reprod Med* 39(1):1–9. <https://doi.org/10.5653/cerm.2012.39.1.1>.
- Hardell L. (2017) "World Health Organization, radiofrequency radiation and health - A hard nut to crack (review)." *Int J Oncol* 51(2):405–413. <https://doi.org/10.3892/ijo.2017.4046>.
- Harremoes P. , Gee D. , MacGarvin M. , Stirling A. , Keys J. , et al (Eds.). (2013) *The precautionary principle in the 20th century: Late lessons from early warnings*. London: Routledge.
- Hassold T. , Chiu D. (1985) "Maternal age-specific rates of numerical chromosome abnormalities with special reference to trisomy." *Hum Genet* 70(1):11–17. <https://doi.org/10.1007/bf00389450>.
- Henshaw D.L. , O'Carroll M.J. (2009) *Scientific committee on emerging and newly identified health risks (SCENIHR)*. Brussels: European Commission.
- Hirsh A. (2003) "Male subfertility." *BMJ* 327(7416):669–672. <https://doi.org/10.1136/bmj.327.7416.669>.
- Hou Q. , Wang M. , Wu S. , Ma X. , An G. , et al (2015) "Oxidative changes and apoptosis induced by 1800-MHz electromagnetic radiation in NIH/3T3 cells." *Electromagn Biol Med* 34(1):85–92. <https://doi.org/10.3109/15368378.2014.900507>.
- Houston B.J. , Nixon B. , King B.V. , Aitken R.J. , De Luliis G.N. (2018a) "Probing the origins of 1,800 MHz radio frequency electromagnetic radiation induced damage in mouse immortalized germ cells and spermatozoa in vitro." *Front Public Health* 6. <https://doi.org/10.3389/fpubh.2018.00270>.
- Houston B.J. , Nixon B. , Martin J.H. , De Luliis G.N. , Trigg N.A. , et al (2018b) "Heat exposure induces oxidative stress and DNA damage in the male germ line." *Biol Reprod* 98(4):593–606. <https://doi.org/10.1093/biolre/iy009>.
- Houston B.J. , Nixon B. , McEwan K.E. , Martin J.H. , King B.V. , et al (2019) "Whole-body exposures to radiofrequency-electromagnetic energy can cause DNA damage in mouse spermatozoa via an oxidative mechanism." *Sci Rep* 9(1):17478. <https://doi.org/10.1038/s41598-019-53983-9>.
- Hsueh A.J. , Kawamura K. , Cheng Y. , Fauser B.C. (2015) "Intraovarian control of early folliculogenesis." *Endocr Rev* 36(1):1–24. <https://doi.org/10.1210/er.2014-1020>.
- Hunt S. , Vollenhoven B. (2020) "Assessment of female fertility in the general practice setting." *Aust J Gen Pract* 49(6):304–308.
- Hur S.S.J. , Cropley J.E. , Suter C.M. (2017) "Paternal epigenetic programming: Evolving metabolic disease risk." *J Mol Endocrinol* 58(3):R159–R168. <https://doi.org/10.1530/jme-16-0236>.
- Hutcheon K. , McLaughlin E.A. , Stanger S.J. , Bernstein I.R. , Dun M.D. , et al (2017) "Analysis of the small non-protein-coding RNA profile of mouse spermatozoa reveals specific enrichment of piRNAs within mature spermatozoa." *RNA Biol* 14(12):1776–1790. <https://doi.org/10.1080/15476286.2017.1356569>.
- Hyland G.J. (2008) "Physical basis of adverse and therapeutic effects of low intensity microwave radiation." *Indian J Exp Biol* 46(5):403–419.
- ICNIRP (1998) "Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)." *Health Phys* 74(4):494–521.
- ICNIRP (2009) "Statement on the 'Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)'." *Health Phys* 97(3):257–258.
- ICNIRP (2020) "Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz)." *Health Phys* 118(5):483–524.
- Ilacqua A. , Izzo G. , Emerenziani G.P. , Baldari C. , Aversa A. (2018) "Lifestyle and fertility: The influence of stress and quality of life on male fertility." *Reprod Biol Endocrinol* 16(1):115. <https://doi.org/10.1186/s12958-018-0436-9>.
- Imai N. , Kawabe M. , Hikage T. , Nojima T. , Takahashi S. , Shirai T. (2011) "Effects on rat testis of 1.95-GHz W-CDMA for IMT-2000 cellular phones." *Syst Biol Reprod Med* 57(4):204–209. <https://doi.org/10.3109/19396368.2010.544839>.
- Iommiello V.M. , Albani E. , Di Rosa A. , Marras A. , Menduni F. , et al (2015) "Ejaculate oxidative stress is related with sperm DNA fragmentation and round cells." *Int J Endocrinol* 2015:321901. <https://doi.org/10.1155/2015/321901>.
- Iwasaki A. , Gagnon C. (1992) "Formation of reactive oxygen species in spermatozoa of infertile patients." *Fertil Steril* 57(2):409–416. [https://doi.org/10.1016/s0015-0282\(16\):54855-9](https://doi.org/10.1016/s0015-0282(16):54855-9).
- Iyoke C.A. , Ugwu G.O. , Ezugwu F.O. , Ajah L.O. , Mba S.G. (2013) "The role of ultrasonography in in-vitro fertilization and embryo transfer (IVF-ET)." *Niger J Med* 22(3):162–170.

- Jensen T.K. , Jacobsen R. , Christensen K. , Nielsen N.C. , Bostofte E. (2009) "Good semen quality and life expectancy: A cohort study of 43,277 men." *Am J Epidemiol* 170(5):559–565. <https://doi.org/10.1093/aje/kwp168>.
- Jones R. , Mann T. , Sherins R. (1979) "Peroxidative breakdown of phospholipids in human spermatozoa, spermicidal properties of fatty acid peroxides, and protective action of seminal plasma*." *Fertil Steril* 31(5):531–537. [https://doi.org/10.1016/S0015-0282\(16\):43999-3](https://doi.org/10.1016/S0015-0282(16):43999-3).
- Jung K.A. , Ahn H.S. , Lee Y.S. , Gye M.C. (2007) "Effect of a 20 kHz sawtooth magnetic field exposure on the estrous cycle in mice." *J Microbiol Biotechnol* 17(3):398–402.
- Jungwirth A. , Diemer T. , Kopa Z. , Krausz C. , Tournaye H. (2015) European association of urology (EAU) guidelines on male infertility. Arnhem: European Association of Urology.
- Kahya M. , Nazıroğlu M. , Çiğ B. (2014) "Selenium reduces mobile phone (900 MHz)-induced oxidative stress, mitochondrial function, and apoptosis in breast cancer cells." *Biol Trace Elem Res* 160(2). <https://doi.org/10.1007/s12011-014-0032-6>.
- Kalra S.K. , Ratcliffe S.J. , Coutifaris C. , Molinaro T. , Barnhart K.T. (2011) "Ovarian stimulation and low birth weight in newborns conceived through in vitro fertilization." *Obstet Gynecol* 118(4):863–871. <https://doi.org/10.1097/AOG.0b013e31822be65f>.
- Karipidis K. , Elwood M. , Benke G. , Sanagou M. , Tjong L. , Croft R.J. (2018) "Mobile phone use and incidence of brain tumour histological types, grading or anatomical location: A population-based ecological study." *BMJ, (Open)* 8(12):e024489. <https://doi.org/10.1136/bmjopen-2018-024489>.
- Karipidis K. , Mate R. , Urban D. , Tinker R. , Wood A. (2021) "5G mobile networks and health-a state-of-the-science review of the research into low-level RF fields above 6 GHz." *J Expo Sci Environ Epidemiol* 31(4):585–605. <https://doi.org/10.1038/s41370-021-00297-6>.
- Katen A.L. , Sipilä P. , Mitchell L.A. , Stanger S.J. , Nixon B. , Roman S.D. (2017) "Epididymal CYP2E1 plays a critical role in acrylamide-induced DNA damage in spermatozoa and paternally mediated embryonic resorptions†." *Biol Reprod* 96(4):921–935. <https://doi.org/10.1093/biolre/i0x021>.
- Kazama M. , Hino A. (2012) "Sea urchin spermatozoa generate at least two reactive oxygen species; the type of reactive oxygen species changes under different conditions." *Mol Reprod Dev* 79(4):283–295. <https://doi.org/10.1002/mrd.22025>.
- Kesari K. , Kumar S. , Behari J. (2011) "Effects of radiofrequency electromagnetic wave exposure from cellular phones on the reproductive pattern in male Wistar rats." *Appl Biochem Biotechnol* 164(4):546–559. <https://doi.org/10.1007/s12010-010-9156-0>.
- Kesari K.K. , Agarwal A. , Henkel R. (2018) "Radiations and male fertility." *Reprod Biol Endocrinol* 16(1):118. <https://doi.org/10.1186/s12958-018-0431-1>.
- Kilgallon S.J. , Simmons L.W. (2005) "Image content influences men's semen quality." *Biol Lett* 1(3):253–255. <https://doi.org/10.1098/rsbl.2005.0324>.
- Kirk M. , Smurthwaite K. , Braunig J. , Trevenar S. , D'Este C. , et al (2018) "The PFAS health study: Systematic literature review", The Australian National University, Canberra.
- Kivrak E.G. , Yurt K.K. , Kaplan A.A. , Alkan I. , Altun G. (2017) "Effects of electromagnetic fields exposure on the antioxidant defense system." *J Microsc Ultrastruct* 5(4):167–176. <https://doi.org/10.1016/j.jmau.2017.07.003>.
- Konc J. , Kanyó K. , Kriston R. , Somoskői B. , Cseh S. (2014) "Cryopreservation of embryos and oocytes in human assisted reproduction." *BioMed Res Int* 2014:307268. <https://doi.org/10.1155/2014/307268>.
- Koppers A.J. , De luliis G.N. , Finnie J.M. , McLaughlin E.A. , Aitken R.J. (2008) "Significance of mitochondrial reactive oxygen species in the generation of oxidative stress in spermatozoa." *J Clin Endocrinol Metab* 93(8):3199–3207. <https://doi.org/10.1210/jc.2007-2616>.
- Kostoff R.N. , Heroux P. , Aschner M. , Tsatsakis A. (2020) "Adverse health effects of 5G mobile networking technology under real-life conditions." *Toxicol Lett* 323:35–40. <https://doi.org/10.1016/j.toxlet.2020.01.020>.
- Kothari S. , Thompson A. , Agarwal A. , du Plessis S.S. (2010) "Free radicals: Their beneficial and detrimental effects on sperm function." *Indian J Exp Biol* 48(5):425–435.
- Koyu A. , Ozguner F. , Yilmaz H. , Uz E. , Cesur G. , Ozcelik N. (2009) "The protective effect of caffeic acid phenethyl ester (CAPE) on oxidative stress in rat liver exposed to the 900 MHz electromagnetic field." *Toxicol Ind Health* 25(6):429–434. <https://doi.org/10.1177/0748233709106821>.
- Krausz C. (2011) "Male infertility: Pathogenesis and clinical diagnosis." *Best Pract Res Clin Endocrinol Metab* 25(2):271–285. <https://doi.org/10.1016/j.beem.2010.08.006>.
- Kuliev A. , Zlatopolsky Z. , Kirillova I. , Spivakova J. , Cieslak Janzen J. (2011) "Meiosis errors in over 20,000 oocytes studied in the practice of preimplantation aneuploidy testing." *Reprod Biomed Online* 22(1):2–8. <https://doi.org/10.1016/j.rbmo.2010.08.014>.
- Kumar N. , Singh A.K. (2015) "Trends of male factor infertility, an important cause of infertility: A review of literature." *J Hum Reprod Sci* 8(4):191–196. <https://doi.org/10.4103/0974-1208.170370>.
- Kumar S. , Behari J. , Sisodia R. (2013) "Influence of electromagnetic fields on reproductive system of male rats." *Int J Radiat Biol* 89(3):147–154. <https://doi.org/10.3109/09553002.2013.741282>.
- Kumar S. , Nirala J.P. , Behari J. , Paulraj R. (2014) "Effect of electromagnetic irradiation produced by 3G mobile phone on male rat reproductive system in a simulated scenario." *Indian J Exp Biol* 52(9):890–897.

La Vignera S. , Condorelli R.A. , Vicari E. , D'Agata R. , Calogero A.E. (2012) "Effects of the exposure to mobile phones on male reproduction: A review of the literature." *J Androl* 33(3):350–356. <https://doi.org/10.2164/jandrol.111.014373>.

Lai H. , Singh N.P. (2004) "Magnetic-field-induced DNA strand breaks in brain cells of the rat." *Environ Health Perspect* 112(6):687–694. <https://doi.org/10.1289/ehp.6355>.

Lee H.J. , Pack J.K. , Kim T.H. , Kim N. , Choi S.Y. , et al (2010) "The lack of histological changes of CDMA cellular phone-based radio frequency on rat testis." *Bioelectromagnetics* 31(7):528–534. <https://doi.org/10.1002/bem.20589>.

Lee K.M. , Ward M.H. , Han S. , Ahn H.S. , Kang H.J. , et al (2009) "Paternal smoking, genetic polymorphisms in CYP1A1 and childhood leukemia risk." *Leuk Res* 33(2):250–258. <https://doi.org/10.1016/j.leukres.2008.06.031>.

Leiva R.A. , Bouchard T.P. , Abdullah S.H. , Ecochard R. (2017) "Urinary luteinizing hormone tests: Which concentration threshold best predicts ovulation?" *Front Public Health* 5. <https://doi.org/10.3389/fpubh.2017.00320>.

Leng L. (2016) "The relationship between mobile phone use and risk of brain tumor: A systematic review and meta-analysis of trials in the last decade." *Chin Neurosurg J* 2(1):38. <https://doi.org/10.1186/s41016-016-0059-y>.

Lenzi A. , Gandini L. , Maresca V. , Rago R. , Sgrò P. , et al (2000) "Fatty acid composition of spermatozoa and immature germ cells." *Mol Hum Reprod* 6(3):226–231. <https://doi.org/10.1093/molehr/6.3.226>.

Levine H. , Jørgensen N. , Martino-Andrade A. , Mendiola J. , Weksler-Derri D. , et al (2017) "Temporal trends in sperm count: A systematic review and meta-regression analysis." *Hum Reprod Update* 23(6):646–659. <https://doi.org/10.1093/humupd/dmx022>.

Lewis R.C. , Mínguez-Alarcón L. , Meeker J.D. , Williams P.L. , Mezei G. , et al (2017) "Self-reported mobile phone use and semen parameters among men from a fertility clinic." *Reprod Toxicol* (Elmsford, N.Y.) 67:42–47. <https://doi.org/10.1016/j.reprotox.2016.11.008>.

Lin Y.Y. , Wu T. , Liu J.Y. , Gao P. , Li K.C. , et al (2017) "1950 MHz radio frequency electromagnetic radiation inhibits testosterone secretion of mouse Leydig cells." *Int J Environ Res Public Health* 15(1). <https://doi.org/10.3390/ijerph15010017>.

Liu C. , Duan W. , Xu S. , Chen C. , He M. , et al (2013a) "Exposure to 1800 MHz radiofrequency electromagnetic radiation induces oxidative DNA base damage in a mouse spermatocyte-derived cell line." *Toxicol Lett* 218(1):2–9. <https://doi.org/10.1016/j.toxlet.2013.01.003>.

Liu C. , Gao P. , Xu S.C. , Wang Y. , Chen C.H. , et al (2013b) "Mobile phone radiation induces mode-dependent DNA damage in a mouse spermatocyte-derived cell line: A protective role of melatonin." *Int J Radiat Biol* 89(11):993–1001. <https://doi.org/10.3109/09553002.2013.811309>.

Liu Q. , Si T. , Xu X. , Liang F. , Wang L. , Pan S. (2015) "Electromagnetic radiation at 900 MHz induces sperm apoptosis through bcl-2, bax and caspase-3 signaling pathways in rats." *Reprod Health* 12(1):65. <https://doi.org/10.1186/s12978-015-0062-3>.

Liu W.M. , Pang R.T. , Chiu P.C. , Wong B.P. , Lao K. , et al (2012) "Sperm-borne microRNA-34c is required for the first cleavage division in mouse." *Proc Natl Acad Sci U S A* 109(2):490–494. <https://doi.org/10.1073/pnas.1110368109>.

Lixia S. , Yao K. , Kaijun W. , Deqiang L. , Huajun H. , et al (2006) "Effects of 1.8 GHz radiofrequency field on DNA damage and expression of heat shock protein 70 in human lens epithelial cells." *Mutat Res* 602(1–2):135–142. <https://doi.org/10.1016/j.mrfmmm.2006.08.010>.

Lord T. , Aitken R.J. (2013) "Oxidative stress and ageing of the post-ovulatory oocyte." *Reproduction* 146(6):R217–R227. <https://doi.org/10.1530/rep-13-0111>.

Lord T. , Nixon B. , Jones K.T. , Aitken R.J. (2013) "Melatonin prevents postovulatory oocyte aging in the mouse and extends the window for optimal fertilization in Vitro1." *Biol Reprod* 88(3). <https://doi.org/10.1095/biolreprod.112.106450>.

Lord T. , Aitken R.J. (2015) "Fertilization stimulates 8-hydroxy-2'-deoxyguanosine repair and antioxidant activity to prevent mutagenesis in the embryo." *Dev Biol* 406(1):1–13. <https://doi.org/10.1016/j.ydbio.2015.07.024>.

Lord T. , Martin J.H. , Aitken R.J. (2015) "Accumulation of electrophilic aldehydes during postovulatory aging of mouse oocytes causes reduced fertility, oxidative stress, and apoptosis." *Biol Reprod* 92(2):33. <https://doi.org/10.1095/biolreprod.114.122820>.

Lotti F. , Maggi M. (2015) "Ultrasound of the male genital tract in relation to male reproductive health." *Hum Reprod Update* 21(1):56–83. <https://doi.org/10.1093/humupd/dmu042>.

Lu Y.S. , Huang B.T. , Huang Y.X. (2012) "Reactive oxygen species formation and apoptosis in human peripheral blood mononuclear cell induced by 900 MHz mobile phone radiation." *Oxid Med Cell Longev* 2012:740280. <https://doi.org/10.1155/2012/740280>.

Madjar H.M. (2016) "Human radio frequency exposure limits: An update of reference levels in Europe, USA, Canada, China, Japan and Korea." 2016 International Symposium on Electromagnetic Compatibility - EMC EUROPE 2016:467–473.

Magras I.N. , Xenos T.D. (1997) "RF radiation-induced changes in the prenatal development of mice." *Bioelectromagnetics* 18(6):455–461. [https://doi.org/10.1002/\(sici\)1521-186x\(1997\):18:6<455::aid-bem8>3.0.co;2-1](https://doi.org/10.1002/(sici)1521-186x(1997):18:6<455::aid-bem8>3.0.co;2-1).

Maheer E.R. , Brueton L.A. , Bowdin S.C. , Luharia A. , Cooper W. , et al (2003) "Beckwith-Wiedemann syndrome and assisted reproduction technology (ART)." *J Med Genet* 40(1):62–64. <https://doi.org/10.1136/jmg.40.1.62>.

Mailankot M. , Kunnath A.P. , Jayalekshmi H. , Koduru B. , Valsalan R. (2009) "Radio frequency electromagnetic radiation (RF-EMR) from GSM (0.9/1.8 GHz) mobile phones induces oxidative stress and reduces sperm motility in rats." *Clin (Sao Paulo, Brazil)* 64(6):561–565. <https://doi.org/10.1590/s1807-59322009000600011>.

Manta A.K. , Papadopoulou D. , Polyzos A.P. , Fragopoulou A.F. , Skouroliakou A.S. , et al (2017) "Mobile-phone radiation-induced perturbation of gene-expression profiling, redox equilibrium and sporadic-apoptosis control in the ovary of *Drosophila melanogaster*." *Fly (Austin)* 11(2):75–95. <https://doi.org/10.1080/19336934.2016.1270487>.

Marchionni I. , Paffi A. , Pellegrino M. , Liberti M. , Apollonio F. , et al (2006) "Comparison between low-level 50 Hz and 900 MHz electromagnetic stimulation on single channel ionic currents and on firing frequency in dorsal root ganglion isolated neurons." *Biochim Biophys Acta* 1758(5):597–605. <https://doi.org/10.1016/j.bbame.2006.03.014>.

Marková E. , Malmgren L.O.G. , Belyaev I.Y. (2010) "Microwaves from mobile phones inhibit 53BP1 focus formation in human stem cells more strongly than in differentiated cells: Possible mechanistic link to cancer risk." *Environ Health Perspect* 118(3):394–399. <https://doi.org/10.1289/ehp.0900781>.

Martin J.H. , Bromfield E.G. , Aitken R.J. , Lord T. , Nixon B. (2018) "Double strand break DNA repair occurs via non-homologous end-joining in mouse MII oocytes." *Sci Rep* 8(1):9685. <https://doi.org/10.1038/s41598-018-27892-2>.

Martin J.H. , Aitken R.J. , Bromfield E.G. , Nixon B. (2019) "DNA damage and repair in the female germline: Contributions to ART." *Hum Reprod Update* 25(2):180–201. <https://doi.org/10.1093/humupd/dmy040>.

Martino C.F. , Castello P.R. (2011) "Modulation of hydrogen peroxide production in cellular systems by low level magnetic fields." *PLOS ONE* 6(8):e22753. <https://doi.org/10.1371/journal.pone.0022753>.

Matwee C. , Kamaruddin M. , Betts D.H. , Basrur P.K. , King W.A. (2001) "The effects of antibodies to heat shock protein 70 in fertilization and embryo development." *Mol Hum Reprod* 7(9):829–837. <https://doi.org/10.1093/molehr/7.9.829>.

Meena R. , Kumari K. , Kumar J. , Rajamani P. , Verma H.N. , Kesari K.K. (2014) "Therapeutic approaches of melatonin in microwave radiations-induced oxidative stress-mediated toxicity on male fertility pattern of Wistar rats." *Electromagn Biol Med* 33(2):81–91. <https://doi.org/10.3109/15368378.2013.781035>.

Merchant R. , Gandhi G. , Allahbadia G.N. (2011) "In vitro fertilization/intracytoplasmic sperm injection for male infertility." *Indian J Urol* 27(1):121–132. <https://doi.org/10.4103/0970-1591.78430>.

Mieusset R. , Grandjean H. , Mansat A. , Pontonnier F. (1985) "Inhibiting effect of artificial cryptorchidism on spermatogenesis." *Fertil Steril* 43(4):589–594. [https://doi.org/10.1016/s0015-0282\(16\):48502-x](https://doi.org/10.1016/s0015-0282(16):48502-x).

Mieusset R. , Bujan L. (1994) "The potential of mild testicular heating as a safe, effective and reversible contraceptive method for men." *Int J Androl* 17(4):186–191. <https://doi.org/10.1111/j.1365-2605.1994.tb01241.x>.

Mihai C.T. , Rotinberg P. , Brinza F. , Vochita G. (2014) "Extremely low-frequency electromagnetic fields cause DNA strand breaks in normal cells." *J Environ Health Sci Eng* 12(1):15. <https://doi.org/10.1186/2052-336x-12-15>.

Mihalas B.P. , De Iulius G.N. , Redgrove K.A. , McLaughlin E.A. , Nixon B. (2017a) "The lipid peroxidation product 4-hydroxynonenal contributes to oxidative stress-mediated deterioration of the ageing oocyte." *Sci Rep* 7(1):6247. <https://doi.org/10.1038/s41598-017-06372-z>.

Mihalas B.P. , Redgrove K.A. , McLaughlin E.A. , Nixon B. (2017b) "Molecular mechanisms responsible for increased vulnerability of the ageing oocyte to oxidative damage." *Oxid Med Cell Longev* 2017:4015874. <https://doi.org/10.1155/2017/4015874>.

Mihalas B.P. , Bromfield E.G. , Sutherland J.M. , De Iulius G.N. , McLaughlin E.A. , et al (2018) "Oxidative damage in naturally aged mouse oocytes is exacerbated by dysregulation of proteasomal activity." *J Biol Chem* 293(49):18944–18964. <https://doi.org/10.1074/jbc.RA118.005751>.

Miller A.B. , Morgan L.L. , Udasin I. , Davis D.L. (2018) "Cancer epidemiology update, following the 2011 IARC evaluation of radiofrequency electromagnetic fields (Monograph 102)." *Environ Res* 167:673–683. <https://doi.org/10.1016/j.envres.2018.06.043>.

Miller A.B. , Sears M.E. , Morgan L.L. , Davis D.L. , Hardell L. , et al (2019) "Risks to health and well-being from radio-frequency radiation emitted by cell phones and other wireless devices." *Front Public Health* 7:223–223. <https://doi.org/10.3389/fpubh.2019.00223>.

Miller J.W.B. , Torday J.S. (2019) "Reappraising the exteriorization of the mammalian testes through evolutionary physiology." *Communicat Integr Biol* 12(1):38–54. <https://doi.org/10.1080/19420889.2019.1586047>.

Mortazavi S. , Parsanezhad M. , Kazempour M. , Ghahramani P. , Mortazavi A. , Davari M. (2013a) "Male reproductive health under threat: Short term exposure to radiofrequency radiations emitted by common mobile jammers." *J Hum Reprod Sci* 6(2):124–128. <https://doi.org/10.4103/0974-1208.117178>.

Mortazavi S.M. , Shirazi K.R. , Mortazavi G. (2013b) "The study of the effects of ionizing and non-ionizing radiations on birth weight of newborns to exposed mothers." *J Nat Sci Biol Med* 4(1):213–217.

<https://doi.org/10.4103/0976-9668.107293>.

Murphy M.P. (2009) "How mitochondria produce reactive oxygen species." *Biochem J* 417(1):1–13. <https://doi.org/10.1042/bj20081386>.

Naeem Z. (2014) "Health risks associated with mobile phones use." *Int J Health Sci (Qassim)* 8(4):V–VI.

Nagy Z.P. , Nel-Themaat L. , Chang C.C. , Shapiro D.B. , Berna D.P. (2014) "Cryopreservation of eggs." *Methods Mol Biol* 1154:439–454. https://doi.org/10.1007/978-1-4939-0659-8_20.

Narayanan S.N. , Kumar R.S. , Karun K.M. , Nayak S.B. , Bhat P.G. (2015) "Possible cause for altered spatial cognition of prepubescent rats exposed to chronic radiofrequency electromagnetic radiation." *Metab Brain Dis* 30(5):1193–1206. <https://doi.org/10.1007/s11011-015-9689-6>.

Nasr-Esfahani M.H. , Deemeh M.R. , Tavalae M. (2012) "New era in sperm selection for ICSI." *Int J Androl* 35(4):475–484. <https://doi.org/10.1111/j.1365-2605.2011.01227.x>.

Negi P. , Singh R. (2021) "Association between reproductive health and nonionizing radiation exposure." *Electromagn Biol Med* 40(1):92–102. <https://doi.org/10.1080/15368378.2021.1874973>.

Neufeld E. , Kuster N. (2018) "Systematic derivation of safety limits for time-varying 5G radiofrequency exposure based on analytical models and thermal dose." *Health Phys* 115(6):705–711. <https://doi.org/10.1097/hp.0000000000000930>.

Newman J.E. , Paul R.C. , Chambers G.M. (2021) *Assisted reproductive technology in Australia and New Zealand 2019*. Sydney: National Perinatal Epidemiology and Statistics Unit, the University of New South Wales, Sydney.

Nikolova T. , Czyz J. , Rolletschek A. , Blyszczuk P. , Fuchs J. , et al (2005) "Electromagnetic fields affect transcript levels of apoptosis-related genes in embryonic stem cell-derived neural progenitor cells." *FASEB J* 19(12):1686–1688. <https://doi.org/10.1096/fj.04-3549fj>.

Nixon B. , De Luliis G.N. , Dun M.D. , Zhou W. , Trigg N.A. , Eamens A.L. (2019) "Profiling of epididymal small non-protein-coding RNAs." *Andrology* 7(5):669–680. <https://doi.org/10.1111/andr.12640>.

Nobranc A. , Peltier M. , Damon-Soubeyrand C. , Kerckove N. , Chabory E. , et al (2012) "Epididymis response partly compensates for spermatozoa oxidative defects in snGPx4 and GPx5 double mutant mice." *PLOS ONE* 7(6):e38565. <https://doi.org/10.1371/journal.pone.0038565>.

Novakovic B. , Lewis S. , Halliday J. , Kennedy J. , Burgner D.P. , et al (2019) "Assisted reproductive technologies are associated with limited epigenetic variation at birth that largely resolves by adulthood." *Nat Commun* 10(1):3922. <https://doi.org/10.1038/s41467-019-11929-9>.

Nowicka-Bauer K. , Nixon B. (2020) "Molecular changes induced by oxidative stress that impair human sperm motility." *Antioxidants (Basel, Switzerland)* 9(2):134. <https://doi.org/10.3390/antiox9020134>.

Ochsendorf F.R. , Thiele J. , Fuchs J. , Schütttau H. , Freisleben H.J. , et al (1994) "Chemiluminescence in semen of infertile men." *Andrologia* 26(5):289–293. <https://doi.org/10.1111/j.1439-0272.1994.tb00804.x>.

O'Flaherty C. (2019) "Orchestrating the antioxidant defenses in the epididymis." *Andrology* 7(5):662–668. <https://doi.org/10.1111/andr.12630>.

O'Flaherty C. (2020) "Reactive oxygen species and male fertility." *Antioxidants* 9(4):287.

Ohmori S. , Yamao Y. , Nakajima N. (2001) "The future generations of mobile communications based on broadband access methods." *J Wirel Pers Commun* 17(2–3):175–190. <https://doi.org/10.1023/a:1011248901400>.

Okechukwu C.E. (2020) "Does the use of mobile phone affect male fertility? A mini-review." *J Hum Reprod Sci* 13(3):174–183. https://doi.org/10.4103/jhrs.JHRS_126_19.

Oral B. , Guney M. , Ozguner F. , Karahan N. , Mungan T. , et al (2006) "Endometrial apoptosis induced by a 900-MHz mobile phone: Preventive effects of vitamins E and C." *Adv Ther* 23(6):957–973. <https://doi.org/10.1007/BF02850217>.

Oscar K.J. , Hawkins T.D. (1977) "Microwave alteration of the blood-brain barrier system of rats." *Brain Res* 126(2):281–293. [https://doi.org/10.1016/0006-8993\(77\):90726-0](https://doi.org/10.1016/0006-8993(77):90726-0).

Ozguner F. , Altinbas A. , Ozaydin M. , Dogan A. , Vural H. , et al (2005) "Mobile phone-induced myocardial oxidative stress: Protection by a novel antioxidant agent caffeic acid phenethyl ester." *Toxicol Ind Health* 21(9):223–230. <https://doi.org/10.1191/0748233705th228oa>.

Ozguner M. , Koyu A. , Cesur G. , Ural M. , Ozguner F. , et al (2005) "Biological and morphological effects on the reproductive organ of rats after exposure to electromagnetic field." *Saudi Med J* 26(3):405–410.

Pall M.L. (2013) "Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects." *J Cell Mol Med* 17(8):958–965. <https://doi.org/10.1111/jcmm.12088>.

Pall M.L. (2015) "Scientific evidence contradicts findings and assumptions of Canadian safety panel 6: Microwaves act through voltage-gated calcium channel activation to induce biological impacts at non-thermal levels, supporting a paradigm shift for microwave/lower frequency electromagnetic field action." *Rev Environ Health* 30(2):99–116. <https://doi.org/10.1515/reveh-2015-0001>.

Pall M.L. (2018) "Wi-fi is an important threat to human health." *Environ Res* 164:405–416. <https://doi.org/10.1016/j.envres.2018.01.035>.

Panagopoulos D.J. , Messini N. , Karabounis A. , Philippetis A.L. , Margaritis L.H. (2000) "A mechanism for action of oscillating electric fields on cells." *Biochem Biophys Res Commun* 272(3):634–640. <https://doi.org/10.1006/bbrc.2000.2746>.

Panagopoulos D.J. , Karabarbounis A. , Margaritis L.H. (2002) "Mechanism for action of electromagnetic fields on cells." *Biochem Biophys Res Commun* 298(1):95–102. [https://doi.org/10.1016/s0006-291x\(02\):02393-8](https://doi.org/10.1016/s0006-291x(02):02393-8).

Panagopoulos D.J. , Karabarbounis A. , Margaritis L.H. (2004) "Effect of GSM 900-MHz mobile phone radiation on the reproductive capacity of *Drosophila melanogaster*." *Electromagn Biol Med* 23(1):29–43. <https://doi.org/10.1081/JBC-120039350>.

Panagopoulos D.J. , Chavdoula E.D. , Nezis I.P. , Margaritis L.H. (2007a) "Cell death induced by GSM 900-MHz and DCS 1800-MHz mobile telephony radiation." *Mutat Res* 626(1–2):69–78. <https://doi.org/10.1016/j.mrgentox.2006.08.008>.

Panagopoulos D.J. , Chavdoula E.D. , Karabarbounis A. , Margaritis L.H. (2007b) "Comparison of bioactivity between GSM 900 MHz and DCS 1800 MHz mobile telephony radiation." *Electromagn Biol Med* 26(1):33–44. <https://doi.org/10.1080/15368370701205644>.

Panagopoulos D.J. , Chavdoula E.D. , Margaritis L.H. (2010) "Bioeffects of mobile telephony radiation in relation to its intensity or distance from the antenna." *Int J Radiat Biol* 86(5):345–357. <https://doi.org/10.3109/09553000903567961>.

Panagopoulos D. , Margaritis L. (2010a) "The identification of an intensity "window" on the bioeffects of mobile telephony radiation." *Int J Radiat Biol* 86(5):358–366. <https://doi.org/10.3109/09553000903567979>.

Panagopoulos D.J. , Margaritis L.H. (2010b) "The effect of exposure duration on the biological activity of mobile telephony radiation." *Mutat Res Genet Toxicol Environ Mutagen* 699(1–2):17–22. <https://doi.org/10.1016/j.mrgentox.2010.04.010>.

Panagopoulos D.J. , Karabarbounis A. , Liolios C. (2013a) "ELF alternating magnetic field decreases reproduction by DNA damage induction." *Cell Biochem Biophys* 67(2):703–716. <https://doi.org/10.1007/s12013-013-9560-5>.

Panagopoulos D.J. , Johansson O. , Carlo G.L. (2013b) "Evaluation of specific absorption rate as a dosimetric quantity for electromagnetic fields bioeffects." *PLOS ONE* 8(6):e62663. <https://doi.org/10.1371/journal.pone.0062663>.

Panagopoulos D.J. , Johansson O. , Carlo G.L. (2015) "Polarization: A key difference between man-made and natural electromagnetic fields, in regard to biological activity." *Sci Rep* 5(1):14914. <https://doi.org/10.1038/srep14914>.

Panagopoulos D.J. (2019) "Comparing DNA damage induced by mobile telephony and other types of man-made electromagnetic fields." *Mutat Res Rev Mutat Res* 781:53–62.

Panagopoulos D.J. , Karabarbounis A. , Yakymenko I. , Chrousos G.P. (2021) "Human-made electromagnetic fields: Ion forced-oscillation and voltage-gated ion channel dysfunction, oxidative stress and DNA damage" (review). *Int J Oncol* 59(5):92. <https://doi.org/10.3892/ijo.2021.5272>.

Pandey N. , Giri S. (2018) "Melatonin attenuates radiofrequency radiation (900 MHz)-induced oxidative stress, DNA damage and cell cycle arrest in germ cells of male swiss albino mice." *Toxicol Ind Health* 34(5):315–327. <https://doi.org/10.1177/0748233718758092>.

Pedersen G.F. (1997) "Amplitude modulated RF fields stemming from a GSM/DCS1800 phone." *Wirel Netw* 3(6):489–498. <https://doi.org/10.1023/A:1019158712657>.

Perry S.W. , Norman J.P. , Barbieri J. , Brown E.B. , Gelbard H.A. (2011) "Mitochondrial membrane potential probes and the proton gradient: A practical usage guide." *BioTechniques* 50(2):98–115. <https://doi.org/10.2144/000113610>.

Pourlis A.F. (2009) "Reproductive and developmental effects of EMF in vertebrate animal models." *Pathophysiology* 16(2–3):179–189. <https://doi.org/10.1016/j.pathophys.2009.01.010>.

Prasad M. , Kathuria P. , Nair P. , Kumar A. , Prasad K. (2017) "Mobile phone use and risk of brain tumours: A systematic review of association between study quality, source of funding, and research outcomes." *Neurol Sci* 38(5):797–810. <https://doi.org/10.1007/s10072-017-2850-8>.

Pu X. , Wang Z. , Klaunig J.E. (2015) "Alkaline comet assay for assessing DNA damage in individual cells." *Curr Protoc Toxicol* 65(1):3.12.1–3.12.11. <https://doi.org/10.1002/0471140856.tx0312s65>.

Quinlan C.L. , Perevoshchikova I.V. , Hey-Mogensen M. , Orr A.L. , Brand M.D. (2013) "Sites of reactive oxygen species generation by mitochondrial oxidizing different substrates." *Redox Biol* 1(1):304–312. <https://doi.org/10.1016/j.redox.2013.04.005>.

Rago R. , Salacone P. , Caponecchia L. , Sebastianelli A. , Marcucci I. , et al (2013) "The semen quality of the mobile phone users." *J Endocrinol Invest* 36(11):970–974. <https://doi.org/10.3275/8996>.

Redmayne M. , Johansson O. (2015) "Radiofrequency exposure in young and old: Different sensitivities in light of age-relevant natural differences." *Rev Environ Health* 30(4):323–335. <https://doi.org/10.1515/reveh-2015-0030>.

Redmayne M. (2016) "International policy and advisory response regarding children's exposure to radio frequency electromagnetic fields (RF-EMF)." *Electromagn Biol Med* 35(2):176–185. <https://doi.org/10.3109/15368378.2015.1038832>.

Reilly J.N. , McLaughlin E.A. , Stanger S.J. , Anderson A.L. , Hutcheon K. , et al (2016) "Characterisation of mouse epididymosomes reveals a complex profile of microRNAs and a potential mechanism for modification of the sperm epigenome." *Sci Rep* 6:31794. <https://doi.org/10.1038/srep31794>.

Remondini D. , Nylund R. , Reivinen J. , Poullietier de Gannes F. , Veyret B. , et al (2006) "Gene expression changes in human cells after exposure to mobile phone microwaves." *Proteomics* 6(17):4745–4754.

<https://doi.org/10.1002/pmic.200500896>.

- Rodgers A.B. , Morgan C.P. , Leu N.A. , Bale T.L. (2015) "Transgenerational epigenetic programming via sperm microRNA recapitulates effects of paternal stress." *Proc Natl Acad Sci U S A* 112(44):13699–13704. <https://doi.org/10.1073/pnas.1508347112>.
- Rodriguez M. , Petitclerc D. , Burchard J.F. , Nguyen D.H. , Block E. , Downey B.R. (2003) "Responses of the estrous cycle in dairy cows exposed to electric and magnetic fields (60 Hz) during 8-h photoperiods." *Anim Reprod Sci* 77(1–2):11–20. [https://doi.org/10.1016/s0378-4320\(02\)00273-7](https://doi.org/10.1016/s0378-4320(02)00273-7).
- Roobeh N. , Abdi F. , Amraee A. , Atarodi Kashani Z. , Darvish L. (2018) "Influence of radiofrequency electromagnetic fields on the fertility system: Protocol for a systematic review and meta-analysis." *JMIR Res Protoc* 7(2):e33. <https://doi.org/10.2196/resprot.9102>.
- Ruder E.H. , Hartman T.J. , Blumberg J. , Goldman M.B. (2008) "Oxidative stress and antioxidants: Exposure and impact on female fertility." *Hum Reprod Update* 14(4):345–357. <https://doi.org/10.1093/humupd/dmn011>.
- Sadeghi M.R. (2015) "Unexplained infertility, the controversial matter in management of infertile couples." *J Reprod Infertil* 16(1):1–2.
- Saikhun J. , Kitiyanant Y. , Vanadurongwan V. , Pavasuthipaisit K. (1998) "Effects of sauna on sperm movement characteristics of normal men measured by computer-assisted sperm analysis." *Int J Androl* 21(6):358–363. <https://doi.org/10.1046/j.1365-2605.1998.00138.x>.
- Sajeda S. , Al-Watter Y. (2011) "Effect of mobile phone usage on semen analysis in infertile men." *Tikrit J Pharm Sci* 7(1):77–82.
- Sakkas D. , Ramalingam M. , Garrido N. , Barratt C.L. (2015) "Sperm selection in natural conception: What can we learn from mother nature to improve assisted reproduction outcomes?" *Hum Reprod Update* 21(6):711–726. <https://doi.org/10.1093/humupd/dmv042>.
- Salford L.G. , Brun A. , Sturesson K. , Eberhardt J.L. , Persson B.R.R. (1994) "Permeability of the blood-brain barrier induced by 915 MHz electromagnetic radiation, continuous wave and modulated at 8, 16, 50, and 200 Hz." *Microsc Res Tech* 27(6):535–542. <https://doi.org/10.1002/jemt.1070270608>.
- Samaras T. , Leitgeb N. , Auvinen A. , Danker-Hopfe H. , Hansson Mild K. , et al (2015) SCENIHR (scientific committee on emerging and newly identified health risks), potential health effects of exposure to electromagnetic fields (EMF), 27 January, 2015.
- Sánchez-Calabuig M.J. , López-Cardona A.P. , Fernández-González R. , Ramos-Ibeas P. , Fonseca Balvís N. , et al (2014) "Potential health risks associated to ICSI: Insights from animal models and strategies for a safe procedure." *Front Public Health* 2. <https://doi.org/10.3389/fpubh.2014.00241>.
- Sangun O. , Dundar B. , Darici H. , Comlekci S. , Doguc D.K. , Celik S. (2015) "The effects of long-term exposure to a 2450 MHz electromagnetic field on growth and pubertal development in female Wistar rats." *Electromagn Biol Med* 34(1):63–71. <https://doi.org/10.3109/15368378.2013.871619>.
- Sarkar S. , Ali S. , Behari J. (1994) "Effect of low power microwave on the mouse genome: A direct DNA analysis." *Mutat Res* 320(1–2):141–147. [https://doi.org/10.1016/0165-1218\(94\)90066-3](https://doi.org/10.1016/0165-1218(94)90066-3).
- Sarookhani M. , Asiabanha M. , Safari A. , Zaroushani V. , Ziaeiha M. (2011) "The influence of 950 MHz magnetic field (mobile phone radiation) on sex organ and adrenal functions of male rabbits." *Afr J Biochem Res* 5:65–68.
- Saygin M. , Caliskan S. , Karahan N. , Koyu A. , Gumral N. , Uguz A. (2011) "Testicular apoptosis and histopathological changes induced by a 2.45 GHz electromagnetic field." *Toxicol Ind Health* 27(5):455–463. <https://doi.org/10.1177/0748233710389851>.
- Scientific Committee on Emerging Newly Identified Health Risks (2015) "Opinion on potential health effects of exposure to electromagnetic fields." *Bioelectromagnetics* 36(6):480–484. <https://doi.org/10.1002/bem.21930>.
- Sengupta P. , Dutta S. , Krajewska-Kulak E. (2017) "The disappearing sperms: Analysis of reports published between 1980 and 2015." *Am J Mens Health* 11(4):1279–1304. <https://doi.org/10.1177/1557988316643383>.
- Sepehrimanesh M. , Kazemipour N. , Saeb M. , Nazifi S. , Davis D.L. (2017) "Proteomic analysis of continuous 900-MHz radiofrequency electromagnetic field exposure in testicular tissue: A rat model of human cell phone exposure." *Environ Sci Pollut Res Int* 24(15):13666–13673. <https://doi.org/10.1007/s11356-017-8882-z>.
- Serbecic N. , Beutelspacher S.C. (2005) "Anti-oxidative vitamins prevent lipid-peroxidation and apoptosis in corneal endothelial cells." *Cell Tissue Res* 320(3):465–475. <https://doi.org/10.1007/s00441-004-1030-3>.
- Sergerie M. , Mieusset R. , Croute F. , Daudin M. , Bujan L. (2007) "High risk of temporary alteration of semen parameters after recent acute febrile illness." *Fertil Steril* 88(4):970.e1–970.e7. <https://doi.org/10.1016/j.fertnstert.2006.12.045>.
- Shahin S. , Singh V.P. , Shukla R.K. , Dhawan A. , Gangwar R.K. , et al (2013) "2.45 GHz microwave irradiation-induced oxidative stress affects implantation or pregnancy in mice, *Mus musculus*." *Appl Biochem Biotechnol* 169(5):1727–1751. <https://doi.org/10.1007/s12010-012-0079-9>.
- Shahin S. , Singh S.P. , Chaturvedi C.M. (2017) "Mobile phone (1800 MHz) radiation impairs female reproduction in mice, *Mus musculus*, through stress induced inhibition of ovarian and uterine activity." *Reprod Toxicol* 73:41–60. <https://doi.org/10.1016/j.reprotox.2017.08.001>.
- Shapiro B.M. (1991) "The control of oxidant stress at fertilization." *Science* 252(5005):533–536. <https://doi.org/10.1126/science.1850548>.
- Sharlip I.D. , Jarow J.P. , Belker A.M. , Lipshultz L.I. , Sigman M. , et al (2002) "Best practice policies for male infertility." *Fertil Steril* 77(5):873–882. [https://doi.org/10.1016/s0015-0282\(02\)03105-9](https://doi.org/10.1016/s0015-0282(02)03105-9).

Sharma U. , Conine C.C. , Shea J.M. , Boskovic A. , Derr A.G. , et al (2016) "Biogenesis and function of tRNA fragments during sperm maturation and fertilization in mammals." *Science* 351(6271):391–396. <https://doi.org/10.1126/science.aad6780>.

Sharma V.P. , Kumar N.R. (2010) "Changes in honeybee behaviour and biology under the influence of cellphone radiations." *Curr Sci* 98(10):1376–1378.

Shekarriz M. , Thomas A.J., Jr. , Agarwal A. (1995) "Incidence and level of seminal reactive oxygen species in normal men." *Urology* 45(1):103–107. [https://doi.org/10.1016/s0090-4295\(95\):97088-6](https://doi.org/10.1016/s0090-4295(95):97088-6).

Simkó M. , Mattsson M-O. (2019) "5G wireless communication and health effects-A pragmatic review based on available studies Regarding 6 to 100 GHz." *Int J Environ Res Public Health* 16(18):3406. <https://doi.org/10.3390/ijerph16183406>.

Simon L. , Zini A. , Dyachenko A. , Ciampi A. , Carrell D.T. (2017) "A systematic review and meta-analysis to determine the effect of sperm DNA damage on in vitro fertilization and intracytoplasmic sperm injection outcome." *Asian J Androl* 19(1):80–90. <https://doi.org/10.4103/1008-682x.182822>.

Simopoulou M. , Sfakianoudis K. , Bakas P. , Giannelou P. , Papapetrou C. , et al (2018) "Postponing pregnancy through oocyte cryopreservation for social reasons: Considerations Regarding clinical practice and the socio-psychological and bioethical issues involved." *Med (Kaunas, Lithuania)* 54(5):76. <https://doi.org/10.3390/medicina54050076>.

Singh R. , Nath R. , Mathur A.K. , Sharma R.S. (2018) "Effect of radiofrequency radiation on reproductive health." *Indian J Med Res* 148(Suppl):S92–s99. https://doi.org/10.4103/ijmr.IJMR_1056_18.

Singh V.P. , Singh P. , Chaturvedi C.M. , Shukla R.K. , Dhawan A. , et al (2009) "2.45 GHz low level CW microwave radiation affects embryo implantation sites and single strand DNA damage in brain cells of mice, *mus musculus*." 2009 international conference on emerging trends in electronic and photonic devices & systems, 22–24 December 2009.

Skakkebaek N.E. , Rajpert-De Meyts E. , Main K.M. (2001) "Testicular dysgenesis syndrome: An increasingly common developmental disorder with environmental aspects." *Hum Reprod* 16(5):972–978. <https://doi.org/10.1093/humrep/16.5.972>.

Smith S. , Pfeifer S.M. , Collins J.A. (2003) "Diagnosis and management of female infertility." *JAMA* 290(13):1767–1770. <https://doi.org/10.1001/jama.290.13.1767>.

Solek P. , Majchrowicz L. , Koziorowski M. (2018) "Aloe arborescens juice prevents EMF-induced oxidative stress and thus protects from pathophysiology in the male reproductive system in vitro." *Environ Res* 166:141–149. <https://doi.org/10.1016/j.envres.2018.05.035>.

Somer R.A. , Surapaneni R. , Beach D.F. (2012) "Relationship of testicular cancer incidence and cellular phone use." *J Clin Oncol* 30(15):e12008–e12008. https://doi.org/10.1200/jco.2012.30.15_suppl.e12008.

Spandorfer S.D. , Avrech O.M. , Colombero L.T. , Palermo G.D. , Rosenwaks Z. (1998) "Effect of parental age on fertilization and pregnancy characteristics in couples treated by intracytoplasmic sperm injection." *Hum Reprod* 13(2):334–338. <https://doi.org/10.1093/humrep/13.2.334>.

Spira A. (1988) "The decline of fecundity with age." *Maturitas Suppl* 1(1):15–22. [https://doi.org/10.1016/0378-5122\(88\)90004-7](https://doi.org/10.1016/0378-5122(88)90004-7).

Starkey S.J. (2016) "Inaccurate official assessment of radiofrequency safety by the advisory group on non-ionising radiation." *Rev Environ Health* 31(4):493–503. <https://doi.org/10.1515/reveh-2016-0060>.

Stefanovic M. , Panic S.R. , de Souza R.A.A. , Reig J. (2017) "Recent advances in RF propagation modeling for 5G systems." *Int J Antennas Propag* 2017:4701208. <https://doi.org/10.1155/2017/4701208>.

Stewart T.A. , Davis F.M. (2019) "An element for development: Calcium signaling in mammalian reproduction and development." *Biochim Biophys Acta (BBA) - Mol Cell Res* 1866(7):1230–1238. <https://doi.org/10.1016/j.bbamcr.2019.02.016>.

Storey B.T. (2008) "Mammalian sperm metabolism: Oxygen and sugar, friend and foe." *Int J Dev Biol* 52(5–6):427–437. <https://doi.org/10.1387/ijdb.072522bs>.

Su H.W. , Yi Y.C. , Wei T.Y. , Chang T.C. , Cheng C.M. (2017) "Detection of ovulation, a review of currently available methods." *Bioeng Transl Med* 2(3):238–246. <https://doi.org/10.1002/btm2.10058>.

Tabong P.T.N. , Adongo P.B. (2013) "Infertility and childlessness: A qualitative study of the experiences of infertile couples in Northern Ghana." *BMC Preg Childbirth* 13(1):72. <https://doi.org/10.1186/1471-2393-13-72>.

Tan D-X. , Manchester L.C. , Esteban-Zubero E. , Zhou Z. , Reiter R.J. (2015) "Melatonin as a potent and inducible endogenous antioxidant: Synthesis and metabolism." *Molecules (Basel, Switzerland)* 20(10):18886–18906. <https://doi.org/10.3390/molecules201018886>.

te Velde E.R. , Pearson P.L. (2002) "The variability of female reproductive ageing." *Hum Reprod Update* 8(2):141–154. <https://doi.org/10.1093/humupd/8.2.141>.

Tilly J.L. , Tilly K.I. (1995) "Inhibitors of oxidative stress mimic the ability of follicle-stimulating hormone to suppress apoptosis in cultured rat ovarian follicles." *Endocrinology* 136(1):242–252. <https://doi.org/10.1210/endo.136.1.7828537>.

Tkalec M. , Stambuk A. , Srut M. , Malarić K. , Klobučar G.I. (2013) "Oxidative and genotoxic effects of 900 MHz electromagnetic fields in the earthworm *Eisenia fetida*." *Ecotoxicol Environ Saf* 90:7–12. <https://doi.org/10.1016/j.ecoenv.2012.12.005>.

Tomruk A. , Guler G. , Dincel A.S. (2010) "The influence of 1800 MHz GSM-like signals on hepatic oxidative DNA and lipid damage in nonpregnant, pregnant, and newly born rabbits." *Cell Biochem Biophys* 56(1):39–47.

<https://doi.org/10.1007/s12013-009-9068-1>.

Tournaye H. (2012) "Male factor infertility and ART." *Asian J Androl* 14(1):103–108.

<https://doi.org/10.1038/aja.2011.65>.

Tremellen K. (2008) "Oxidative stress and male infertility—A clinical perspective." *Hum Reprod Update* 14(3):243–258. <https://doi.org/10.1093/humupd/dmn004>.

Trigg N.A. , Eamens A.L. , Nixon B. (2019) "The contribution of epididymosomes to the sperm small RNA profile." *Reproduction* 157(6):R209–R223. <https://doi.org/10.1530/rep-18-0480>.

Trigg N.A. , Skerrett-Byrne D.A. , Xavier M.J. , Zhou W. , Anderson A.L. , et al (2021) "Acrylamide modulates the mouse epididymal proteome to drive alterations in the sperm small non-coding RNA profile and dysregulate embryo development." *Cell Rep* 37(1):109787. <https://doi.org/10.1016/j.celrep.2021.109787>.

Tsarna E. , Reedijk M. , Birks L.E. , Guxens M. , Ballester F. , et al (2019) "Associations of maternal cell-phone use during pregnancy with pregnancy duration and fetal growth in 4 birth cohorts." *Am J Epidemiol* 188(7):1270–1280. <https://doi.org/10.1093/aje/kwz092>.

Tumkaya L. , Kalkan Y. , Bas O. , Yilmaz A. (2016) "Mobile phone radiation during pubertal development has no effect on testicular histology in rats." *Toxicol Ind Health* 32(2):328–336.

<https://doi.org/10.1177/0748233713500820>.

Turrens J.F. (2003) "Mitochondrial formation of reactive oxygen species." *J Physiol* 552(2):335–344.

<https://doi.org/10.1113/jphysiol.2003.049478>.

Valko M. , Rhodes C.J. , Moncol J. , Izakovic M. , Mazur M. (2006) "Free radicals, metals and antioxidants in oxidative stress-induced cancer." *Chem Biol Interact* 160(1):1–40. <https://doi.org/10.1016/j.cbi.2005.12.009>.

Van Voorhis B.J. (2006) "Outcomes from assisted reproductive technology." *Obstet Gynecol* 107(1):183–200. <https://doi.org/10.1097/01.AOG.0000194207.06554.5b>.

Vander Borgh M. , Wyns C. (2018) "Fertility and infertility: Definition and epidemiology." *Clin Biochem* 62:2–10. <https://doi.org/10.1016/j.clinbiochem.2018.03.012>.

Velizarov S. , Raskmark P. , Kwee S. , (1999): "The effects of radiofrequency fields on cell proliferation are non-thermal", *Bioelectrochemistry and Bioenergetics*, 48, 177–180.

Vernet P. , Aitken R.J. , Drevet J.R. (2004) "Antioxidant strategies in the epididymis." *Mol Cell Endocrinol* 216(1–2):31–39. <https://doi.org/10.1016/j.mce.2003.10.069>.

Wagner H. , Cheng J.W. , Ko E.Y. (2018) "Role of reactive oxygen species in male infertility: An updated review of literature." *Arab J Urol* 16(1):35–43. <https://doi.org/10.1016/j.aju.2017.11.001>.

Wang C. , Machaty Z. (2013) "Calcium influx in mammalian eggs." *Reproduction* 145(4):R97–R105. <https://doi.org/10.1530/rep-12-0496>.

Wang J. , Sauer M.V. (2006) "In vitro fertilization (IVF) a review of 3 decades of clinical innovation and technological advancement." *Ther Clin Risk Manag* 2(4):355–364. <https://doi.org/10.2147/tcrm.2006.2.4.355>.

Wang S. , He G. , Chen M. , Zuo T. , Xu W. , Liu X. (2017) "The role of antioxidant enzymes in the ovaries." *Oxid Med Cell Longev* 2017:4371714. <https://doi.org/10.1155/2017/4371714>.

Wdowiak A. , Wdowiak L. , Wiktor H. (2007) "Evaluation of the effect of using mobile phones on male fertility." *Ann Agric Environ Med* 14(1):169–172.

Weisbrot D. , Lin H. , Ye L. , Blank M. , Goodman R. (2003) "Effects of mobile phone radiation on reproduction and development in *Drosophila melanogaster*." *J Cell Biochem* 89(1):48–55.

Wong J.L. , Wessel G.M. (2005) "Reactive oxygen species and Udx1 during early sea urchin development." *Dev Biol* 288(2):317–333. <https://doi.org/10.1016/j.ydbio.2005.07.004>.

Xiao M. , Zhong H. , Xia L. , Tao Y. , Yin H. (2017) "Pathophysiology of mitochondrial lipid oxidation: Role of 4-hydroxynonenal (4-HNE) and other bioactive lipids in mitochondria." *Free Radic Biol Med* 111:316–327. <https://doi.org/10.1016/j.freeradbiomed.2017.04.363>.

Yakymenko I. , Tsybulin O. , Sidorik E. , Henshel D. , Kyrylenko O. , Kyrylenko S. (2016) "Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation." *Electromagn Biol Med* 35(2):186–202. <https://doi.org/10.3109/15368378.2015.1043557>.

Yamashita H. , Hata K. , Yamaguchi H. , Tsurita G. , Wake K. , et al (2010) "Short-term exposure to a 1439-MHz TDMA signal exerts no estrogenic effect in rats." *Bioelectromagnetics* 31(7):573–575. <https://doi.org/10.1002/bem.20593>.

Yan J.G. , Agresti M. , Bruce T. , Yan Y.H. , Granlund A. , Matloub H.S. (2007) "Effects of cellular phone emissions on sperm motility in rats." *Fertil Steril* 88(4):957–964. <https://doi.org/10.1016/j.fertnstert.2006.12.022>.

Yao K. , Wu W. , Wang K. , Ni S. , Ye P. , et al (2008) "Electromagnetic noise inhibits radiofrequency radiation-induced DNA damage and reactive oxygen species increase in human lens epithelial cells." *Mol Vis* 14:964–969.

Yüksel M. , Nazıroğlu M. , Özkaya M.O. (2016) "Long-term exposure to electromagnetic radiation from mobile phones and wi-fi devices decreases plasma prolactin, progesterone, and estrogen levels but increases uterine oxidative stress in pregnant rats and their offspring." *Endocrine* 52(2):352–362. <https://doi.org/10.1007/s12020-015-0795-3>.

Zalata A. , El-Samanoudy A.Z. , Shaalan D. , El-Baiomy Y. , Mostafa T. (2015) "In vitro effect of cell phone radiation on motility, DNA fragmentation and clusterin gene expression in human sperm." *Int J Fertil Steril* 9(1):129–136. <https://doi.org/10.22074/ijfs.2015.4217>.

- Zegers-Hochschild F. , Adamson G.D. , de Mouzon J. , Ishihara O. , Mansour R. , et al (2009) "International committee for monitoring assisted reproductive technology (ICMART) and the World Health Organization (WHO) revised glossary of ART terminology, 2009." *Fertil Steril* 92(5):1520–1524. <https://doi.org/10.1016/j.fertnstert.2009.09.009>.
- Zhang G. , Yan H. , Chen Q. , Liu K. , Ling X. , et al (2016) "Effects of cell phone use on semen parameters: Results from the MARHCS cohort study in Chongqing, China." *Environ Int* 91:116–121. <https://doi.org/10.1016/j.envint.2016.02.028>.
- Zini A. , de Lamirande E. , Gagnon C. (1993) "Reactive oxygen species in semen of infertile patients: Levels of superoxide dismutase- and catalase-like activities in seminal plasma and spermatozoa." *Int J Androl* 16(3):183–188.
- Zmyslony M. , Palus J. , Jajte J. , Dziubaltowska E. , Rajkowska E. (2000) "DNA damage in rat lymphocytes treated in vitro with iron cations and exposed to 7 mT magnetic fields (static or 50 Hz)." *Mutat Res Fundam Mol Mech Mutagen* 453(1):89–96. [https://doi.org/10.1016/S0027-5107\(00\)00094-4](https://doi.org/10.1016/S0027-5107(00)00094-4).
- Zwamborn A.P.M. , Vossen S.H.J. , van Leersum B.J.A. , Ouwens M.A. , Makel W.N. (2003) Effects of global communication system radio-frequency fields on well being and cognitive functions of human subjects with and without subjective complaints. FEL-03-C148. The Hague, the Netherlands: TNO Physics and Electronics Laboratory. (Available in http://home.tiscali.be/milieugezondheid/dossiers/gsm/TNO_rapport_Nederland_sept_2003.pdf.)

Effects of Wireless Communication Electromagnetic Fields on Human and Animal Brain Activity

- Adey W.R. , (1981): Tissue interactions with non-ionizing electromagnetic fields. *Physiological Reviews* 61(2), 435–514.
- Adey W.R. , (1993): Biological effects of electromagnetic fields. *Journal of Cellular Biochemistry* 51(4), 410–416.
- Azmy R. , Shamloul R. , Elsayw N.A. , Elkholy S. , Maher E. , (2020): Effects of mobile phones electromagnetic radiation on patients with epilepsy: An EEG study. *Egyptian Journal of Neurology, Psychiatry and Neurosurgery* 56(1), 36. <https://doi.org/10.1186/s41983-020-00167-2>.
- Barry R.J. , Clarke A.R. , Johnstone S.J. , Magee C.A. , Rushby J.A. , (2007): EEG differences between eyes-closed and eyes-open resting conditions. *Clinical Neurophysiology* 118(12), 2765–2773.
- Bertagna F. , Lewis R. , Silva S.R.P. , McFadden J. , Jeevaratnam K. , (2021): Effects of electromagnetic fields on neuronal ion channels: A systematic review. *Annals of the New York Academy of Sciences* 1499(1), 82–103.
- Blackman C. , (2009): Cell phone radiation: Evidence from ELF and RF studies supporting more inclusive risk identification and assessment. *Pathophysiology* 16(2–3), 205–216.
- Carmena J.M. , Lebedev M.A. , Crist R.E. , O'Doherty J.E. , Santucci D.M. , Dimitrov D.F. , Patil P.G. , Henriquez C.S. , Nicolelis M.A. , (2003): Learning to control a brain-machine interface for reaching and grasping by primates. *PLOS Biology* 1(2), E42. <https://doi.org/10.1371/journal.pbio.0000042>.
- Carpenter D.O. , (2013): Human disease resulting from exposure to electromagnetic fields. *Reviews on Environmental Health* 28(4), 159–172. <https://doi.org/10.1515/reveh-2013-0016>.
- Cassel J.C. , Cosquer B. , Galani R. , Kuster N. , (2004): Whole-body exposure to 2.45 GHz electromagnetic fields does not alter radial-maze performance in rats. *Behavioural Brain Research* 155(1), 37–43.
- Cecchetto C. , Maschietto M. , Boccaccio P. , Vassanelli S. , (2020): Electromagnetic field affects the voltage-dependent potassium channel Kv1.3. *Electromagnetic Biology and Medicine* 39(4), 316–322.
- Chen A.C. , Feng W. , Zhao H. , Yin Y. , Wang P. , (2008): EEG default mode network in the human brain: Spectral regional field powers. *Neuroimage* 41(2), 561–574.
- Cosquer B. , Kuster N. , Cassel J.C. , (2005): Whole-body exposure to 2.45 GHz electromagnetic fields does not alter 12-arm radial maze with reduced access to spatial cues in rats. *Behavioural Brain Research* 161(2), 331–334.
- Croft R.J. , Chandler J.S. , Burgess A.P. , Barry R.J. , Williams J.D. , Clarke A.R. , (2002): Acute mobile phone operation affects neural function in humans. *Clinical Neurophysiology* 113(10), 1623–1632.
- Croft R.J. , Hamblin D. , Spong J. , Wood A. , McKenzie R. , Stough C. , (2008): The effect of mobile phone electromagnetic fields on the alpha rhythm of human electroencephalogram. *Bioelectromagnetics* 29(1), 1–10.
- Croft R.J. , Leung S. , McKenzie R.J. , Loughran S.P. , Iskra S. , Hamblin D.L. , Cooper N.R. , (2010): Effects of 2G and 3G mobile phones on human alpha rhythms: Resting EEG in adolescents, young adults, and the elderly. *Bioelectromagnetics* 31(6), 434–444.
- Curcio G. , Ferrara M. , Moroni F. , D'Inzeo G. , Bertini M. , De Gennaro L. , (2005): Is the brain influenced by a phone call? An EEG study of resting wakefulness. *Neuroscience Research* 53(3), 265–270.
- Curcio G. , Mazzucchi E. , Della Marca G. , Vollono C. , Rossini P.M. , (2015): Electromagnetic fields and EEG spiking rate in patients with focal epilepsy. *Clinical Neurophysiology* 126(4), 659–666.

Curwen P. , Whalley J. , (2008): Mobile communications in the 21st century. In: A.C. Harper's , R.V. Bures (Eds.), *Mobile telephones: Networks, applications and performance*. Nova Science Publishers, New York, 29–75.

Dalecki A. , Verrender A. , Loughran S.P. , Croft R.J. , (2021): The effect of GSM electromagnetic field exposure on the waking electroencephalogram: Methodological influences. *Bioelectromagnetics* 42(4), 317–328. <https://doi.org/10.1002/bem.22338>.

Danker-Hopf H. , Dorn H. , Bolz T. , Peter A. , Hansen M-L. , Eggert T. , Sauter C. , (2016): Effects of mobile phone exposure (GSM 900 and WCDMA/UMTS) on polysomnography based sleep quality: An intra- and inter-individual perspective. *Environmental Research* 145, 50–60.

Danker-Hopf H. , Eggert T. , Dorn H. , Sauter C. , (2019): Effects of RF-EMF on the human resting-state EEG- the inconsistencies in the consistency. Part 1: Non-exposure-related limitations of comparability between studies. *Bioelectromagnetics* 40(5), 291–318. <https://doi.org/10.1002/bem.22194>.

Dawe A.S. , Smith B. , Thomas D.W. , Greedy S. , Vasic N. , Gregory A. , Loader B. , de Pomerai D.I. , (2006): A small temperature rise may contribute towards the apparent induction by microwaves of heat-shock gene expression in the nematode *Caenorhabditis elegans*. *Bioelectromagnetics* 27(2), 88–97.

D'Costa H. , Trueman G. , Tang L. , Abdel-Rahman U. , Abdel-Rahman W. , Ong K. , Cosic I. , (2003): Human brain wave activity during exposure to radiofrequency field emissions from mobile phones. *Australasian Physical and Engineering Sciences in Medicine* 26(4), 162–167.

Detari L. , (2000): Tonic and phasic influence of basal forebrain unit activity on the cortical EEG. *Behavioural Brain Research* 115(2), 159–170.

Diem E. , Schwarz C. , Adlkofer F. , Jahn O. , Rudiger H. , (2005): Non-thermal DNA breakage by mobile-phone radiation (1800 MHz) in human fibroblasts and in transformed GFSH-R17 rat granulosa cells in vitro. *Mutation Research* 583(2), 178–183.

Dogan M. , Turtay M.G. , Oguzturk H. , Samdanci E. , Turkoz Y. , Tasmemir S. , Alkan A. , Bakir S. , (2012): Effects of electromagnetic radiation produced by 3G mobile phones on rat brains: Magnetic resonance spectroscopy, biochemical, and histopathological evaluation. *Human and Experimental Toxicology*, 31(6), 557–564. <https://doi.org/10.1177/0960327111412092>.

Duhaini I. , (2016): The effects of electromagnetic fields on human health. *Physica Medica* 32(3), 213.

Eggert T. , Dorn H. , Sauter C. , Schmid G. , Danker-Hopf H. , (2020): RF-EMF exposure effects on sleep – Age doesn't matter in men! *Environmental Research* 191, 110173.

Friedman A. , Behrens C.J. , Heinemann U. , (2007): Cholinergic dysfunction in temporal lobe epilepsy. *Epilepsia* 48(Suppl 5), 126–130.

Ghosn R. , Yahia-Cherif L. , Hugueville L. , Ducorps A. , Lemarechal J.D. , Thuroczy G. , de Seze R. , Selmaoui B. , (2015): Radiofrequency signal affects alpha band in resting electroencephalogram. *Journal of Neurophysiology* 113(7), 2753–2759.

Goodman E.M. , Greenebaum B. , Marron M.T. , (1995): Effects of electromagnetic fields on molecules and cells. *International Review of Cytology* 158, 279–338.

Hardell L. , Carlberg M. , Söderqvist F. , Mild K.H. , Morgan L.L. , (2007): Long-term use of cellular phones and brain tumours: Increased risk associated with use for > or =10 years. *Occupational and Environmental Medicine* 64(9), 626–632.

Hardell L. , Carlberg M. , Hansson Mild K. , (2009): Epidemiological evidence for an association between use of wireless phones and tumor diseases. *Pathophysiology* 16(2–3), 113–122.

Hardell L. , Carlberg M. , Hansson Mild K. , (2013): Use of mobile phones and cordless phones is associated with increased risk for glioma and acoustic neuroma. *Pathophysiology* 20(2), 85–110.

Hardell L. , Carlberg M. , (2020): Health risks from radiofrequency radiation, including 5G, should be assessed by experts with no conflicts of interest. *Oncology Letters* 20(4), 15.

Hardell L. , Carlberg M. , (2021): Lost opportunities for cancer prevention: Historical evidence on early warnings with emphasis on radiofrequency radiation. *Reviews on Environmental Health*. <https://doi.org/10.1515/revveh-2020-0168>.

Harmony T. , (2013): The functional significance of delta oscillations in cognitive processing. *Frontiers in Integrative Neuroscience* 7, 83. <https://doi.org/10.3389/fnint.2013.00083>.

Herweg N.A. , Solomon E.A. , Kahana M.J. , (2020): Theta oscillations in human memory. *Trends in Cognitive Sciences* 24(3), 208–227. <https://doi.org/10.1016/j.tics.2019.12.006>.

Hickey P. , Race E. , (2021): Riding the slow wave: Exploring the role of entrained low-frequency oscillations in memory formation. *Neuropsychologia*, 160, 107962. <https://doi.org/10.1016/j.2021.107962>.

Hietanen M. , Kovala T. , Hämäläinen A-M. , (2000): Human brain activity during exposure to radiofrequency fields emitted by cellular phones. *Scandinavian Journal of Work, Environment and Health*, 26 (2), 87–92.

Hinrikus H. , Bachmann M. , Lass J. , Karai D. , Tuulik V. , (2008): Effect of low frequency modulated microwave exposure on human EEG: Individual sensitivity. *Bioelectromagnetics* 29(7), 527–538.

Hinrikus H. , Lass J. , Karai D. , Pilt K. , Bachmann M. , (2015): Microwave effect on diffusion: A possible mechanism for non-thermal effect. *Electromagnetic Biology and Medicine* 34(4), 327–333.

Hinrikus H. , Bachmann M. , Karai D. , Lass J. , (2017): Mechanism of low-level microwave radiation effect on nervous system. *Electromagnetic Biology and Medicine* 36(2), 202–212. <https://doi.org/10.1080/15368378.2016.1251451>.

Hossmann K.A. , Hermann D.M. , (2003): Effects of electromagnetic radiation of mobile phones on the central nervous system. *Bioelectromagnetics* 24(1), 49–62. <https://doi.org/10.1002/bem.10068>.

Huber R. , Graf T. , Cote K.A. , Wittmann L. , Gallmann E. , Matter D. , Schuderer J. , Kuster N. , Borbely A.A. , Achermann P. , (2000): Exposure to pulsed high-frequency electromagnetic field during waking affects human sleep EEG. *NeuroReport* 11(15), 3321–3325.

Huber R. , Treyer V. , Borbely A.A. , Schuderer J. , Gottselig J.M. , Landolt H.P. , Werth E. , Berthold T. , Kuster N. , Buck A. , Achermann P. , (2002): Electromagnetic fields, such as those from mobile phones, alter regional cerebral blood flow and sleep and waking EEG. *Journal of Sleep Research* 11(4), 289–295.

Huber R. , Treyer V. , Schuderer J. , Berthold T. , Buck A. , Kuster N. , Landolt H-P. , Achermann P. , (2005): Exposure to pulse-modulated radio frequency electromagnetic fields affects regional cerebral blood flow. *European Journal of Neuroscience* 21(4), 1000–1006.

Hyland G.J. , (2000): Physics and biology of mobile telephony. *Lancet* 356(9244), 1833–1836.

Hyland G.J. , (2008): Physical basis of adverse and therapeutic effects of low intensity microwave radiation. *Indian Journal of Experimental Biology* 46(5), 403–419.

ICNIRP , (1998): Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz). *Health Physics* 74, 494–522.

ICNIRP , (2009): ICNIRP statement on the “Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)”. *Health Physics* 97(3), 257–258. <https://doi.org/10.1097/HP.0b013e3181aff9db>.

ICNIRP , (2020): ICNIRP guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz. *Health Physics* 118(5), 483–524.

Ivancsits S. , Diem E. , Jahn O. , Rüdiger H.W. , (2003): Intermittent extremely low frequency electromagnetic fields cause DNA damage in a dose-dependent way. *International Archives of Occupational and Environmental Health* 76(6), 431–436.

Kirschfeld K. , (2008): Relationship between the amplitude of alpha waves and reaction time. *NeuroReport*, 19(9), 907–910.

Klimesch W. , Sauseng P. , Hanslmayr S. , (2007): EEG alpha oscillations: The inhibition-timing hypothesis. *Brain Research Reviews* 53(1), 63–88.

Knyazev G.G. , (2012): EEG delta oscillations as a correlate of basic homeostatic and motivational processes. *Neuroscience and Biobehavioral Reviews* 36(1), 677–695. <https://doi.org/10.1016/j.neubiorev.2011.10.002>.

Krause C.M. , Sillanmäki L. , Koivisto M. , Häggqvist A. , Saarela C. , Revonsuo A. , Laine M. , Hämäläinen H. , (2000a): Effects of electromagnetic field emitted by cellular phones on the EEG during a memory task. *NeuroReport* 11(4), 761–764. <https://doi.org/10.1097/00001756-200003200-00021>.

Krause C.M. , Sillanmäki L. , Koivisto M. , Häggqvist A. , Saarela C. , Revonsuo A. , Laine M. , Hämäläinen H. , (2000b): Effects of electromagnetic fields emitted by cellular phones on the electroencephalogram during a visual working memory task. *International Journal of Radiation Biology* 76(12), 1659–1667. <https://doi.org/10.1080/09553000050201154>.

Leach V. , Weller S. , Redmayne M. , (2018): A novel database of bio-effects from non-ionizing radiation. *Reviews on Environmental Health* 33(3):273–280.

Lebedeva N. , Sulimov A. , Sulimova O. , Kotrovskaya T. , Gailus T. , (2000): Cellular phone electromagnetic field effects on bioelectric activity of human brain. *Critical Reviews in Biomedical Engineering* 28(1–2), 323–338.

Li M. , Wang Y. , Zhang Y. , Zhou Z. , Yu Z. , (2008): Elevation of plasma corticosterone levels and hippocampal glucocorticoid receptor translocation in rats: A potential mechanism for cognition impairment following chronic low-power-density microwave exposure. *Journal of Radiation Research (Tokyo)* 49(2), 163–170.

Li Y. , Yan X. , Liu J. , Li L. , Hu X. , Sun H. , Tian J. , (2014): Pulsed electromagnetic field enhances brain-derived neurotrophic factor expression through L-type voltage-gated calcium channel- and Erk-dependent signaling pathways in neonatal rat dorsal root ganglion neurons. *Neurochemistry International* 75, 96–104.

Lisi A. , Ledda M. , Rosola E. , Pozzi D. , D'Emilia E. , Giuliani L. , Foletti A. , Modesti A. , Morris S.J. , Grimaldi S. , (2006): Extremely low frequency electromagnetic field exposure promotes differentiation of pituitary corticotrope-derived AT20 D16V cells. *Bioelectromagnetics* 27, 641–651.

Liu L. , Deng H. , Tang X. , Lu Y. , Zhou J. , Wang X. , Zhao Y. , Huang B. , Shi Y. , (2021): Specific electromagnetic radiation in the wireless signal range increases wakefulness in mice. *Proceedings of the National Academy of Sciences of the USA*, 118(31), e2105838118. <https://doi.org/10.1073/pnas.2105838118>.

Loughran S.P. , Wood A.W. , Barton J.M. , Croft R.J. , Thompson B. , Stough C. , (2005): The effect of electromagnetic fields emitted by mobile phones on human sleep. *NeuroReport* 16(17), 1973–1976.

Loughran S.P. , Verrinder A. , Dalecki A. , Burdon C.A. , Tagami K. , Park J. , Taylor N. , Croft R.J. , (2019): Radiofrequency electromagnetic field exposure and the resting EEG: Exploring the thermal mechanism hypothesis. *International Journal of Environmental Research and Public Health*, 16(9), 1505. <https://doi.org/10.3390/ijerph16091505>.

Lowry C.A. , Plant A. , Shanks N. , Ingram C.D. , Lightman S.L. , (2003): Anatomical and functional evidence for a stress-responsive, monoamine-accumulating area in the dorsomedial hypothalamus of adult rat brain. *Hormones and Behavior* 43(1), 254–262.

Lustenberger C. , Murbach M. , Tüshaus L. , Wehrle F. , Kuster N. , Achermann P. , Huber R. , (2015): Inter-individual and intra-individual variation of the effects of pulsed RF EMF exposure on the human sleep EEG. *Bioelectromagnetics* 36(3), 169–177. <https://doi.org/10.1002/bem.21893>.

Lv B. , Su C. , Yang L. , Xie Y. , Wu T. , (2014): Whole brain EEG synchronization likelihood modulated by long term evolution electromagnetic fields exposure. Annual International Conference of the IEEE Engineering in Medicine and Biology Society. IEEE Engineering in Medicine and Biology Society. Annual International Conference 2014, 986–989.

Maby E. , Le Bouquin Jeanes R. , Faucon G. , (2006): Short-term effects of GSM mobiles phones on spectral components of the human electroencephalogram. Annual International Conference of the IEEE Engineering in Medicine and Biology Society IEEE 1, 3751–3754.

Magras I.N. , Xenos T.D. , (1997): RF radiation-induced changes in the prenatal development of mice. *Bioelectromagnetics* 18(6), 455–461.

Mann K. , Röschke J. , (2004): Sleep under exposure to high-frequency electromagnetic fields. *Sleep Medicine Reviews* 8(2), 95–107. [https://doi.org/10.1016/S1087-0792\(03\)00004-2](https://doi.org/10.1016/S1087-0792(03)00004-2).

Miller A.B. , Morgan L.L. , Udasin I. , Davis D.L. , (2018): Cancer epidemiology update, following the 2011 IARC evaluation of radiofrequency electromagnetic fields (Monograph 102). *Environmental Research* 167, 673–683.

Miller A.B. , Sears M.E. , Morgan L.L. , Davis D.L. , Hardell L. , Oremus M. , Soskolne C.L. , (2019): Risks to health and well-being From radio-frequency radiation emitted by cell phones and other wireless devices. *Frontiers in Public Health* 7, 223. <https://doi.org/10.3389/fpubh.2019.00223>.

Minarik T. , Berger B. , Sauseng P. , (2018): The involvement of alpha oscillations in voluntary attention directed towards encoding episodic memories. *Neuroimage* 166, 307–316.

Mitchell D.J. , McNaughton N. , Flanagan D. , Kirk I.J. , (2008): Frontal-midline theta from the perspective of hippocampal 'theta'. *ProgNeurobiol* 86(3), 156–185.

Mohammal H.S. , Radwan N.M. , Nawal A.A. , (2011): Long-term low-level electromagnetic radiation causes changes in the EEG of freely-moving rats. *Romanian Journal of Biophysics* 21, 43–51.

Mohammed H.S. , Fahmy H.M. , Radwan N.M. , Elsayed A.A. , (2013): Non-thermal continuous and modulated electromagnetic radiation fields effects on sleep EEG of rats. *Journal of Advanced Research* 4(2), 181–187. <https://doi.org/10.1016/j.jare.2012.05.005>.

Neufeld E. , Kuster N. , (2018): Systematic derivation of safety limits for time-varying 5G radiofrequency exposure based on analytical models and thermal dose. *Health Physics* 115(6), 705–711.

Niedermeyer E. , Da Silva F.L. , (2005): *Electroencephalography: Basic principles, clinical applications, and related fields*. Lippincott Williams & Wilkins, Philadelphia, USA.

Noor N.A. , Mohammed H.S. , Ahmed N.A. , Radwan N.M. , (2011): Variations in amino acid neurotransmitters in some brain areas of adult and young male albino rats due to exposure to mobile phone radiation. *European Review for Medical and Pharmacological Sciences* 15(7), 729–742.

Ohayon M.M. , Stolc V. , Freund F.T. , Milesi C. , Sullivan S.S. , (2019): The potential for impact of man-made super low and extremely low frequency electromagnetic fields on sleep. *Sleep Medicine Reviews* 47, 28–38. <https://doi.org/10.1016/j.smr.2019.06.001>.

Pall M.L. , (2013): Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects. *Journal of Cellular and Molecular Medicine* 17(8), 958–965. <https://doi.org/10.1111/jcmm.12088>.

Pall M.L. , (2016): Microwave frequency electromagnetic fields (EMFs) produce widespread neuropsychiatric effects including depression. *Journal of Chemical Neuroanatomy* 75(Pt B), 43–51. <https://doi.org/10.1016/j.jchemneu.2015.08.001>.

Palva S. , Palva J.M. , (2007): New vistas for a-frequency band oscillations. *Trends in Neurosciences* 30(4), 150–157.

Panagopoulos D.J. , Messini N. , Karabarbounis A. , Philippetis A.L. , Margaritis L.H. , (2000): A mechanism for action of oscillating electric fields on cells. *Biochemical and Biophysical Research Communications* 272(3), 634–640.

Panagopoulos D.J. , Karabarbounis A. , Margaritis L.H. , (2002): Mechanism for action of electromagnetic fields on cells. *Biochemical and Biophysical Research Communications* 298(1), 95–102. [https://doi.org/10.1016/s0006-291x\(02\)02393-8](https://doi.org/10.1016/s0006-291x(02)02393-8).

Panagopoulos D.J. , Johansson O. , Carlo G.L. , (2015): Polarization: A key difference between man-made and natural electromagnetic fields, in regard to biological activity. *Scientific Reports* 5, 14914.

Panagopoulos D.J. , (2017): Mobile telephony radiation effects on insect ovarian cells. The necessity for real exposures bioactivity assessment. The key role of polarization, and the ion forced-oscillation mechanism. In: C.D. Geddes (Ed.), *Microwave effects on DNA and proteins*, 1–48, Springer, Cham, Switzerland.

Panagopoulos D.J. , (2019): Comparing DNA damage induced by mobile telephony and other types of man-made electromagnetic fields. *Mutation Research Reviews* 781, 53–62.

Panagopoulos D.J. , (2020): Comparing chromosome damage induced by mobile telephony radiation and a high caffeine dose. Effect of combination and exposure duration. *General Physiology and Biophysics* 39(6), 531–544.

Panagopoulos D.J. , Karabarbounis A. , Yakymenko I. , Chrousos G.P. , (2021): Mechanism of DNA damage induced by human-made electromagnetic fields. *International Journal of Oncology* 59(5), 92.

Pedersen G.F. , (1997): Amplitude modulated RF fields stemming from a GSM/DCS-1800 phone. *Wireless Networks* 3(6), 489–498.

Perentos N. , Croft R.J. , McKenzie R.J. , Cvetkovic D. , Cosic I. , (2007): Comparison of the effects of continuous and pulsed mobile phone like RF exposure on the human EEG. *Australasian Physics & Engineering Sciences in Medicine* 30(4), 274–280.

Perentos N. , Croft R.J. , McKenzie R.J. , Cosic I. , (2013): The alpha band of the resting electroencephalogram under pulsed and continuous radio frequency exposures. *IEEE Transactions on Bio-Medical Engineering* 60(6), 1702–1710.

Petrova E.V. , Gulyaeva N.V. , Titarov S.I. , Rozhnov Y.V. , Koval'zon V.M. , (2005): Actions of pulsed ultra-broadband electromagnetic irradiation on the EEG and sleep in laboratory animals. *Neuroscience and Behavioral Physiology* 35(2), 165–170. <https://doi.org/10.1007/s11055-005-0062-9>.

Phillips J.L. , Singh N.P. , Lai H. , (2009): Electromagnetic fields and DNA damage. *Pathophysiology* 16(2–3), 79–88.

Pirard W. , Vatovez B. , (2014): Study of pulsed character of radiation emitted by wireless telecommunication systems. Institut scientifique de service public, Liège, Belgium. https://www.issep.be/wp-content/uploads/7IWSBEEMF_B-Vatovez_W-Pirard.pdf.

Puranen L. , Jokela K. , (1996): Radiation hazard assessment of pulsed microwave radars. *Journal of Microwave Power and Electromagnetic Energy* 31(3), 165–177.

Regel S.J. , Gottselig J.M. , Schuderer J. , Tinguely G. , Rétey J.V. , Kuster N. , Landolt H-P. , Achermann P. , (2007): Pulsed radio-frequency radiation affects cognitive performance and the waking electroencephalogram. *NeuroReport* 18(8), 803–807.

Reiser H. , Dimpfel W. , Schober F. , (1995): The influence of electromagnetic fields on human brain activity. *European Journal of Medical Research* 1(1), 27–32.

Roelfsema P.R. , Engel A.K. , König P. , Singer W. , (1997): Visuomotor integration is associated with zero time-lag synchronization among cortical areas. *Nature* 385(6612), 157–161. <https://doi.org/10.1038/385157a0>.

Roggeveen S. , van Os J. , Viechtbauer W. , Lousberg R. , (2015a): EEG changes due to experimentally induced 3G mobile phone radiation. *PLOS ONE* 10(6), e0129496. <https://doi.org/10.1371/journal.pone.0129496>.

Roggeveen S. , van Os J. , Lousberg R. , (2015b): Does the brain detect 3G mobile phone radiation peaks? An explorative in-depth analysis of an experimental study. *PLOS ONE* 10(5), e0125390. <https://doi.org/10.1371/journal.pone.0125390>.

Röschke J. , Mann K. , (1997): No short-term effects of digital mobile radio telephone on the awake human electroencephalogram. *Bioelectromagnetics* 18(2), 172–176.

Saroka K.S. , Persinger M.A. , (2014): Quantitative evidence for direct effects between ionosphere Schumann resonances and human cerebral cortical activity. *International Letters of Chemistry, Physics and Astronomy* 39, 166–194.

Schmid M.R. , Loughran S.P. , Regel S.J. , Murbach M. , Bratic Grunauer A. , Rusterholz T. , Bersagliere A. , Kuster N. , Achermann P. , (2012): Sleep EEG alterations: Effects of different pulse-modulated radio frequency electromagnetic fields. *Journal of Sleep Research* 21(1), 50–58. <https://doi.org/10.1111/j.1365-2869.2011.00918.x>.

Schreier N. , Huss A. , Roosli M. , (2006): The prevalence of symptoms attributed to electromagnetic field exposure: A cross-sectional representative survey in Switzerland. *Sozial- und Präventivmedizin* 51(4), 202–209.

Schumann W.O. , Koenig H. , (1954): Über die Beobachtung von “atmosphärischen” bei geringsten Frequenzen. *Naturwissenschaften* 8, 183–184.

Sienkiewicz Z.J. , Blackwell R.P. , Haylock R.G. , Saunders R.D. , Cobb B.L. , (2000): Low-level exposure to pulsed 900 MHz microwave radiation does not cause deficits in the performance of a spatial learning task in mice. *Bioelectromagnetics* 21(3), 151–158.

Suhhova A. , Bachmann M. , Karai D. , Lass J. , Hinrikus H. , (2013): Effect of microwave radiation on human EEG at two different levels of exposure. *Bioelectromagnetics* 34(4), 264–274.

Sullivan D. , Mizuseki K. , Sorgi A. , Buzsáki G. , (2014): Comparison of sleep spindles and theta oscillations in the hippocampus. *Journal of Neuroscience* 34(2), 662–674.

Szemerszky R. , Zelena D. , Barna I. , Bárdos G. , (2010): Stress-related endocrinological and psychopathological effects of short-and long-term 50 Hz electromagnetic field exposure in rats. *Brain Research Bulletin* 81(1), 92–99. <https://doi.org/10.1016/j.brainresbull.2009.10.015>.

Vecchio F. , Babiloni C. , Ferreri F. , Curcio G. , Fini R. , Del Percio C. , Rossini P.M. , (2007): Mobile phone emission modulates interhemispheric functional coupling of EEG alpha rhythms. *European Journal of Neuroscience* 25(6), 1908–1913.

Vecchio F. , Buffo P. , Sergio S. , Iacoviello D. , Rossini P.M. , Babiloni C. , (2012): Mobile phone emission modulates event-related desynchronization of alpha rhythms and cognitive-motor performance in healthy humans. *Clinical Neurophysiology* 123(1), 121–128.

Vecsei Z. , Knakker B. , Juhász P. , Thuróczy G. , Trunk A. , Hernádi I. , (2018a): Short-term radiofrequency exposure from new generation mobile phones reduces EEG alpha power with no effects on cognitive performance. *Scientific Reports* 8(1), 18010. <https://doi.org/10.1038/s41598-018-36353-9>.

Vecsei Z. , Thuróczy G. , Hernádi I. , (2018b): The effect of a single 30-min long term evolution mobile phone-like exposure on thermal pain threshold of young healthy volunteers. *International Journal of Environmental Research and Public Health* 15(9), 1849–1860.

Van Wijngaarden E. , Savitz D.A. , Kleckner R.C. , Cai J. , Loomis D. , (2000): Exposure to electromagnetic fields and suicide among electric utility workers: A nested case-control study. *Occupational and Environmental Medicine* 57(4), 258–263.

Von Klitzing L. , (1995): Medical/biological study (experimental study) low-frequency pulsed electromagnetic fields influence EEG of man. *Physica medica* 11, 77–80.

Vorobyov V. , Janač B. , Pešić V. , Prolić Z. , (2010): Repeated exposure to low-level extremely low frequency-modulated microwaves affects cortex-hypothalamus interplay in freely moving rats: EEG study. *International Journal of Radiation Biology* 86(5), 376–383. <https://doi.org/10.3109/09553000903567938>.

Wagner P. , Röschke J. , Mann K. , Hiller W. , Frank C. , (1998): Human sleep under the influence of pulsed radiofrequency electromagnetic fields: A polysomnographic study using standardized conditions. *Bioelectromagnetics* 19(3), 199–202.

Wilson B.W. , (1988): Chronic exposure to ELF fields may induce depression. *Bioelectromagnetics* 9(2), 195–205.

Yakymenko I. , Tsybulin O. , Sidorik E. , Henshel D. , Kyrylenko O. , Kyrylenko S. , (2016): Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation. *Electromagnetic Biology and Medicine* 35(2), 186–202.

Yakymenko I. , Burlaka A. , Tsybulin I. , Brieieva I. , Buchynska L. , Tsehmistrenko I. , Chekhun F. , (2018): Oxidative and mutagenic effects of low intensity GSM 1800 MHz microwave radiation. *Experimental Oncology* 40(4), 282–287.

Yang L. , Chen Q. , Lv B. , Wu T. , (2017): Long-term evolution electromagnetic fields exposure modulates the resting state EEG on alpha and beta bands. *Clinical EEG and Neuroscience* 48(3), 168–175.

Zhang J. , Sumich A. , Wang G.Y. , (2017): Acute effects of radiofrequency electromagnetic field emitted by mobile phone on brain function. *Bioelectromagnetics* 38(5), 329–338. <https://doi.org/10.1002/bem.22052>.

Zhang F. , Wang F. , Yue L. , Zhang H. , Peng W. , Hu L. , (2019): Cross-species investigation on resting state electroencephalogram. *Brain Topography* 32(5), 808–824. <https://doi.org/10.1007/s10548-019-00723-x>.

Zheng Y. , Xia P. , Dong L. , Tian L. , Xiong C. , (2021): Effects of modulation on sodium and potassium channel currents by extremely low frequency electromagnetic fields stimulation on hippocampal CA1 pyramidal cells. *Electromagnetic Biology and Medicine* 17, 1–12.

Electro-hypersensitivity as a Worldwide, Man-made Electromagnetic Pathology:

Aalto, S. , Haarala, C. , Brück, A. , Sipilä, H. , Hämäläinen, H. and Rinne, J. O. , (2006): Mobile phone affects cerebral blood flow in humans. *J Cereb Blood Flow Metab* 26(7):885–890.

Abbott, N. J. , (2000): Inflammatory mediators and modulation of blood-brain barrier permeability. *Cell Mol Neurobiol* 20(2):131–147.

Aboul Ezz, H. S. , Khadrawy, Y. A. , Ahmed, N. A. , Radwan, N. M. and El Bakry, M. M. , (2013): The effect of pulsed electromagnetic radiation from mobile phone on the levels of monoamine neurotransmitters in four different areas of rat brain. *Eur Rev Med Pharmacol Sci* 17(13):1782–1788.

Adachi, N. , (2005): Cerebral ischemia and brain histamine. *Brain Res Brain Res Rev* 50(2):275–286.

Ahlbom, A. , Day, N. , Feychting, M. , et al., (2000): A pooled analysis of magnetic fields and childhood leukaemia. *Br J Cancer* 83(5):692–698.

Akerboom, T. P. and Sies, H. , (1981): Assay of glutathione, glutathione disulfide, and glutathione mixed disulfides in biological samples. *Methods Enzymol* 77:373–382.

Albert, P. J. , Proal, A. D. and Marshall, T. G. , (2009): Vitamin D: The alternative hypothesis. *Autoimmun Rev* 8(8):639–644.

Aldad, T. S. , Gan, G. , Gao, X. B. and Taylor, H. S. , (2012): Fetal radiofrequency radiation exposure from 800–1900 MHz-rated cellular telephones affects neurodevelopment and behavior in mice. *Sci Rep* 2:312.

Arnetz, B. B. , Akerstedt, T. , Hillert, L. , Lowden, A. , Kuster, N. and Wiholm, C. , (2007): The effects of 884 MHz GSM wireless communication signals on self-reported symptom and sleep (EEG): An experimental provocation study. *PIERS Online* 3(7):1148–1150.

Arnold, W. , Pfaltz, R. and Altermatt, H. J. , (1985): Evidence of serum antibodies against inner ear tissues in the blood of patients with certain sensorineural hearing disorders. *Acta Otolaryngol* 99(3–4):437–444.

Aruoma, O. I. , Hayashi, Y. , Marotta, F. , Mantello, P. , Rachmilewitz, E. and Montagnier, L. , (2010): Applications and bioefficacy of the functional food supplement fermented papaya preparation. *Toxicology* 278(1):6–16.

Augner, C. and Hacker, G. W. , (2009): Are people living next to mobile phone base stations more strained? Relationship of health concerns, self-estimated distance to base station, and psychological parameters. *Indian J Occup Environ Med* 13(3):141–145.

- Augner, C. , Gnamb, T. , Winker, R. and Barth, A. , (2012): Acute effects of electromagnetic fields emitted by GSM mobile phones on subjective well-being and physiological reactions: A meta-analysis. *Sci Total Environ* 424:11–15.
- Auvinen, A. , Feychting, M. , Ahlbom, A. , et al., (2019): Headache, tinnitus and hearing loss in the international cohort study of mobile phone use and health (COSMOS) in Sweden and Finland. *Int J Epidemiol* 48(5):1567–1579.
- Bagheri Hosseinabadi, M. , Khanjani, N. , Ebrahimi, M. H. , Haji, B. and Abdollahfar, M. , (2019): The effect of chronic exposure to extremely low-frequency electromagnetic fields on sleep quality, stress, depression and anxiety. *Electromagn Biol Med* 38(1):96–101.
- Balassa, T. , Varró, P. , Elek, S. , Drozdovszky, O. , Szemerszky, R. , Világi, I. and Bárdos, G. , (2013): Changes in synaptic efficacy in rat brain slices following extremely low-frequency magnetic field exposure at embryonic and early postnatal age. *Int J Dev Neurosci* 31(8):724–730.
- Balcavage, W. X. , Alvager, T. , Swez, J. , Goff, C. W. , Fox, M. T. , Abdullyava, S. and King, M. W. , (1996): A mechanism for action of extremely low frequency electromagnetic fields on biological systems. *Biochem Biophys Res Commun* 222(2):374–378.
- Baliatsas, C. , Bolte, J. , Yzermans, J. , Kelfkens, G. , Hooiveld, M. , Lebret, E. and van Kamp, I. , (2015): Actual and perceived exposure to electromagnetic fields and non-specific physical symptoms: An epidemiological study based on self-reported data and electronic medical records. *Int J Hyg Environ Health* 218(3):331–344.
- Baliatsas, C. , van Kamp, I. , Hooiveld, M. , Yzermans, J. and Lebret, E. , (2014): Comparing non-specific physical symptoms in environmentally sensitive patients: Prevalence, duration, functional status and illness behavior. *J Psychosom Res* 76(5):405–413.
- Baliatsas, C. , van Kamp, I. , Kelfkens, G. , Schipper, M. , Bolte, J. , Yzermans, J. and Lebret, E. , (2011): Non-specific physical symptoms in relation to actual and perceived proximity to mobile phone base stations and powerlines. *BMC Public Health* 11:421.
- Baliatsas, C. , van Kamp, I. , Lebret, E. and Rubin, G. J. , (2012): Idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF): A systematic review of identifying criteria. *BMC Public Health* 12:643.
- Balmori, A. , (2005): Possible effects of electromagnetic fields from phone masts on a population of White Stork (*Ciconia ciconia*). *Electromagn Biol Med* 24(2):109–119.
- Balmori, A. , (2006): The incidence of electromagnetic pollution on the amphibian decline: Is this an important piece of the puzzle? *Toxicol Environ Chem* 88(2):287–299.
- Bandara, P. and Carpenter, D. O. , (2018): Planetary electromagnetic pollution: It is time to assess its impact. *Lancet Planet Health* 2(12):e512–e514.
- Barsam, T. , Monazzam, M. R. , Haghdoost, A. A. , Ghotbi, M. R. and Dehghan, S. F. , (2012): Effect of extremely low frequency electromagnetic field exposure on sleep quality in high voltage substations. *Iran J Environ Health Sci Eng* 9(1):15.
- Bartha, L. , Baumzweiger, W. , Buscher, D. S. , et al., (1999): Multiple chemical sensitivity: A 1999 consensus. *Arch Environ Health* 54(3):147–149.
- Bas, O. , Odaci, E. , Kaplan, S. , Acer, N. , Uçok, K. and Colakoglu, S. , (2009): 900 MHz electromagnetic field exposure affects qualitative and quantitative features of hippocampal pyramidal cells in the adult female rat. *Brain Res* 1265:178–185.
- Bawin, S. M. and Adey, W. R. , (1976): Sensitivity of calcium binding in cerebral tissue to weak environmental electric fields oscillating at low frequency. *Proc Natl Acad Sci U S A* 73(6):1999–2003.
- Baydas, G. , Ozer, M. , Yasar, A. , Koz, S. T. and Tuzcu, M. , (2006): Melatonin prevents oxidative stress and inhibits reactive gliosis induced by hyperhomocysteinemia in rats. *Biochem (Mosc)* 71:S91–S95.
- Bell, I. R. , Miller, C. S. and Schwartz, G. E. , (1992): An olfactory-limbic model of multiple chemical sensitivity syndrome: Possible relationships to kindling and affective spectrum disorders. *Biol Psychiatry* 32(3):218–242.
- Bell, R. D. and Zlokovic, B. V. , (2009): Neurovascular mechanisms and blood-brain barrier disorder in Alzheimer's disease. *Acta Neuropathol* 118(1):103–113.
- Belpomme, D. , Irigaray, P. , Hardell, L. , Clapp, R. , Montagnier, L. , Epstein, S. and Sascio, A. J. , (2007): The multitude and diversity of environmental carcinogens. *Environ Res* 105(3):414–429.
- Belpomme, D. , Campagnac, C. and Irigaray, P. , (2015): Reliable disease biomarkers characterizing and identifying electrohypersensitivity and multiple chemical sensitivity as two etiopathogenic aspects of a unique pathological disorder. *Rev Environ Health* 30(4):251–271.
- Belpomme, D. , Campagnac, C. and Irigaray, P. , (2016): Corrigendum to: Reliable disease biomarkers characterizing and identifying electrohypersensitivity and multiple chemical sensitivity as two etiopathogenic aspects of a unique pathological disorder. *Rev Environ Health*. <https://doi.org/10.1515/reveh-2015-8888>.
- Belpomme, D. , Hardell, L. , Belyaev, I. , Burgio, E. and Carpenter, D. O. , (2018): Thermal and non-thermal health effects of low intensity non-ionizing radiation: An international perspective. *Environ Pollut* 242(A):643–658.
- Belpomme, D. and Irigaray, P. , (2020): Electrohypersensitivity as a newly identified and characterized neurologic pathological disorder: How to diagnose, treat, and prevent it. *Int J Mol Sci* 21(6):1915.

Belpomme, D. , Carlo, G. L. , Irigaray, P. , et al., (2021): The critical importance of molecular biomarkers and imaging in the study of electrohypersensitivity. A scientific consensus international report. *Int J Mol Sci* 22(14):7321.

Belpomme, D. and Irigaray, P. , (2021): Why scientifically unfounded and misleading claim should be dismissed to make true research progress in the acknowledgment of electrohypersensitivity as a new worldwide emerging pathology. *Rev Environ Health*. <https://doi.org/10.1515/reveh-2021-0104>.

Belpomme, D. and Irigaray, P. , (2022): Why electrohypersensitivity and related symptoms are caused by non-ionizing man-made electromagnetic fields: An overview and medical assessment. *Environ Res*. 212(Pt A):113374.

Belsey, R. , Deluca, H. F. and Potts, J. T. Jr. , (1971): Competitive binding assay for vitamin D and 25-OH vitamin D. *J Clin Endocrinol Metab* 33(3):554–557.

Belyaev, I. , (2005): Non-thermal biological effects of microwaves. *Microw Rev* 11:3–29.

Belyaev, I. Y. , Hillert, L. , Protopopova, M. , Tamm, C. , Malmgren, L. O. , Persson, B. R. , Selivanova, G. , Harms-Ringdahl, M. , (2005): 915 MHz microwaves and 50 Hz magnetic field affect chromatin conformation and 53BP1 foci in human lymphocytes from hypersensitive and healthy persons. *Bioelectromagnetics* 26(3):173–184.

Belyaev, I. Y. , Koch, C. B. , Terenius, O. , et al., (2006): Exposure of rat brain to 915 MHz GSM microwaves induces changes in gene expression but not double stranded DNA breaks or effects on chromatin conformation. *Bioelectromagnetics* 27(4):295–306.

Belyaev, I. Y. , Markovà, E. , Hillert, L. , Malmgren, L. O. and Persson, B. R. , (2009): Microwaves from UMTS/GSM mobile phones induce long-lasting inhibition of 53BP1/gamma-H2AX DNA repair foci in human lymphocytes. *Bioelectromagnetics* 30(2):129–141.

Belyaev, S. Y. and Kravchenko, V. G. , (1994): Resonance effect of low-intensity millimeter waves on the chromatin conformational state of rat thymocytes. *Z Naturforsch C J Biosci* 49(5–6):352–358.

Berberian, P. A. , Myers, W. , Tytell, M. , Challa, V. and Bond, M. G. , (1990): Immunohistochemical localization of heat shock protein-70 in normal appearing and atherosclerotic specimens of human arteries. *Am J Pathol* 136(1):71–80.

Béres, S. , Németh, Á. , Ajtay, Z. , Kiss, I. , Németh, B. and Hejjel, L. , (2018): Cellular phone irradiation of the head affects heart rate variability depending on inspiration/expiration ratio. *In Vivo* 32(5):1145–1153.

Berg, M. , (1988): Skin problems in workers using visual display terminals: A study of 201 patients. *Contact Dermatitis* 19(5):335–341.

Berg, N. D. , Rasmussen, H. B. , Linneberg, A. , et al., (2010): Genetic susceptibility factors for multiple chemical sensitivity revisited. *Int J Hyg Environ Health* 213(2):131–139.

Bergqvist, U. and Vogel, E. , (1997): Possible health implications of subjective symptoms and electromagnetic fields. In A report prepared by a European group of experts for the European commission, DGV; Arbete Och Hälsa, 19. Stockholm: Swedish National Institute for Working Life. <http://www2.niwl.se/forlag/en/>.

Bergqvist, U. and Wahlberg, J. E. , (1994): Skin symptoms and disease during work with visual display terminals. *Contact Dermatitis* 30(4):197–204.

Bergqvist, U. O. , (1984): Video display terminals and health: A technical and medical appraisal of the state of the art. *Scand J Work Environ Health* 10:1–87.

Bertagna, F. , Lewis, R. , Silva, S. R. P. , McFadden, J. and Jeevaratnam, K. , (2021): Effects of electromagnetic fields on neuronal ion channels: A systematic review. *Ann N Y Acad Sci*. <https://doi.org/10.1111/nyas.14597>.

Beyer, C. , Christen, P. , Jelesarov, I. and Fröhlich, J. , (2013): Experimental system for real-time assessment of potential changes in protein conformation induced by electromagnetic fields. *Bioelectromagnetics* 34(6):419–428.

Bickmore, W. A. and Carothers, A. D. , (1995): Factors affecting the timing and imprinting of replication on a mammalian chromosome. *J Cell Sci* 108(8):2801–2809.

Blackman, C. , (2009): Cell phone radiation: Evidence from ELF and RF studies supporting more inclusive risk identification and assessment. *Pathophysiology* 16(2–3):205–216.

Blanchard, J. P. and Blackman, C. F. , (1994): Clarification and application of an ion parametric resonance model for magnetic field interactions with biological systems. *Bioelectromagnetics* 15(3):217–238.

Blank, M. , (2005): Do electromagnetic fields interact with electrons in the Na,K-ATPase? *Bioelectromagnetics* 26(8):677–683.

Blank, M. , (2008): Protein and DNA reactions stimulated by electromagnetic fields. *Electromagn Biol Med* 27(1):3–23.

Blank, M. and Goodman, R. , (1999): Electromagnetic fields may act directly on DNA. *J Cell Biochem* 75(3):369–374.

Blank, M. and Goodman, R. , (2009): Electromagnetic fields stress living cells. *Pathophysiology* 16(2–3):71–78.

Blank, M. and Goodman, R. , (2011): DNA is a fractal antenna in electromagnetic fields. *Int J Radiat Biol* 87(4):409–415.

Blank, M. and Soo, L. , (2001): Electromagnetic acceleration of electron transfer reactions. *J Cell Biochem* 81(2):278–283.

Blettner, M. , Schlehofer, B. , Breckenkamp, J. , et al., (2009): Mobile phone base stations and adverse health effects: Phase 1 of a population-based, cross-sectional study in Germany. *Occup Environ Med* 66(2):118–123.

Bohr, H. and Bohr, J. , (2000): Microwave-enhanced folding and denaturation of globular proteins. *Phys Rev E Stat Phys Plasmas Fluids Relat Interdiscip Topics* 61(4 Pt B):4310–4314.

Bolte, J. F. , Baliatsas, C. , Eikelboom, T. and van Kamp, I. , (2015): Everyday exposure to power frequency magnetic fields and associations with non-specific physical symptoms. *Environ Pollut* 196:224–229.

Bonhomme-Faivre, L. , Marion, S. , Bezie, Y. , Auclair, H. , Fredj, G. and Hommeau, C. , (1998): Study of human neurovegetative and hematologic effects of environmental low-frequency (50-Hz) electromagnetic fields produced by transformers. *Arch Environ Health* 53(2):87–92.

Borgens, R. B. , (1988): Stimulation of neuronal regeneration and development by steady electrical fields. In S. G. Waxman ed., *Advances in Neurology*, 47:547–564.

Bortkiewicz, A. , Gadzicka, E. , Szyjkowska, A. , Politański, P. , Mamrot, P. , Szymczak, W. and Zmysłony, M. , (2012): Subjective complaints of people living near mobile phone base stations in Poland. *Int J Occup Med Environ Health* 25(1):31–40.

Bozic, B. , Cucnik, S. , Kveder, T. and Rozman, B. , (2007): Autoimmune reactions after electro-oxidation of IgG from healthy persons: Relevance of electric current and antioxidants. *Ann N Y Acad Sci* 1109:158–166.

Braune, S. , Wrocklage, C. , Raczek, J. , Gailus, T. and Lücking, C. H. , (1998): Resting blood pressure increase during exposure to a radio-frequency electromagnetic field. *Lancet* 351(9119):1857–1858.

Broadbent, D. E. , Broadbent, M. H. , Male, J. C. and Jones, M. R. , (1985): Health of workers exposed to electric fields. *Br J Ind Med* 42(2):75–84.

Brzezinski, A. , (1997): Melatonin in humans. *N Engl J Med* 336(3):186–195.

Bunch, C. and Crook, D. W. M. , (1998): Opportunistic infections. In Delves P.J., Roitt I.M. (Eds): *Encyclopedia of immunology* (2nd ed.). San Diego, CA: Academic Press, pp. 1881–1884, ISBN: 0-12-226765-6.

Burch, J. B. , Reif, J. S. , Yost, M. G. , Keefe, T. J. and Pitrat, C. A. , (1999): Reduced excretion of a melatonin metabolite in workers exposed to 60 Hz magnetic fields. *Am J Epidemiol* 150(1):27–36.

Burgess, A. P. , Fouquet, N. C. , Seri, S. , et al., (2016): Acute exposure to terrestrial trunked radio (TETRA) has effects on the electroencephalogram and electrocardiogram, consistent with vagal nerve stimulation. *Environ Res* 150:461–469.

Byun, Y. H. , Ha, M. , Kwon, H. J. , et al., (2013): Mobile phone use, blood lead levels, and attention deficit hyperactivity symptoms in children: A longitudinal study. *PLOS ONE* 8(3):e59742.

Cabr -Riera, A. , Torrent, M. , Donaire-Gonzalez, D. , Vrijheid, M. , Cardis, E. and Guxens, M. , (2019): Telecommunication devices use, screen time and sleep in adolescents. *Environ Res* 171:341–347.

Caccamo, D. , Cesareo, E. , Mariani, S. , et al., (2013): Xenobiotic sensor- and metabolism-related gene variants in environmental sensitivity-related illnesses: A survey on the Italian population. *Oxid Med Cell Longev* 2013:831969.

Califf, R. M. , (2018): Biomarker definitions and their applications. *Exp Biol Med* (Maywood) 243(3):213–221.

Calvente, I. , P rez-Lobato, R. , N n ez, M. I. et al., (2016): Does exposure to environmental radiofrequency electromagnetic fields cause cognitive and behavioral effects in 10-year-old boys? *Bioelectromagnetics* 37(1):25–36.

Cammaerts, M. C. and Johansson, O. , (2014): Ants can be used as bio-indicators to reveal biological effects of electromagnetic waves from some wireless apparatus. *Electromagn Biol Med* 33(4):282–288.

Cao, Z. , Zhang, H. , Tao, Y. and Liu, J. , (2000): Effects of microwave radiation on lipid peroxidation and the content of neurotransmitters in mice. *Wei Sheng Yan Jiu* 29(1):28–29.

Cardis, E. , Deltour, I. , Mann, S. , et al., (2008): Distribution of RF energy emitted by mobile phones in anatomical structures of the brain. *Phys Med Biol* 53(11):2771–2783.

Carles, C. , Esquirol, Y. , Turuban, M. , et al., (2020): Residential proximity to power lines and risk of brain tumor in the general population. *Environ Res* 185:109473.

Carlsson, F. , Karlson, B. ,  rbaek, P. , Osterberg, K. and Ostergren, P. O. , (2005): Prevalence of annoyance attributed to electrical equipment and smells in a Swedish population, and relationship with subjective health and daily functioning. *Public Health* 119(7):568–577.

Carpenter, D. O. , (2014): Excessive exposure to radiofrequency electromagnetic fields may cause the development of electrohypersensitivity. *Altern Ther Health Med* 20(6):40–42.

Carpenter, D. O. , (2015): The microwave syndrome or electro-hypersensitivity: Historical background. *Rev Environ Health* 30(4):217–222.

Carpenter, D. O. and Belpomme, D. , (2015): Idiopathic environmental intolerance. *Rev Environ Health* 30(4):207.

Carpenter, D. O. and Sage, C. , (2008): Setting prudent public health policy for electromagnetic field exposures. *Rev Environ Health* 23(2):91–117.

Carrubba, S. and Marino, A. A. , (2008): The effects of low-frequency environmental-strength electromagnetic fields on brain electrical activity: A critical review of the literature. *Electromagn Biol Med* 27(2):83–101.

Carrubba, S. , Frilot, C. 2nd. , Chesson, A. L. Jr. and Marino, A. A. , (2010): Mobile-phone pulse triggers evoked potentials. *Neurosci Lett* 469(1):164–168.

- Charnay, Y. and Léger, L. , (2010): Brain serotonergic circuitries. *Dial Clin Neurosci* 12(4):471–487.
- Chen, C. , Ma, Q. , Liu, C. , et al., (2014): Exposure to 1800 MHz radiofrequency radiation impairs neurite outgrowth of embryonic neural stem cells. *Sci Rep* 4:5103.
- Chen, Y. Y. , Lv, J. , Xue, X. Y. , He, G. H. , Zhou, Y. , Jia, M. and Luo, X. X. , (2010): Effects of sympathetic histamine on vasomotor responses of blood vessels in rabbit ear to electrical stimulation. *Neurosci Bull* 26(3):219–224.
- Chevalier, G. , Sinatra, S. T. , Oschman, J. L. , Sokal, K. and Sokal, P. , (2012): Earthing: Health implications of reconnecting the human body to the earth's surface electrons. *J Environ Public Health*:291541. <https://doi.org/10.1155/2012/291541>.
- Chia, S. E. , Chia, H. P. and Tan, J. S. , (2000): Prevalence of headache among handheld cellular telephone users in Singapore: A community study. *Environ Health Perspect* 108(11):1059–1062.
- Chiu, C. T. , Chang, Y. H. , Chen, C. C. , Ko, M. C. and Li, C. Y. , (2015): Mobile phone use and health symptoms in children. *J Formos Med Assoc* 114(7):598–604.
- Cho, Y. M. , Lim, H. J. , Jang, H. , et al., (2016a): A cross-sectional study of the association between mobile phone use and symptoms of ill health. *Environ Health Toxicol* 31:e2016022.
- Cho, Y. M. , Lim, H. J. , Jang, H. , et al., (2016b): A follow-up study of the association between mobile phone use and symptoms of ill health. *Environ Health Toxicol* 32:e2017001.
- Chrousos, G. P. and Gold, P. W. , (1992): The concepts of stress and stress system disorders: Overview of physical and behavioral homeostasis. *JAMA* 267(9):1244–1252.
- Crasson, M. , Legros, J. J. , Scarpa, P. and Legros, W. , (1999): 50 Hz magnetic field exposure influence on human performance and psychophysiological parameters: Two double-blind experimental studies. *Bioelectromagnetics* 20(8):474–486.
- Croft, R. J. , Chandler, J. S. , Burgess, A. P. , Barry, R. J. , Williams, J. D. and Clarke, A. R. , (2002): Acute mobile phone operation affects neural function in humans. *Clin Neurophysiol* 113(10):1623–1632.
- Croft, R. J. , Hamblin, D. L. , Spong, J. , Wood, A. W. , McKenzie, R. J. and Stough, C. , (2008): The effect of mobile phone electromagnetic fields on the alpha rhythm of human electroencephalogram. *Bioelectromagnetics* 29(1):1–10.
- Cucurachi, S. , Tamis, W. L. , Vijver, M. G. , Peijnenburg, W. J. , Bolte, J. F. and de Snoo, G. R. , (2013): A review of the ecological effects of radiofrequency electromagnetic fields (RF-EMF). *Environ Int* 51:116–140.
- Curcio, G. , Ferrara, M. , Limongi, T. , et al., (2009): Acute mobile phones exposure affects frontal cortex hemodynamics as evidenced by functional near-infrared spectroscopy. *J Cereb Blood Flow Metab* 29(5):903–910.
- Curcio, G. , Ferrara, M. , Moroni, F. , D'Inzeo, G. , Bertini, M. and De Gennaro, L. , (2005): Is the brain influenced by a phone call? An EEG study of resting wakefulness. *Neurosci Res* 53(3):265–270.
- Dahmen, N. , Ghezel-Ahmadi, D. and Engel, A. , (2009): Blood laboratory findings in patients suffering from self-perceived electromagnetic hypersensitivity (EHS). *Bioelectromagnetics* 30(4):299–306.
- Dale, H. H. , (1906): On some physiological actions of ergot. *J Physiol* 34(3):163–206.
- Dasdag, S. , Akdag, M. Z. , Erdal, M. E. , et al., (2015a): Long term and excessive use of 900 MHz radiofrequency radiation alter microRNA expression in brain. *Int J Radiat Biol* 91(7):555–561.
- Dasdag, S. , Akdag, M. Z. , Erdal, M. E. , et al., (2015b): Effects of 2.4 GHz radiofrequency radiation emitted from wi-fi equipment on microRNA expression in brain tissue. *Int J Radiat Biol* 91(7):555–561.
- Dasdag, S. , Akdag, M. Z. , Kizil, G. , Kizil, M. , Cakir, D. U. and Yokus, B. , (2012): Effect of 900 MHz radio frequency radiation on beta amyloid protein, protein carbonyl, and malondialdehyde in the brain. *Electromagn Biol Med* 31(1):67–74.
- Dasdag, S. , Sert, C. , Akdag, Z. and Batun, S. , (2002): Effects of extremely low frequency electromagnetic fields on hematologic and immunologic parameters in welders. *Arch Med Res* 33(1):29–32.
- Davanipour, Z. and Sobel, E. , (2009): Long-term exposure to magnetic fields and the risks of Alzheimer's disease and breast cancer: Further biological research. *Pathophysiology* 16(2–3):149–156.
- Davis, S. , (1997): Weak residential magnetic fields affect melatonin in humans. *Microw News* 17(6):novembre–décembre 1997. <http://microwavenews.com/news/backissues/n-d97issue.pdf>.
- De Iuliis, G. N. , Newey, R. J. , King, B. V. and Aitken, R. J. , (2009): Mobile phone radiation induces reactive oxygen species production and DNA damage in human spermatozoa in vitro. *PLOS ONE* 4(7):e6446.
- De Luca, C. , Scordo, M. G. , Cesareo, E. , et al., (2010): Biological definition of multiple chemical sensitivity from redox state and cytokine profiling and not from polymorphisms of xenobiotic-metabolizing enzymes. *Toxicol Appl Pharmacol* 248(3):285–292.
- De Luca, C. , Thai, J. C. , Raskovic, D. , Cesareo, E. , Caccamo, D. , Trukhanov, A. and Korkina, L. , (2014): Metabolic and genetic screening of electromagnetic hypersensitive subjects as a feasible tool for diagnostics and intervention. *Mediators Inflamm* 2014:924184.
- De Pomerai, D. , Daniells, C. , David, H. , et al., (2000): Non-thermal heat-shock response to microwaves. *Nature* 405(6785):417–418.
- De, A. K. and Roach, S. E. , (2004): Detection of the soluble heat shock protein 27 (hsp27) in human serum by an ELISA. *J Immunoassay Immunochem* 25(2):159–170.

Del Giudice, E. , Stefanini, P. , Tedeschi, A. and Vitiello, G. , (2011): The interplay of biomolecules and water at the origin of the active behavior of living organisms. *J Phys Conf S* 329, Article ID: 012001.

Deshmukh, P. S. , Megha, K. , Banerjee, B. D. , Ahmed, R. S. , Chandna, S. , Abegaonkar, M. P. and Tripathi, A. K. , (2013): Detection of low level microwave radiation induced deoxyribonucleic acid damage vis-à-vis genotoxicity in brain of Fischer rats. *Toxicol Int* 20(1):19–24.

Dessaint, J. P. , Bout, D. , Wattre, P. and Capron, A. , (1975): Quantitative determination of specific IgE antibodies to *Echinococcus granulosus* and IgE levels in sera from patients with hydatid disease. *Immunology* 29(5):813–823.

Di Carlo, A. , White, N. , Guo, F. , Garrett, P. and Litovitz, T. , (2002): Chronic electromagnetic field exposure decreases HSP70 levels and lowers cytoprotection. *J Cell Biochem* 84(3):447–454.

Díaz-Del Cerro, E. , Vida, C. , Martínez de Toda, I. , Félix, J. and De la Fuente, M. , (2020): The use of a bed with an insulating system of electromagnetic fields improves immune function, redox and inflammatory states, and decrease the rate of aging. *Environ Health* 19(1):118.

Diem, E. , Schwarz, C. , Adlkofer, F. , Jahn, O. and Rüdiger, H. , (2005): Non-thermal DNA breakage by mobile-phone radiation (1800 MHz) in human fibroblasts and in transformed GFSH-R17 rat granulosa cells in vitro. *Mutat Res* 583(2):178–183.

Dieudonné, M. , (2016): Does electromagnetic hypersensitivity originate from nocebo responses? Indications from a qualitative study. *Bioelectromagnetics* 37(1):14–24.

Dieudonné, M. , (2020): Electromagnetic hypersensitivity: A critical review of explanatory hypotheses. *Environ Health* 19(1):48.

Dik, M. G. , Jonker, C. , Hack, C. E. , Smit, J. H. , Comijs, H. C. and Eikelenboom, P. , (2005): Serum inflammatory proteins and cognitive decline in older persons. *Neurology* 64(8):1371–1377.

Ding, G. R. , Li, K. C. , Wang, X. W. , et al., (2009): Effect of electromagnetic pulse exposure on brain microvascular permeability in rats. *Biomed Environ Sci* 22(3):265–268.

Dodge, C. , (1969): Clinical and hygienic aspects of exposure to electromagnetic radiation. Bioscience Division of US Navy, US Naval Observatory. Washington DC.

Donato, R. , (2001): S100: A multigenic family of calcium-modulated proteins of the EF-hand type with intracellular and extracellular functional roles. *Int J Biochem Cell Biol* 33(7):637–668.

Draper, G. , Vincent, T. , Kroll, M. E. and Swanson, J. , (2005): Childhood cancer in relation to distance from high voltage power lines in England and Wales: A case-control study. *BMJ* 330(7503):1290.

Dunn, J. R. , Fuller, M. , Zoeger, J. , et al., (1995): Magnetic material in the human hippocampus. *Brain Res Bull* 36(2):149–153.

Durusoy, R. , Hassoy, H. , Özkurt, A. and Karababa, A. O. , (2017): Mobile phone use, school electromagnetic field levels and related symptoms: A cross-sectional survey among 2150 high school students in Izmir. *Environ Health* 16(1):51.

Eberhardt, J. L. , Persson, B. R. , Brun, A. E. , Salford, L. G. and Malmgren, L. O. , (2008): Blood-brain barrier permeability and nerve cell damage in rat brain 14 and 28 days after exposure to microwaves from GSM mobile phones. *Electromagn Biol Med* 27(3):215–229.

Eghlidospour, M. , Ghanbari, A. , Mortazavi, S. M. J. and Azari, H. , (2017): Effects of radiofrequency exposure emitted from a GSM mobile phone on proliferation, differentiation, and apoptosis of neural stem cells. *Anat Cell Biol* 50(2):115–123.

Ehrlich, P. , (1885): *Das Sauerstoffbedürfnis des Organismus: Eine farbanalytische Studie*. Berlin: Hirschwald-Verlag.

Eltiti, S. , Wallace, D. , Zougkou, K. , Russo, R. , Joseph, S. , Rasor, P. and Fox, E. , (2007): Development and evaluation of the electromagnetic hypersensitivity questionnaire. *Bioelectromagnetics* 28(2):137–151.

Eltiti, S. , Wallace, D. , Russo, R. and Fox, E. , (2015): Aggregated data from two double blind base station provocation studies comparing individuals with idiopathic environmental intolerance with attribution to electromagnetic fields and controls. *Bioelectromagnetics* 36(2):96–107.

Engels, S. , Schneider, N. L. , Lefeldt, N. , et al., (2014): Anthropogenic electromagnetic noise disrupts magnetic compass orientation in a migratory bird. *Nature* 509(7500):353–356.

Erickson, M. A. and Banks, W. A. , (2013): Blood-brain barrier dysfunction as a cause and consequence of Alzheimer's disease. *J Cereb Blood Flow Metab* 33(10):1500–1513.

Eyles, D. W. , Feron, F. , Cui, X. , et al., (2009): Developmental vitamin D deficiency causes abnormal brain development. *Psychoneuroendocrinology* 34:S247–S257.

Eyvazlou, M. , Zarei, E. , Rahimi, A. and Abazari, M. , (2016): Association between overuse of mobile phones on quality of sleep and general health among occupational health and safety students. *Chronobiol Int* 33(3):293–300.

Falcioni, L. , Bua, L. , Tibaldi, E. , et al., (2018): Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission. *Environ Res* 165:496–450.

FDA-NIH Biomarker Working Group ., (2016): BEST (biomarkers, EndpointS, and other tools) resource. Silver Spring (MD); Bethesda (MD): Food and Drug Administration (US); National Institutes of Health (US). www.ncbi.nlm.nih.gov/books/NBK326791/.

Forman, S. A. , Holmes, C. K. , McManamon, T. V. and Wedding, W. R. , (1982): Psychological symptoms and intermittent hypertension following acute microwave exposure. *J Occup Med* 24(11):932–934.

Foster, K. R. , (2000): Thermal and nonthermal mechanisms of interaction of radio-frequency energy with biological systems. *IEEE Trans Plasma Sci* 28(1):15–23.

Fragopoulou, A. F. , Samara, A. , Antonelou, M. H. , et al., (2012): Brain proteome response following whole body exposure of mice to mobile phone or wireless DECT base radiation. *Electromagn Biol Med* 31(4):250–274.

Frei, P. , Mohler, E. , Braun-Fahrlander, C. , Fröhlich, J. , Neubauer, G. , Röösli, M. and QUALIFEX-Team ., (2012): Cohort study on the effects of everyday life radio frequency electromagnetic field exposure on non-specific symptoms and tinnitus. *Environ Int* 38(1):29–36.

French, P. W. , Penny, R. , Laurence, J. A. and McKenzie, D. R. , (2001): Mobile phones, heat shock proteins and cancer. *Differentiation* 67(4–5):93–97.

Freude, G. , Ullsperger, P. , Eggert, S. and Ruppe, I. , (1998): Effects of microwaves emitted by cellular phones on human slow brain potentials. *Bioelectromagnetics* 19(6):384–387.

Frey, A. H. , (1993): Electromagnetic field interactions with biological systems. *FASEB J* 7(2):272–281.

Frick, U. , Rehm, J. and Eichhammer, P. , (2002): Risk perception, somatization, and self report of complaints related to electromagnetic fields—A randomized survey study. *Int J Hyg Environ Health* 205(5):353–360.

Funk, R. H. , (2015): Endogenous electric fields as guiding cue for cell migration. *Front Physiol* 6:143.

Furtado-Filho, O. V. , Borba, J. B. , Maraschin, T. , Souza, L. M. , Henriques, J. A. , Moreira, J. C. and Saffi, J. , (2015): Effects of chronic exposure to 950 MHz ultra-high-frequency electromagnetic radiation on reactive oxygen species metabolism in the right and left cerebral cortex of young rats of different ages. *Int J Radiat Biol* 91(11):891–897.

Furubayashi, T. , Ushiyama, A. , Terao, Y. , et al., (2009): Effects of short-term W-CDMA mobile phone base station exposure on women with or without mobile phone related symptoms. *Bioelectromagnetics* 30(2):100–113.

Gandhi, O. P. , Lazzi, G. and Furse, C. M. , (1996): Electromagnetic absorption in the human head and neck for mobile telephones at 835 and 1900 MHz. *IEEE Trans Microw Theor Tech* 44(10):1884–1897.

García, A. M. , Sisternas, A. and Hoyos, S. P. , (2008): Occupational exposure to extremely low frequency electric and magnetic fields and Alzheimer disease: A meta-analysis. *Int J Epidemiol* 37(2):329–340.

Gazerani, P. , Pourpak, Z. , Ahmadiani, A. , Hemmati, A. and Kazemnejad, A. , (2003): A correlation between migraine, histamine and immunoglobulin E. *Scand J Immunol* 57(3):286–290.

Geegar, R. J. , Foley, L. E. , Casselman, A. and Reppert, S. M. , (2010): Animal cryptochromes mediate magnetoreception by an unconventional photochemical mechanism. *Nature* 463(7282):804–807.

Genius, S. J. and Lipp, C. T. , (2012): Electromagnetic hypersensitivity: Fact or fiction? *Sci Total Environ* 414:103–112.

Genius, S. J. , (2010): Sensitivity-related illness: The escalating pandemic of allergy, food intolerance and chemical sensitivity. *Sci Total Environ* 408(24):6047–6061.

Georgopoulos, C. and Welch, W. J. , (1993): Role of the major heat shock proteins as molecular chaperones. *Annu Rev Cell Biol* 9:601–634.

Ghosn, R. , Yahia-Cherif, L. , Hugueville, L. , et al., (2015): Radiofrequency signal affects alpha band in resting electroencephalogram. *J Neurophysiol* 113(7):2753–2759.

Gibson, P. R. , Kovach, S. and Lupfer, A. , (2015): Unmet health care needs for persons with environmental sensitivity. *J Multidisc Healthc* 8:59–66.

Glaser, Z. R. , (1972): Bibliography of reported biological phenomena ("effects") and clinical manifestation attributed to microwave and radio-frequency radiation. Project MF12.524.015-00043 Report No. 2. Second Printing, with Revisions, Corrections, and Additions. Naval Medical Research Institute. National Naval Medical Center Bethesda, Maryland 20014, U.S.A.

Goodman, R. and Blank, M. , (2002): Insights into electromagnetic interaction mechanisms. *J Cell Physiol* 192(1):16–22.

Gökçek-Saraç, Ç. , Akçay, G. , Karakurt, S. , Ateş, K. , Özen, Ş. and Derin, N. , (2021): Possible effects of different doses of 2.1 GHz electromagnetic radiation on learning, and hippocampal levels of cholinergic biomarkers in Wistar rats. *Electromagn Biol Med* 40(1):179–190.

Greaves, M. W. and Sabroe, R. A. , (1996): Histamine: The quintessential mediator. *J Dermatol* 23(11):735–740.

Greco, F. , (2020): Technical assessment of ultrasonic cerebral Tomosphygmography and new scientific evaluation of its clinical interest for the diagnosis of electrohypersensitivity and multiple chemical sensitivity. *Diagnostics (Basel)* 10(6):427.

Grehl, S. , Martina, D. , Goyenvale, C. , Deng, Z. D. , Rodger, J. and Sherrard, R. M. , (2016): In vitro magnetic stimulation: A simple stimulation device to deliver defined low intensity electromagnetic fields. *Front Neural Circuits* 10:85.

Grigoriev, Y. G. , Grigoriev, O. A. , Ivanov, A. A. , Lyaginskaya, A. M. , Merkulov, A. V. , Stepanov, V. S. and Shagina, N. B. , (2010): Autoimmune process after long-term low-level exposure to electromagnetic field (experimental results). Part 1. Mobile communications and changes in electromagnetic conditions for the population: Need for additional substantiation of existing hygienic standards. *Biophysics* 55(6):1041–1045.

Gunaydin, H. and Houk, K. N. , (2009): Mechanisms of peroxynitrite-mediated nitration of tyrosine. *Chem Res Toxicol* 22(5):894–898.

Günzler, W. A. , Kremers, H. and Flohé, L. , (1974): An improved coupled test procedure for glutathione peroxidase (EC 1-11-1-9) in blood. *Z Klin Chem Klin Biochem* 12(10):444–448.

Guxens, M. , van Eijsden, M. , Vermeulen, R. , et al., (2013): Maternal cell phone and cordless phone use during pregnancy and behaviour problems in 5-year-old children. *JECH* 67(5):432–438.

Haas, H. L. , Sergeeva, O. A. and Selbach, O. , (2008): Histamine in the nervous system. *Physiol Rev* 88(3):1183–1241.

Hagström, M. , Auranen, J. and Ekman, R. , (2013): Electromagnetic hypersensitive Finns: Symptoms, perceived sources and treatments, a questionnaire study. *Pathophysiology* 20(2):117–122.

Hallberg, O. and Oberfeld, G. , (2006): Letter to the editor: Will we all become electrosensitive? *Electromagn Biol Med* 25(3):189–191.

Hardell, L. , (2017): World Health Organization, radiofrequency radiation and health - A hard nut to crack. *Int J Oncol* 51(2):405–413.

Hardell, L. and Carlberg, M. , (2020): Health risks from radiofrequency radiation, including 5G, should be assessed by experts with no conflicts of interest. *Oncol Lett* 20(4):15.

Hardell, L. , Carlberg, M. and Hansson Mild, K. , (2013): Use of mobile phones and cordless phones is associated with increased risk for glioma and acoustic neuroma. *Pathophysiology* 20(2):85–110.

Hardell, L. and Nyberg, R. , (2020): Appeals that matter or not on a moratorium on the deployment of the fifth generation, 5G, for microwave radiation. *Mol Clin Oncol* 12(3):247–257.

Hartl, F. U. , (1996): Molecular chaperones in cellular protein folding. *Nature* 381(6583):571–579.

Havas, M. , Marrongelle, J. , Pollner, B. , Kelley, E. , Rees, C. and Tully, L. , (2010): Provocation study using heart rate variability shows microwave radiation from 2.4 GHz cordless phone affects autonomic nervous system. In Giuliani L, Soffritti M (Eds): *Non-thermal effects and mechanisms of interaction between electromagnetic fields and living matter*. Fidenza: Mattioli, pp. 273–300. ISBN: 9788862611664.

Havas, M. , (2013): Radiation from wireless technology affects the blood, the heart, and the autonomic nervous system. *Rev Environ Health* 28(2–3):75–84.

Heneka, M. T. and O'Banion, M. K. , (2007): Inflammatory processes in Alzheimer's disease. *J Neuroimmunol* 184(1–2):69–91.

Heuser, G. and Heuser, S. A. , (2017): Functional brain MRI in patients complaining of electrohypersensitivity after long term exposure to electromagnetic fields. *Rev Environ Health* 32(3):291–299.

Hillert, L. , Hedman, B. K. , Söderman, E. and Arnetz, B. B. , (1999): Hypersensitivity to electricity: Working definition and additional characterization of the syndrome. *J Psychosom Res* 47(5):429–438.

Hillert, L. , Berglund, N. , Arnetz, B. B. and Bellander, T. , (2002): Prevalence of self-reported hypersensitivity to electric or magnetic fields in a population-based questionnaire survey. *Scand J Work Environ Health* 28(1):33–41.

Hillert, L. , Musabasic, V. , Berglund, H. , Ciumas, C. and Savic, I. , (2007): Odor processing in multiple chemical sensitivity. *Hum Brain Mapp* 28(3):172–182.

Hocking, B. , (1998): Preliminary report: Symptoms associated with mobile phone use. *Occup Med (Lond)* 48(6):357–360.

Hocking, B. and Westerman, R. , (2002): Neurological changes induced by a mobile phone. *Occup Med (Lond)* 52(7):413–415.

Hocking, B. and Westerman, R. , (2003): Neurological effects of radiofrequency radiation. *Occup Med (Lond)* 53(2):123–127.

Holmstrom, K. M. and Finkel, T. , (2014): Cellular mechanisms and physiological consequences of redox-dependent signaling. *Nat Rev Mol Cell Biol* 15(6):411–421.

Hu, C. , Zuo, H. and Li, Y. , (2021): Effects of radiofrequency electromagnetic radiation on neurotransmitters in the brain. *Front Public Health* 9:691880.

Huber, R. , Treyer, V. , Borbély, A. A. , et al., (2002): Electromagnetic fields, such as those from mobile phones, alter regional cerebral blood flow and sleep and waking EEG. *J Sleep Res* 11(4):289–295.

Huber, R. , Treyer, V. , Schuderer, J. , et al., (2005): Exposure to pulse-modulated radio frequency electromagnetic fields affects regional cerebral blood flow. *Eur J Neurosci* 21(4):1000–1006.

Huss, A. , van Eijsden, M. , Guxens, M. , et al., (2015): Environmental radiofrequency electromagnetic fields exposure at home, mobile and cordless phone use, and sleep problems in 7-year-old children. *PLOS ONE* 10(10):e0139869.

Hutter, H. P. , Moshammer, H. , Wallner, P. and Kundi, M. , (2006): Subjective symptoms, sleeping problems, and cognitive performance in subjects living near mobile phone base stations. *Occup Environ Med* 63(5):307–313.

IARC (International Agency for Research on Cancer) , (2002): Non-ionizing radiation, part 1: Static and extremely low-frequency (ELF) electric and magnetic fields. In IARC monographs on the evaluation of carcinogenic risks to humans. Lyon: IARC Press, Vol. 80, p. 341.

IARC (International Agency for Research on Cancer) , (2013): Non-ionization radiation, part 2: Radiofrequency electromagnetic fields. In IARC monographs on the evaluation of carcinogenic risks to humans. Lyon: IARC

Press, Vol. 102, p. 406.

ICNIRP (The International Commission on Non-Ionizing Radiation Protection) ., (1998): Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz). *Health Phys* 74:494–522.

ICNIRP (The International Commission on Non-Ionizing Radiation Protection) ., (2010): Guidelines for limiting exposure to time-varying electric and magnetic fields (1 Hz to 100 kHz). *Health Phys* 99(6):818–836.

ICNIRP (The International Commission on Non-Ionizing Radiation Protection) ., (2020): Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz). *Health Phys* 118(5):483–524.

Ikwegbue, P. C. , Masamba, P. , Oyinloye, B. E. and Kappo, A. P. , (2017): Roles of heat shock proteins in apoptosis, oxidative stress, human inflammatory diseases, and cancer. *Pharmaceuticals (Basel)* 11(1):2.

Inaba, R. , Shishido, K. , Okada, A. and Moroji, T. , (1992): Effects of whole body microwave exposure on the rat brain contents of biogenic amines. *Eur J Appl Physiol Occup Physiol* 65(2):124–128.

Irigaray, P. and Belpomme, D. , (2010): Basic properties and molecular mechanisms of exogenous chemical carcinogens. *Carcinogenesis* 31(2):135–148.

Irigaray, P. , Caccamo, D. and Belpomme, D. , (2018a): Oxidative stress in electrohypersensitivity self reporting patients: Results of a prospective in vivo investigation with comprehensive molecular analysis. *Int J Mol Med* 42(4):1885–1898.

Irigaray, P. , Garrel, C. , Houssay, C. , Mantello, P. and Belpomme, D. , (2018b): Beneficial effects of a fermented papaya preparation for the treatment of electrohypersensitivity self-reporting patients: Results of a phase I–II clinical trial with special reference to cerebral pulsation measurement and oxidative stress analysis. *Funct Foods Health Dis* 8(2):122–144.

Irigaray, P. , Lebar, P. and Belpomme, D. , (2018c): How ultrasonic cerebral Tomosphygmography can contribute to the diagnosis of electrohypersensitivity. *J Clin Diagn Res* 6:143.

Ischiropoulos, H. , Zhu, L. , Chen, J. , Tsai, M. , Martin, J. C. , Smith, C. D. and Beckman, J. S. , (1992): Peroxynitrite-mediated tyrosine nitration catalyzed by superoxide dismutase. *Arch Biochem Biophys* 298(2):431–437.

Ivancsits, S. , Diem, E. , Pilger, A. , Rüdiger, H. W. and Jahn, O. , (2002): Induction of DNA strand breaks by intermittent exposure to extremely-low-frequency electromagnetic fields in human diploid fibroblasts. *Mutat Res* 519(1–2):1–13.

Ivancsits, S. , Diem, E. , Jahn, O. and Rüdiger, H. W. , (2003): Age-related effects on induction of DNA strand breaks by intermittent exposure to electromagnetic fields. *Mech Ageing Dev* 124(7):847–850.

Ji, J. , Zhang, Y. H. , Yang, X. Q. , Jiang, R. P. , Guo, D. M. and Cui, X. , (2012): The influence of microwave radiation from cellular phone on fetal rat brain. *Electromagn Biol Med* 31(1):57–66.

Jocelyn, P. C. , (1987): Spectrophotometric assay of thiols. *Methods Enzymol* 143:44–67.

Johansson, A. , Nordin, S. , Heiden, M. and Sandström, M. , (2010): Symptoms, personality traits, and stress in people with mobile phone-related symptoms and electromagnetic hypersensitivity. *J Psychosom Res* 68(1):37–45.

Johansson, O. , (2009): Disturbance of the immune system by electromagnetic fields-A potentially underlying cause for cellular damage and tissue repair reduction which could lead to disease and impairment. *Pathophysiology* 16(2–3):157–177.

Johansson, O. , Gangi, S. , Liang, Y. , Yoshimura, K. , Jing, C. and Liu, P. Y. , (2001): Cutaneous mast cells are altered in normal healthy volunteers sitting in front of ordinary TVs/PCs—Results from open-field provocation experiments. *J Cutan Pathol* 28(10):513–519.

Johnsen, S. and Lohmann, K. J. , (2005): The physics and neurobiology of magnetoreception. *Nat Rev Neurosci* 6(9):703–712.

Johnston, L. , (2008): Suicides “linked to phone masts”. *Express.co.uk*, 22 juin 2008. www.express.co.uk/posts/view/49330/Suicides-linked-to-phone-masts.

Joubert, V. , Bourthoumieu, S. , Leveque, P. and Yardin, C. , (2008): Apoptosis is induced by radiofrequency fields through the caspase-independent mitochondrial pathway in cortical neurons. *Radiat Res* 169(1):38–45.

Juutilainen, J. , Matilainen, P. , Saarikoski, S. , Läärä, E. and Suonio, S. , (1993): Early pregnancy loss and exposure to 50-Hz magnetic fields. *Bioelectromagnetics* 14(3):229–236.

Kapural, M. , Krizanac-Bengez, Lj. , Barnett, G. , et al. , (2002): Serum S-100beta as a possible marker of blood-brain barrier disruption. *Brain Res* 940(1–2):102–104.

Kato, Y. and Johansson, O. , (2012): Reported functional impairments of electrohypersensitive Japanese: A questionnaire survey. *Pathophysiology* 19(2):95–100.

Kelly, S. and Yenari, M. A. , (2002): Neuroprotection: Heat shock proteins. *Curr Med Res Opin* 18:s55–s60.

Kesari, K. K. , Meena, R. , Nirala, J. , Kumar, J. and Verma, H. N. , (2014): Effect of 3G cell phone exposure with computer controlled 2-D stepper motor on non-thermal activation of the hsp27/p38MAPK stress pathway in rat brain. *Cell Biochem Biophys* 68(2):347–358.

Kheifets, L. , Repacholi, M. , Saunders, R. and van Deventer, E. , (2005): The sensitivity of children to electromagnetic fields. *Pediatrics* 116(2):e303–e313.

Kirschvink, J. L. , (1996): Microwave absorption by magnetite: A possible mechanism for coupling nonthermal levels of radiation to biological systems. *Bioelectromagnetics* 17(3):187–194.

- Kirschvink, J. L. , Kobayashi-Kirschvink, A. and Woodford, B. J. , (1992): Magnetite biomineralization in the human brain. *Proc Natl Acad Sci U S A* 89(16):7683–7687.
- Kleinlogel, H. , Dierks, T. , Koenig, T. , Lehmann, H. , Minder, A. and Berz, R. , (2008): Effects of weak mobile phone - Electromagnetic fields (GSM, UMTS) on event related potentials and cognitive functions. *Bioelectromagnetics* 29(6):488–497.
- Knave, B. G. , Wibom, R. I. , Voss, M. , Hedström, L. D. and Bergqvist, U. O. , (1985): Work with video display terminals among office employees. I. Subjective symptoms and discomfort. *Scand J Work Environ Health* 11(6):457–466.
- Koh, S. X. and Lee, J. K. , (2014): S100B as a marker for brain damage and blood-brain barrier disruption following exercise. *Sports Med* 44(3):369–385.
- Koppel, T. , Vilcane, I. and Ahonen, M. , (2018): 50 Hz magnetic field affects heart rate variability—An experimental study. In *Proceedings of the 2018 EMF-Med 1st world conference on biomedical applications of electromagnetic fields (EMF-Med)*, Split, Croatia, 10–13 September 2018; New York: IEEE, pp. 1–2. <https://doi.org/10.23919/EMF-MED.2018.8526072>.
- Korpinen, L. H. and Pääkkönen, R. J. , (2009): Self-report of physical symptoms associated with using mobile phones and other electrical devices. *Bioelectromagnetics* 30(6):431–437.
- Köteles, F. , Szemerszky, R. , Gubányi, M. , et al., (2013): Idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF) and electrosensitivity (ES) - Are they connected? *Int J Hyg Environ Health* 216(3):362–370.
- Kovács, J. , Brodner, W. , Kirchlechner, V. , Arif, T. and Waldhauser, F. , (2000): Measurement of urinary melatonin: A useful tool for monitoring serum melatonin after its oral administration. *J Clin Endocrinol Metab* 85(2):666–670.
- Kowall, B. , Breckenkamp, J. , Blettner, M. , Schlehofer, B. , Schüz, J. and Berg-Beckhoff, G. , (2012): Determinants and stability over time of perception of health risks related to mobile phone base stations. *Int J Public Health* 57(4):735–743.
- Krause, C. M. , Sillanmäki, L. , Koivisto, M. , et al., (2000): Effects of electromagnetic field emitted by cellular phones on the EEG during a memory task. *NeuroReport* 11(4):761–764.
- Küçer, N. and Pamukçu, T. , (2014): Self-reported symptoms associated with exposure to electromagnetic fields: A questionnaire study. *Electromagn Biol Med* 33(1):15–17.
- Kumar, G. , Gupta, N. and Sinha, N. K. , (2018): Mobile phone users and its effect of hearing in terms of distortion product otoacoustic emission (DPOAE). *J Evol Med Dent Sci* 7(52):5520–5523.
- Lacour, M. , Zunder, T. , Schmidtke, K. , Vaith, P. and Scheidt, C. , (2005): Multiple chemical sensitivity syndrome (MCS)—Suggestions for an extension of the U.S. MCS-case definition. *Int J Hyg Environ Health* 208(3):141–151.
- Lai, H. , (2021): Genetic effects of non-ionizing electromagnetic fields. *Electromagn Biol Med* 40(2):264–273.
- Lai, H. and Singh, N. P. , (1995): Acute low-intensity microwave exposure increases DNA single-strand breaks in rat brain cells. *Bioelectromagnetics* 16(3):207–210.
- Lai, H. and Singh, N. P. , (2004): Magnetic-field-induced DNA strand breaks in brain cells of the rat. *Environ Health Perspect* 112(6):687–694.
- Lai, Y. F. , Wang, H. Y. and Peng, R. Y. , (2021): Establishment of injury models in studies of biological effects induced by microwave radiation. *Mil Med Res* 8(1):12.
- Landgrebe, M. , Frick, U. , Hauser, S. , Langguth, B. , Rosner, R. , Hajak, G. and Eichhammer, P. , (2008): Cognitive and neurobiological alterations in electromagnetic hypersensitive patients: Results of a case-control study. *Psychol Med* 38(12):1781–1791.
- Leak, R. K. , Zhang, L. , Stetler, R. A. , et al., (2013): HSP27 protects the blood-brain barrier against ischemia-induced loss of integrity. *CNS Neurol Disord Drug Targets* 12(3):325–337.
- Lebel, B. , Arnoux, B. , Chanez, P. , Bougeard, Y. H. , Dures, J. P. , Bousquet, J. and Campbell, A. M. , (1996): Ex vivo pharmacologic modulation of basophil histamine release in asthmatic patients. *Allergy* 51(6):394–400.
- Leone, L. , Fusco, S. , Mastrodonato, A. , et al., (2014): Epigenetic modulation of adult hippocampal neurogenesis by extremely low-frequency electromagnetic fields. *Mol Neurobiol* 49(3):1472–1486.
- Leszczynski, D. , Joenväärä, S. , Reivinen, J. and Kuokka, R. , (2002): Non-thermal activation of the hsp27/p38MAPK stress pathway by mobile phone radiation in human endothelial cells: Molecular mechanism for cancer- and blood-brain barrier-related effects. *Differentiation* 70(2–3):120–129.
- Levallois, P. , (2002): Hypersensitivity of human subjects to environmental electric and magnetic field exposure: A review of the literature. *Environ Health Perspect* 110:613–618.
- Levallois, P. , Neutra, R. , Lee, G. and Hristova, L. , (2002): Study of self-reported hypersensitivity to electromagnetic fields in California. *Environ Health Perspect* 110:619–623.
- Li, H. J. , Peng, R. Y. , Wang, C. Z. , et al., (2015): Alterations of cognitive function and 5-HT system in rats after long term microwave exposure. *Physiol Behav* 140:236–246.
- Liburdy, R. P. , (1979): Radiofrequency radiation alters the immune system: Modulation of T- and B-lymphocyte levels and cell-mediated immunocompetence by hyperthermic radiation. *Radiat Res* 77(1):34–46.
- Liburdy, R. P. , (1980): Radiofrequency radiation alters the immune system. II. Modulation in vivo lymphocyte circulation. *Radiat Res* 83(1):66–73.

Liburdy, R. P. , (1992): Calcium signalling in lymphocytes and ELF fields: Evidence for an electric field metric and a site of interaction involving the calcium ion channel. *FEBS Lett* 301(1):53–59.

Liburdy, R. P. and Wyant, A. , (1984): Radiofrequency radiation and the immune system. Part 3. In vitro effects on human immunoglobulin and on murine T- and B-lymphocytes. *Int J Radiat Biol Relat Stud Phys Chem Med* 46(1):67–81.

Lin, H. , Blank, M. and Goodman, R. , (1999): A magnetic field-responsive domain in the human HSP70 promoter. *J Cell Biochem* 75(1):170–176.

Lin, H. , Blank, M. , Rossol-Haseroth, K. and Goodman, R. , (2001): Regulating genes with electromagnetic response elements. *J Cell Biochem* 81(1):143–148.

Lin, H. , Opler, M. , Head, M. , Blank, M. and Goodman, R. , (1997): Electromagnetic field exposure induces rapid, transitory heat shock factor activation in human cells. *J Cell Biochem* 66(4):482–488.

Lindén, V. and Rolfsen, S. , (1981): Video computer terminals and occupational dermatitis. *Scand J Work Environ Health* 7(1):62–64.

Liu, H. , Chen, G. , Pan, Y. , et al., (2014): Occupational electromagnetic field exposures associated with sleep quality: A cross-sectional study. *PLOS ONE* 9(10):e110825.

Liu, S. , Wing, Y. K. , Hao, Y. , Li, W. , Zhang, J. and Zhang, B. , (2019): The associations of long-time mobile phone use with sleep disturbances and mental distress in technical college students: A prospective cohort study. *Sleep* 42(2). doi: 10.1093/sleep/zsy213

Londero, D. and Lo Greco, P. , (1996): Automated high-performance liquid chromatographic separation with spectrofluorometric detection of a malondialdehyde-thiobarbituric acid adduct in plasma. *J Chromatogr A* 729(1–2):207–210.

Loos, N. , Thuróczy, G. , Ghosn, R. , et al., (2013): Is the effect of mobile phone radiofrequency waves on human skin perfusion non-thermal? *Microcirculation* 20(7):629–636.

Loughran, S. P. , Verrender, A. , Dalecki, A. , et al., (2019): Radiofrequency electromagnetic field exposure and the resting EEG: Exploring the thermal mechanism hypothesis. *Int J Environ Res Public Health* 16(9):1505.

Lowden, A. , Akerstedt, T. , Ingre, M. , et al., (2011): Sleep after mobile phone exposure in subjects with mobile phone-related symptoms. *Bioelectromagnetics* 32(1):4–14.

Lustenberger, C. , Murbach, M. , Dürr, R. , Schmid, M. R. , Kuster, N. , Achermann, P. and Huber, R. , (2013): Stimulation of the brain with radiofrequency electromagnetic field pulses affects sleep-dependent performance improvement. *Brain Stimul* 6(5):805–811.

Ma, Q. , Deng, P. , Zhu, G. , et al., (2014): Extremely low-frequency electromagnetic fields affect transcript levels of neuronal differentiation-related genes in embryonic neural stem cells. *PLOS ONE* 9(3):e90041.

Maher, B. A. , Ahmed, I. A. , Karloukovski, V. , et al., (2016): Magnetite pollution nanoparticles in the human brain. *Proc Natl Acad Sci U S A* 113(39):10797–10801.

Mahmoudabadi, F. S. , Ziaei, S. , Firoozabadi, M. and Kazemnejad, A. , (2015): Use of mobile phone during pregnancy and the risk of spontaneous abortion. *J Environ Health Sci Eng* 13:34.

Malek, F. , Rani, K. A. , Rahim, H. A. and Omar, M. H. , (2015): Effect of short-term mobile phone base station exposure on cognitive performance, body temperature, heart rate and blood pressure of Malaysians. *Sci Rep* 5:13206.

Mann, K. and Röschke, J. , (1996): Effects of pulsed high-frequency electromagnetic fields on human sleep. *Neuropsychobiology* 33(1):41–47.

Mannervik, B. , (2001): Measurement of glutathione reductase activity. *Curr Protoc Toxicol* Chapter 7:Unit7.2. doi: 10.1002/0471140856.tx0702s00

Marchi, N. , Cavaglia, M. , Fazio, V. , Bhudia, S. , Hallene, K. and Janigro, D. , (2004): Peripheral markers of blood-brain barrier damage. *Clin Chim Acta* 342(1–2):1–12.

Marklund, S. and Marklund, G. , (1974): Involvement of the superoxide anion radical in the autoxidation of pyrogallol and a convenient assay for superoxide dismutase. *Eur J Biochem* 47(3):469–474.

Marková, E. , Hillert, L. , Malmgren, L. , Persson, B. R. and Belyaev, I. Y. , (2005): Microwaves from GSM mobile telephones affect 53BP1 and gamma-H2AX foci in human lymphocytes from hypersensitive and healthy persons. *Environ Health Perspect* 113(9):1172–1177.

Marquardt, D. L. , (1983): Histamine. *Clin Rev Allergy* 1(3):343–351.

Marshall, J. S. , (2004): Mast-cell responses to pathogens. *Nat Rev Immunol* 4(10):787–799.

Martens, A. L. , Slottje, P. , Smid, T. , Kromhout, H. , Vermeulen, R. C. H. and Timmermans, D. R. M. , (2018): Longitudinal associations between risk appraisal of base stations for mobile phones, radio or television and non-specific symptoms. *J Psychosom Res* 112:81–89.

Martens, A. L. , Slottje, P. , Timmermans, D. R. M. , Kromhout, H. , Reedijk, M. , Vermeulen, R. C. H. and Smid, T. , (2017): Modeled and perceived exposure to radiofrequency electromagnetic fields from mobile-phone base stations and the development of symptoms over time in a general population cohort. *Am J Epidemiol* 186(2):210–219.

Mashevich, M. , Folkman, D. , Kesar, A. , Barbul, A. , Korenstein, R. , Jerby, E. and Avivi, L. , (2003): Exposure of human peripheral blood lymphocytes to electromagnetic fields associated with cellular phones leads to chromosomal instability. *Bioelectromagnetics* 24(2):82–90.

Mathie, A. , Kennard, L. E. and Veale, E. L. , (2003): Neuronal ion channels and their sensitivity to extremely low frequency weak electric field effects. *Radiat Prot Dosim* 106(4):311–316.

Mayhan, W. G. , (1996): Role of nitric oxide in histamine-induced increases in permeability of the blood-brain barrier. *Brain Res* 743(1–2):70–76.

McCaig, C. D. , Rajnicek, A. M. , Song, B. and Zhao, M. , (2005): Controlling cell behavior electrically: Current views and future potential. *Physiol Rev* 85(3):943–978.

McCaig, C. D. and Zhao, M. , (1997): Physiological electric fields modify cell behaviour. *BioEssays* 19(9):819–826.

McCarty, D. E. , Carrubba, S. , Chesson, A. L. , Frilot, C. , Gonzalez-Toledo, E. and Marino, A. A. , (2011): Electromagnetic hypersensitivity: Evidence for a novel neurological syndrome. *Int J Neurosci* 121(12):670–676.

McInerney, T. K. , (2012): The cell phone right to know act H.R., 6358. Federal Legislation on Wireless. Letter on behalf of the American Academy of Pediatrics (AAP) to Dennis Kucinich (Washington DC). December 12. <https://skyvisionsolutions.files.wordpress.com/2013/04/aap-letter.pdf>.

McKeown-Eyssen, G. , Baines, C. , Cole, D. E. , Riley, N. , Tyndale, R. F. , Marshall, L. and Jazmaji, V. , (2004): Case-control study of genotypes in multiple chemical sensitivity: CYP2D6, NAT1, NAT2, PON1, PON2 and MTHFR. *Int J Epidemiol* 33(5):971–978.

McLean, L. , (2008): The impacts of radiofrequency radiation from mobile phone antennas. EMR Australia report. http://www.champs-electromagnetiques.com/images_doc/australie_antennerelais.pdf.

McMahan, S. and Meyer, J. , (1995): Symptom prevalence and worry about high voltage transmission lines. *Environ Res* 70(2):114–118.

Medeiros, L. N. and Sanchez, T. G. , (2016): Tinnitus and cell phones: The role of electromagnetic radiofrequency radiation. *Braz J Otorhinolaryngol* 82(1):97–104.

Meg Tseng, M. C. , Lin, Y. P. and Cheng, T. J. , (2011): Prevalence and psychiatric comorbidity of self-reported electromagnetic field sensitivity in Taiwan: A population-based study. *J Formos Med Assoc* 110(10):634–641.

Meggs, W. J. , (1993): Neurogenic inflammation and sensitivity to environmental chemicals. *Environ Health Perspect* 101(3):234–238.

Meggs, W. J. , (1997): Hypothesis for induction and propagation of chemical sensitivity based on biopsy studies. *Environ Health Perspect* 105:473–478.

Megha, K. , Deshmukh, P. S. , Banerjee, B. D. , Tripathi, A. K. , Ahmed, R. and Abegaonkar, M. P. , (2015a): Low intensity microwave radiation induced oxidative stress, inflammatory response and DNA damage in rat brain. *Neurotoxicology* 51:158–165.

Megha, K. , Deshmukh, P. S. , Ravi, A. K. , Tripathi, A. K. , Abegaonkar, M. P. and Banerjee, B. D. , (2015b): Effect of low-intensity microwave radiation on monoamine neurotransmitters and their key regulating enzymes in rat brain. *Cell Biochem Biophys* 73(1):93–100.

Merritt, J. H. , Chamness, A. F. and Allen, S. J. , (1978): Studies on blood-brain barrier permeability after microwave-radiation. *Radiat Environ Biophys* 15(4):367–377.

Michetti, F. , Corvino, V. , Geloso, M. C. , Lattanzi, W. , Bernardini, C. , Serpero, L. and Gazzolo, D. , (2012): The S100B protein in biological fluids: More than a lifelong biomarker of brain distress. *J Neurochem* 120(5):644–659.

Migheli, A. , Cordera, S. , Bendotti, C. , Atzori, C. , Piva, R. and Schiffer, D. , (1999): S-100beta protein is upregulated in astrocytes and motor neurons in the spinal cord of patients with amyotrophic lateral sclerosis. *Neurosci Lett* 261(1–2):25–28.

Mild, K. H. , Repacholi, M. , van Deventer, E. and Ravazzani, P. , (2006): Electromagnetic hypersensitivity. In *Proceedings of the WHO international seminar and working group meeting on EMF hypersensitivity*, Prague, Czech Republic, 25–27 October 2004; Geneva: World Health Organization. ISBN: 92-4-159412-8.

Milde-Busch, A. , von Kries, R. , Thomas, S. , Heinrich, S. , Straube, A. and Radon, K. , (2010): The association between use of electronic media and prevalence of headache in adolescents: Results from a population-based cross-sectional study. *BMC Neurol* 10:12.

Miller, A. B. , Sears, M. E. , Morgan, L. L. , Davis, D. L. , Hardell, L. , Oremus, M. and Soskolne, C. L. , (2019): Risks to health and well-being from radio-frequency radiation emitted by cell phones and other wireless devices. *Front Public Health* 7:223.

Miller, C. S. , (1999): Are we on the threshold of a new theory of disease? Toxicant-induced loss of tolerance and its relationship to addiction and abidction. *Toxicol Ind Health* 15(3–4):284–294.

Mohler, E. , Frei, P. , Fröhlich, J. , Braun-Fahrlander, C. , Rössli, M. and QUALIFEX-Team , (2012): Exposure to radiofrequency electromagnetic fields and sleep quality: A prospective cohort study. *PLOS ONE* 7(5):e37455.

Monazzam, M. R. , Hosseini, M. , Matin, L. F. , Aghaei, H. A. , Khosroabadi, H. and Hesami, A. , (2014): Sleep quality and general health status of employees exposed to extremely low frequency magnetic fields in a petrochemical complex. *J Environ Health Sci Eng* 12:78.

Moretti, R. , Pansiot, J. , Bettati, D. , et al., (2015): Blood-brain barrier dysfunction in disorders of the developing brain. *Front Neurosci* 9:40.

Mortazavi, S. M. J. , Ahmadi, J. and Shariati, M. , (2007): Prevalence of subjective poor health symptoms associated with exposure to electromagnetic fields among university students. *Bioelectromagnetics* 28(4):326–330.

Mousavy, S. J. , Riazi, G. H. , Kamarei, M. , et al., (2009): Effects of mobile phone radiofrequency on the structure and function of the normal human hemoglobin. *Int J Biol Macromol* 44(3):278–285.

Muehsam, D. , Lalezari, P. , Lekhraj, R. , et al., (2013): Non-thermal radio frequency and static magnetic fields increase rate of hemoglobin deoxygenation in a cell-free preparation. *PLOS ONE* 8(4):e61752.

Mueller, C. H. and Schierz, C. , (2004): Project NEMESIS: Doubleblind study on effects of 50 Hz EMF on sleep quality, physiological parameters and field perception in people suffering from electrical hypersensitivity. In K. H. Mild , M. Repacholi , E. van Deventer and P. Ravazzani ed., *Electromagnetic hypersensitivity: Proceedings of the international workshop on EMF hypersensitivity*. Prague, World Health Organization, pp. 107–121.

Murakamai, S. , Takayama, F. , Egashira, T. , Imao, M. and Morio, A. , (2012): Protective effect of fermented papaya preparation on stress-induced acute gastric mucosal lesion. *J Biophys Chem* 3:311–316.

Murakami, M. , Yoshikawa, T. , Nakamura, T. , et al., (2015): Involvement of the histamine H1 receptor in the regulation of sympathetic nerve activity. *Biochem Biophys Res Commun* 458(3):584–589.

Myung, S. K. , Ju, W. , McDonnell, D. D. , Lee, Y. J. , Kazinets, G. , Cheng, C. T. and Moskowitz, J. M. , (2009): Mobile phone use and risk of tumors: A meta-analysis. *J Clin Oncol* 27(33):5565–5572.

National Toxicology Program ., (2018a): NTP technical report on the toxicology and carcinogenesis studies in Hsd: Sprague Dawley SD rats exposed to whole-body radio frequency radiation at a frequency (900 MHz) and modulations (GSM and CDMA) used by cell phones. Washington, DC: NTP. https://ntp.niehs.nih.gov/ntp/about_ntp/trpanel/2018/march/tr595peerdraft.pdf.

National Toxicology Program ., (2018b): NTP technical report on the toxicology and carcinogenesis studies in B6C3F1/N mice exposed to whole-body radio frequency radiation at a frequency (1900 MHz) and modulations (GSM and CDMA) used by cell phones. Washington, DC: NTP. https://ntp.niehs.nih.gov/ntp/about_ntp/trpanel/2018/march/tr596peerdraft.

Navarro, E. A. , Segura, J. , Portoles, M. and Gomez-Perretta, C. , (2003): The microwave syndrome: A preliminary study in Spain. *Electromagn Biol Med* 22(2–3):161–169.

NIEHS (National Institute of Environmental Health Sciences) ., (1998): Assessment of health effects from exposure to power-line frequency electric and magnetic fields. Publication No. 98-3981. Research Triangle Park, NC: NIEHS.

Nilsen, A. , (1982): Facial rash in visual display unit operators. *Contact Dermatitis* 8(1):25–28.

Nitby, H. , Brun, A. , Eberhardt, J. , Malmgren, L. , Persson, B. R. and Salford, L. G. , (2009): Increased blood-brain barrier permeability in mammalian brain 7 days after exposure to the radiation from a GSM-900 mobile phone. *Pathophysiology* 16(2–3):103–112.

Nitby, H. , Grafström, G. , Eberhardt, J. L. , Malmgren, L. , Brun, A. , Persson, B. R. and Salford, L. G. , (2008): Radiofrequency and extremely low-frequency electromagnetic field effects on the blood-brain barrier. *Electromagn Biol Med* 27(2):103–126.

Noor, N. A. , Mohammed, H. S. , Ahmed, N. A. and Radwan, N. M. , (2011): Variations in amino acid neurotransmitters in some brain areas of adult and young male albino rats due to exposure to mobile phone radiation. *Eur Rev Med Pharmacol Sci* 15(7):729–742.

Nordal, R. A. and Wong, C. S. , (2005): Molecular targets in radiation-induced blood-brain barrier disruption. *Int J Radiat Oncol Biol Phys* 62(1):279–287.

Nordenson, I. , Mild, K. H. , Andersson, G. and Sandström, M. , (1994): Chromosomal aberrations in human amniotic cells after intermittent exposure to fifty hertz magnetic fields. *Bioelectromagnetics* 15(4):293–301.

Nordin, S. , Neely, G. , Olsson, D. and Sandström, M. , (2014): Odor and noise intolerance in persons with self-reported electromagnetic hypersensitivity. *Int J Environ Res Public Health* 11(9):8794–8805.

Nordmann, G. C. , Hochstoeger, T. and Keays, D. A. , (2017): Magnetoreception-A sense without a receptor. *PLOS Biol* 15(10):e2003234.

Nuccitelli, R. , (1988): Ionic currents in morphogenesis. *Experientia* 44(8):657–666.

Nuccitelli, R. (2003): Endogenous electric fields during development, regeneration and wound healing. *Radiat Prot Dosimetry*. 106(4):375–383.

Oberfeld, G. , Navarro, E. , Portoles, M. , Ceferino, M. and Gomez-Perretta, C. , (2004): The microwave syndrome further aspect of a Spanish study. In *Proceedings of the international conference in Kos. Greece*, pp. 1–5.

Odaci, E. , Hanci, H. , İkinçi, A. , et al., (2016): Maternal exposure to a continuous 900-MHz electromagnetic field provokes neuronal loss and pathological changes in cerebellum of 32-day-old female rat offspring. *J Chem Neuroanat* 75(B):105–110.

Odemer, R. and Odemer, F. , (2019): Effects of radiofrequency electromagnetic radiation (RF-EMF) on honey bee queen development and mating success. *Sci Total Environ* 661:553–562.

Ohkawa, H. , Ohishi, N. and Yagi, K. , (1979): Assay for lipid peroxides in animal tissues by thiobarbituric acid reaction. *Anal Biochem* 95(2):351–358.

Ohmori, H. and Kanayama, N. , (2003): Mechanisms leading to autoantibody production: Link between inflammation and autoimmunity. *Curr Drug Targets Inflamm Allergy* 2(3):232–241.

Onodera, K. , Yamatodani, A. , Watanabe, T. and Wada, H. , (1994): Neuropharmacology of the histaminergic neuron system in the brain and its relationship with behavioral disorders. *Prog Neurobiol* 42(6):685–702.

Oscar, K. J. and Hawkins, T. D. , (1977): Microwave alteration of the blood-brain barrier system of rats. *Brain Res* 126(2):281–293.

Pacher, P. , Beckman, J. S. and Liaudet, L. , (2007): Nitric oxide and peroxynitrite in health and disease. *Physiol Rev* 87(1):315–424.

Padawer, J. , (1963): Quantitative studies with mast cells. *Ann N Y Acad Sci* 103(1):87–138.

Pall, M. L. , (2013): Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects. *J Cell Mol Med* 17(8):958–965.

Pall, M. L. , (2018): Wi-fi is an important threat to human health. *Environ Res* 164:405–416.

Palmquist, E. , Claeson, A. S. , Neely, G. , Stenberg, B. and Nordin, S. , (2014): Overlap in prevalence between various types of environmental intolerance. *Int J Hyg Environ Health* 217(4–5):427–434.

Panagopoulos, D. J. , Messini, N. , Karabarbounis, A. , Filippelis, A. L. and Margaritis, L. H. , (2000): A mechanism for action of oscillating electric fields on cells. *Biochem Biophys Res Commun* 272(3):634–640.

Panagopoulos, D. J. , Karabarbounis, A. and Margaritis, L. H. , (2002): Mechanism for action of electromagnetic fields on cells. *Biochem Biophys Res Commun* 298(1):95–102.

Panagopoulos, D. J. , Chavdoula, E. D. , Nezis, I. P. and Margaritis, L. H. , (2007): Cell Death induced by GSM 900 MHz and DCS 1800 MHz mobile telephony radiation. *Mutat Res* 626(1–2):69–78.

Panagopoulos, D. J. , Chavdoula, E. D. and Margaritis, L. H. , (2010): Bioeffects of mobile telephony radiation in relation to its intensity or distance from the Antenna. *Int J Radiat Biol* 86(5):345–357.

Panagopoulos, D. J. , Johansson, O. and Carlo, G. L. , (2015): Polarization: A key difference between man-made and natural electromagnetic fields, in regard to biological activity. *Sci Rep* 12:14914.

Panagopoulos, D. J. , (2019): Comparing DNA damage induced by mobile telephony and other types of man-made electromagnetic fields. *Mutat Res Rev Mutat Res* 781:53–62.

Panagopoulos, D. J. and Chrousos, G. P. , (2019): Shielding methods and products against man-made electromagnetic fields: Protection versus risk. *Sci Total Environ* 667C:255–262.

Panagopoulos, D. J. , (2020): Comparing chromosome damage induced by mobile telephony radiation and a high caffeine dose: Effect of combination and exposure duration. *Gen Physiol Biophys* 39(6):531–544.

Panagopoulos, D. J. , Karabarbounis, A. , Yakymenko, I. and Chrousos, G. P. , (2021): Human-made electromagnetic fields: Ion forced-oscillation and voltage-gated ion channel dysfunction, oxidative stress and DNA damage (review). *Int J Oncol* 59(5):92. <https://doi.org/10.3892/ijo.2021.5272>.

Panula, P. and Nuutinen, S. , (2013): The histaminergic network in the brain: Basic organization and role in disease. *Nat Rev Neurosci* 14(7):472–487.

Patel, J. P. and Frey, B. N. , (2015): Disruption in the blood-brain barrier: The missing link between brain and body inflammation in bipolar disorder? *Neural Plast* 2015:708306.

Pearson, T. A. , Mensah, G. A. , Alexander, R. W. , et al.; Centers for Disease Control and Prevention; American Heart Association ., (2003): Markers of inflammation and cardiovascular disease: Application to clinical and public health practice: A statement for healthcare professionals from the Centers for Disease Control and Prevention and the American Heart Association. *Circulation* 107(3):499–511.

Perry, F. S. , Reichmanis, M. , Marino, A. A. and Becker, R. O. , (1981): Environmental power-frequency magnetic fields and suicide. *Health Phys* 41(2):267–277.

Petkov, V. D. and Konstantinova, E. , (1986): Effects of the ergot alkaloid elymoclavine on the level and turnover of biogenic monoamines in the rat brain. *Arch Int Pharmacodyn Ther* 281(1):22–34.

Phares, T. W. , Fabis, M. J. , Brimer, C. M. , Kean, R. B. and Hooper, D. C. , (2007): A peroxynitrite-dependent pathway is responsible for blood-brain barrier permeability changes during a central nervous system inflammatory response: TNF-alpha is neither necessary nor sufficient. *J Immunol* 178(11):7334–7343.

Phillips, A. , (2002): Peer review and quality of science. Comments Posted at 07/08/2006 on Powerwatch Website. <https://www.powerwatch.org.uk/columns/aphilips/index.asp>.

Phillips, J. L. , Singh, N. P. and Lai, H. , (2009): Electromagnetic fields and DNA damage. *Pathophysiology* 16(2–3):79–88.

Pihan, G. A. and Doxsey, S. J. , (1999): The mitotic machinery as a source of genetic instability in cancer. *Semin Cancer Biol* 9(4):289–302.

Pinton, G. , Ferraro, A. , Balma, M. and Moro, L. , (2020): Specific low-frequency electromagnetic fields induce expression of active KDM6B associated with functional changes in U937 cells. *Electromagn Biol Med* 39(2):139–153.

Pockley, A. G. , Shepherd, J. and Corton, J. M. , (1998): Detection of heat shock protein 70 (Hsp70) and anti-Hsp70 antibodies in the serum of normal individuals. *Immunol Investig* 27(6):367–377.

Pollack, H. , (1979): The microwave syndrome. *Bull N Y Acad Med* 55(11):1240–1243.

Poole, C. , Kavet, R. , Funch, D. P. , Donelan, K. , Charry, J. M. and Dreyer, N. A. , (1993): Depressive symptoms and headaches in relation to proximity of residence to an alternating-current transmission line right-of-way. *Am J Epidemiol* 137(3):318–330.

Porcelli, M. , Cacciapuoti, G. , Fusco, S. , Massa, R. , d'Ambrosio, G. , Bertoldo, C. , De Rosa, M. and Zappia, V. , (1997): Non-thermal effects of microwaves on proteins: Thermophilic enzymes as model system. *FEBS Lett* 402(2–3):102–106.

Profumo, E. , Buttari, B. and Riganò, R. , (2011): Oxidative stress in cardiovascular inflammation: Its involvement in autoimmune responses. *Int J Inflamm* 2011:295705.

Purkayastha, S. and Sorond, F. , (2012): Transcranial doppler ultrasound: Technique and application. *Semin Neurol* 32(4):411–420.

Qiu, C. , Fratiglioni, L. , Karp, A. , Winblad, B. and Bellander, T. , (2004): Occupational exposure to electromagnetic fields and risk of Alzheimer's disease. *Epidemiology* 15(6):687–694.

Randolph, T. G. , (1962): Human ecology and susceptibility to the chemical environment. Charles C Thomas publisher, Springfield, US.

Rea, W. J. , (2016): History of chemical sensitivity and diagnosis. *Rev Environ Health* 31(3):353–361.

Rea, W. J. , Pan, Y. , Fenyves, E. F. , et al., (1991): Electromagnetic field sensitivity. *J Bioelectr* 10:214–256.

Redlarski, G. , Lewczuk, B. , Żak, A. , et al., (2015): The influence of electromagnetic pollution on living organisms: Historical trends and forecasting changes. *BioMed Res Int* 2015:234098.

Redmayne, M. and Johansson, O. , (2014): Could myelin damage from radiofrequency electromagnetic field exposure help explain the functional impairment electrohypersensitivity? A review of the evidence. *J Toxicol Environ Health B Crit Rev* 17(5):247–258.

Reeves, G. I. , (2000): Review of extensive workups of 34 patients over-exposed to radiofrequency radiation. *Aviat Space Environ Med* 71(3):206–215.

Repacholi, M. H. , (1998): Low-level exposure to radiofrequency electromagnetic fields: Health effects and research needs. *Bioelectromagnetics* 19(1):1–19.

Report of the workshop on Multiple Chemical Sensitivities (MCS), Berlin, Germany, (21–23 February 1996). <https://apps.who.int/iris/handle/10665/26723/browse?authority=Multiple+Chemical+Sensitivity&type=mesh>.

Ribatti, D. , (2015): The crucial role of mast cells in blood-brain barrier alterations. *Exp Cell Res* 338(1):119–125.

Rinne, J. O. , Anichtchik, O. V. , Eriksson, K. S. , et al., (2002): Increased brain histamine levels in Parkinson's disease but not in multiple system atrophy. *J Neurochem* 81(5):954–960.

Rocha, S. M. , Pires, J. , Esteves, M. , Graça, B. and Bernardino, L. , (2014): Histamine: A new immunomodulatory player in the neuron-glia crosstalk. *Front Cell Neurosci* 8:120.

Rodríguez-De la Fuente, A. O. , Alcocer-González, J. M. , Heredia-Rojas, J. A. , et al., (2010): Effect of 60 Hz electromagnetic fields on the activity of hsp70 promoter: An in vivo study. *Cell Biol Int Rep* 19(1):e00014.

Roggeveen, S. , van Os, J. , Viechtbauer, W. and Lousberg, R. , (2015): EEG changes due to experimentally induced 3G mobile phone radiation. *PLOS ONE* 10(6):e0129496.

Rööslä, M. , (2008): Radiofrequency electromagnetic field exposure and non-specific symptoms of ill health: A systematic review. *Environ Res* 107(2):277–287.

Rööslä, M. , Frei, P. , Mohler, E. and Hug, K. , (2010a): Systematic review on the health effects of exposure to radiofrequency electromagnetic fields from mobile phone base stations. *Bull World Health Organ* 88(12):887–896.

Rööslä, M. , Mohler, E. and Frei, P. , (2010b): Sense and sensibility in the context of radiofrequency electromagnetic field exposure. *C R Phys* 11(9–10):576–584.

Rosado, M. M. , Simkó, M. , Mattsson, M. O. and Pioli, C. , (2018): Immune-modulating perspectives for low frequency electromagnetic fields in innate immunity. *Front Public Health* 6:85.

Roser, K. , Schoeni, A. and Rööslä, M. , (2016): Mobile phone use, behavioural problems and concentration capacity in adolescents: A prospective study. *Int J Hyg Environ Health* 219(8):759–769.

Roshangar, L. , Hamdi, B. A. , Khaki, A. A. , Rad, J. S. and Soleimani-Rad, S. , (2014): Effect of low-frequency electromagnetic field exposure on oocyte differentiation and follicular development. *Adv Biomed Res* 3:76.

Rubin, G. J. , Nieto-Hernandez, R. and Wessely, S. , (2010): Idiopathic environmental intolerance attributed to electromagnetic fields (formerly 'electromagnetic hypersensitivity'): An updated systematic review of provocation studies. *Bioelectromagnetics* 31(1):1–11.

Rubin, G. J. , Hillert, L. , Nieto-Hernandez, R. , van Rongen, E. and Oftedal, G. , (2011): Do people with idiopathic environmental intolerance attributed to electromagnetic fields display physiological effects when exposed to electromagnetic fields? A systematic review of provocation studies. *Bioelectromagnetics* 32(8):593–609.

Rubin, L. L. and Staddon, J. M. , (1999): The cell biology of the blood-brain barrier. *Annu Rev Neurosci* 22:11–28.

Sabirzhanov, B. , Stoica, B. A. , Hanscom, M. , Piao, C. S. and Faden, A. I. , (2012): Over-expression of HSP70 attenuates caspase-dependent and caspase-independent pathways and inhibits neuronal apoptosis. *J Neurochem* 123(4):542–554.

Saikhedkar, N. , Bhatnagar, M. , Jain, A. , Sukhwal, P. , Sharma, C. and Jaiswal, N. , (2014): Effects of mobile phone radiation (900 MHz radiofrequency) on structure and functions of rat brain. *Neurol Res* 36(12):1072–1079.

Saili, L. , Hanini, A. , Smirani, C. , et al., (2015): Effects of acute exposure to WIFI signals (2.45 GHz) on heart variability and blood pressure in Albinos rabbit. *Environ Toxicol Pharmacol* 40(2):600–605.

Salford, L. G. , Brun, A. , Stureson, K. , Eberhardt, J. L. and Persson, B. R. , (1994): Permeability of the blood-brain barrier induced by 915 MHz electromagnetic radiation, continuous wave and modulated at 8, 16, 50, and 200 Hz. *Microsc Res Tech* 27(6):535–542.

Salford, L. G. , Brun, A. E. , Eberhardt, J. L. , Marmgren, L. and Persson, B. R. , (2003): Nerve cell damage in mammalian brain after exposure to microwaves from GSM mobile phones. *Environ Health Perspect* 111(7):881–883.

Santini, R. , Santini, P. , LeRuz, P. , Danze, J. M. and Seigne, M. , (2003): Survey study of people living in the vicinity of cellular phone base stations. *Electromagn Biol Med* 22(1):41–49.

Santini, R. , Seigne, M. , Bonhomme-Faivre, L. , Bouet, S. , Defrasme, E. and Sage, M. , (2002): Symptoms experienced by users of digital cellular phones: A study of a French engineering school. *Electromagn Biol Med* 21(1):81–88.

Saunders, N. R. , Dreifuss, J. J. , Dziegielewska, K. M. , Johansson, P. A. , Habgood, M. D. , Møllgård, K. and Bauer, H. C. , (2014): The rights and wrongs of blood-brain barrier permeability studies: A walk through 100 years of history. *Front Neurosci* 8:404.

Schilling, C. J. , (1997): Effects of acute exposure to ultrahigh radiofrequency radiation on three antenna engineers. *Occup Environ Med* 54(4):281–284.

Schilling, C. J. , (2000): Effects of exposure to very high frequency radiofrequency radiation on six antenna engineers in two separate incidents. *Occup Med (Lond)* 50(1):49–56.

Schmid, M. R. , Loughran, S. P. , Regel, S. J. , et al., (2012): Sleep EEG alterations: Effects of different pulse-modulated radio frequency electromagnetic fields. *J Sleep Res* 21(1):50–58.

Schmidt, R. , Schmidt, H. , Curb, J. D. , Masaki, K. , White, L. R. and Launer, L. J. , (2002): Early inflammation and dementia: A 25-year follow-up of the Honolulu-Asia aging study. *Ann Neurol* 52(2):168–174.

Schmiedchen, K. , Driessen, S. and Oftedal, G. , (2019): Methodological limitations in experimental studies on symptom development in individuals with idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF) - A systematic review. *Environ Health* 18(1):88.

Schoeni, A. , Roser, K. , Bürgi, A. and Rössli, M. , (2016): Symptoms in Swiss adolescents in relation to exposure from fixed site transmitters: A prospective cohort study. *Environ Health* 15(1):77.

Schoeni, A. , Roser, K. and Rössli, M. , (2017): Symptoms and the use of wireless communication devices: A prospective cohort study in Swiss adolescents. *Environ Res* 154:275–283.

Schreier, N. , Huss, A. and Rössli, M. , (2006): The prevalence of symptoms attributed to electromagnetic field exposure: A cross-sectional representative survey in Switzerland. *Soz Präventivmed* 51(4):202–209.

Schröttner, J. and Leitgeb, N. , (2008): Sensitivity to electricity—Temporal changes in Austria. *BMC Public Health* 8:310.

Schumacher, M. , Nanninga, A. and Leidenberger, F. , (1989): S-35 and 1–125 radioimmunoassays for the measurement of 6-sulphatoxymelatonin in human urine. *Acta Endocrinol* 120:132.

Schüz, J. , Petters, C. , Egle, U. T. , et al., (2006): The “Mainzer EMF-Wachhund”: Results from a watchdog project on self-reported health complaints attributed to exposure to electromagnetic fields. *Bioelectromagnetics* 27(4):280–287.

Semin, I. A. , Shvartsburg, L. K. and Dubovik, B. V. , (1995): Changes in the secondary structure of DNA under the influence of external low-intensity electromagnetic field. *Radiats Biol Radioecol* 35(1):36–41.

Shanson, D. C. and FRCPath, M. B. , (1989): Opportunistic infections in microbiology in clinical practice (2nd ed.), 151–167. ISBN: 9780723614036.

Sharma, V. P. and Kumar, N. R. , (2010): Changes in honeybee behaviour and biology under the influence of cellphone radiations. *Curr Sci* 98:1376–1378.

Sheffler, Z. M. , Reddy, V. and Pillarisetty, L. S. , (2021): Physiology, Neurotransmitters. Treasure Island, FL: StatPearls Publishing.

Sheng, J. G. , Mrak, R. E. and Griffin, W. S. , (1997): Glial-neuronal interactions in Alzheimer disease: Progressive association of IL-1 α + microglia and S100 β + astrocytes with neurofibrillary tangle stages. *J Neuropathol Exp Neurol* 56(3):285–290.

Shi, R. and Borgens, R. B. , (1995): Three-dimensional gradients of voltage during development of the nervous system as invisible coordinates for the establishment of embryonic pattern. *Dev Dyn* 202(2):101–114.

Silva, D. F. , Barros, W. R. , Almeida Mda, C. and Rêgo, M. A. , (2015): Exposure to non-ionizing electromagnetic radiation from mobile telephony and the association with psychiatric symptoms. *Cad Saude Publ* 31(10):2110–2126.

Silverberg, A. B. , Shah, S. D. , Haymond, M. W. and Cryer, P. E. , (1978): Norepinephrine: Hormone and neurotransmitter in man. *Am J Physiol* 234(3):E252–E256.

Sirav, B. and Seyhan, N. , (2016): Effects of GSM modulated radio-frequency electromagnetic radiation on permeability of blood-brain barrier in male & female rats. *J Chem Neuroanat* 75(B):123–127.

Slottje, P. , van Moorselaar, I. , van Strien, R. , Vermeulen, R. , Kromhout, H. and Huss, A. , (2017): Electromagnetic hypersensitivity (EHS) in occupational and primary health care: A nation-wide survey among general practitioners, occupational physicians and hygienists in the Netherlands. *Int J Hyg Environ Health* 220(2 Pt B):395–400.

Smit, L. H. , Korse, C. M. and Bonfrer, J. M. , (2005): Comparison of four different assays for determination of serum S-100B. *Int J Biol Markers* 20(1):34–42.

Sobel, E. , Davanipour, Z. , Sulkava, R. , et al., (1995): Occupations with exposure to electromagnetic fields: A possible risk factor for Alzheimer's disease. *Am J Epidemiol* 142(5):515–524.

Sobel, E. , Dunn, M. , Davanipour, Z. , Qian, Z. and Chui, H. C. , (1996): Elevated risk of Alzheimer's disease among workers with likely electromagnetic field exposure. *Neurology* 47(6):1477–1481.

Söderqvist, F. , Carlberg, M. and Hardell, L. , (2009a): Use of wireless telephones and serum S100B levels: A descriptive cross-sectional study among healthy Swedish adults aged 18–65 years. *Sci Total Environ* 407(2):798–805.

Söderqvist, F. , Carlberg, M. , Hansson Mild, K. and Hardell, L. , (2009b): Exposure to an 890-MHz mobile phone-like signal and serum levels of S100B and transthyretin in volunteers. *Toxicol Lett* 189(1):63–66.

Söderqvist, F. , Carlberg, M. and Hardell, L. , (2008): Use of wireless telephones and self-reported health symptoms: A population-based study among Swedish adolescents aged 15–19 years. *Environ Health* 7:18.

Söderqvist, F. , Carlberg, M. and Hardell, L. , (2015): Biomarkers in volunteers exposed to mobile phone radiation. *Toxicol Lett* 235(2):140–146.

Söderqvist, F. , Hardell, L. , Carlberg, M. and Mild, K. H. , (2010): Radiofrequency fields, transthyretin, and Alzheimer's disease. *J Alzheimers Dis* 20(2):599–606.

Soffritti, M. , Tibaldi, E. , Padovani, M. , et al., (2016): Synergism between sinusoidal-50 Hz magnetic field and formaldehyde in triggering carcinogenic effects in male Sprague-Dawley rats. *Am J Ind Med* 59(7):509–521.

Somanah, J. , Aruoma, O. I. , Gunness, T. K. , et al., (2012): Effects of a short-term supplementation of a fermented papaya preparation on biomarkers of diabetes mellitus in a randomized Mauritian population. *Prev Med* 54:S90–S97.

Sonmez, O. F. , Odaci, E. , Bas, O. and Kaplan, S. , (2010): Purkinje cell number decreases in the adult female rat cerebellum following exposure to 900 MHz electromagnetic field. *Brain Res* 1356:95–101.

Sosa, M. , Bernal-Alvarado, J. , Jiménez-Moreno, M. , et al., (2005): Magnetic field influence on electrical properties of human blood measured by impedance spectroscopy. *Bioelectromagnetics* 26(7):564–570.

Stalin, P. , Abraham, S. B. , Kanimozhy, K. , Prasad, R. V. , Singh, Z. and Purty, A. J. , (2016): Mobile phone usage and its health effects among adults in a semi-urban area of Southern India. *J Clin Diagn Res* 10(1):LC14–LC16.

Stam, R. , (2010): Electromagnetic fields and the blood-brain barrier. *Brain Res Rev* 65(1):80–97.

Stamataki, E. , Stathopoulos, A. , Garini, E. , et al., (2013): Serum S100B protein is increased and correlates with interleukin 6, hypoperfusion indices, and outcome in patients admitted for surgical control of hemorrhage. *Shock* 40(4):274–280.

Stein, Y. and Udasin, I. G. , (2020): Electromagnetic hypersensitivity (EHS, microwave syndrome) - Review of mechanisms. *Environ Res* 186:109445.

Strimbu, K. and Tavel, J. A. , (2010): What are biomarkers? *Curr Opin HIV AIDS* 5(6):463–466.

Sudan, M. , Kheifets, L. , Arah, O. , Olsen, J. and Zeltzer, L. , (2012): Prenatal and postnatal cell phone exposures and headaches in children. *Open Pediatr Med J* 6(2012):46–52.

Szmigielski, S. , (2013): Reaction of the immune system to low-level RF/MW exposures. *Sci Total Environ* 454–455:393–400.

Szykowska, A. , Gadzicka, E. , Szymczak, W. and Bortkiewicz, A. , (2014): The risk of subjective symptoms in mobile phone users in Poland—An epidemiological study. *Int J Occup Med Environ Health* 27(2):293–303.

Tan, K. H. , Harrington, S. , Purcell, W. M. and Hurst, R. D. , (2004): Peroxynitrite mediates nitric oxide-induced blood-brain barrier damage. *Neurochem Res* 29(3):579–587.

Tan, S. Z. , Tan, P. C. , Luo, L. Q. , et al., (2019): Exposure effects of terahertz waves on primary neurons and neuron-like cells under nonthermal conditions. *Biomed Environ Sci* 32(10):739–754.

Tao, R. and Huang, K. , (2011): Reducing blood viscosity with magnetic fields. *Phys Rev E Stat Nonlin Soft Matter Phys* 84(1 Pt 1):011905.

Teimori, F. , Khaki, A. A. , Rajabzadeh, A. and Roshangar, L. , (2016): The effects of 30 mT electromagnetic fields on hippocampus cells of rats. *Surg Neurol Int* 7:70.

Terzi, M. , Ozberk, B. , Deniz, O. G. and Kaplan, S. , (2016): The role of electromagnetic fields in neurological disorders. *J Chem Neuroanat* 75(B):77–84.

Tettamanti, G. , Auvinen, A. , Åkerstedt, T. , et al., (2020): Long-term effect of mobile phone use on sleep quality: Results from the cohort study of mobile phone use and health (COSMOS). *Environ Int* 140:105687.

Thielens, A. , Bell, D. , Mortimore, D. B. , Greco, M. K. , Martens, L. and Joseph, W. , (2018): Exposure of insects to radio-frequency electromagnetic fields from 2 to 120 GHz. *Sci Rep* 8(1):3924.

Trimmel, M. and Schweiger, E. , (1998): Effects of an ELF (50 Hz, 1 mT) electromagnetic field (EMF) on concentration in visual attention, perception and memory including effects of EMF sensitivity. *Toxicol Lett* 96–97:377–382.

Trosko, J. E. , (2000): Human health consequences of environmentally-modulated gene expression: Potential roles of ELF-EMF induced epigenetic versus mutagenic mechanisms of disease. *Bioelectromagnetics* 21(5):402–406.

Tsurita, G. , Ueno, S. , Tsuno, N. H. , Nagawa, H. and Muto, T. , (1999): Effects of exposure to repetitive pulsed magnetic stimulation on cell proliferation and expression of heat shock protein 70 in normal and malignant cells. *Biochem Biophys Res Commun* 261(3):689–694.

Tuengler, A. and von Klitzing, L. , (2013): Hypothesis on how to measure electromagnetic hypersensitivity. *Electromagn Biol Med* 32(3):281–290.

Tuohimaa, P. , Keisala, T. , Minasyan, A. , Cachat, J. and Kalueff, A. , (2009): Vitamin D, nervous system and aging. *Psychoneuroendocrinology* 34:S278–S286.

Valentini, E. , Ferrara, M. , Presaghi, F. , De Gennaro, L. and Curcio, G. , (2010): Systematic review and meta-analysis of psychomotor effects of mobile phone electromagnetic fields. *Occup Environ Med* 67(10):708–716.

van Dongen, D. , Smid, T. and Timmermans, D. R. , (2014): Symptom attribution and risk perception in individuals with idiopathic environmental intolerance to electromagnetic fields and in the general population. *Perspect Public Health* 134(3):160–168.

Vander Vorst, A. , Rosen, A. and Kotsuka, Y. , (2006): RF-microwave interaction with biological tissues. 2006 Wiley IEE Press, Hoboken (New Jersey). ISBN:047173277X, 9780471732778.

Vecchio, F. , Buffo, P. , Sergio, S. , Iacoviello, D. , Rossini, P. M. and Babiloni, C. , (2012): Mobile phone emission modulates event-related desynchronization of α rhythms and cognitive-motor performance in healthy humans. *Clin Neurophysiol* 123(1):121–128.

Verkasalo, P. K. , Kaprio, J. , Varjonen, J. , Romanov, K. , Heikkilä, K. and Koskenvuo, M. , (1997): Magnetic fields of transmission lines and depression. *Am J Epidemiol* 146(12):1037–1045.

Verrender, A. , Loughran, S. P. , Dalecki, A. , McKenzie, R. and Croft, R. J. , (2016): Pulse modulated radiofrequency exposure influences cognitive performance. *Int J Radiat Biol* 92(10):603–610.

Volkow, N. D. , Tomasi, D. , Wang, G. J. , et al., (2011): Effects of cell phone radiofrequency signal exposure on brain glucose metabolism. *JAMA* 305(8):808–813.

von Klitzing, L. , (1995): Low-frequency pulsed electromagnetic fields influence EEG of man. *Phys Med XI*:77–80.

von Klitzing, L. , (2021): Artificial EMG by WLAN-exposure. *J Biostat Biom App* 6:101. ISSN: 2455-765X.

Wada, H. , Inagaki, N. , Yamatodani, A. and Watanabe, T. , (1991): Is the histaminergic neuron system a regulatory center for whole brain activity? *Trends Neurosci* 14(9):415–418.

Wagner, P. , Röschke, J. , Mann, K. , Fell, J. , Hiller, W. , Frank, C. and Grözinger, M. , (2000): Human sleep EEG under the influence of pulsed radio frequency electromagnetic fields. Results from polysomnographies using submaximal high power flux densities. *Neuropsychobiology* 42(4):207–212.

Walleczek, J. , (1992): Electromagnetic field effects on cells of the immune system: The role of calcium signaling. *FASEB J* 6(13):3177–3185.

Weisenseel, M. H. , (1983): Control of differentiation and growth by endogenous electric currents. In W. Hoppe , W. Lohmann , H. Markl and H. Ziegler ed., *Biophysics*. Berlin: Springer–Verlag, pp. 460–465.

Wever, R. , (1970): The effects of electric fields on circadian rhythmicity in men. *Life Sci Space Res* 8:177–187.

Wever, R. , (1973): Human circadian rhythms under the influence of weak electric fields and the different aspects of these studies. *Int J Biometeorol* 17(3):227–232.

Wever, R. , (1979): *The circadian system of man: Results of experiments under temporal isolation*. Springer-Verlag, New York.

WHO (World Health Organization) ., (2005): *Electromagnetic fields and public health, electromagnetic hypersensitivity*; WHO fact sheet no. 296. Geneva: World Health Organization.

WHO (World Health Organization) ., (2006): *Framework for developing health-based EMF standards*. Geneva: WHO. ISBN: 9241594330. www.who.int/peh-emf/standards/EMF_standards_framework%5b1%5d.pdf.

WHO (World Health Organization) ., (2014): *Electromagnetic fields and public health: Mobile phones; fact sheet no. 193*. Geneva: World Health Organization.

Williams, R. A. and Webb, T. S. , (1980): Exposure to radiofrequency radiation from an aircraft radar unit. *Aviat Space Environ Med* 51(11):1243–1244.

Xiong, L. , Sun, C. F. , Zhang, J. , et al., (2015): Microwave exposure impairs synaptic plasticity in the rat hippocampus and PC12 cells through over-activation of the NMDA receptor signaling pathway. *Biomed Environ Sci* 28(1):13–24.

Yakymenko, I. , Tsybulin, O. , Sidorik, E. , Henshel, D. , Kyrylenko, O. and Kyrylenko, S. , (2016): Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation. *Electromagn Biol Med* 35(2):186–202.

Yang, S. , Chen, Y. , Deng, X. , et al., (2013): Hemoglobin-induced nitric oxide synthase overexpression and nitric oxide production contribute to blood-brain barrier disruption in the rat. *J Mol Neurosci* 51(2):352–363.

Yang, X. S. , He, G. L. , Hao, Y. T. , Xiao, Y. , Chen, C. H. , Zhang, G. B. and Yu, Z. P. , (2012): Exposure to 2.45 GHz electromagnetic fields elicits an HSP-related stress response in rat hippocampus. *Brain Res Bull* 88(4):371–378.

Yao, L. , McCaig, C. D. and Zhao, M. , (2009): Electrical signals polarize neuronal organelles, direct neuron migration, and orient cell division. *Hippocampus* 19(9):855–868.

Yenari, M. A. , Liu, J. , Zheng, Z. , Vexler, Z. S. , Lee, J. E. and Giffard, R. G. , (2005): Antiapoptotic and anti-inflammatory mechanisms of heat-shock protein protection. *Ann N Y Acad Sci* 1053:74–83.

Zalata, A. , El-Samanoudy, A. Z. , Shaalan, D. , El-Baiomy, Y. and Mostafa, T. , (2015): In vitro effect of cell phone radiation on motility, DNA fragmentation and clusterin gene expression in human sperm. *Int J Fertil Steril* 9(1):129–136.

Zaret, M. M. , (1973): Microwave cataracts. *Med Trial Tech Q* 19(3):246–252.

Zhang, Y. , Li, Z. , Gao, Y. and Zhang, C. , (2015): Effects of fetal microwave radiation exposure on offspring behavior in mice. *J Radiat Res* 56(2):261–268.

Zheng, F. , Gao, P. , He, M. et al., (2014): Association between mobile phone use and inattention in 7102 Chinese adolescents: A population-based cross-sectional study. *BMC Public Health* 14:1022.

Zheng, F. , Gao, P. , He, M. , et al., (2015): Association between mobile phone use and self-reported well-being in children: A questionnaire-based cross-sectional study in Chongqing, China. *BMJ (Open)* 5(5):e007302.

Zuo, H. , Lin, T. , Wang, D. , et al., (2014): Neural cell apoptosis induced by microwave exposure through mitochondria-dependent caspase-3 pathway. *Int J Med Sci* 11(5):426–435.

Carcinogenic Effects of Non-thermal Exposure to Wireless Communication Electromagnetic Fields

Abdel-Rassoul, G. , El-Fateh, O. A. , Salem, M. A. , et al. (2007). Neurobehavioral effects among inhabitants around mobile phone base stations. *Neurotoxicology* 28(2):434–440.

Agarwal, A. , Desai, N. R. , Makker, K. , et al. (2009). Effects of radiofrequency electromagnetic waves (RF-EMW) from cellular phones on human ejaculated semen: An in vitro pilot study. *Fertil Steril* 92(4):1318–1325.

Ahlbom, A. , Green, A. , Kheifets, L. , et al. (2004). Epidemiology of health effects of radiofrequency exposure. *Environ Health Perspect* 112(17):1741–1754.

Akhavan-Sigari, R. , Mazloun Farsi Baf, M. , Ariabod, V. , Rohde, V. , Rahighi, S. (2014). Connection between cell phone use, p53 gene expression in different zones of glioblastoma multiforme and survival prognoses. *Rare Tumors* 6(3):5350.

Alkis, M. E. , Bilgin, H. M. , Akpolat, V. , et al. (2019). Effect of 900-, 1800-, and 2100-MHz radiofrequency radiation on DNA and oxidative stress in brain. *Electromagn Biol Med* 38(1):32–47.

Baan, R. , Grosse, Y. , Lauby-Secretan, B. , et al. (2011). Carcinogenicity of radiofrequency electromagnetic fields. *Lancet Oncol* 12(7):624–626.

Barnes, D. E. , Bero, L. A. (1998). Why review articles on the health effects of passive smoking reach different conclusions. *JAMA* 279(19):1566–1570.

Belyaev, I. , Dean, A. , Eger, H. , et al. (2016). EUROPAEM EMF Guideline 2016 for the prevention, diagnosis and treatment of EMF-related health problems and illnesses. *Rev Environ Health* 31(3):363–397.

Blank, M. (2014). *Overpowered: The dangers of electromagnetic radiation (EMF) and what you can do about it*. Seven Stories Press, New York.

Breckenkamp, J. , Berg, G. , Blettner, M. (2003). Biological effects on human health due to radiofrequency/microwave exposure: A synopsis of cohort studies. *Radiat Environ Biophys* 42(3):141–154.

Burlaka, A. , Tsybulin, O. , Sidorik, E. , et al. (2013). Overproduction of free radical species in embryonic cells exposed to low intensity radiofrequency radiation. *Exp Oncol* 35(3):219–225.

Byus, C. V. , Kartun, K. , Pieper, S. , Adey, W. R. (1988). Increased ornithine decarboxylase activity in cultured cells exposed to low energy modulated microwave fields and phorbol ester tumor promoters. *Cancer Res* 48(15):4222–4226.

Cardis, E. , Deltour, I. , Vrijheid, M. (2010). Brain tumour risk in relation to mobile telephone use: Results of the INTERPHONE international case-control study. *Int J Epidemiol* 39(3):675–694.

Carlberg, M. , Koppel, T. , Hedendahl, L. K. , Hardell, L. (2020). Is the increasing incidence of thyroid cancer in the Nordic countries caused by use of mobile phones? *Int J Environ Res Public Health* 17(23): 9129.

Carpenter, D. O. (2019). Extremely low frequency electromagnetic fields and cancer: How source of funding affects results. *Environ Res* 178:108688.

Chekhun, V. , Yakymenko, I. , Sidorik, E. , et al. (2014). Current state of international and national public safety limits for radiofrequency radiation. *Sci J Minist Health Ukr*, 1 (5):57–64.

Chou, C. K. , Guy, A. W. , Kunz, L. L. , et al. (1992). Long-term, low-level microwave irradiation of rats. *Bioelectromagnetics* 13(6):469–496.

Christ, A. , Gosselin, M. C. , Christopoulou, M. , Kühn, S. , Kuster, N. (2010). Age-dependent tissue-specific exposure of cell phone users. *Phys Med Biol* 55(7):1767–1783.

Clark, D. E. , Folz, D. C. , West, J. K. (2000). Processing materials with microwave energy. *Mater Sci Eng A* 287(2):153–158.

Clifford, A. , Morgan, D. , Yuspa, S. H. , Soler, A. P. , Gilmour, S. (1995). Role of ornithine decarboxylase in epidermal tumorigenesis. *Cancer Res* 55(8):1680–1686.

Coureau, G. , Bouvier, G. , Lebailly, P. , et al. (2014). Mobile phone use and brain tumours in the CERENAT case-control study. *Occup Environ Med* 71(7):514–522.

Davis, R. L. , Mostofi, F. K. (1993). Cluster of testicular cancer in police officers exposed to hand-held radar. *Am J Ind Med* 24(2):231–233.

De Lullis, G. N. , Newey, R. J. , King, B. V. , Aitken, R. J. (2009). Mobile phone radiation induces reactive oxygen species production and DNA damage in human spermatozoa in vitro. *PLOS ONE* 4(7):e6446.

De Salles, A. A. , Bulla, G. , Rodriguez, C. E. (2006). Electromagnetic absorption in the head of adults and children due to mobile phone operation close to the head. *Electromagn Biol Med* 25(4):349–360.

Degrave, E. , Meeusen, B. , Grivegne, A. R. , Boniol, M. , Autier, P. (2009). Causes of death among Belgian professional military radar operators: A 37-year retrospective cohort study. *Int J Cancer* 124(4):945–951.

Diem, E. , Schwarz, C. , Adlkofer, F. , Jahn, O. , Rüdiger, H. (2005). Non-thermal DNA breakage by mobile-phone radiation (1800 MHz) in human fibroblasts and in transformed GFSH-R17 rat granulosa cells in vitro. *Mutat Res* 583(2):178–183.

Ding, S.-S. , Sun, P. , Zhang, Z. , et al. (2018). Moderate dose of trolox preventing the deleterious effects of wi-fi radiation on spermatozoa in vitro through reduction of oxidative stress damage. *Chin Med J (Engl)* 131(4):402.

Dowd, M. (2010). Are cells the new cigarettes? *The New York Times*, June 27: 11.

Eger, H. , Hagen, K. , Lucas, B. , et al. (2004). Influence of the proximity of mobile phone base stations on the incidence of cancer. *Environ Med Soc* 17:273–356.

Ericsson . (2009). LTE – An introduction. White Paper.

Falcioni L. , Bua L. , Tibaldi E. , et al. (2018): Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8GHz GSM base station environmental emission, *Environmental Research*, 165: 496–503.

Ferreira, A. R. , Bonatto, F. , de Bittencourt Pasquali, M. A. , et al. (2006). Oxidative stress effects on the central nervous system of rats after acute exposure to ultra high frequency electromagnetic fields. *Bioelectromagnetics* 27(6):487–493.

Finkelstein, M. M. (1998). Cancer incidence among Ontario police officers. *Am J Ind Med*, 34(2):157–162.

Frank, J. W. (2021). Electromagnetic fields, 5G and health: What about the precautionary principle? *J Epidemiol Community Health*, 75(6):562–566.

Frei, M. R. , Jauchem, J. R. , Dusch, S. J. , et al. (1998). Chronic, low-level (1.0 W/kg) exposure of mice prone to mammary cancer to 2450 MHz microwaves. *Radiat Res*, 150(5):568–576.

Friedman, J. , Kraus, S. , Hauptman, Y. , Schiff, Y. , Seger, R. (2007). Mechanism of short-term ERK activation by electromagnetic fields at mobile phone frequencies. *Biochem J*, 405(3):559–568.

Gandhi, G. , Anita . (2005). Genetic damage in mobile phone users: Some preliminary findings. *Indian J Hum Genet* 11(2):99–104.

Gandhi, O. , Lazzi, G. , Furse, C. (1996). Electromagnetic absorption in the human head and neck for mobile telephones at 835 and 1900 MHz. *IEEE Trans Microw Theor Tech* 44(10):1884–1897.

Goldsmith, J. R. (1997). Epidemiological evidence relevant to radar (microwave) effects. *Environ Health Perspect* 105(6):1579–1587.

Goodman, E. M. , Greenebaum, B. , Marron, M. T. (1995). Effects of electro-magnetic fields on molecules and cells. *Int Rev Cytol* 158:279–338.

Grayson, J. K. (1996). Radiation exposure, socioeconomic status, and brain tumor risk in the US Air Force: A nested case-control study. *Am J Epidemiol* 143(5):480–486.

Grigoriev, Y. G. , Grigoriev, O. A. , Ivanov, A. A. , et al. (2010). Confirmation studies of Soviet research on immunological effects of microwaves: Russian immunology results. *Bioelectromagnetics* 31(8):589–602.

Gulati, S. , Yadav, A. , Kumar, N. , et al. (2016). Effect of GSTM1 and GSTT1 polymorphisms on genetic damage in humans populations exposed to radiation from mobile towers. *Arch Environ Contam Toxicol* 70(3):615–625.

Guler, G. , Tomruk, A. , Ozgur, E. , et al. (2012). The effect of radiofrequency radiation on DNA and lipid damage in female and male infant rabbits. *Int J Radiat Biol* 88(4):367–373.

Gundestrup, M. , Storm, H. H. (1999). Radiation-induced acute myeloid leukaemia and other cancers in commercial jet cockpit crew: A population-based cohort study. *Lancet* 354(9195):2029–2031.

Halliwel, B. , Whiteman, M. (2004). Measuring reactive species and oxidative damage in vivo and in cell culture: How should you do it and what do the results mean? *Br J Pharmacol* 142(2):231–255.

Halliwel, B. (2007). Biochemistry of oxidative stress [review]. *Biochem Soc Trans* 35(5):1147–1150.

Hardell, L. , Mild, K. H. , Pålsson, A. , Hallquist, A. (2001). Ionizing radiation, cellular telephones and the risk for brain tumours. *Eur J Cancer Prev* 10(6):523–529.

Hardell, L. , Mild, K. H. , Carlberg, M. (2003). Further aspects on cellular and cordless telephones and brain tumours. *Int J Oncol* 22(2):399–408.

Hardell, L. , Mild, K. H. , Carlberg, M. , Hallquist, A. (2004). Cellular and cordless telephone use and the association with brain tumors in different age groups. *Arch Environ Health An Int J* 59(3):132–137.

Hardell, L. , Eriksson, M. , Carlberg, M. , Sundström, C. , Mild, K. H. (2005). Use of cellular or cordless telephones and the risk for non-Hodgkin's lymphoma. *Int Arch Occup Environ Health* 78(8):625–632.

Hardell, L. , Carlberg, M. , Mild, K. H. (2006). Pooled analysis of two case–control studies on use of cellular and cordless telephones and the risk for malignant brain tumours diagnosed in 1997–2003. *Int Arch Occup Environ Health* 79(8):630–639.

Hardell, L. , Carlberg, M. , Ohlson, C. G. , et al. (2007). Use of cellular and cordless telephones and risk of testicular cancer. *Int J Androl* 30(2):115–122.

- Hardell, L. , Sage, C. (2008). Biological effects from electromagnetic field exposure and public exposure standards. *Biomed Pharmacother* 62(2):104–109.
- Hardell, L. , Carlberg, M. , Hansson Mild, K. (2009). Epidemiological evidence for an association between use of wireless phones and tumor diseases. *Pathophysiology* 16(2–3):113–122.
- Hardell, L. , Carlberg, M. , Koppel, T. , Nordström, M. , Hedendahl, L. K. (2020). Central nervous system lymphoma and radiofrequency radiation - A case report and incidence data in the Swedish cancer register on non-Hodgkin lymphoma. *Med Hypo* 144:110052.
- Heinrich, S. , Thomas, S. , Heumann, C. , von Kries, R. , Radon, K. (2010). Association between exposure to radiofrequency electromagnetic fields assessed by dosimetry and acute symptoms in children and adolescents: A population based cross-sectional study. *Environ Health* 9:75.
- Hoyto, A. , Juutilainen, J. , Naarala, J. (2007). Ornithine decarboxylase activity is affected in primary astrocytes but not in secondary cell lines exposed to 872 MHz RF radiation. *Int J Radiat Biol* 83(6):367–374.
- Huss, A. , Egger, M. , Hug, K. , Huwiler-Müntener, K. , Rössli, M. (2007). Source of funding and results of studies of health effects of mobile phone use: Systematic review of experimental studies. *Environ Health Perspect* 115(1):1–4.
- Huss, A. , Spoerri, A. , Egger, M. , et al. (2018). Occupational extremely low frequency magnetic fields (ELF-MF) exposure and hematolymphopoietic cancers–Swiss National Cohort analysis and updated meta-analysis. *Environ Res* 164:467–474.
- Hutter, H. P. , Moshammer, H. , Wallner, P. , Kundi, M. (2006). Subjective symptoms, sleeping problems, and cognitive performance in subjects living near mobile phone base stations. *Occup Environ Med* 63(5):307–313.
- Hyland, G. J. (2000). Physics and biology of mobile telephony. *Lancet* 356(9244):1833–1836.
- Hyland, G. J. (2008). Physical basis of adverse and therapeutic effects of low intensity microwave radiation. *Indian J Exp Biol* 46(5):403–419.
- IARC . (2002). IARC monographs on the evaluation of carcinogenic risks to humans: Volume 80. In Non-ionizing radiation, part 1: Static and extremely low-frequency (ELF) electric and magnetic fields. International Agency for Research on Cancer, Lyon, France. .
- IARC , (2013): Non-ionizing radiation, part 2: Radiofrequency electromagnetic fields, Vol. 102, International Agency for Research on Cancer, Lyon, France.
- ICNIRP . (1998). Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz). *Health Phys* 74(4):494–522.
- ICNIRP . (2010). Guidelines for limiting exposure to time-varying electric and magnetic fields (1 Hz to 100 kHz). *Health Phys* 99(6):818–836.
- ICNIRP . (2020). Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz). *Health Phys* 118(5):483–524.
- IEEE . (2002). Std 521–2002 standard letter designations for radar-frequency bands. In IEEE Std 521-2002 (Revision of IEEE Std 521-1984).1-10. doi: 10.1109/IEEESTD.2003.94224.
- Interphone . (2011). Acoustic neuroma risk in relation to mobile telephone use: Results of the INTERPHONE international case–control study. *Cancer Epidemiol* 35(5):453–464.
- Irmak, M. K. , Fadillioglu, E. , Gulec, M. , et al. (2002). Effects of electromagnetic radiation from a cellular telephone on the oxidant and antioxidant levels in rabbits. *Cell Biochem Funct* 20(4):279–283.
- Juutilainen, J. , Läärä, E. , Pukkala, E. (1990). Incidence of leukaemia and brain tumours in Finnish workers exposed to ELF magnetic fields. *Int Arch Occup Environ Health* 62(4):289–293.
- Kesari, K. K. , Behari, J. , Kumar, S. (2010). Mutagenic response of 2.45 GHz radiation exposure on rat brain. *Int J Radiat Biol* 86(4):334–343.
- Khalil, A. M. , Gagaa, M. H. , Alshamali, A. M. (2012). 8-Oxo-7, 8-dihydro-2'-deoxyguanosine as a biomarker of DNA damage by mobile phone radiation. *Hum Exp Toxicol* 31(7):734–740.
- Khurana, V. G. , Teo, C. , Kundi, M. , Hardell, L. , Carlberg, M. (2009). Cell phones and brain tumors: A review including the long-term epidemiologic data. *Surg Neurol* 72(3):205–215.
- Kundi, M. (2009). The controversy about a possible relationship between mobile phone use and cancer. *Environ Health Perspect* 117(3):316–324.
- Kundi, M. , Hutter, H. P. (2009). Mobile phone base stations-effects on wellbeing and health. *Pathophysiology* 16(2–3):123–135.
- Lai, H. , Singh, N. P. (1995). Acute low-intensity microwave exposure increases DNA single-strand breaks in rat brain cells. *Bioelectromagnetics* 16(3):207–210.
- Lai, H. , Singh, N. P. (1996). Single- and double-strand DNA breaks in rat brain cells after acute exposure to radiofrequency electromagnetic radiation. *Int J Radiat Biol* 69(4):513–521.
- Leszczynski, D. , Xu, Z. (2010). Mobile phone radiation health risk controversy: The reliability and sufficiency of science behind the safety standards. *Health Res Policy Syst* 8(1):2.
- Lexchin, J. , Bero, L. A. , Djulbegovic, B. , Clark, O. (2003). Pharmaceutical industry sponsorship and research outcome and quality: Systematic review. *BMJ* 326(7400):1167–1170.
- Linnet, M. S. , Taggart, T. , Severson, R. K. , et al. (2006). Cellular telephones and non-Hodgkin lymphoma. *Int J Cancer* 119(10):2382–2388.

Litovitz, T. A. , Krause, D. , Penafiel, M. , Elson, E. C. , Mullins, J. M. (1993). The role of coherence time in the effect of microwaves on ornithine decarboxylase activity. *Bioelectromagnetics* 14(5):395–403.

Litovitz, T. A. , Penafiel, L. M. , Farrel, J. M. , et al. (1997). Bioeffects induced by exposure to microwaves are mitigated by superposition of ELF noise. *Bioelectromagnetics* 18(6):422–430.

Lönn, S. , Ahlbom, A. , Hall, P. , Feychting, M. (2004). Mobile phone use and the risk of acoustic neuroma. *Epidemiology* 15(6):653–659.

Löscher, W. (2001). Do cocarcinogenic effects of ELF electromagnetic fields require repeated longterm interaction with carcinogens? Characteristics of positive studies using the DMBA breast cancer model in rats. *Bioelectromagnetics* 22(8):603–614.

Luukkonen, J. , Hakulinen, P. , Maki-Paakkanen, J. , Juutilainen, J. , Naarala, J. (2009). Enhancement of chemically induced reactive oxygen species production and DNA damage in human SH-SY5Y neuroblastoma cells by 872 MHz radiofrequency radiation. *Mutat Res* 662(1–2):54–58.

Milde-Busch, A. , von Kries, R. , Thomas, S. , et al. (2010). The association between use of electronic media and prevalence of headache in adolescents: Results from a population-based cross-sectional study. *BMC Neurol* 10:12.

Miller A.B. , Morgan L.L. , Udasin I. , Davis D.L. , (2018): Cancer epidemiology update, following the 2011 IARC evaluation of radiofrequency electromagnetic fields (Monograph 102), *Environ Res* 167: 673-683, 2018.

Miller, A. B. , Sears, M. E. , Morgan, L. L. , et al. (2019). Risks to health and well-being from radio-frequency radiation emitted by cell phones and other wireless devices. *Front Public Health* 7:223.

Morgan, L. L. (2009). Estimating the risk of brain tumors from cellphone use: Published case-control studies. *Pathophysiology* 16(2–3):137–147.

Navarro, E. , Segura, J. , Portoles, M. , Gómez-Perretta de Mateo, C. (2003). The microwave syndrome: A preliminary study in Spain. *Electromagn Biol Med* 22(2–3):161–169.

NTP . (2018). Toxicology and carcinogenesis studies in B6C3F1/N mice exposed to whole-body radio frequency radiation at a frequency (1,900 MHz) and modulations (GSM and CDMA) used by cell phones. National Toxicology Program Technical Report Series (596).

Ozguner, F. , Altinbas, A. , Ozaydin, M. , et al. (2005a). Mobile phone-induced myocardial oxidative stress: Protection by a novel antioxidant agent caffeic acid phenethyl ester. *Toxicol Ind Health* 21(9):223–230.

Ozguner, F. , Oktem, F. , Ayata, A. , Koyu, A. , Yilmaz, H. R. (2005b). A novel antioxidant agent caffeic acid phenethyl ester prevents long-term mobile phone exposure-induced renal impairment in rat. Prognostic value of malondialdehyde, N-acetyl-beta-D-glucosaminidase and nitric oxide determination. *Mol Cell Biochem* 277(1–2):73–80.

Ozguner, E. , Guler, G. , Seyhan, N. (2010). Mobile phone radiation-induced free radical damage in the liver is inhibited by the antioxidants N-acetyl cysteine and epigallocatechin-gallate. *Int J Radiat Biol* 86(11):935–945.

Panagopoulos, D. J. , Karabarbounis, A. , Margaritis, L. H. (2002). Mechanism for action of electromagnetic fields on cells. *Biochem Biophys Res Commun* 298(1):95–102.

Panagopoulos, D. J. , Chavdoula, E. D. , Margaritis, L. H. (2010). Bioeffects of mobile telephony radiation in relation to its intensity or distance from the Antenna. *Int J Radiat Biol* 86(5):345–357.

Panagopoulos, D. , Johansson, O. , Carlo, G. (2013). Evaluation of specific absorption rate as a dosimetric quantity for electromagnetic fields bioeffects. *PLOS ONE* 8(6):e62663.

Panagopoulos, D. , Johansson, O. , Carlo, G. (2015). Polarization: A key difference between man-made and natural electromagnetic fields, in regard to biological activity. *Sci Rep* 5(1):1–10.

Panagopoulos, D. J. (2019). Comparing DNA damage induced by mobile telephony and other types of man-made electromagnetic fields. *Rev Mutat Res*, 781:53–62.

Panagopoulos, D. , Karabarbounis, A. , Yakymenko, I. , Chrousos, G. P. (2021). Humanmade electromagnetic fields: Ion forced oscillation and voltagegated ion channel dysfunction, oxidative stress and DNA damage. *Int J Oncol*, 59(5):1–16.

Paulraj, R. , Behari, J. , Rao, A. R. (1999). Effect of amplitude modulated RF radiation on calcium ion efflux and ODC activity in chronically exposed rat brain. *Indian J Biochem Biophys* 36(5):337–340.

Paulraj, R. , Behari, J. (2006). Single strand DNA breaks in rat brain cells exposed to microwave radiation. *Mutat Res* 596(1–2):76–80.

Pedersen, G. F. (1997). Amplitude modulated RF fields stemming from a GSM/DCS1800 phone. *Wirel Netw* 3(6):489–498.

Peleg, M. , Nativ, O. , Richter, E. D. (2018). Radio frequency radiation-related cancer: Assessing causation in the occupational/military setting. *Environ Res* 163:123–133.

Puranen, L. , Jokela, K. (1996). Radiation hazard assessment of pulsed microwave radars. *J Microw Power Electromagn Energy* 31(3):165–177.

Qi, G. , Zuo, X. , Zhou, L. , et al. (2015). Effects of extremely low-frequency electromagnetic fields (ELF-EMF) exposure on B6C3F1 mice. *Environ Health Prev Med* 20(4):287–293.

Rafnsson, V. , Hrafnkelsson, J. , Tulinius, H. (2000). Incidence of cancer among commercial airline pilots. *Occup Environ Med* 57(3):175–179.

Read, R. , O'Riordan, T. (2017). The precautionary principle under fire. *Environ Sci Policy Sustain Dev* 59(5):4–15.

Repacholi, M. H. , Basten, A. , GebSKI, V. , et al. (1997). Lymphomas in E mu-Pim1 transgenic mice exposed to pulsed 900 MHz electromagnetic fields. *Radiat Res* 147(5):631–640.

Robinette, C. D. , Silverman, C. , Jablon, S. (1980). Effects upon health of occupational exposure to microwave radiation (radar). *Am J Epidemiol*, 112(1):39–53.

Rodrigues, N. C. P. , Dode, A. C. , de Noronha Andrade, M. K. , et al. (2021). The effect of continuous low-intensity exposure to electromagnetic fields from radio base stations to cancer mortality in Brazil. *Int J Environ Res Public Health*, 18(3):1229.

Roosli, M. , Frei, P. , Bolte, J. , et al. (2010). Conduct of a personal radiofrequency electromagnetic field measurement study: Proposed study protocol. *Environ Health* 9:23.

Ruediger, H. W. (2009). Genotoxic effects of radiofrequency electromagnetic fields. *Pathophysiology* 16(2–3):89–102.

Sadetzki, S. , Chetrit, A. , Jarus-Hakak, A. , et al. (2008). Cellular phone use and risk of benign and malignant parotid gland tumors—A nationwide case-control study. *Am J Epidemiol* 167(4):457–467.

Santini, R. , Santini, P. , Danze, J. M. , Le Ruz, P. , Seigne, M. (2002). Study of the health of people living in the vicinity of mobile phone base stations: 1. Influences of distance and sex. *Pathol Biol (Paris)* 50(6):369–373.

Sato, Y. , Akiba, S. , Kubo, O. , Yamaguchi, N. (2011). A case-case study of mobile phone use and acoustic neuroma risk in Japan. *Bioelectromagnetics* 32(2):85–93.

Savitz, D. A. , Calle, E. E. (1987). Leukemia and occupational exposure to electromagnetic fields: Review of epidemiologic surveys. *J Occup Med* 29(1):47–51.

Schwarz, C. , Kratochvil, E. , Pilger, A. , et al. (2008). Radiofrequency electromagnetic fields (UMTS, 1,950 MHz) induce genotoxic effects in vitro in human fibroblasts but not in lymphocytes. *Int Arch Occup Environ Health* 81(6):755–767.

Seomun, G. , Lee, J. , Park, J. (2021). Exposure to extremely low-frequency magnetic fields and childhood cancer: A systematic review and meta-analysis. *PLOS ONE* 16(5):e0251628.

Sidorik, E. , Yakymenko, I. (2013). A brief review on animal research and human health effects following the Chernobyl accident. *Radiat Emerg Med* 2(1):5–13.

SmithRoe, S. L. , Wyde, M. E. , Stout, M. D. , et al. (2020). Evaluation of the genotoxicity of cell phone radiofrequency radiation in male and female rats and mice following subchronic exposure. *Environ Mol Mutagen* 61(2):276–290.

Sokolovic, D. , Djindjic, B. , Nikolic, J. , et al. (2008). Melatonin reduces oxidative stress induced by chronic exposure of microwave radiation from mobile phones in rat brain. *J Radiat Res (Tokyo)* 49(6):579–586.

Stang, A. , Anastassiou, G. , Ahrens, W. , et al. (2001). The possible role of radiofrequency radiation in the development of uveal melanoma. *Epidemiology* 12(1):7–12.

Szmigielski, S. , Szudzinski, A. , Pietraszek, A. , et al. (1982). Accelerated development of spontaneous and benzo(a)pyrene-induced skin cancer in mice exposed to 2450-MHz microwave radiation. *Bioelectromagnetics* 3(2):179–191.

Szmigielski, S. (1985). Polish epidemiological study links RF/MW exposures to cancer. *Microw News* 5(2):1–2.

Szmigielski, S. (1996). Cancer morbidity in subjects occupationally exposed to high frequency (radiofrequency and microwave) electromagnetic radiation. *Sci Total Environ* 180(1):9–17.

Thomas, S. , Heinrich, S. , Kuhnlein, A. , Radon, K. (2010). The association between socioeconomic status and exposure to mobile telecommunication networks in children and adolescents. *Bioelectromagnetics* 31(1):20–27.

Toler, J. C. , Shelton, W. W. , Frei, M. R. , Merritt, J. H. , Stedham, M. A. (1997). Long-term, low-level exposure of mice prone to mammary tumors to 435 MHz radiofrequency radiation. *Radiat Res* 148(3):227–234.

Tynes, T. , Hannevik, M. , Andersen, A. , Vistnes, A. I. , Haldorsen, T. (1996). Incidence of breast cancer in Norwegian female radio and telegraph operators. *Cancer Causes Control* 7(2):197–204.

Valko, M. , Rhodes, C. J. , Moncol, J. , Izakovic, M. , Mazur, M. (2006). Free radicals, metals and antioxidants in oxidative stress-induced cancer. *Chem Biol Interact* 160(1):1–40.

Valko, M. , Leibfritz, D. , Moncol, J. , et al. (2007). Free radicals and antioxidants in normal physiological functions and human disease. *Int J Biochem Cell Biol* 39(1):44–84.

Viel, J.-F. , Clerc, S. , Barrera, C. , et al. (2009). Residential exposure to radiofrequency fields from mobile phone base stations, and broadcast transmitters: A population-based survey with personal meter. *Occup Environ Med* 66(8):550–556.

Wertheimer, N. , Leeper, E. (1979). Electrical wiring configurations and childhood cancer. *Am J Epidemiol* 109(3):273–284.

Wertheimer, N. , Leeper, E. (1982). Adult cancer related to electrical wires near the home. *Int J Epidemiol* 11(4):345–355.

Wolf, R. , Wolf, D. (2007). Increased incidence of cancer near a cell-phone transmitted station. In F. Columbus (Ed.), *Trends in cancer prevention* (pp. 1–8). Nova Science Publishers Inc., New York.

Wu, W. , Yao, K. , Wang, K. J. , et al. (2008). Blocking 1800 MHz mobile phone radiation-induced reactive oxygen species production and DNA damage in lens epithelial cells by noise magnetic fields. *Zhejiang Da Xue Xue Bao Yi Xue Ban*, 37(1):34–38.

Xu, S. , Zhou, Z. , Zhang, L. , et al. (2010). Exposure to 1800 MHz radiofrequency radiation induces oxidative damage to mitochondrial DNA in primary cultured neurons. *Brain Res* 1311:189–196.

Yadav, A. S. , Sharma, M. K. (2008). Increased frequency of micronucleated exfoliated cells among humans exposed in vivo to mobile telephone radiations. *Mutat Res* 650(2):175–180.

Yakymenko, I. , Sidorik, E. (2010). Risks of carcinogenesis from electromagnetic radiation of mobile telephony devices. *Exp Oncol* 32(2):54–60.

Yakymenko, I. , Sidorik, E. , Kyrylenko, S. , Chekhun, V. (2011). Long-term exposure to microwave radiation provokes cancer growth: Evidences from radars and mobile communication systems. *Exp Oncol* 33(2):62–70.

Yakymenko, I. , Tsybulin, O. , Sidorik, E. , et al. (2016). Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation. *Electromagn Biol Med* 35(2):186–202.

Yakymenko, I. , Burlaka, A. , Tsybulin, I. , et al. (2018). Oxidative and mutagenic effects of low intensity GSM 1800 MHz microwave radiation. *Exp Oncol* 40(4):282–287.

Yokus, B. , Cakir, D. U. , Akdag, M. Z. , Sert, C. , Mete, N. (2005). Oxidative DNA damage in rats exposed to extremely low frequency electro magnetic fields. *Free Radic Res* 39(3):317–323.

Yokus, B. , Akdag, M. Z. , Dasdag, S. , Cakir, D. U. , Kizil, M. (2008). Extremely low frequency magnetic fields cause oxidative DNA damage in rats. *Int J Radiat Biol* 84(10):789–795.

Zeeb, H. , Hammer, G. P. , Langner, I. , et al. (2010). Cancer mortality among German aircrew: Second follow-up. *Radiat Environ Biophys* 49(2):187–194.

Zmyslony, M. , Politanski, P. , Rajkowska, E. , Szymczak, W. , Jajte, J. (2004). Acute exposure to 930 MHz CW electromagnetic radiation in vitro affects reactive oxygen species level in rat lymphocytes treated by iron ions. *Bioelectromagnetics* 25(5):324–328.

Zothansiam, Zosangzuali, M. , Lalramdinpui, M. , et al. (2017). Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations. *Electromagn Biol Med* 36(3):295–305.

Effects of Man-made and Especially Wireless Communication Electromagnetic Fields on Wildlife

Adams, J. A. , Galloway, T. S. , Mondal, D. , Esteves, S. C. , and Mathews, F. (2014). Effect of mobile telephones on sperm quality: A systematic review and meta-analysis. *Environment International*, 70, 106–112.

Adelaja, O. J. , Ande, A. T. , Abdulraheem, G. D. , Oluwakorode, I. A. , Oladipo, O. A. , and Oluwajobi, A. O. (2021). Distribution, diversity and abundance of some insects around a telecommunication mast in Ilorin, Kwara State, Nigeria. *Bulletin of the National Research Centre*, 45(1), 1–7.

Adey, W. R. (1996). Bioeffects of mobile communications fields: Possible mechanisms for cumulative dose. In N. Kuster , Q. Balzano , and J. C. Lin (Eds.), *Mobile communication safety*, pp. 95–131. Chapman & Hall, London.

Agarwal, A. , Deepinder, F. , Sharma, R. K. , Ranga, G. , and Li, J. (2008). Effect of cell phone usage on semen analysis in men attending infertility clinic: An observational study. *Fertility and Sterility*, 89(1), 124–128.

Agiwal, M. , and Jin, H. (2018). Directional paging for 5G communications based on partitioned user ID. *Sensors*, 18(6), 1845. <https://doi.org/10.3390/s18061845>.

Akar, A. , Karayiğit, M. Ö. , Bolat, D. , Gültiken, M. E. , Yarim, M. , and Castellani, G. (2013). Effects of low level electromagnetic field exposure at 2.45 GHz on rat cornea. *International Journal of Radiation Biology*, 89(4), 243–249.

Aldad, T. S. , Gan, G. , Gao, X. B. , and Taylor, H. S. (2012). Fetal radiofrequency radiation exposure from 800–1900 MHz rated cellular telephones affects neurodevelopment and behavior in mice. *Scientific Reports*, 2, 312.

Alkis, M. E. , Bilgin, H. M. , Akpolat, V. , Dasdag, S. , Yegin, K. , Yavas, M. C. , and Akdag, M. Z. (2019a). Effect of 900-, 1800-, and 2100-MHz radiofrequency radiation on DNA and oxidative stress in brain. *Electromagnetic Biology and Medicine*, 38(1), 32–47.

Alkis, M. E. , Akdag, M. Z. , Dasdag, S. , Yegin, K. , and Akpolat, V. (2019b). Single-strand DNA breaks and oxidative changes in rat testes exposed to radiofrequency radiation emitted from cellular phones. *Biotechnology and Biotechnological Equipment*, 33(1), 1733–1740.

Alkis, M. E. , Akdag, M. Z. , and Dasdag, S. (2021). Effects of low-intensity microwave radiation on oxidant antioxidant parameters and DNA damage in the liver of rats. *Bioelectromagnetics*, 42(1), 76–85.

Armstrong, F. A. , Hill, H. A. O. , and Walton, N. J. (1988). Direct electrochemistry of redox proteins. *Accounts of Chemical Research*, 21(11), 407–413.

Atli, E. , and Ünlü, H. (2006). The effects of microwave frequency electromagnetic fields on the development of *Drosophila melanogaster*. *International Journal of Radiation Biology*, 82(6), 435–441.

Atli, E. , and Ünlü, H. (2007). The effects of microwave frequency electromagnetic fields on the fecundity of *Drosophila melanogaster*. *Turkish Journal of Biology*, 31, 1–5.

Azimzadeh, M. , and Jelodar, G. (2020a). Prenatal and early postnatal exposure to radiofrequency waves (900 MHz) adversely affects passive avoidance learning and memory. *Toxicology and Industrial Health*, 36(12), 1024–1030.

- Azimzadeh, M. , and Jelodar, G. (2020b). Trace elements homeostasis in brain exposed to 900 MHz RFW emitted from a BTS antenna model and the protective role of vitamin E. *Journal of Animal Physiology and Animal Nutrition*, 104(5), 1568–1574.
- Balci, M. , Devrim, E. , and Durak, I. (2007). Effects of mobile phones on oxidant/antioxidant balance in cornea and lens of rats. *Current Eye Research*, 32(1), 21–25.
- Balmori, A. (2004). Pueden afectar las microondas pulsadas emitidas por las antenas de telefonía a los árboles y otros vegetales? *Ecosistemas*, 13, 79–87. (available in: <https://www.revistaecosistemas.net/index.php/ecosistemas>).
- Balmori, A. (2005). Possible effects of electromagnetic fields from phone masts on a population of white stork (*Ciconia ciconia*). *Electromagnetic Biology and Medicine*, 24(2), 109–119.
- Balmori, A. (2006). The incidence of electromagnetic pollution on the amphibian decline: Is this an important piece of the puzzle? *Toxicological and Environmental Chemistry*, 88(2), 287–299.
- Balmori, A. , and Hallberg, Ö. (2007). The urban decline of the house sparrow (*Passer domesticus*): A possible link with electromagnetic radiation. *Electromagnetic Biology and Medicine*, 26(2), 141–151.
- Balmori, A. (2009). Electromagnetic pollution from phone masts: Effects on wildlife. *Pathophysiology*, 16(2–3), 191–199.
- Balmori, A. (2010). Mobile phone mast effects on common frog (*Rana temporaria*) tadpoles: The city turned into a laboratory. *Electromagnetic Biology and Medicine*, 29(1–2), 31–35.
- Balmori, A. (2014). Electrosmog and species conservation. *Science of the Total Environment*, 496, 314–316.
- Balmori, A. (2015). Anthropogenic radiofrequency electromagnetic fields as an emerging threat to wildlife orientation. *Science of the Total Environment*, 518, 58–60.
- Balmori, A. (2016). Radiotelemetry and wildlife: Highlighting a gap in the knowledge on radiofrequency radiation effects. *Science of the Total Environment*, 543(A), 662–669.
- Balmori, A. (2021a). Electromagnetic radiation as an emerging driver factor for the decline of insects. *Science of the Total Environment*, 767, 144913.
- Balmori, A. (2021b). Electromagnetic pollution as a possible explanation for the decline of house sparrows in interaction with other factors. *Birds*, 2(3), 329–337.
- Balmori, A. (2022). Corneal opacity in Northern Bald Ibises (*Geronticus eremita*) equipped with radio transmitters. *Electromagnetic Biology and Medicine*. In press. <https://doi.org/10.1080/15368378.2022.2046046>.
- Balode, Z. (1996). Assessment of radio-frequency electromagnetic radiation by the micronucleus test in Bovine peripheral erythrocytes. *Science of the Total Environment*, 180(1), 81–85.
- Balodis, V. G. , Brumelis, K. , Kalvickis, O. , Nikodemus, D. , Tjarve, V. Z. , and Znotia, V. (1996). Does the Skruna radio location station diminish the radial growth of pine trees? *Science of the Total Environment*, 180(1), 57–64.
- Bamikole, A. O. , Olukayode, O. A. , Obajuluwa, T. , Pius, O. , Ibadun, O. O. , Adewale, F. O. , and Adeleke, O. O. (2019). Exposure to a 2.5 GHz non-ionizing electromagnetic field alters hematological profiles, biochemical parameters, and induces oxidative stress in male albino rats. *Biomedical and Environmental Sciences*, 32(11), 860–863.
- Bandara, P. , and Carpenter, D. O. (2018). Planetary electromagnetic pollution: It is time to assess its impact. *The Lancet Planetary Health*, 2(12), e512–e514.
- Barman, P. , and Bhattacharya, R. (2016). Impact of electric and magnetic field exposure on young plants-A review. *International Journal of Current Research and Academic Review*, 2(2), 182–192.
- Bartos, P. , Netušil, R. , Slaby, P. , Dolezel, D. , Ritz, T. , and Vacha, M. (2019). Weak radiofrequency fields affect the insect circadian clock. *Journal of the Royal Society Interface*, 16(158), 20190285.
- Batellier, F. , Couty, I. , Picard, D. , and Brillard, J. P. (2008). Effects of exposing chicken eggs to a cell phone in “call” position over the entire incubation period. *Theriogenology*, 69(6), 737–745.
- Beason, R. C. , and Semm, P. (2002). Responses of neurons to an amplitude modulated microwave stimulus. *Neuroscience Letters*, 333(3), 175–178.
- Beaubois, E. , Girard, S. , Lallechere, S. , Davies, E. , Paladian, F. , Bonnet, P. , Ledoit, G. , and Vian, A. (2007). Intercellular communication in plants: Evidence for two rapidly transmitted systemic signals generated in response to electromagnetic field stimulation in tomato. *Plant, Cell and Environment*, 30(7), 834–844.
- Begall, S. , Červený, J. , Neef, J. , Vojtěch, O. , and Burda, H. (2008). Magnetic alignment in grazing and resting cattle and deer. *Proceedings of the National Academy of Sciences of the United States of America*, 105(36), 13451–13455.
- Begall, S. , Malkemper, E. P. , Červený, J. , Němec, P. , and Burda, H. (2013). Magnetic alignment in mammals and other animals. *Mammalian Biology*, 78(1), 10–20.
- Belyaev, I. (2005). Non-thermal biological effects of microwaves. *Microwave Review*, 11(2), 13–29.
- Bellono, N. W. , Leitch, D. B. , and Julius, D. (2017). Molecular basis of ancestral vertebrate electroreception. *Nature*, 543(7645), 391–396.
- Belyavskaya, N. A. (2001). Ultrastructure and calcium balance in meristem cells of pea roots exposed to extremely low magnetic fields. *Advances in Space Research*, 28(4), 645–650.
- Benediktová, K. , Adámková, J. , Svoboda, J. , Painter, M. S. , Bartoš, L. , Nováková, P. , Hart, V. , Phillips, J. , and Burda, H. (2020). Magnetic alignment enhances homing efficiency of hunting dogs. *eLife*, 9, e55080.

- Berigan, L. A. , Greig, E. I. , and Bonter, D. N. (2020). Urban house sparrow (*Passer domesticus*) populations decline in North America. *The Wilson Journal of Ornithology*, 132(2), 248–258.
- Berman, E. , Chacon, L. , House, D. , Koch, B. A. , Koch, W. E. , Leal, J. , Wagner, P. , Mantiply, E. , Martin, A. H. , and Martucci, G. I. (1990). Development of chicken embryos in a pulsed magnetic field. *Bioelectromagnetics*, 11(2), 169–187.
- Bernatzky, A. (1986). Elektromagnetischer Smog – Feind des Lebens. *Der Naturarzt*, 11, 22–25.
- Betti, L. , Trebbi, G. , Lazzarato, L. , Brizzi, M. , Calzoni, G. L. , Marinelli, F. , and Borghini, F. (2004). Nonthermal microwave radiations affect the hypersensitive response of tobacco to tobacco mosaic virus. *Journal of Alternative and Complementary Medicine*, 10(6), 947–957.
- Bhat, T. A. , and Singh, D. (2019). Effect of mobile tower radiation on avian fauna: A case study of lolab valley, Kupwara Jammu and Kashmir. *JETIR*, 6, 570–576.
- Bhattacharya, R. , and Roy, R. (2013). Impacts of communication towers on avians: A review. *IJECT*, 4, Issue Spl - 1, 137–139.
- Bhattacharya, R. , and Roy, R. (2014). Impact of electromagnetic pollution from mobile phone towers on local birds. *International Journal of Innovative Research in Science, Engineering and Technology*, 3, 32–36.
- Bianco, G. , Köhler, R. C. , Ilieva, M. , and Åkesson, S. (2019). Magnetic body alignment in migratory songbirds: A computer vision approach. *Journal of Experimental Biology*, 222(5), jeb196469.
- Blank, M. (2014). Cell biology and EMF safety standards. *Electromagnetic Biology and Medicine*, 25, 1–3.
- Blank, M. , and Goodman, R. (2009). Electromagnetic fields stress living cells. *Pathophysiology*, 16(2–3), 71–78. <https://doi.org/10.1016/j.pathophys.2009.01.006>.
- Blaustein, A. R. , Hoffman, P. D. , Kiesecker, J. M. , and Hays, J. B. (1996). DNA repair activity and resistance to solar UV-B radiation in eggs of the red-legged frog. *Conservation Biology*, 10(5), 1398–1402.
- Borgens, R. B. (1988). Stimulation of neuronal regeneration and development by steady electrical fields. In S. G. Waxman (Ed.), *Advances in neurology; functional recovery in neurological disease*, 47, 547–564. Raven Press, New York.
- Bose, S. , Roy, R. , Chakraborti, U. , Samanta, R. , Jana, S. , Mondal, T. , and Bhattacharya, S. C. R. (2020). Impressions of high frequency radio-waves from cell phone towers on birds: A base-line study. *Journal of Multidisciplinary Research*, 1, 54–62.
- Brauer, I. (1950). Experimentelle Untersuchungen über die Wirkung von Meterwellen verschiedener Feldstärke auf das Teilungswachstum der Pflanzen. *Chromosoma*, 3(6), 483–509.
- Burda, H. , Begall, S. , Červený, J. , Neef, J. , and Nĕmec, P. (2009). Extremely low-frequency electromagnetic fields disrupt magnetic alignment of ruminants. *Proceedings of the National Academy of Sciences of the United States of America*, 106(14), 5708–5713.
- Burlaka, A. , Tsybulin, O. , Sidorik, E. , Lukin, S. , Polishuk, V. , Tshmistrenko, S. , and Yakymenko, I. (2013). Overproduction of free radical species in embryonic cells exposed to low intensity radiofrequency radiation. *Experimental Oncology*, 35(3), 219–225.
- Bürgi, A. , Scanferla, D. , and Lehmann, H. (2014). Time averaged transmitter power and exposure to electromagnetic fields from mobile phone base stations. *International Journal of Environmental Research and Public Health*, 11(8), 8025–8037.
- Calis, P. , Seymen, M. , Soykan, Y. , Delen, K. , Aral, B. S. , Take Kaplanoglu, G. , and Karcaaltincaba, D. (2019). Does exposure of smart phones during pregnancy affect the offspring's ovarian reserve? A rat model study. *Fetal and Pediatric Pathology*, 40(2), 142–152.
- Cammaerts, M. C. , De Doncker, P. , Patris, X. , Bellens, F. , Rachidi, Z. , and Cammaerts, D. (2012). GSM 900 MHz radiation inhibits ants' association between food sites and encountered cues. *Electromagnetic Biology and Medicine*, 31(2), 151–165.
- Cammaerts, M. C. , Rachidi, Z. , Bellens, F. , and De Doncker, P. (2013). Food collection and response to pheromones in an ant species exposed to electromagnetic radiation. *Electromagnetic Biology and Medicine*, 32(3), 315–332.
- Cammaerts, M. C. , and Johansson, O. (2014). Ants can be used as bio-indicators to reveal biological effects of electromagnetic waves from some wireless apparatus. *Electromagnetic Biology and Medicine*, 33(4), 282–288.
- Cammaerts, M. C. , and Johansson, O. (2015). Effect of man-made electromagnetic fields on common Brassicaceae *Lepidium sativum* (cress d'Alinois) seed germination: A preliminary replication study. *Fyton*, 84, 132–137.
- Camlitepe, Y. , Aksoy, V. , Uren, N. , Yilmaz, A. , and Becenen, I. (2005). An experimental analysis on the magnetic field sensitivity of the black-meadow ant *Formica pratensis* Retzius (Hymenoptera: Formicidae). *Acta Biologica Hungarica*, 56(3–4), 215–224.
- Carpenter, D. O. (2013). Human disease resulting from exposure to electromagnetic fields. *Reviews on Environmental Health*, 28(4), 159–172. <https://doi.org/10.1515/reveh-2013-0016>.
- Chavdoula, E. D. , Panagopoulos, D. J. , and Margaritis, L. H. (2010). Comparison of biological effects between continuous and intermittent exposure to GSM-900-MHz mobile phone radiation: Detection of apoptotic cell-death features. *Mutation Research/Genetic Toxicology and Environmental Mutagenesis*, 700(1–2), 51–61.
- Chou, C. K. , Guy, A. W. , Kunz, L. L. , Johnson, R. B. , Crowley, J. J. , and Krupp, J. H. (1992). Longterm, low-level microwave irradiation of rats. *Bioelectromagnetics*, 13(6), 469–496.

- Coghill, R. W. , Steward, J. , and Philips, A. (1996). Extra low frequency electric and magnetic fields in the bed place of children diagnosed with leukaemia: A case-control study. *European Journal of Cancer Prevention*, 5(3), 153–158.
- Crick, H. Q. , Robinson, R. A. , Appleton, G. F. , Clark, N. A. , and Rickard, A. D. (2002). Investigation into the causes of the decline of starlings and house sparrows in Great Britain. BTO Research Report N 290. Department for Environment, Food and Rural Affairs (DEFRA), London.
- Cucurachi, S. , Tamis, W. L. M. , Vijver, M. G. , Peijnenburg, W. J. G. M. , Bolte, J. F. B. , and Snoo, G. R. (2013). A review of the ecological effects of radiofrequency electromagnetic fields (RF-EMF). *Environment International*, 51, 116–140.
- Dadam, D. , Robinson, R. A. , Clements, A. , Peach, W. J. , Bennett, M. , Rowcliffe, J. M. , and Cunningham, A. A. (2019). Avian malaria-mediated population decline of a widespread iconic bird species. *Royal Society Open Science*, 6(7), 182197.
- Darney, K. , Girardin, A. , Joseph, R. , Abadie, P. , Aupinel, P. , Decourtye, A. , and Gauthier, M. (2016). Effect of high-frequency radiations on survival of the honeybee (*Apis mellifera* L.). *Apidologie*, 47(5), 703–710.
- Dasdag, S. , Ketani, M. A. , Akdag, Z. , Ersay, A. R. , Sar, I. , Demirtas, O. C. , and Celik, M. S. (1999). Whole body microwave exposure emitted by cellular phones and testicular function of rats. *Urological Research*, 27(3), 219–223. <https://doi.org/10.1007/s002400050113>.
- Davoudi, M. , Brössner, C. , and Kuber, W. (2002). Der Einfluss elektromagnetischer Wellen auf die Spermienmotilität. *Journal für Urologie und Urogynäkologie*, 9, 18–22.
- De Coster, G. , De Laet, J. , Vangestel, C. , Adriaensen, F. , and Lens, L. (2015). Citizen science in action—Evidence for long-term, region-wide house sparrow declines in Flanders, Belgium. *Landscape and Urban Planning*, 134, 139–146.
- De Lullis, G. N. , Newey, R. J. , King, B. V. , and Aitken, R. J. (2009). Mobile phone radiation induces reactive oxygen species production and DNA damage in human spermatozoa in vitro. *PLOS ONE*, 4(7), e6446.
- De Laet, J. , and Summers-Smith, J. D. (2007). The status of the urban house sparrow *Passer domesticus* in North-Western Europe: A review. *Journal of Ornithology*, 148(2), 275–278.
- Delen, K. , Sirav, B. , Oruç, S. , Seymen, C. M. , Kuzay, D. , Yeğin, K. , and Take Kaplanoğlu, G. (2021). Effects of 2600 MHz radiofrequency radiation in brain tissue of male Wistar rats and neuroprotective effects of melatonin. *Bioelectromagnetics*, 42(2), 159–172.
- Delgado, J. M. R. (1985). Biological effects of extremely low frequency electromagnetic fields. *Journal of Bioelectricity*, 4(1), 75–91.
- Di Carlo, A. , White, N. , Guo, F. , Garrett, P. , and Litovitz, T. (2002). Chronic electromagnetic field exposure decreases HSP70 levels and lowers cytoprotection. *Journal of Cellular Biochemistry*, 84(3), 447–454.
- Diego-Rasilla, F. J. , Pérez-Mellado, V. , and Pérez-Cembranos, A. (2017). Spontaneous magnetic alignment behaviour in free-living lizards. *The Science of Nature*, 104(3–4), 13.
- Diem, E. , Schwarz, C. , Adlkofer, F. , Jahn, O. , and Rudiger, H. (2005). Non-thermal DNA breakage by mobile-phone radiation (1800 MHz) in human fibroblasts and in transformed GFSH-R17 rat granulosa cells in vitro. *Mutation Research*, 583(2), 178–183.
- Divan, H. A. , Kheifets, L. , Obel, C. , and Olsen, J. (2008). Prenatal and postnatal exposure to cell phone use and behavioral problems in children. *Epidemiology*, 19(4), 523–529.
- Doherty, P. F. , and Grubb, T. C. (1996). Effects of high-voltage power lines on birds breeding within the power lines' electromagnetic fields. *Sialia*, 18, 129–134.
- Dubrov, A. P. (1978). *The geomagnetic field and life - Geomagnetobiology*. Plenum Press, New York.
- Eberhardt, J. L. , Persson, B. R. , Brun, A. E. , Salford, L. G. , and Malmgren, L. O. (2008). Blood-brain barrier permeability and nerve cell damage in rat brain 14 and 28 days after exposure to microwaves from GSM mobile phones. *Electromagnetic Biology and Medicine*, 27(3), 215–229.
- Engelmann, J. C. , Deeken, R. , Müller, T. , Nitz, G. , Roelfsema, M. R. G. , and Hedrich, R. (2008). Is gene activity in plant cells affected by UMTS-irradiation? A whole genome approach. *Advances and Applications in Bioinformatics and Chemistry: AABC*, 1, 71.
- Engels, S. , Schneider, N. L. , Lefeldt, N. , Hein, C. M. , Zapka, M. , Michalik, A. , Elbers, D. , Kittel, A. , Hore, P. J. , and Mouritsen, H. (2014). Anthropogenic electromagnetic noise disrupts magnetic compass orientation in a migratory bird. *Nature*. <http://doi.org/10.1038/nature13290>.
- European Environment Agency . (2013). Late lessons from early warnings: Science, precaution, innovation. EEA Report No 1/2013. <http://www.eea.europa>.
- Everaert, J. , and Bauwens, D. (2007). A possible effect of electromagnetic radiation from mobile phone base stations on the number of breeding house sparrows (*Passer domesticus*). *Electromagnetic Biology and Medicine*, 26(1), 63–72.
- Fahmy, H. M. , and Mohammed, F. F. (2021). Hepatic injury induced by radio frequency waves emitted from conventional wi-fi devices in Wistar rats. *Human and Experimental Toxicology*, 40(1), 136–147.
- Falcioni, L. , Bua, L. , Tibaldi, E. , Lauriola, M. , De Angelis, L. , Gnudi, F. and Belpoggi, F. (2018). Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission. *Environmental Research*, 165, 496–503.

- Farrell, J. M. , Litovitz, T. L. , Penafiel, M. , Montrose, C. J. , Doinov, P. , Barber, M. , and Litovitz, T. A. (1997). The effect of pulsed and sinusoidal magnetic fields on the morphology of developing chick embryos. *Bioelectromagnetics*, 18(6), 431–438.
- Favre, D. (2011). Mobile phone-induced honeybee worker piping. *Apidologie*, 42(3), 270–279.
- Fejes, I. , Za Vaczki, Z. , Szollosi, J. , Kolosza, R. S. , Daru, J. , Kovacs, L. , and Pa, L. A. (2005). Is there a relationship between cell phone use and semen quality? *Archives of Andrology*, 51, 385–393. <https://doi.org/10.1080/014850190924520>.
- Fernie, K. J. , Bird, D. M. , Dawson, R. D. , and Laguë, P. C. (2000). Effects of electromagnetic fields on the reproductive success of American kestrels. *Physiological and Biochemical Zoology*, 73(1), 60–65.
- Fernie, K. J. , and Bird, D. M. (2001). Evidence of oxidative stress in American kestrels exposed to electromagnetic fields. *Environmental Research*, 86(2), 198–207.
- Fernie, K. J. , and Reynolds, S. J. (2005). The effects of electromagnetic fields from power lines on avian reproductive biology and physiology: A review. *Journal of Toxicology and Environmental Health, Part B*, 8(2), 127–140.
- Ferrari, T. (2014). Magnets, magnetic field fluctuations and geomagnetic disturbances impair the homing ability of honey bee (*Apis m.*). *Journal of Apicultural Research*, 53(4), 452–456.
- Flipe, D. , Fournier, M. , Benquet, C. , Roux, P. , Le Boulaire, C. , Pinsky, C. , and Krzystyniak, K. (1998). Increased apoptosis, changes in intracellular Ca²⁺, and functional alterations in lymphocytes and macrophages after in vitro exposure to static magnetic field. *Journal of Toxicology and Environmental Health: Part A*, 54(1), 63–76.
- Formicki, K. , KorzeleckaOrkisz, A. , and Tański, A. (2019). Magnetoreception in fish. *Journal of Fish Biology*, 95(1), 73–91.
- Frey, A. H. (1985). Science and standards: Data analysis reveals significant microwave-induced eye damage in humans. *Journal of Microwave Power*, 20(1), 53–55.
- Frey, A. H. , and Feld, S. R. (1975). Avoidance by rats of illumination with low power nonionizing electromagnetic energy. *Journal of Comparative and Physiological Psychology*, 89(2), 183–188. <https://doi.org/10.1037/h0076662>.
- Friesen, M. , and Havas, M. (2020). Effects of non-ionizing electromagnetic pollution on invertebrates, including pollinators such as honey bees: What we know, what we don't know, and what we need to know. In D. Danyluk (Ed.), *Working landscapes: Proceedings of the 12th Prairie conservation and endangered species conference*, pp. 127–138. February 2019. Critical Wildlife Habitat Program, Winnipeg, Manitoba. <http://pcesc.ca/media/45404/final-2019-pcesc-proceedings.pdf>.
- Fritz, J. , Eberhard, B. , Esterer, C. , Goenner, B. , Trobe, D. , Unsoeld, M. , and Scope, A. (2020). Biologging is suspect to cause corneal opacity in two populations of wild living Northern Bald Ibises (*Geronticus eremita*). *Avian Research*, 11(1), 1–9.
- Galeev, A. L. (2000). The effects of microwave radiation from mobile telephones on humans and animals. *Neuroscience and Behavioral Physiology*, 30(2), 187–194.
- Gandhi, G. , and Singh, P. (2005). Cytogenetic damage in mobile phone users: Preliminary data. *International Journal of Human Genetics*, 5(4), 259–265.
- Gang, Y. , Bai, Z. , Chao, S. , Cheng, Q. , Wang, G. , Tang, Z. , and Yang, S. (2021). Current progress on the effect of mobile phone radiation on sperm quality: An updated systematic review and meta-analysis of human and animal studies. *Environmental Pollution*, 282, 116952.
- Gill, A. B. , Bartlett, M. , and Thomsen, F. (2012). Potential interactions between diadromous fishes of UK conservation importance and the electromagnetic fields and subsea noise from marine renewable energy developments. *Journal of Fish Biology*, 81(2), 664–695.
- Gómez-Perretta, C. , Navarro, E. A. , Segura, J. , and Portolés, M. (2013). Subjective symptoms related to GSM radiation from mobile phone base stations: A cross-sectional study. *BMJ Open*, 3(12), e003836.
- Granger, J. , Walkowicz, L. , Fitak, R. , and Johnsen, S. (2020). Gray whales strand more often on days with increased levels of atmospheric radio-frequency noise. *Current Biology*, 30(4), R155–R156.
- Greenberg, B. , Bindokas, V. P. , and Gauger, J. R. (1981). Biological effects of a 765kV transmission line: Exposures and thresholds in honeybee colonies. *Bioelectromagnetics*, 2(4), 315–328.
- Grémiaux, A. , Girard, S. , Guérin, V. , Lothier, J. , Baluška, F. , Davies, E. , Bonnet, P. , and Vian, A. (2016). Low-amplitude, high-frequency electromagnetic field exposure causes delayed and reduced growth in *Rosa hybrida*. *Journal of Plant Physiology*, 190, 44–53.
- Grefner, N. M. , Yakovleva, T. L. , and Boreysha, I. K. (1998). Effects of electromagnetic radiation on tadpole development in the common frog (*Rana temporaria* L.). *Russian Journal of Ecology*, 29, 133–134.
- Grigoriev, I. U. G. , Luk'ianova, S. N. , Makarov, V. P. , Rynskov, V. V. , and Moiseeva, N. V. (1995). Motor activity of rabbits in conditions of chronic low-intensity pulse microwave irradiation. *Radiatsionnaia Biologiya i Radioecologiya*, 35, 29–35.
- Grigor'ev, O. A. , Bicheldeĭ, E. P. , and Merkulo, A. V. (2003). Anthropogenic EMF effects on the condition and function of natural ecosystems. *Radiatsionnaia Biologiya i Radioecologiya*, 43(5), 544–551.
- Grigoriev, J. G. (2003). Influence of the electromagnetic field of the mobile phones on chickens embryo, to the evaluation of the dangerousness after the criterion of this mortality. *Radiation Biology*, 5, 541–544.

- Gustavino, B. , Carboni, G. , Petrillo, R. , Paoluzzi, G. , Santovetti, E. , and Rizzoni, M. (2016). Exposure to 915 MHz radiation induces micronuclei in *Vicia faba* root tips. *Mutagenesis*, 31(2), 187–192.
- Haggerty, K. (2010). Adverse influence of radio frequency background on trembling aspen seedlings: Preliminary observations. *International Journal of Forestry Research*, 2010, 836278.
- Halgamuge, M. N. , Yak, S. K. , and Eberhardt, J. L. (2015). Reduced growth of soybean seedlings after exposure to weak microwave radiation from GSM 900 mobile phone and base station. *Bioelectromagnetics*, 36(2), 87–95.
- Halgamuge, M. N. (2017). Review: Weak radiofrequency radiation exposure from mobile phone radiation on plants. *Electromagnetic Biology and Medicine*, 36(2), 213–235.
- Hallmann, C. A. , Sorg, M. , Jongejans, E. , Siepel, H. , Hofland, N. , Schwan, H. , and Goulson, D. (2017). More than 75 percent decline over 27 years in total flying insect biomass in protected areas. *PLOS ONE*, 12(10), e0185809.
- Hallberg, Ö. , and Johansson, O. (2013). Increasing melanoma—Too many skin cell damages or too few repairs? *Cancers*, 5(1), 184–204.
- Hardell, L. , Carlberg, M. , Söderqvist, F. , Mild, K. H. , and Morgan, L. L. (2007). Long-term use of cellular phones and brain tumours: Increased risk associated with use for > or =10 years > or =10 years. *Occupational and Environmental Medicine*, 64(9), 626–632.
- Hardell, L. , and Carlberg, M. (2020). [Comment] health risks from radiofrequency radiation, including 5G, should be assessed by experts with no conflicts of interest. *Oncology Letters*, 20(4), 1–1.
- Hardell, L. (2021). Health council of the Netherlands and evaluation of the fifth generation, 5G, for wireless communication and cancer risks. *World Journal of Clinical Oncology*, 12(6), 393.
- Hardell, L. , Nilsson, M. , Koppel, T. , and Carlberg, M. (2021). Aspects on the international commission on non-ionizing radiation protection (ICNIRP) 2020 guidelines on radiofrequency radiation. *Journal of Cancer Science and Clinical Therapeutics*, 5(2), 250–285.
- Harremoës, P. , Gee, D. , MacGarvin, M. , Stirling, A. , Keys, J. , Wynne, B. , and Vaz, S. G. (Eds.). (2013). *The precautionary principle in the 20th century: Late lessons from early warnings*. Routledge, London.
- Harst, W. , Kuhn, J. , and Stever, H. (2006). Can electromagnetic exposure cause a change in behaviour? Studying possible non-thermal influences on honeybees—An approach within the framework of educational informatics. *Acta Syst IIAS Int. J.*, 6(1), 1–6.
- Hart, V. , Kušta, T. , Němec, P. , Bláhová, V. , Ježek, M. , Nováková, P. and Burda, H. (2012). Magnetic alignment in carps: Evidence from the Czech Christmas fish market. *PLOS ONE*, 7(12), e51100.
- Harte, C. (1950). Mutationsauslösung durch Ultrakurzwellen. *Chromosoma*, 3, 140–147.
- Harte, C. (1972). Auslösung von Chromosomenmutationen durch Meterwellen in Pollenmutterzellen von *Oenothera*. *Chromosoma*, 36(4), 329–337.
- Hässig, M. , Jud, F. , and Spiess, B. (2012). Increased occurrence of nuclear cataract in the calf after erection of a mobile phone base station. *Schweizer Archiv für Tierheilkunde*, 154(2), 82–86.
- Hässig, M. , Wullschleger, M. , Naegeli, H. , Kupper, J. , Spiess, B. , Kuster, N. , and Murbach, M. (2014). Influence of non ionizing radiation of base stations on the activity of redox proteins in bovines. *BMC Veterinary Research*, 10(1), 1–11.
- Hertel, U. (1991). The forest dies as politicians look on. *Raum y Zeit*, 51(May–junio), 91.
- Hiscock, H. G. , Mouritsen, H. , Manolopoulos, D. , and Hore, P. J. (2017). Disruption of magnetic compass orientation in migratory birds by radiofrequency electromagnetic fields. *Biophysical Journal*, 113(7), 1475–1484. <https://doi.org/10.1016/j.bpj.2017.07.031>.
- Hotary, K. B. , and Robinson, K. R. (1992). Evidence of a role for endogenous electrical fields in chick embryo development. *Development*, 114(4), 985–996.
- Hsu, C. Y. , Ko, F. Y. , Li, C. W. , Fann, K. , and Lue, J. T. (2007). Magnetoreception system in honeybees (*Apis mellifera*). *PLOS ONE*, 2(4), e395. <http://doi.org/10.1371/journal.pone.0000395>.
- Huber, R. , Graf, T. , Cote, K. A. , Wittmann, L. , Gallmann, E. , Matter, D. , Schuderer, J. , Kuster, N. , Borbely, A. A. , and Achermann, P. (2000). Exposure to pulsed high-frequency electromagnetic field during waking affects human sleep EEG. *NeuroReport*, 11(15), 3321–3325.
- Hussein, R. A. , and El-Maghraby, M. A. (2014). Effect of two brands of cell phone on germination rate and seedling of wheat (*Triticum aestivum*). *Journal of Environment Pollution and Human Health*, 2, 85–90.
- Hutchison, Z. L. , Gill, A. B. , Sigray, P. , He, H. , and King, J. W. (2020). Anthropogenic electromagnetic fields (EMF) influence the behaviour of bottom-dwelling marine species. *Scientific Reports*, 10(1), 1–15.
- Hyland, G. J. (2000). Physics and biology of mobile telephony. *Lancet*, 356(9244), 1833–1836.
- Hyland, G. J. (2008). Physical basis of adverse and therapeutic effects of low intensity microwave radiation. *Indian Journal of Experimental Biology*, 46(5), 403–419.
- ICNIRP . (2010). Guidelines for limiting exposure to time-varying electric and magnetic fields (1 Hz to 100 kHz). *Health Physics*, 99(6), 818–836.
- ICNIRP . (2020). Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz). *Health Physics*, 118(5), 483–524.
- Jayasanka, S. M. D. H. , and Asaeda, T. (2013). The significance of microwaves in the environment and its effect on plants. *Environmental Reviews*, 22(3), 220–228.

- Jerman, I. , Berden, M. , Ruzic, R. , and Skarja, M. (1998). Biological effects of TV set electromagnetic fields on the growth of spruce seedlings. *Electromagnetic Biology and Medicine*, 17(1), 31–42.
- Johansson, O. (2009). Disturbance of the immune system by electromagnetic fields-A potentially underlying cause for cellular damage and tissue repair reduction which could lead to disease and impairment. *Pathophysiology*, 16(2–3), 157–177.
- Johnsen, S. , and Lohmann, K. J. (2005). The physics and neurobiology of magnetoreception. *Nature Reviews Neuroscience*, 6(9), 703–712.
- Johnson-Liakouris, A. G. (1998). Radiofrequency (RF) sickness in the Lilienfeld study: An effect of modulated microwaves? *Archives of Environmental Health: An International Journal*, 53(3), 236–238.
- Kalmijn, A. J. (1988). Detection of weak electric fields. In J. Atema, R.R. Fay, A.N. Popper, W.N. Tavolga (Eds): *Sensory biology of aquatic animals*, pp. 151–186. Springer, New York.
- Keles, A. I. (2020). Morphological changes in the vertebrae and central canal of rat pups born after exposure to the electromagnetic field of pregnant rats. *Acta Histochemica*, 122(8), 151652.
- Khan, M. D. , Ali, S. , Azizullah, A. , and Shuijin, Z. (2018). Use of various biomarkers to explore the effects of GSM and GSM-like radiations on flowering plants. *Environmental Science and Pollution Research International*, 25(25), 24611–24628.
- Kheifets, L. , Ahlbom, A. , Crespi, C. M. , Draper G. , Hagihara J. , et al. (2010). Pooled analysis of recent studies on magnetic fields and childhood leukaemia. *British Journal of Cancer*, 103(7), 1128–1135.
- Kiepenheuer, K. O. , Brauer, I. , and Harte, C. (1949). Über die Wirkung von Meterwellen auf das Teilungswachstum der Pflanzen. *Naturwissenschaften*, 36(1), 27.
- Kiernan, V. (1995). Forest grows tall on radio waves. *New Scientist*, 14, 5.
- Kim, H. S. , Choi, H. D. , Pack, J. K. , Kim, N. , and Ahn, Y. H. (2021). Biological effects of exposure to a radiofrequency electromagnetic field on the placental barrier in pregnant rats. *Bioelectromagnetics*, 42(3), 191–199.
- Kirschvink, J. L. , and Gould, J. L. (1981). Biogenic magnetite as a basis for magnetic field sensitivity in animals. *Biological Systems*, 13(3), 181–201.
- Kirschvink, J. L. (1989). Magnetite biomineralization and geomagnetic sensitivity in higher animals: An update and recommendations for future study. *Bioelectromagnetics*, 10(3), 239–259.
- Kirschvink, J. L. , Walker, M. M. , and Diebel, C. E. (2001). Magnetite-based magnetoreception. *Current Opinion in Neurobiology*, 11(4), 462–467.
- Kler, T. K. , Kumar, M. , and Vashishat, N. (2018). Effects of electromagnetic radiations on diversity and breeding biology of birds living near power lines and mobile towers at Ludhiana, Punjab. *Journal of Environmental Biology*, 39(2), 247–252.
- Kolodynski, A. A. , and Kolodynska, V. V. (1996). Motor and psychological functions of school children living in the area of the Skrunđa radio location station in Latvia. *Science of the Total Environment*, 180(1), 87–93.
- Kostoff, R. N. , Heroux, P. , Aschner, M. , and Tsatsakis, A. (2020). Adverse health effects of 5G mobile networking technology under real-life conditions. *Toxicology Letters*, 323, 35–40.
- Kramarenko, A. V. , and Tan, U. (2003). Effects of high-frequency electromagnetic fields on human EEG: A brain mapping study. *International Journal of Neuroscience*, 113(7), 1007–1019.
- Krishnan, V. , Park, S. A. , Shin, S. S. , Alon, L. , Tressler, C. M. , Stokes, W. , and Pelled, G. (2018). Wireless control of cellular function by activation of a novel protein responsive to electromagnetic fields. *Scientific Reports*, 8(1), 1–12.
- Krstic, D. D. , Dindic, B. J. , Sokolovic, D. T. , Markovic, V. V. , Petkovic, D. M. & Radic, S. B. (2005, September). The results of experimental exposition of mice by mobile telephones. In *TELSIKS 2005-2005 International Conference on Telecommunication in Modern Satellite, Cable and Broadcasting Services (Vol. 2, pp. 465–470)*. IEEE.
- Kumar, N. R. , Rana, N. , and Kalia, P. (2013). Biochemical changes in haemolymph of *Apis mellifera* L. drone under the influence of cell phone radiations. *Journal of Applied and Natural Science*, 5(1), 139–141.
- Kumar, A. , Singh, H. P. , Batish, D. R. , Kaur, S. , and Kohli, R. K. (2016). EMF radiations (1800 MHz) inhibited early seedling growth of maize (*Zea mays*) involves alterations in starch and sucrose metabolism. *Protoplasma*, 253(4), 1043–1049.
- Kumar, R. , Deshmukh, P. S. , Sharma, S. , and Banerjee, B. D. (2021). Effect of mobile phone signal radiation on epigenetic modulation in the hippocampus of Wistar rat. *Environmental Research*, 192, 110297.
- Kundu, A. , and IEEE . (2013). Specific absorption rate evaluation in apple exposed to RF radiation from GSM mobile towers. In *IEEE applied electromagnetics conference (AEMC)*, pp. 1–2. IEEE. (ISBN 978-1-4799-3266-5). doi: 10.1109/AEMC.2013.7045044.
- Lai, H. (2005). Biological effects of radiofrequency electromagnetic field. *Encyclopedia of Biomaterials and Biomedical Engineering*, 10, 1–8.
- Lai, H. , Carino, M. A. , Horita, A. , and Guy, A. W. (1989). Acute low-level microwave exposure and central cholinergic activity: A doseresponse study. *Bioelectromagnetics*, 10(2), 203–209.
- Lai, H. , and Singh, N. P. (1995). Acute low-intensity microwave exposure increases DNA single-strand breaks in rat brain cells. *Bioelectromagnetics*, 16(3), 207–210.

- Lai, H. , and Singh, N. P. (1997). Acute exposure to a 60 Hz magnetic field increases DNA strand breaks in rat brain cells. *Bioelectromagnetics*, 18(2), 156–165.
- Lázaro, A. , Chroni, A. , Tschulin, T. , Devalez, J. , Matsoukas, C. , and Petanidou, T. (2016). Electromagnetic radiation of mobile telecommunication antennas affects the abundance and composition of wild pollinators. *Journal of Insect Conservation*, 20(2), 315–324.
- Lee, G. M. , Neutra, R. R. , Hristova, L. , Yost, M. , and Hiatt, R. A. (2002). A nested case-control study of residential and personal magnetic field measures and miscarriages. *Epidemiology*, 13(1), 21–31.
- Lee, W. , and Yang, K. L. (2014). Using medaka embryos as a model system to study biological effects of the electromagnetic fields on development and behavior. *Ecotoxicology and Environment Safety*, 108, 187–194.
- Lee, D. , Lee, J. , and Lee, I. (2015). Cell phone-generated radio frequency electromagnetic field effects on the locomotor behaviors of the fishes *Poecilia reticulata* and *Danio rerio*. *International Journal of Radiation Biology*, 91(10), 843–850.
- Lerchl, D. , Lerchl, A. , Hantsch, P. , Bitz, A. , Streckert, J. , & Hansen, V. (2000). Studies on the effects of radio-frequency fields on conifers. In *Bioelectromagnetics Society Annual Meeting* (pp. 9–16).
- Leszczynski, D. , Joenväärä, S. , Reivinen, J. , and Kuokka, R. (2002). Non-thermal activation of the hsp27/p38MAPK stress pathway by mobile phone radiation in human endothelial cells: Molecular mechanism for cancer-and blood-brain barrier-related effects. *Differentiation; Research in Biological Diversity*, 70(2–3), 120–129.
- Levengood, W. C. (1969). A new teratogenic agent applied to amphibian embryos. *Journal of Embryology and Experimental Morphology*, 21(1), 23–31.
- Levin, M. (2003). Bioelectromagnetics in morphogenesis. *Bioelectromagnetics*, 24(5), 295–315.
- Levitt, B. B. , and Lai, H. (2010). Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays. *Environmental Reviews*, 18, 369–395.
- Levitt, B. B. , Lai, H. C. , and Manville, A. M. (2021a). Effects of non-ionizing electromagnetic fields on flora and fauna, part 1. Rising ambient EMF levels in the environment. *Reviews on Environmental Health*, 37(1), 81–122.
- Levitt, B. B. , Lai, H. C. , and Manville, A. M. (2021b). Effects of non-ionizing electromagnetic fields on flora and fauna, part 2 impacts: How species interact with natural and man-made EMF. *Reviews on Environmental Health*, 37(3): 327–406.
- Liboff, A. R. , and Jenrow, K. A. (2000). New model for the avian magnetic compass. *Bioelectromagnetics*, 21(8), 555–565.
- Lopatina, N. G. , Zachepilo, T. G. , Kamyshev, N. G. , Dyuzhikova, N. A. , and Serov, I. N. (2019). Effect of non-ionizing electromagnetic radiation on behavior of the honeybee, *Apis mellifera* L. (Hymenoptera, Apidae). *Entomological Review*, 99(1), 24–29.
- López-Martín, E. , Jorge-Barreiro, F. J. , Relova-Quintero, J. L. , Salas-Sánchez, A. A. , and Ares-Pena, F. J. (2020). Exposure to 2.45 GHz radiofrequency modulates calcitonin-dependent activity and HSP-90 protein in parafollicular cells of rat thyroid gland. *Tissue and Cell*, 68, 101478.
- López, I. , Félix, N. , Rivera, M. , Alonso, A. , and Maestú, C. (2021). What is the radiation before 5G? A correlation study between measurements in situ and in real time and epidemiological indicators in Vallecas, Madrid. *Environmental Research*, 194, 110734.
- Loscher, W. , and Kas, G. (1998). Conspicuous behavioural abnormalities in a dairy cow herd near a TV and radio transmitting antenna. *Practical Veterinary Surgeon*, 29, 437–444.
- Luo, K. , Luo, C. , Li, G. , Yao, X. , Gao, R. , Hu, Z. , and Zhao, H. (2019). Highvoltage electrostatic fieldinduced oxidative stress: Characterization of the physiological effects in *Sitobion avenae* (Hemiptera: Aphididae) across multiple generations. *Bioelectromagnetics*, 40(1), 52–61.
- Lupi, D. , Tremolada, P. , Colombo, M. , Giacchini, R. , Benocci, R. , Parenti, P. , Zambon, G. , and Vighi, M. (2020). Effects of pesticides and electromagnetic fields on honeybees: A field study using biomarkers. *International Journal of Environmental Research*, 14(1), 107–122.
- Lupi, D. , Palamara Mesiano, M. , Adani, A. , Benocci, R. , Giacchini, R. , Parenti, P. and Tremolada, P. (2021). Combined effects of pesticides and electromagnetic-fields on honeybees: Multi-stress exposure. *Insects*, 12(8), 716.
- Madjar, H. M. (2016). Human radio frequency exposure limits: An update of reference levels in Europe, USA, Canada, China, Japan and Korea. In *2016 international symposium on electromagnetic compatibility-EMC EUROPE* (pp. 467–473). IEEE. doi: 10.1109/EMCEurope.2016.7739164
- Magone, I. (1996). The effect of electromagnetic radiation from the Skrunđa Radio Location Station on *Spirodela polyrhiza* (L.) Schleiden cultures. *Science of the Total Environment*, 180(1), 75–80.
- Magras, I. N. , and Xenos, T. D. (1997). RF radiation-induced changes in the prenatal development of mice. *Bioelectromagnetics*, 18(6), 455–461.
- Malkemper, P. , Eder, S. H. K. , Begall, S. , Phillips, J. B. , Winklhofer, M. , Hart, V. , and Burda, H. (2015). Magnetoreception in the wood mouse (*Apodemus sylvaticus*): Influence of weak frequency-modulated radio frequency fields. *Scientific Reports*, 5, 9917. <https://doi.org/10.1038/srep09917>.
- Mann, K. , and Roschke, J. (1996). Effects of pulsed high-frequency electromagnetic fields on human sleep. *Neuropsychobiology*, 33(1), 41–47.
- Margaritis, L. H. , Manta, A. K. , Kokkaliaris, K. D. et al. (2014). *Drosophila* oogenesis as a bio-marker responding to EMF sources. *Electromagnetic Biology and Medicine*, 33(3), 165–189.

Marino, A. A. , Hart, F. X. , and Reichmanism, M. (1983). Weak electric fields affect plant development. *IEEE Transactions on Bio-Medical Engineering*, 12(12), 833–834.

Marino, A. A. , Nilsen, E. , and Frilot, C. (2003). Nonlinear changes in brain electrical activity due to cell phone radiation. *Bioelectromagnetics*, 24(5), 339–346.

Marks, T. A. , Ratke, C. C. , and English, W. O. (1995). Strain voltage and developmental, reproductive and other toxicology problems in dogs, cats and cows: A discussion. *Veterinary and Human Toxicology*, 37, 163–172.

Martínez, E. , Carbonell, M. V. , and Flórez, M. (2003). Estimulación de la germinación y el crecimiento por exposición a campos magnéticos. *Investigación y Ciencia*, 324, 24–28.

Mazor, R. , Korenstein-Ilan, A. , Barbul, A. , Eshet, Y. , Shahadi, A. , Jerby, E. , and Korenstein, R. (2008). Increased levels of numerical chromosome aberrations after in vitro exposure of human peripheral blood lymphocytes to radiofrequency electromagnetic fields for 72 hours. *Radiation Research*, 169(1), 28–37.

Mech, L. D. , and Barber, S. M. (2002). A critique of wildlife radio-tracking and its use in national parks. A Report to the US National Park Service, Northern Prairie Wildlife Research Center.

Migdał, P. , Murawska, A. , Biełkowski, P. , Berbeć, E. , and Roman, A. (2021). Changes in honeybee behavior parameters under the influence of the E-field at 50 Hz and variable intensity. *Animals*, 11(2), 247.

Miura, M. , and Okada, J. (1991). Non-thermal vasodilatation by radio frequency burst-type electromagnetic field radiation in the frog. *Journal of Physiology*, 435, 257–273.

Mohammed, H. S. , Fahmy, H. M. , Radwan, N. M. , and Elsayed, A. A. (2013). Non-thermal continuous and modulated electromagnetic radiation fields effects on sleep EEG of rats. *Journal of Advanced Research*, 4(2), 181–187. <https://doi.org/10.1016/j.jare.2012.05.005>.

Mohring, B. , Henry, P. Y. , Jiguet, F. , Malher, F. , and Angelier, F. (2020). Investigating temporal and spatial correlates of the sharp decline of an urban exploiter bird in a large European city. *Urban Ecosystems*, 24(3), 501–513.

Møller, A. P. (2019). Parallel declines in abundance of insects and insectivorous birds in Denmark over 22 years. *Ecology and Evolution*, 9(11), 6581–6587.

Moorhouse, T. P. , and Macdonald, D. W. (2005). Indirect negative impacts of radio-collaring: Sex ratio variation in water voles. *Journal of Applied Ecology*, 42(1), 91.

Nagata, H. , and Yamagish, S. (2013). Re-introduction of crested ibis on Sado Island, Japan. In P. S. Soorae (Ed.), *Global re-introduction perspectives: Further case studies from around the globe*, pp. 58–62. Gland and Abu Dhabi: IUCN/SSC Re-introduction Specialist Group and Environment Agency-Abu Dhabi.

National Toxicology Program (NTP) , (2018). Toxicology and carcinogenesis studies of GSM- and CDMA-modulated cell phone radiofrequency radiation at 900 MHz in Sprague Dawley Rats (whole body exposure). Technical Report Series No. 595. National Toxicology Program Public Health Service U.S. Department of Health and Human Services ISSN: 2378-8925 Research Triangle Park, North Carolina, USA.

Navakatikian, M. A. , and Tomashevskaya, L. A. (1994). Phasic behavioral and endocrine effects of microwaves of nonthermal intensity. In D. O. Carpenter (Ed.), *Biological effects of electric and magnetic fields*, vol. 1, 333–342, Academic Press, San Diego.

Neufeld, E. , and Kuster, N. (2018). Systematic derivation of safety limits for time-varying 5G radiofrequency exposure based on analytical models and thermal dose. *Health Physics*, 115(6), 705–711.

Neurath, P. W. (1968). High gradient magnetic fields inhibit embryonic development of frogs. *Nature*, 21(5161), 1358–1359.

Nicholls, B. , and Racey, P. A. (2007). Bats avoid radar installations: Could electromagnetic fields deter bats from colliding with wind turbines? *PLOS ONE*, 3(3), e297.

Nikolaevich, N. , Igorevna, A. , and Vasil, G. (2001). Influence of highfrequency electromagnetic radiation at non-thermal intensities on the human body (a review of work by Russian and Ukrainian researchers). *No Place to Hide*, 3 Supplement.

Nirwane, A. , Sridhar, V. , and Majumdar, A. (2016). Neurobehavioural changes and brain oxidative stress induced by acute exposure to GSM900 mobile phone radiations in zebrafish (*Danio rerio*). *Toxicological Research*, 32(2), 123–132.

Nishimura, T. , Okano, H. , Tada, H. , Nishimura, E. , Sugimoto, K. , Mohri, K. , and Fukushima, M. (2010). Lizards respond to an extremely low-frequency electromagnetic field. *Journal of Experimental Biology*, 213(12), 1985–1990.

Novoselova, E. T. , and Fesenko, E. E. (1998). Stimulation of production of tumor necrosis factor by murine macrophages when exposed in vivo and in vitro to weak electromagnetic waves in the centimeter range. *Biofizika*, 43(6), 1132–1133.

Ntzouni, M. P. , Stamatakis, A. , Stylianopoulou, F. , and Margaritis, L. H. (2011). Short-term memory in mice is affected by mobile phone radiation. *Pathophysiology*, 18(3), 193–199.

Nuccitelli, R. (1988). Ionic currents in morphogenesis. *Experientia*, 44(8), 657–666.

Obajuluwa, A. O. , Akinyemi, A. J. , Afolabi, O. B. , Adekoya, K. , Sanya, J. O. , and Ishola, A. O. (2017). Exposure to radiofrequency electromagnetic waves alters acetylcholinesterase gene expression, exploratory and motor coordinationlinked behaviour in male rats. *Toxicology Reports*, 4, 530–534.

Odemer, R. , and Odemer, F. (2019). Effects of radiofrequency electromagnetic radiation (RF-EMF) on honey bee queen development and mating success. *Science of the Total Environment*, 661, 553–562.

Ozel, H. B. , Cetin, M. , Sevik, H. , Varol, T. , Isik, B. , and Yaman, B. (2021). The effects of base station as an electromagnetic radiation source on flower and cone yield and germination percentage in *Pinus brutia* Ten. *Biologia Futura*, 72(3), 359–365..

Ozgun, E. , Kismali, G. , Guler, G. , Akcay, A. , Ozkurt, G. , Sel, T. , and Seyhan, N. (2013). Effects of prenatal and postnatal exposure to GSM-like radiofrequency on blood chemistry and oxidative stress in infant rabbits, an experimental study. *Cell Biochemistry and Biophysics*, 67(2), 743–751.

Pall, M. L. (2013). Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects. *Journal of Cellular and Molecular Medicine*, 17(8), 958–965.

Pall, M. (2016). Electromagnetic fields act similarly in plants as in animals: Probable activation of calcium channels via their voltage sensor. *Current Chemical Biology*, 10(1), 74–82.

Panagopoulos, D. J. , Messini, N. , Karabarbounis, A. , Filippidis, A. L. , and Margaritis, L. H. (2000). A mechanism for action of oscillating electric fields on cells. *Biochemical and Biophysical Research Communications*, 272(3), 634–640.

Panagopoulos, D. J. , Karabarbounis, A. , and Margaritis, L. H. (2002). Mechanism for action of electromagnetic fields on cells. *Biochemical and Biophysical Research Communications*, 298(1), 95–102.

Panagopoulos, D. J. , Karabarbounis, A. , and Margaritis, L. H. (2004). Effect of GSM 900 MHz mobile phone radiation on the reproductive capacity of *Drosophila melanogaster*. *Electromagnetic Biology and Medicine*, 23(1), 29–43.

Panagopoulos, D. J. , Chavdoula, E. D. , Nezis, I. P. , and Margaritis, L. H. (2007a). Cell death induced by GSM 900-MHz and DCS 1800-MHz mobile telephony radiation. *Mutation Research/Genetic Toxicology and Environmental Mutagenesis*, 626(1–2), 69–78.

Panagopoulos, D. J. , Chavdoula, E. D. , Karabarbounis, A. , and Margaritis, L. H. (2007b). Comparison of bioactivity between GSM 900 MHz and DCS 1800 MHz mobile telephony radiation. *Electromagnetic Biology and Medicine*, 26(1), 33–44.

Panagopoulos, D. J. , Chavdoula, E. D. , and Margaritis, L. H. (2010). Bioeffects of mobile telephony radiation in relation to its intensity or distance from the antenna. *International Journal of Radiation Biology*, 86(5), 345–357.

Panagopoulos, D. J. (2012). Effect of microwave exposure on the ovarian development of *Drosophila melanogaster*. *Cell Biochemistry and Biophysics*, 63(2), 121–132.

Panagopoulos, D. J. (2013). Electromagnetic interaction between environmental fields and living systems determines health and well-being. In M.H. Kwang and S.O. Yoon (Eds) *Electromagnetic fields: Principles, engineering applications and biophysical effects*, 99–140. Nova Science Publishers, New York.

Panagopoulos, D. J. , Karabarbounis, A. , and Liolios, C. (2013). ELF alternating magnetic field decreases reproduction by DNA damage induction. *Cell Biochemistry and Biophysics*, 67(2), 703–716.

Panagopoulos, D. J. , Johansson, O. , and Carlo, G. L. (2015a). Polarization: A key difference between man-made and natural electromagnetic fields, in regard to biological activity. *Scientific Reports*, 5, 14914. <https://doi.org/10.1038/srep14914>.

Panagopoulos, D. J. , Johansson, O. , and Carlo, G. L. (2015b). Real versus simulated mobile phone exposures in experimental studies. *BioMed Research International*, 2015, 607053.

Panagopoulos, D. J. , and Balmori, A. (2017). On the biophysical mechanism of sensing atmospheric discharges by living organisms. *Science of the Total Environment*, 599, 2026–2034.

Panagopoulos, D. J. (2017). Mobile telephony radiation effects on insect ovarian cells: The necessity for real exposures bioactivity assessment: The key role of polarization, and the ion forced-oscillation mechanism. In C. D. Geddes (Ed.), *Microwave effects on DNA and proteins*. Springer, Cham, Switzerland.

Panagopoulos, D. J. (2019). Comparing DNA damage induced by mobile telephony and other types of man-made electromagnetic fields. *Mutation Research Reviews*, 781, 53–62.

Panagopoulos, D. J. (2020). Comparing chromosome damage induced by mobile telephony radiation and a high caffeine dose: Effect of combination and exposure duration. *General Physiology and Biophysics*, 39(6), 531–544.

Panagopoulos, D. J. , and Karabarbounis, A. (2020). Comments on “diverse radiofrequency sensitivity and radiofrequency effects of mobile or cordless phone near fields exposure in *Drosophila melanogaster*”. *Advances in Environmental Studies*, 4(1), 271–276.

Panagopoulos, D. J. , Balmori, A. , and Chrousos, G. P. (2020). On the biophysical mechanism of sensing upcoming earthquakes by animals. *Science of the Total Environment*, 717, 136989.

Panagopoulos, D. J. , Karabarbounis, A. , Yakymenko, I. , and Chrousos, G. P. (2021). Human-made electromagnetic fields: Ion forced-oscillation and voltage-gated ion channel dysfunction, oxidative stress and DNA damage. *International Journal of Oncology*, 59(5), 1–16.

Pandey, N. , and Giri, S. (2018). Melatonin attenuates radiofrequency radiation (900 MHz)-induced oxidative stress, DNA damage and cell cycle arrest in germ cells of male Swiss albino mice. *Toxicology and Industrial Health*, 34(5), 315–327.

Pavel, A. , Ungureanu, C. E. , Bara, I. I. , Gassner, P. , and Creanga, D. E. (1998). Cytogenetic changes induced by low-intensity microwaves in the species *Triticum aestivum*. *Revista Medico-Chirurgicala a Societatii de Medici si Naturalisti din Iasi*, 102(3–4), 89–92.

- Pedersen, G. F. (1997). Amplitude modulated RF fields stemming from a GSM/DCS-1800 phone. *Wireless Networks*, 3(6), 489–498.
- Pereira, M. C. , Guimarães, I. D. C. , Acosta-Avalos, D. , and Antoniali Junior, W. F. (2019). Can altered magnetic field affect the foraging behaviour of ants? *PLOS ONE*, 14(11), e0225507.
- Pesnya, D. S. , and Romanovsky, A. V. (2013). Comparison of cytotoxic and genotoxic effects of plutonium-239 alpha particles and mobile phone GSM 900 radiation in the *Allium cepa* test. *Mutation Research/Genetic Toxicology and Environmental Mutagenesis*, 750(1–2), 27–33.
- Phillips, J. B. , Borland, S. C. , Freake, M. J. , Brassart, J. , and Kirschvink, J. L. (2002). Fixed-axis' magnetic orientation by an amphibian: Non-shoreward-directed compass orientation, misdirected homing or positioning a magnetite-based map detector in a consistent alignment relative to the magnetic field? *Journal of Experimental Biology*, 205(24), 3903–3914.
- Phillips, J. B. , Jorge, P. E. , and Muheim, R. (2010). Light-dependent magnetic compass orientation in amphibians and insects: Candidate receptors and candidate molecular mechanisms. *Journal of the Royal Society*, 7(Suppl 2), S241–S256.
- Powney, G. D. , Carvell, C. , Edwards, M. , Morris, R. K. , Roy, H. E. , Woodcock, B. A. , and Isaac, N. J. (2019). Widespread losses of pollinating insects in Britain. *Nature Communications*, 10(1), 1–6.
- Presman, A. S. (1977). *Electromagnetic fields and life*, 3rd ed. Plenum Press, New York.
- Puranen, L. , and Jokela, K. (1996). Radiation hazard assessment of pulsed microwave radars. *Journal of Microwave Power and Electromagnetic Energy*, 31(3), 165–177.
- Radomska, M. M. , Horobtsov, I. V. , Cherniak, L. M. , and Tykhenko, O. M. (2021). The analysis of airports' physical factors impacts on wildlife. *Науковий вісник НЛТУ України*, 31(3), 74–79.
- Rafati, A. , Rahimi, S. , Talebi, A. , Soleimani, A. , Haghani, M. , and Mortazavi, S. M. J. (2015). Exposure to radiofrequency radiation emitted from common mobile phone jammers alters the pattern of muscle contractions: An animal model study. *Journal of Biomedical Physics and Engineering*, 5(3), 133.
- Raveendran, R. , and Tabet Aoul, K. A. (2021). A meta-integrative qualitative study on the hidden threats of smart buildings/cities and their associated impacts on humans and the environment. *Buildings*, 11(6), 251.
- Ribeiro-Oliveira, J. P. (2019). Electromagnetism and plant development: A new unknown in a known world. *Theoretical and Experimental Plant Physiology*, 31(4), 423–427.
- Ritz T. , Adem S. , Schulten K. (2000). A model for photoreceptor-based magnetoreception in birds. *Biophys. J.*, 78, 707–718.
- Ritz, T. , Thalau, P. , Phillips, J. B. , Wiltschko, R. , and Wiltschko, W. (2004). Resonance effects indicate a radical-pair mechanism for avian magnetic compass. *Nature*, 429(6988), 177–180.
- Ritz, T. , Wiltschko, R. , Hore, P. J. , Rodgers, C. T. , Stapput, K. , Thalau, P. , and Wiltschko, W. (2009). Magnetic compass of birds is based on a molecule with optimal directional sensitivity. *Biophysical Journal*, 96(8), 3451–3457.
- Rodrigues, N. C. P. , Dode, A. C. , Andrade, M. K. D. N. , O'Dwyer, G. , Monteiro, D. L. M. , Reis, I. N. C. , Frossard, V. C. , and Lino, V. T. S. (2021). The effect of continuous low-intensity exposure to electromagnetic fields from radio base stations to cancer mortality in Brazil. *International Journal of Environmental Research and Public Health*, 18(3), 1229.
- Roman, A. , and Tombarkiewicz, B. (2009). Prolonged weakening of the geomagnetic field (GMF) affects the immune system of rats. *Bioelectromagnetics*, 30(1), 21–28.
- Roux, D. , Vian, A. , Girard, S. , Bonnet, P. , Paladian, F. , Davies, E. , and Ledoigt, G. (2006). Electromagnetic fields (900 MHz) evoke consistent molecular responses in tomato plants. *Physiologia Plantarum*, 128(2), 283–288.
- Roux, D. , Vian, A. , Girard, S. , Bonnet, P. , Paladian, F. , Davies, E. , and Ledoigt, G. (2008). High frequency (900 MHz) low amplitude (5 V m⁻¹) electromagnetic field: A genuine environmental stimulus that affects transcription, translation, calcium and energy charge in tomato. *Planta*, 227(4), 883–891.
- Salford, L. G. , Brun, A. E. , Eberhardt, J. L. , Malmgren, L. , and Persson, B. R. (2003). Nerve cell damage in mammalian brain after exposure to microwaves from GSM mobile phones. *Environmental Health Perspectives*, 111(7), 881–883.
- Sánchez-Bayo, F. , and Wyckhuys, K. A. (2019). Worldwide decline of the entomofauna: A review of its drivers. *Biological Conservation*, 232, 8–27.
- Sandú, D. D. , Goiceanu, C. , Ispas, A. , Creanga, I. , Miclaus, S. , and Creanga, D. E. (2005). A preliminary study on ultra high frequency electromagnetic fields effect on black locust chlorophylls. *Acta Biologica Hungarica*, 56(1–2), 109–117.
- Sauter, M. (2011). *From GSM to LTE: An introduction to mobile networks and mobile broadband*. John Wiley & Sons, New Jersey.
- Selga, T. , and Selga, M. (1996). Response of *Pinus sylvestris* L. needles to electromagnetic fields: Cytological and ultrastructural aspects. *Science of the Total Environment*, 180(1), 65–73.
- Senavirathna, M. D. H. J. , and Asaeda, T. (2014). Radio-frequency electromagnetic radiation alters the electric potential of *Myriophyllum aquaticum*. *Biologia Plantarum*, 58(2), 355–362.
- Senavirathna, M. D. , and Takashi, A. (2014). The significance of microwaves in the environment and its effect on plants. *Environmental Reviews*, 22(3), 220–228.

- Sharma, V. P. , Singh, H. P. , Kohli, R. K. , and Batish, D. R. (2009). Mobile phone radiation inhibits *Vigna radiata* (mung bean) root growth by inducing oxidative stress. *Science of the Total Environment*, 407(21), 5543–5547.
- Sharma, V. P. , and Kumar, N. R. (2010). Changes in honeybee behaviour and biology under the influence of cellphone radiations. *Current Science*, 98, 1376–1378.
- Shepherd, S. , Lima, M. A. P. , Oliveira, E. E. , Sharkh, S. M. , Jackson, C. W. , and Newland, P. L. (2018). Extremely low frequency electromagnetic fields impair the cognitive and motor abilities of honey bees. *Scientific Reports*, 8(1), 1–9.
- Shende, V. A. , and Patil, K. G. (2015). Electromagnetic radiations: A possible impact on population of house sparrow (*Passer domesticus*). *Engineering International*, 3(1), 45–52.
- Sheridan, E. , Randolet, J. , DeVault, T. L. , Seamans, T. W. , Blackwell, B. F. , and Fernández-Juricic, E. (2015). The effects of radar on avian behavior: Implications for wildlife management at airports. *Applied Animal Behaviour Science*, 171, 241–252.
- Schlegel, P. A. (1997). Behavioral sensitivity of the European blind cave salamander, *Proteus anguinus*, and a Pyrenean newt, *Euproctus asper*, to electrical fields in water. *Brain Behaviour and Evolution*, 49(3), 121–131.
- Schmutz, P. , Siegenthaler, J. , Stäger, C. , Tarjan, D. , and Bucher, J. B. (1996). Long-term exposure of young spruce and beech trees to 2450 MHz microwave radiation. *Science of the Total Environment*, 180(1), 43–48.
- Sharma, V. P. , and Kumar, N. R. (2010). Changes in honeybee behaviour and biology under the influence of cellphone radiations. *Current Science*, 98, 1376–1378.
- Shim, Y. , Lee, I. , and Park, S. (2013). The impact of LTE UE on audio devices. *ETRI Journal*, 35(2), 332–335.
- Singh, H. P. , Sharma, V. P. , Batish, D. R. , and Kohli, R. K. (2012). Cell phone electromagnetic field radiations affect rhizogenesis through impairment of biochemical processes. *Environmental Monitoring and Assessment*, 184(4), 1813–1821.
- Singh, K. V. , Gautam, R. , Meena, R. , Nirala, J. P. , Jha, S. K. , and Rajamani, P. (2020). Effect of mobile phone radiation on oxidative stress, inflammatory response, and contextual fear memory in Wistar rat. *Environmental Science and Pollution Research International*, 27(16), 19340–19351.
- Singh, R. , Kour, D. N. , Ahmad, F. , and Sahi, D. N. (2013). The causes of decline of House Sparrow (*Passer domesticus*, Linnaeus 1758) in urban and suburban areas of Jammu region, J & K. *Entomology Zoology*, 8, 803–811.
- Singh, R. K. , Bisht, D. , and Prasad, R. C. (2017). Development of 5G mobile network technology and its architecture. *International Journal of Recent Trends in Engineering & Research*, 3(10), 196–201.
- Sirav, B. , and Seyhan, N. (2016). Effects of GSM modulated radio-frequency electromagnetic radiation on permeability of blood–brain barrier in male & female rats. *Journal of Chemical Neuroanatomy*, 75(B), 123–127.
- Szmigielski, S. (2013). Reaction of the immune system to low-level RF/MW exposures. *Science of the Total Environment*, 454–455, 393–400.
- SmithRoe, S. L. , Wyde, M. E. , Stout, M. D. , Winters, J. W. , Hobbs, C. A. , Shepard, K. G. , and Witt, K. L. (2020). Evaluation of the genotoxicity of cell phone radiofrequency radiation in male and female rats and mice following subchronic exposure. *Environmental and Molecular Mutagenesis*, 61(2), 276–290.
- Soja, G. , Kunsch, B. , Gerzabek, M. , Reichenauer, T. , Soja, A. M. , Rippar, G. , and Bolhar-Nordenkamp, H. R. (2003). Growth and yield of winter wheat (*Triticum aestivum*) and corn (*Zea mays*) near a high voltage transmission line. *Bioelectromagnetics*, 24(2), 91–102.
- Soran, M. L. , Stan, M. , Niinemets, Ü. , and Copolovici, L. (2014). Influence of microwave frequency electromagnetic radiation on terpene emission and content in aromatic plants. *Journal of Plant Physiology*, 171(15), 1436–1443.
- Stanojević, V. , Prolić, Z. , Savić, T. , Todorović, D. , and Janać, B. (2005). Effects of extremely low frequency (50 Hz) magnetic field on development dynamics of the housefly (*Musca domestica* L.). *Electromagnetic Biology and Medicine*, 24(2), 99–107.
- Stefi, A. L. , Margaritis, L. H. , and Christodoulakis, N. S. (2016). The effect of the non ionizing radiation on cultivated plants of *Arabidopsis thaliana* (Col.). *Flora*, 223, 114–120.
- Stever, J. , Kuhn, C. , Otten, B. , and Wunder, W. H. (2005). Verhaltensänderung unter Elektromagnetischer Exposition. Pilotstudie, Institut für Mathematik. Arbeitsgruppe, Bildungsinformatik. Universität Koblenz-Landau, Mainz, Germany.
- Suetov, A. A. , and Alekperov, S. I. (2019). Acute ocular lesions after exposure to electromagnetic radiation of ultrahigh frequency (an experimental study). *Vestnik Oftalmologii*, 135(4), 41–49.
- Sultangaliyeva, I. , Beisenova, R. , Tazitdinova, R. , Abzhalelov, A. , and Khanturin, M. (2020). The influence of electromagnetic radiation of cell phones on the behavior of animals. *Veterinary World*, 13(3), 549.
- Summers-Smith, J. D. . (2003). The decline of the House Sparrow: a review. *Brit. Bird*, 96, 439–446.
- Surducun, V. , Surducun, E. , Neamtu, C. , Mot, A. C. , and Ciorîță, A. (2020). Effects of long-term exposure to low-power 915 MHz unmodulated radiation on *Phaseolus vulgaris* L. *Bioelectromagnetics*, 41(3), 200–212.
- Surendran, N. S. , Siddiqui, N. A. , Mondal, P. , and Nandan, A. (2020). Repercussion of electromagnetic radiation from cell towers/mobiles and their impact on migratory birds. In: Siddiqui, N., Tauseef, S., Abbasi, S., Khan, F. (eds) *Advances in Air Pollution Profiling and Control*. (pp. 193–202), *Transactions in Civil and Environmental Engineering*. Springer, Singapore. https://doi.org/10.1007/978-981-15-0954-4_12.

- Sutherland, W. J. , Butchart, S. H. , Connor, B. , Culshaw, C. , Dicks, L. V. , Dinsdale, J. , and Jiang, Z. (2018). A 2018 horizon scan of emerging issues for global conservation and biological diversity. *Trends in Ecology and Evolution*, 33(1), 47–58.
- Tanner, J. A. , and Romero-Sierra, C. (1974). Beneficial and harmful growth induced by the action of nonionizing radiation. *Annals of the New York Academy of Sciences*, 238, 171–175.
- Tang, J. , Zhang, Y. , Yang, L. , Chen, Q. , Tan, L. , Zuo, S. , Chen, Z. , and Zhu, G. (2015). Exposure to 900 MHz electromagnetic fields activates the mmp-1/ERK pathway and causes blood-brain barrier damage and cognitive impairment in rats. *Brain Research*, 1601, 92–101.
- Taye, R. R. , Deka, M. K. , Rahman, A. , and Bathari, M. (2017). Effect of electromagnetic radiation of cell phone tower on foraging behaviour of Asiatic honey bee, *Apis cerana F.* (Hymenoptera: Apidae). *Journal of Entomology and Zoology Studies*, 5, 1527–1529.
- Thalau, P. , Ritz, T. , Burda, H. , Wegner, R. E. , and Wiltschko, R. (2006). The magnetic compass mechanisms of birds and rodents are based on different physical principles. *Journal of the Royal Society. Interface / the Royal Society*, 3(9), 583–587.
- Thielens, A. , Bell, D. , Mortimore, D. B. , Greco, M. K. , Martens, L. , and Joseph, W. (2018). Exposure of insects to radio-frequency electromagnetic fields from 2 to 120 GHz. *Scientific Reports*, 8(1), 1–10.
- Thielens, A. , and European Parliamentary Research Service . (2021). Environmental impacts of 5G: A literature review of effects of radio-frequency electromagnetic field exposure of non-human vertebrates, invertebrates and plants. <http://www.europarl.europa.eu/stoa> (STOA website).
- Tkalec, M. , Malarić, K. , and Pevalek-Kozlina, B. (2005). Influence of 400, 900, and 1900 MHz. Electromagnetic fields on *Lemna minor* growth and peroxidase activity. *Bioelectromagnetics*, 26(3), 185–193.
- Tkalec, M. , Malarić, K. , Pavlica, M. , Pevalek-Kozlina, B. , and Vidaković-Cifrek, Ž. (2009). Effects of radiofrequency electromagnetic fields on seed germination and root meristematic cells of *Allium cepa* L. *Mutation Research/Genetic Toxicology and Environmental Mutagenesis*, 672(2), 76–81.
- Tofani, S. , Agnesod, G. , Ossola, P. , Ferrini, S. , and Bussi, R. (1986). Effects of continuous low-level exposure to radio-frequency radiation on intrauterine development in rats. *Health Physics*, 51(4), 489–499.
- Tumkaya, L. , Yilmaz, A. , Akyildiz, K. , Mercantepe, T. , Yazici, Z. A. , and Yilmaz, H. (2019). Prenatal effects of a 1,800-MHz electromagnetic field on rat livers. *Cells, Tissues, Organs*, 207(3–4), 187–196.
- Úbeda, A. J. , Leal, M. A. , Trillo, M. A. , Jimenez, J. , and Delgado, M. R. (1983). Pulse shape of magnetic fields influences chick embryogenesis. *J Anat.*, 137, 513–536.
- Úbeda, A. , Trillo, M. A. , Chacón, L. , Blanco, M. J. , and Leal, J. (1994). Chick embryo development can be irreversibly altered by early exposure to weak extremely-low-frequency magnetic fields. *Bioelectromagnetics*, 15(5), 385–398.
- Vácha, M. , Půžová, T. , and Kvícalová, M. (2009). Radio frequency magnetic fields disrupt magnetoreception in American cockroach. *Journal of Experimental Biology*, 212(21), 3473–3477.
- Vaitkuvienė, D. , and Dagys, M. (2014). Possible effects of electromagnetic field on White Storks *Ciconia ciconia* breeding on low-voltage electricity line poles. *Zoology and Ecology*, 24(4), 289–296.
- Vanbergen, A. J. , Potts, S. G. , Vian, A. , Malkemper, E. P. , Young, J. , and Tscheulin, T. (2019). Risk to pollinators from anthropogenic electro-magnetic radiation (EMR): Evidence and knowledge gaps. *Science of the Total Environment*, 695, 133833.
- Vargová, B. , Kurimský, J. , Cimbala, R. , Kostelec, M. , Majláth, I. , Pipová, N. , Jankowiak, Ł. , and Majláthová, V. (2017). Ticks and radio-frequency signals: Behavioural response of ticks (*Dermacentor reticulatus*) in a 900 MHz electromagnetic field. *Systematic and Applied Acarology*, 22(5), 683–693.
- Varotsos, P. , Alexopoulos, K. , and Lazaridou, M. (1993). Latest aspects of earthquake prediction in Greece based on seismic electric signals. II. *Tectonophysics*, 224, 1–37.
- Vian, A. , Davies, E. , Gendraud, M. , and Bonnet, P. (2016). Plant responses to high frequency electromagnetic fields. *BioMed Research International*, 2016, 1830262.
- Vijver, M. G. , Bolte, J. F. , Evans, T. R. , Tamis, W. L. , Peijnenburg, W. J. , Musters, C. J. M. , and de Snoo, G. R. (2014). Investigating short-term exposure to electromagnetic fields on reproductive capacity of invertebrates in the field situation. *Electromagnetic Biology and Medicine*, 33(1), 21–28.
- Vogel, G. (2017). Where have all the insects gone? *Science*, 356(6338), 576–579.
- Volkrodt, W. (1987). Wer ist am Waldsterben Schuld? *Mikrowellensmog der Funk- und Nachrichtensysteme. Raum Zeit*, 26, 53–62.
- Volkrodt, W. (1991). Droht den Mikrowellen ein ähnliches Fiasko wie der Atomenergie? *Wetter-Boden-Mensch*, 4, 16–23.
- Wajnberg, E. , Acosta-Avalos, D. , Alves, O. C. , de Oliveira, J. F. , Srygley, R. B. , and Esquivel, D. M. (2010). Magnetoreception in eusocial insects: An update. *Journal of the Royal Society*, 7, S207–S225.
- Waldmann-Selsam, C. , and Eger, H. (2013). Baumschäden im Umkreis von Mobilfunkseideanlagen, 26. *Umwelt Medizin Gesellschaft*, pp. 198–208.
- Waldmann-Selsam, C. , Balmori-de la Puente, A. , Breunig, H. , and Balmori, A. (2016). Radiofrequency radiation injures trees around mobile phone base stations. *Science of the Total Environment*, 572, 554–569.
- Walleczek, J. (1992). Electromagnetic field effects on cells of the immune system: The role of calcium signaling. *FASEB Journal*, 6(13), 3177–3185.

- Warnke, U. (2009). Bees, Birds and Mankind: Destroying nature by 'electrosmog' effects of wireless communication technologies. A brochure series by the competence initiative for the protection of humanity, environment and democracy, Kempten, 1st edn, November 2007, ISBN: 978-3-00-023124-7, English edn, March 2009, pp. 14–33.
- Wdowiak, A. , Wdowiak, L. , and Wiktor, H. (2007). Evaluation of the effect of using mobile phones on male fertility. *Annals of Agricultural and Environmental Medicine*, 14(1), 169–172.
- Weisbrot, D. , Lin, H. , Ye, L. , Blank, M. , and Goodman, R. (2003). Effects of mobile phone radiation on reproduction and development in *Drosophila melanogaster*. *Journal of Cellular Biochemistry*, 89(1), 48–55.
- Wertheimer, N. , and Leeper, E. (1979). Electrical wiring configurations and childhood cancer. *American Journal of Epidemiology*, 109(3), 273–284.
- Wiltschko, R. , Stapput, K. , Ritz, T. , Thalau, P. , and Wiltschko, W. (2007). Magnetoreception in birds: Different physical processes for two types of directional responses. *HFSP Journal*, 1(1), 41–48.
- Wiltschko, R. , Thalau, P. , Gehring, D. , Nießner, C. , Ritz, T. , and Wiltschko, W. (2015). Magnetoreception in birds: The effect of radio-frequency fields. *Journal of the Royal Society. Interface / the Royal Society*, 12(103), 20141103.
- Wyszowska, J. , Shepherd, S. , Sharkh, S. , Jackson, C. W. , and Newland, P. L. (2016). Exposure to extremely low frequency electromagnetic fields alters the behaviour, physiology and stress protein levels of desert locusts. *Scientific Reports*, 6(1), 1–9.
- Yakymenko, I. , Tsybulin, O. , Sidorik, E. , Henshel, D. , and Kyrylenko, S. (2016). Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation. *Electromagnetic Biology and Medicine*, 35(2), 186–202.
- Yakymenko, I. , Burlaka, A. , Tsybulin, I. , Briieieva, I. , Buchynska, L. , Tsehmistrenko, I. , and Chekhun, F. (2018). Oxidative and mutagenic effects of low intensity GSM 1800 MHz microwave radiation. *Experimental Oncology*, 40(4), 282–287.
- Yanagawa, A. , Tomaru, M. , Kajiwara, A. , Nakajima, H. , Quemener, E. D. L. , Steyer, J. P. , and Mitani, T. (2020). Impact of 2.45 GHz microwave irradiation on the fruit fly, *Drosophila melanogaster*. *Insects*, 11(9), 598.
- Yoshii, T. , Ahmad, M. , and Helfrich-Förster, C. (2009). Cryptochrome mediates light-dependent magnetosensitivity of *Drosophila*'s circadian clock. *PLoS Biology*, 7(4), e1000086.
- Youbicier-Simo, B. J. , and Bastide, M. (1999). Pathological effects induced by embryonic and postnatal exposure to EMFs radiation by cellular mobile phones. *Radiation Protection*, 1, 218–223.
- Yu, G. , Tang, Z. , Chen, H. , Chen, Z. , Wang, L. , Cao, H. , and Bai, Z. (2020). Long-term exposure to 4G smartphone radiofrequency electromagnetic radiation diminished male reproductive potential by directly disrupting Spock3–MMP2–BTB axis in the testes of adult rats. *Science of the Total Environment*, 698, 133860.
- Zbyryt, A. , Jankowiak, L. , Jerzak, L. , and Tryjanowski, P. (2021). Head and body orientation of the White Stork *Ciconia Ciconia* during incubation: Effect of wind, apex predators and power lines. *Journal of Ornithology*. <https://doi.org/10.1007/s10336-021-01920-x>.
- Zhang, J. P. , Zhang, K. Y. , Guo, L. , Chen, Q. L. , Gao, P. , Wang, T. , Guo, G. Z. , and Ding, G. R. (2017). Effects of 1.8 GHz radiofrequency fields on the emotional behavior and spatial memory of adolescent mice. *International Journal of Environmental Research and Public Health*, 14(11), 1344.
- Zhou, R. , Xiong, Y. , Xing, G. , Sun, L. , and Ma, J. (2010). Zifi: Wireless LAN Discovery via ZigBee Interference Signatures *MobiCom'10*, September 20–24. Chicago, Illinois.

Mechanism of Ion Forced-Oscillation and Voltage-Gated Ion Channel Dysfunction by Polarized and Coherent Electromagnetic Fields

- Adair R.K. , (1991a): Biological effects on the cellular level of electric field pulses, *Health Physics*, 61(3), 395–399.
- Adair R.K. , (1991b): Constraints on biological effects of weak extremely-low-frequency electromagnetic fields, *Physical Review: Part A*, 43(2), 1039–1048.
- Alberts B. , Johnson A. , Lewis J. , Raff M. , Roberts K. , Walter P. , (2002): *Membrane transport of small molecules and the electrical properties of membranes - molecular biology of the cell*, Garland Science, New York.
- Alexopoulos C.D. , (1960): *Mechanics and Acoustics*, Athens (Αλεξόπουλος ΚΔ, Μηχανική-Ακουστική, Αθήνα, 1960).
- Alonso M. , Finn E.J. , (1967): *Fundamental university physics, Vol. 1, Mechanics and Thermodynamics*, Addison-Wesley.
- Baker P.F. , Hodgkin A.L. , Shaw T.L. , (1962): The effects of changes in internal ionic concentration on the electrical properties of perfused giant axons, *Journal of Physiology*, 164, 355–374.
- Balcavage W.X. , Alvager T. , Swez J. , Goff C.W. , Fox M.T. , Abdullyava S. , King M.W. , (1996): A mechanism for action of extremely low frequency electromagnetic fields on biological systems, *Biochemical and Biophysical Research Communications*, 222(2), 374–378.

Balmori A. , (2006): The incidence of electromagnetic pollution on the amphibian decline: Is this an important piece of the puzzle?, *Toxicological and Environmental Chemistry*, 88(2), 287–299.

Balmori A. , (2010): Mobile phone mast effects on common frog (*Rana temporaria*) tadpoles: The city turned into a laboratory, *Electromagnetic Biology and Medicine*, 29(1–2), 31–35.

Barr R. , Llanwyn Jones D. , Rodger C.J. , (2000): ELF and VLF radio waves, *Journal of Atmospheric and Solar-Terrestrial Physics*, 62(17–18), 1689–1718.

Bawin S.M. , Kaczmarek L.K. , Adey W.R. , (1975): Effects of modulated VHF fields, on the central nervous system, *Annals of the New York Academy of Sciences*, 247, 74–81.

Bawin S.M. , Adey W.R. , Sabbot I.M. , (1978): Ionic factors in release of $^{45}\text{Ca}^{2+}$ from chick cerebral tissue by electromagnetic fields, *Proceedings of the National Academy of Sciences of the United States of America*, 75(12), 6314–6318.

Bear H.S. , (1962): *Differential equations*, Addison Wesley, Reading, Mass., USA.

Belyaev I. , (2005): Non-thermal biological effects of microwaves, *Microwave Review*, 11(2), 13–29.

Berridge M.J. , (1988): Inositol triphosphate-induced membrane potential oscillations in *Xenopus* oocytes, *Journal of Physiology*, 403, 589–599.

Berridge M.J. , Galione A. , (1988): Cytosolic calcium oscillators, *FASEB Journal*, 2(15), 3074–3082.

Bertagna F. , Lewis R. , Silva S.R.P. , McFadden J. , Jeevaratnam K. , (2021): Effects of electromagnetic fields on neuronal ion channels: A systematic review, *Annals of the New York Academy of Sciences*, 1499(1), 82–103.

Betti L. , Trebbi G. , Lazzarato L. , Brizzi M. , Calzoni G.L. , Marinelli F. , Nani D. , Borghini F. , (2004): Nonthermal microwave radiations affect the hypersensitive response of tobacco to tobacco mosaic virus, *Journal of Alternative and Complementary Medicine*, 10(6), 947–957.

Bezanilla F. , (2000): The voltage sensor in voltage-dependent ion channels, *Physiological Reviews*, 80(2), 555–592.

Bezanilla F. , (2018): Gating currents, *Journal of General Physiology*, 150(7), 911–932.

Bianco B. , Chiabrera A. , Morro A. , Parodi M. , (1988): Effects of magnetic exposure on ions in electric fields, *Ferroelectrics*, 86(1), 159–168.

Blackman C.F. , Benane S.G. , Elder J.A. , House D.E. , Lampe J.A. , Faulk J.M. , (1980): Induction of calcium-ion efflux from brain tissue by radiofrequency radiation: Effect of sample number and modulation frequency on the power-density window, *Bioelectromagnetics*, 1(1), 35–43.

Blanchard J.P. , Blackman C.F. , (1994): Clarification and application of an ion parametric resonance model for magnetic field interactions with biological systems, *Bioelectromagnetics*, 15(3), 217–238.

Bolshakov M.A. , Alekseev S.I. , (1992): Bursting responses of Lymnea neurons to microwave radiation, *Bioelectromagnetics*, 13(2), 119–129.

Brocklehurst B. , McLauchlan K.A. , (1996): Free radical mechanism for the effects of environmental electromagnetic fields on biological systems, *International Journal of Radiation Biology*, 69(1), 3–24.

Bronson R. , (1973): *Differential equations*, McGraw-Hill, New York.

Burlaka A. , Tsybulin O. , Sidorik E. , Lukin S. , Polishuk V. , Tsehmistrenko S. , Yakymenko I. , (2013): Overproduction of free radical species in embryonic cells exposed to low intensity radiofrequency radiation, *Experimental Oncology*, 35(3), 219–225.

Campisi A. , Gulino M. , Acquaviva R. , Bellia P. , Raciti G. , Grasso R. , Musumeci F. , Vanella A. , Triglia A. , (2010): Reactive oxygen species levels and DNA fragmentation on astrocytes in primary culture after acute exposure to low intensity microwave electromagnetic field, *Neuroscience Letters*, 473(1), 52–55.

Cecchetto C. , Maschietto M. , Boccaccio P. , Vassanelli S. , (2020): Electromagnetic field affects the voltage-dependent potassium channel Kv1.3, *Electromagnetic Biology and Medicine*, 39(4), 316–322.

Chavdoula E.D. , Panagopoulos D.J. , Margaritis L.H. , (2010): Comparison of biological effects between continuous and intermittent exposure to GSM-900 MHz mobile phone radiation: Detection of apoptotic cell death features, *Mutation Research*, 700(1–2), 51–61.

Chiabrera A. , Grattarola M. , Viviani R. , (1984): Interaction between electromagnetic fields and cells: Microelectrophoretic effect on ligands and surface receptors, *Bioelectromagnetics*, 5(2), 173–191.

Chiabrera A. , Bianco B. , Moggia E. , Tommasi T. , (1994): Interaction mechanism between electromagnetic fields and ion absorption: Endogenous forces and collision frequency, *Bioelectrochemistry and Bioenergetics*, 35(1–2), 33–37.

Cleary S.F. , Liu L.M. , Graham R. , Diegelmann R.F. , (1988): Modulation of tendon fibroplasia by exogenous electric currents, *Bioelectromagnetics*, 9(2), 183–194.

Coggle J.E. , (1983): *Biological effects of radiation*, Taylor & Francis, London.

Coghill R.W. , Steward J. , Phillips A. , (1996): Extra low frequency electric and magnetic fields in the bed place of children diagnosed with leukaemia: A case-control study, *European Journal of Cancer Prevention*, 5(3), 153–158.

Creasey W.A. , Goldberg R.B. , (2001): A new twist on an old mechanism for EMF bioeffects?, *EMF Health Report*, 9(2), 1–11.

Cucurachi S. , Tamis W.L. , Vijver M.G. , Peijnenburg W.J. , Bolte J.F. , de Snoo G.R. , (2013): A review of the ecological effects of radiofrequency electromagnetic fields (RF-EMF), *Environment International*, 51, 116–140.

De Coursey T.E. , (2003): Interactions between NADPH oxidase and voltage-gated proton channels: Why electron transport depends on proton transport, *FEBS Letters*, 555(1), 57–61.

De Iuliis G.N. , Newey R.J. , King B.V. , Aitken R.J. , (2009): Mobile phone radiation induces reactive oxygen species production and DNA damage in human spermatozoa in vitro, *PLOS ONE*, 4(7), e6446.

Delgado J.M.R. , (1985): Biological effects of extremely low frequency electromagnetic fields, *Journal of Bioelectricity*, 4(1), 75–91.

Diem E. , Schwarz C. , Adlkofer F. , Jahn O. , Rudiger H. , (2005): Non-thermal DNA breakage by mobile-phone radiation (1800 MHz) in human fibroblasts and in transformed GFSH-R17 rat granulosa cells in vitro, *Mutation Research*, 583(2), 178–183.

Engstrom S. , (1996): Dynamic properties of Lednev's parametric resonance mechanism, *Bioelectromagnetics*, 17(1), 58–70.

Francis G. , (1960): Ionization phenomena in gases, Butterworths Scientific Publications, London.

Franzellitti S. , Valbonesi P. , Ciancaglini N. , Biondi C. , Contin A. , Bersani F. , Fabbri E. , (2010): Transient DNA damage induced by high-frequency electromagnetic fields (GSM 1.8 GHz) in the human trophoblast HTR-8/SVneo cell line evaluated with the alkaline comet assay, *Mutation Research*, 683(1–2), 35–42.

Frei M. , Jauchem J. , Heinmets F. , (1988): Physiological effects of 2.8 GHz radio-frequency radiation: A comparison of pulsed and continuous-wave radiation, *Journal of Microwave Power and Electromagnetic Energy*, 23(2), 2.

Fröhlich H. , (1968): Long-range coherence and energy storage in biological systems, *International Journal of Quantum Chemistry*, 2(5), 641–649.

Furuya K. , Enomoto K. , Yamagishi S. , (1993): Spontaneous calcium oscillations and mechanically and chemically induced calcium responses in mammary epithelial cells, *Pflügers Archiv: European Journal of Physiology*, 422(4), 295–304.

Gautreau R. , Savin W. , (1978): Theory and problems of modern physics, McGraw-Hill, New York.

Georgiou C.D. , (2010): Oxidative stress-induced biological damage by low-level EMFs: Mechanism of free radical pair electron spin-polarization and biochemical amplification. In Giuliani L. , Soffrittis M. (Eds.), *Non-thermal effects and mechanisms of interaction between electromagnetic fields and living matter*, 63–113.

Gomer R. , (1961): Field emission and field ionization, Harvard University Press, Cambridge, Mass., USA.

Goodman E.M. , Greenebaum B. , Marron M.T. , (1995): Effects of electro-magnetic fields on molecules and cells, *International Review of Cytology*, 158, 279–338.

Gray P.T.A. , (1988): Oscillations of free cytosolic calcium evoked by cholinergic and catecholaminergic agonists in rat parotid acinar cells, *Journal of Physiology*, 406, 35–53.

Groome J.R. , Bayless-Edwards L. , (2020): Roles for counter charge in the voltage sensor domain of ion channels, *Frontiers in Pharmacology*, 11, 160. <https://doi.org/10.3389/fphar.2020.0016>.

Gulati S. , Yadav A. , Kumar N. , Kanupriya, Aggarwal N.K. , Kumar R. , Gupta R. , (2016): Effect of GSTM1 and GSTT1 polymorphisms on genetic damage in humans populations exposed to radiation from mobile towers, *Archives of Environmental Contamination and Toxicology*, 70(3), 615–625.

Halgamuge M.N. , Abeyrathne C.D. , (2011): Behavior of charged particles in a biological cell exposed to AC-DC electromagnetic fields, *Environmental Engineering Science*, 28(1), 1–11.

Hall E.J. , Giaccia A.J. , (2006): Radiobiology for the radiologist, Lippincott Williams & Wilkins, Philadelphia.

Hardell L. , Carlberg M. , Söderqvist F. , Mild K.H. , Morgan L.L. , (2007): Long-term use of cellular phones and brain tumours: Increased risk associated with use for > or =10 years, *Occupational and Environmental Medicine*, 64(9), 626–632.

Hardell L. , Carlberg M. , Hansson Mild K. , (2009): Epidemiological evidence for an association between use of wireless phones and tumor diseases, *Pathophysiology*, 16(2–3), 113–122.

Hardell L. , Nyberg R. , (2020): Appeals that matter or not on a moratorium on the deployment of the fifth generation, 5G, for microwave radiation, *Molecular and Clinical Oncology*. <https://doi.org/10.3892/mco.2020.1984>.

Hille B. , (1992): Ionic channels of excitable membranes, 2nd ed., Sinauer, Sunderland.

Hodgkin A.L. , Huxley A.F. , (1952): A quantitative description of membrane current and its application to conduction and excitation in nerve, *Journal of Physiology*, 117(4), 500–544.

Honig B.H. , Hubbell W.L. , Flewelling R.F. , (1986): Electrostatic interactions in membranes and proteins, *Annual Review of Biophysics and Biophysical Chemistry*, 15, 163–193.

Höytö A. , Luukkonen J. , Juutilainen J. , Naarala J. , (2008): Proliferation, oxidative stress and cell death in cells exposed to 872 MHz radiofrequency radiation and oxidants, *Radiation Research*, 170(2), 235–243.

Huber R. , Treyer V. , Borbély A.A. , Schuderer J. , Gottselig J.M. , Landolt H.P. , Werth E. , Berthold T. , Kuster N. , Buck A. , Achermann P. , (2002): Electromagnetic fields, such as those from mobile phones, alter regional cerebral blood flow and sleep and waking EEG, *Journal of Sleep Research*, 11(4), 289–295.

Hyland G.J. , (2008): Physical basis of adverse and therapeutic effects of low intensity microwave radiation, *Indian Journal of Experimental Biology*, 46(5), 403–419.

IARC , (2002): Non-ionizing radiation, part 1: Static and extremely low-frequency (ELF) electric and magnetic fields, Vol. 80, World Health Organization, Lyon, France.

IARC , (2013): Non-ionizing radiation, part 2: Radiofrequency electromagnetic fields (Vol. 102), World Health Organization, Lyon, France.

ICNIRP , (1998): Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300GHz), *Health Physics*, 74, 494–522.

ICNIRP , (2010): Guidelines for limiting exposure to time-varying electric and magnetic fields (1Hz to 100 kHz), *Health Physics*, 99(6), 818–836.

ICNIRP , (2020): Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz), *Health Physics* [Published ahead of print].

Ivancsits S. , Diem E. , Pilger A. , Rüdiger H.W. , Jahn O. , (2002): Induction of DNA strand breaks by intermittent exposure to extremely-low-frequency electromagnetic fields in human diploid fibroblasts, *Mutation Research*, 519(1–2), 1–13.

Ivancsits S. , Diem E. , Jahn O. , Rüdiger H.W. , (2003): Intermittent extremely low frequency electromagnetic fields cause DNA damage in a dose-dependent way, *International Archives of Occupational and Environmental Health*, 76(6), 431–436.

Jackson J.D. , (1975): *Classical electrodynamics*, John Wiley & Sons, Inc., New York.

Ji S. , Oh E. , Sul D. , Choi J.W. , Park H. , Lee E. , (2004): DNA damage of lymphocytes in volunteers after 4 hours use of mobile phone, *Journal of Preventive Medicine and Public Health*, 37(4), 373–380.

Kirschvink J.L. , (1989): Magnetite biomineralization and geomagnetic sensitivity in higher animals: An update and recommendations for future study, *Bioelectromagnetics*, 10(3), 239–259.

Lai H. , (2021): Genetic effects of non-ionizing electromagnetic fields, *Electromagnetic Biology and Medicine*, 40(2), 264–273.

La Vignera S. , Condorelli R.A. , Vicardi E. , D'Agata R. , Calogero A.E. , (2012): Effects of the exposure to mobile phones on male reproduction: A review of the literature, *Journal of Andrology*, 33(3), 350–356.

Leach V. , Weller S. , Redmayne M. , (2018): A novel database of bio-effects from non-ionizing radiation, *Reviews on Environmental Health*, 33(3), 1–8.

Lednev V.V. , (1991): Possible mechanism for the influence of weak magnetic fields on biological systems, *Bioelectromagnetics*, 12(2), 71–75.

Lee R.C. , Canaday D.J. , Doong H. , (1993): A review of the biophysical basis for the clinical application of electric fields in soft-tissue repair, *Journal of Burn Care and Rehabilitation*, 14(3), 319–335.

Liboff A.R. , (1985): Cyclotron resonance in membrane transport. In Chiabrera A. , Nicolini C. , Schwan H.P. (Eds.), *Interactions between electromagnetic fields and cells*, Plenum Press, London, 281–296.

Liboff A.R. , McLeod B.R. , (1988): Kinetics of channelized membrane ions in magnetic fields, *Bioelectromagnetics*, 9(1), 39–51.

Liboff A.R. , (2003a): Ion cyclotron resonance in biological systems: Experimental evidence. In Stavroulakis P. (Ed.), *Biological effects of electromagnetic fields*, Springer, Berlin, 76–113.

Liboff A.R. , (2003b): Biological effects of electromagnetic fields (book review), *Electromagnetic Biology and Medicine*, 22(1), 85–86.

Liburdy R.P. , (1992): Calcium signaling in lymphocytes and ELF fields: Evidence for an electric field metric and a site of interaction involving the calcium ion channel, *FEBS Letters*, 301(1), 53–59.

Liman E.R. , Hess P. , Weaver F. , Koren G. , (1991): Voltage sensing residues in the S4 region of a mammalian K⁺ channel, *Nature*, 353(6346), 752–756.

López I. , Félix N. , Rivera M. , Alonso A. , Maestú C. , (2021): What is the radiation before 5G? A correlation study between measurements in situ and in real time and epidemiological indicators in Vallecas, Madrid, *Environmental Research*, 194, 110734.

Ludwig H.W. , (1974): Electric and magnetic field strengths in the open and in shielded rooms in the ULF to LF zone. In Persinger M.A. (Ed.), *ELF and VLF electromagnetic fields*, Plenum Press, New York, 35–80.

MacKinnon R. , (2003): Potassium channels, *FEBS Letters*, 555(1), 62–65.

Manna D. , Ghosh R. , (2016): Effect of radiofrequency radiation in cultured mammalian cells: A review, *Electromagnetic Biology and Medicine*, 35(3), 265–301.

Mathie A. , Kennard L.E. , Veale E.L. , (2003): Neuronal ion channels and their sensitivity to extremely low frequency weak electric field effects, *Radiation Protection Dosimetry*, 106(4), 311–316.

McLeod K.J. , Lee R.C. , Ehrlich H.P. , (1987): Frequency dependence of electric field modulation of fibroblast protein synthesis, *Science*, 236(4807), 1465–1469.

Metaxas A.C. , (1991): Microwave heating, *Power Engineering Journal*, 5(5), 237–247.

Miller A.B. , To T. , Agnew D.A. , Wall C. , Green L.M. , (1996): Leukemia following occupational exposure to 60-Hz electric and magnetic fields among Ontario electric utility workers, *American Journal of Epidemiology*, 144(2), 150–160.

Miller A.B. , Morgan L.L. , Udasin I. , Davis D.L. , (2018): Cancer epidemiology update, following the 2011 IARC evaluation of radiofrequency electromagnetic fields (Monograph 102), *Environmental Research*, 167, 673–683.

Miller A.B. , Sears M.E. , Morgan L.L. , Davis D.L. , Hardell L. , Oremus M. , and Soskolne C.L. , (2019): Risks to health and well-being from radio-frequency radiation emitted by cell phones and other wireless devices, *Frontiers in Public Health*, 7, 223. <https://doi.org/10.3389/fpubh.2019.00223>.

Miller C. , (2000): An overview of the potassium channel family, *Genome Biology*, 1(4).

Mohammed H.S. , Fahmy H.M. , Radwan N.M. , Elsayed A.A. , (2013): Non-thermal continuous and modulated electromagnetic radiation fields effects on sleep EEG of rats, *Journal of Advanced Research*, 4(2), 181–187.

Neher E. , Sakmann B. , (1992): The patch clamp technique, *Scientific American*, 266(3), 28–35.

Noda M. , Ikeda T. , Kayano T. , Suzuki H. , Takeshima H. , Kurasaki M. , Takahashi H. , and Numa S. , (1986): Existence of distinct sodium channel messenger RNAs in rat brain, *Nature*, 320(6058), 188–192.

Office of Research Integrity , (1999): Findings of scientific misconduct, NIH Guide for Grants and Contracts, 1999(June 18), 1. PMID: 12458593; PMCID: PMC4259611.

Pacher P. , Beckman J.S. , Liaudet L. , (2007): Nitric oxide and peroxynitrite in health and disease, *Physiological Reviews*, 87(1), 315–424.

Pall M.L. , (2013): Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects, *Journal of Cellular and Molecular Medicine*, 17(8), 958–965.

Pall M.L. , (2018): Wi-fi is an important threat to human health, *Environmental Research*, 164, 405–416.

Palmer L.G. , (1986): New insights into cell and membrane transport processes. In Poste G. , Crooke S.T. (Eds.), Plenum Press, New York, 331.

Panagopoulos D.J. , Messini N. , Karabarounis A. , Filippidis A.L. , Margaritis L.H. , (2000): A mechanism for action of oscillating electric fields on cells, *Biochemical and Biophysical Research Communications*, 272(3), 634–640.

Panagopoulos D.J. , Karabarounis A. , Margaritis L.H. , (2002): Mechanism for action of electromagnetic fields on cells, *Biochemical and Biophysical Research Communications*, 298(1), 95–102.

Panagopoulos D.J. , Margaritis L.H. , (2003a): Theoretical considerations for the biological effects of electromagnetic fields. In Stavroulakis P. (Ed.), *Biological effects of electromagnetic fields*, Springer, Berlin, 5–33.

Panagopoulos D.J. , Margaritis L.H. , (2003b): Effects of electromagnetic fields on the reproductive capacity of *Drosophila melanogaster*. In Stavroulakis P. (Ed.), *Biological effects of electromagnetic fields*, Springer, Berlin, 545–578.

Panagopoulos D.J. , Karabarounis A. , Margaritis L.H. , (2004): Effect of GSM 900-MHz mobile phone radiation on the reproductive capacity of *Drosophila melanogaster*, *Electromagnetic Biology and Medicine*, 23(1), 29–43.

Panagopoulos D.J. , Margaritis L.H. , (2010): The identification of an intensity “window” on the bioeffects of mobile telephony radiation, *International Journal of Radiation Biology*, 86(5), 358–366.

Panagopoulos D.J. , Chavdoula E.D. , Margaritis L.H. , (2010a): Bioeffects of mobile telephony radiation in relation to its intensity or distance from the antenna, *International Journal of Radiation Biology*, 86(5), 345–357.

Panagopoulos D.J. , Karabarounis A. , Margaritis L.H. , (2010b): Comment on mechanism for alternating electric fields induced-effects on cytosolic calcium, *Chinese Physics Letters*, 27(4), 1.

Panagopoulos D.J. , (2011): Biological impacts, action mechanisms, dosimetry and protection issues of mobile telephony radiation. In Barnes M.C. , Meyers N.P. (Eds.), *Mobile phones: Technology, networks and user issues*, Nova Science Publishers, Inc., New York, 1–54.

Panagopoulos D.J. , Karabarounis A. , (2011): Comments on study of charged particle's behavior in a biological cell exposed to AC-DC electromagnetic fields, and on comparison between two models of interaction between electric and magnetic fields and proteins in cell membranes, *Environmental Engineering Science*, 28(10), 749–751.

Panagopoulos D.J. , (2013): Electromagnetic interaction between environmental fields and living systems determines health and well-being. In MH Kwang and SO Yoon (Eds), *Electromagnetic fields: Principles, engineering applications and biophysical effects*, Nova Science Publishers, New York, 87–130.

Panagopoulos D.J. , Johansson O. , Carlo G.L. , (2013): Evaluation of specific absorption rate as a dosimetric quantity for electromagnetic fields bioeffects, *PLOS ONE*, 8(6), e62663.
<https://doi.org/10.1371/journal.pone.0062663>.

Panagopoulos D.J. , Johansson O. , Carlo G.L. , (2015a): Polarization: A key difference between man-made and natural electromagnetic fields, in regard to biological activity, *Scientific Reports*, 5, 14914.
<https://doi.org/10.1038/srep14914>.

Panagopoulos D.J. , Johansson O. , Carlo G.L. , (2015b): Real versus simulated mobile phone exposures in experimental studies, *BioMed Research International*, 2015, 607053.

Panagopoulos D.J. , Cammaerts M.C. , Favre D. , Balmori A. , (2016): Comments on environmental impact of radiofrequency fields from mobile phone base stations, *Critical Reviews in Environmental Science and Technology*, 46(9), 885–903.

Panagopoulos D.J. , (2017): Mobile telephony radiation effects on insect ovarian cells. The necessity for real exposures bioactivity assessment. The key role of polarization, and the “Ion forced-oscillation mechanism”. In Geddes C.D. (Ed.), *Microwave effects on DNA and proteins*, Springer, Cham, Switzerland, 1–48.

Panagopoulos D.J. , Balmori A. , (2017): On the biophysical mechanism of sensing atmospheric discharges by living organisms, *Science of the Total Environment*, 599–600, 2026–2034.

Panagopoulos D.J. , (2018): Man-made electromagnetic radiation is not quantized. In Reimer A. (Ed.), *Horizons in world physics*, Vol. 296, Nova Science Publishers, New York, 1–57.

Panagopoulos D.J. , (2019): Comparing DNA damage induced by mobile telephony and other types of man-made electromagnetic fields, *Mutation Research Reviews*, 781, 53–62.

Panagopoulos D.J. , (2020): Comparing chromosome damage induced by mobile telephony radiation and a high caffeine dose: Effect of combination and exposure duration, *General Physiology and Biophysics*, 39(6), 531–544.

Panagopoulos D.J. , Balmori A. , Chrousos G.P. , (2020): On the biophysical mechanism of sensing upcoming earthquakes by animals, *Science of the Total Environment*, 717, 136989.

Panagopoulos D.J. , Karabarbounis A. , (2020): Comments on “diverse radiofrequency sensitivity and radiofrequency effects of mobile or cordless phone near fields exposure in *Drosophila melanogaster*”, *Advances in Environmental Studies*, 4(1), 271–276.

Panagopoulos D.J. , Karabarbounis A. , Yakymenko I. , Chrousos G.P. , (2021): Mechanism of DNA damage induced by human-made electromagnetic fields, *International Journal of Oncology*, 59(5), 92.

Panagopoulos D.J. , (2021): Comments on Pall's “Millimeter (MM) wave and microwave frequency radiation produce deeply penetrating effects: The biology and the physics”, *Reviews on Environmental Health*. <https://doi.org/10.1515/REVEH-2021-0090>.

Pedersen G.F. , (1997): Amplitude modulated RF fields stemming from a GSM/DCS-1800 phone, *Wireless Networks*, 3(6), 489–498.

Penafiel L.M. , Litovitz T. , Krause D. , Desta A. , Mullins J.M. , (1997): Role of modulation on the effects of microwaves on ornithine decarboxylase activity in L929 cells, *Bioelectromagnetics*, 18(2), 132–141.

Phillips J.L. , Singh N.P. , Lai H. , (2009): Electromagnetic fields and DNA damage, *Pathophysiology*, 16(2–3), 79–88.

Piacentini R. , Ripoli C. , Mezzogori D. , Azzena G.B. , Grassi C. , (2008): Extremely low-frequency electromagnetic fields promote in vitro neurogenesis via upregulation of Cav1-channel activity, *Journal of Cellular Physiology*, 215(1), 129–139.

Pirard W. , Vatovez B. : Study of pulsed character of radiation emitted by wireless telecommunication systems, Institut scientifique de service public, Liège, Belgium. https://www.issep.be/wp-content/uploads/7IWSBEEEMF_B-Vatovez_W-Pirard.pdf.

Ritz T. , Adem S. , Schulten K. , (2000): A model for photoreceptor-based magnetoreception in birds, *Biophysical Journal*, 78(2), 707–718.

Sandipan C. , Baron C. , (2015): Basic mechanisms of voltage sensing. In Zheng J. , Trudeau M.C. (Eds.), *Handbook of ion channels*, CRC Press, London, 25–39.

Santini M.T. , Ferrante A. , Rainaldi G. , Indovina P. , Indovina P.L. , (2005): Extremely low frequency (ELF) magnetic fields and apoptosis: A review, *International Journal of Radiation Biology*, 81(1), 1–11.

Schmidt W.F. , Thomas C.G. , (2012): More precise model of α -helix and transmembrane α -helical peptide backbone structure, *Journal of Biophysical Chemistry*, 3(4), 295–303.

Seredenina T. , Demaurex N. , Krause K.H. , (2015): Voltage-gated proton channels as novel drug targets: From NADPH oxidase regulation to sperm biology, *Antioxidants & Redox Signaling*, 23(5), 490–513.

Sheppard A.R. , Swicord M.L. , Balzano Q. , (2008): Quantitative evaluations of mechanisms of radiofrequency interactions with biological molecules and processes, *Health Physics*, 93(4), 365–396.

Shi Y.P. , Thouta S. , Claydon T.W. , (2020): Modulation of hERG K⁺ channel deactivation by voltage sensor relaxation, *Frontiers in Pharmacology*, 11, 139. <https://doi.org/10.3389/fphar.2020.00139>.

Stavroulakis P. , (2003): *Biological effects of electromagnetic fields*, Springer, Berlin.

Stephenson G. , (1973): *Mathematical methods for science students*, 2nd ed., Longman group, London.

Stryer L. , (1995): *Biochemistry*, Freeman, New York.

Stühmer W. , Conti F. , Suzuki H. , Wang X. , Noda M. , Yahagi N. , Kubo H. , Numa S. , (1989): Structural parts involved in activation and inactivation of the sodium channel, *Nature*, 339(6226), 597–603.

Tombola F. , Pathak M.M. , Isacoff E.Y. , (2006): How does voltage open an ion channel?, *Annual Review of Cell and Developmental Biology*, 22, 23–52.

Tsunoda Y. , (1990): Cytosolic free calcium spiking affected by intracellular pH change, *Experimental Cell Research*, 188(2), 294–301.

Tytgat J. , Nakazawa K. , Gross A. , Hess P. , (1993): Pursuing the voltage sensor of a voltage-gated mammalian potassium channel, *Journal of Biological Chemistry*, 268(32), 23777–23779.

Ueda S. , Oiki S. , Okada Y. , (1986): Oscillations of cytoplasmic concentrations of Ca²⁺ and K⁺ in fused L cells, *Journal of Membrane Biology*, 91(1), 65–72.

Villalba-Galea C.A. , Chiem A.T. , (2020): Hysteretic behavior in voltage-gated channels, *Frontiers in Pharmacology*, 11, 579596. <https://doi.org/10.3389/fphar.2020.579596>.

Walleczek J. , (1992): Electromagnetic field effects on cells of the immune system: The role of calcium signaling, *FASEB Journal*, 6(13), 3177–3185.

Walleczek J. , (1995): Magnetokinetic effects on radical pairs: A paradigm for magnetic field interactions with biological systems at lower than thermal energy, *Advances in Chemotherapy*, 250, 395–420.

Weisbrot D. , Lin H. , Ye L. , Blank M. , Goodman R. , (2003): Effects of mobile phone radiation on reproduction and development in *Drosophila melanogaster*, *Journal of Cellular Biochemistry*, 89(1), 48–55.

Wiltshcko R. , Thalau P. , Gehring D. , Nießner C. , Ritz T. , Wiltshcko W. , (2015): Magnetoreception in birds: The effect of radio-frequency fields, *Journal of the Royal Society. Interface*, 12(103), 20141103.

Yakymenko I. , Sidorik E. , Kyrylenko S. , Chekhun V. , (2011): Long-term exposure to microwave radiation provokes cancer growth: Evidences from radars and mobile communication systems, *Experimental Oncology*, 33(2), 62–70.

Yakymenko I. , Tsybulin O. , Sidorik E. , Henshel D. , Kyrylenko O. , Kyrylenko S. , (2016): Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation, *Electromagnetic Biology and Medicine*, 35(2), 186–202.

Yakymenko I. , Burlaka A. , Tsybulin I. , Brieieva I. , Buchynska L. , Tshmistrenko I. , Chekhun F. , (2018): Oxidative and mutagenic effects of low intensity GSM 1800 MHz microwave radiation, *Experimental Oncology*, 40(4), 282–287.

Zhadin M.N. , (1998): Combined action of static and alternating magnetic fields on ion motion in a macromolecule: Theoretical aspects, *Bioelectromagnetics*, 19(5), 279.

Zhang X.C. , Yang H. , Liu Z. , Sun F. , (2018): Thermodynamics of voltage-gated ion channels, *Biophysics Reports*, 4(6), 300–319.

Zheng Y. , Xia P. , Dong L. , Tian L. , Xiong C. , (2021): Effects of modulation on sodium and potassium channel currents by extremely low frequency electromagnetic fields stimulation on hippocampal CA1 pyramidal cells, *Electromagnetic Biology and Medicine*, 17, 1–12.

Zhou R. , Xiong Y. , Xing G. , Sun L. , Ma J. , (2010): Zifi: Wireless LAN discovery via ZigBee interference signatures, *MobiCom'10*, September 20–24, Chicago.

Zothansiana M. , Zosangzuali M. , Lalramdinpui M. , Jagetia G.C. , (2017): Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations, *Electromagnetic Biology and Medicine*, 36(3), 295–305.

Electromagnetic Field-induced Dysfunction of Voltage-Gated Ion Channels, Oxidative Stress, DNA Damage, and Related Pathologies

Abdel-Rassoul G. , El-Fateh O.A. , Salem M.A. , Michael A. , Farahat F. , El-Batanouny M. , Salem E. , (2007): Neurobehavioral effects among inhabitants around mobile phone base stations. *Neurotoxicology*, 28(2):434–440.

Agarwal A. , Deepinder F. , Sharma R.K. , Ranga G. , Li J. , (2008): Effect of cell phone usage on semen analysis in men attending infertility clinic: An observational study. *Fertil Steril*, 89(1):124–128.

Agarwal A. , Desai N.R. , Makker K. , Varghese A. , Mouradi R. , Sabanegh E. , Sharma R. , (2009): Effects of radiofrequency electromagnetic waves (RF-EMW) from cellular phones on human ejaculated semen: An in vitro pilot study. *Fertil Steril*, 92(4):1318–1325.

Ahlbom A. , Day N. , Feychting M. , Roman E. , Skinner J. , Dockerty J. , Linet M. , McBride M. , Michaelis J. , Olsen J.H. , Tynes T. , Verkasalo P.K. , (2000): A pooled analysis of magnetic fields and childhood leukaemia. *Br J Cancer*, 83(5):692–698.

Aitken R.J. , Bennetts L.E. , Sawyer D. , Wiklendt A.M. , King B.V. , (2005): Impact of radio frequency electromagnetic radiation on DNA integrity in the male germline. *Int J Androl*, 28(3):171–179.

Akbarali H.I. , (2014): Oxidative stress and ion channels. In Lahers I. (Ed.), *Systems biology of free radicals and antioxidants*, Springer, Berlin, Heidelberg, 355–373.

Alberts B. , Bray D. , Lewis J. , Raff M. , Roberts K. , Watson J.D. , (1994): *Molecular Biology of the Cell*, Garland Publishing, Inc., N.Y., USA.

Alberts B. , Johnson A. , Lewis J. , Raff M. , Roberts K. , Walter P. , (2002): *Membrane transport of small molecules and the electrical properties of membranes-molecular biology of the cell*, Garland Science, New York.

Ames B.N. , (1989): Endogenous DNA damage as related to cancer and aging. *Mutat Res*, 214(1):41–46.

Azumi H. , Inoue N. , Takeshita S. , Rikitake Y. , Kawashima S. , Hayashi Y. , Itoh H. , Yokoyama M. , (1999): Expression of NADH/NADPH oxidase p22phox in human coronary arteries. *Circulation*, 100(14):1494–1498. <https://doi.org/10.1161/01.cir.100.14.1494>.

Baan R. , Grosse Y. , Lauby-Secretan B. , El Ghissassi F. , Bouvard V. , Benbrahim-Tallaa L. , Guha N. , Islami F. , Galichet L. , Straif K. ; WHO International Agency for Research on Cancer Monograph Working Group , (2011): Carcinogenicity of radiofrequency electromagnetic fields. *Lancet Oncol*, 12(7):624–626.

Bacandritsos N. , Granato A. , Budge G. , Papanastasiou I. , Roinioti E. , Caldon M. , Falcaro C. , Gallina A. , Mutinelli F. , (2010): Sudden deaths and colony population decline in Greek honey bee colonies. *J Invertebr Pathol*, 105(3):335–340.

Balasubramanian B. , Pogozelski W.K. , Tullius T.D. , (1998): DNA strand breaking by hydroxyl radical is governed by the accessible surface area of the hydrogen atom of the DNA backbone. *PNAS*, 95(17):9738–9743.

Balmori A. , (2005): Possible effects of electromagnetic fields from phone masts on a population of White Stork (*Ciconia ciconia*). *Electromagn Biol Med*, 24(2):109–119.

Balmori A. , (2006): The incidence of electromagnetic pollution on the amphibian decline: Is this an important piece of the puzzle? *Toxicol Environ Chem*, 88(2):287–299.

Balmori A. , Hallberg O. , (2007): The urban decline of the house sparrow (*Passer domesticus*): A possible link with electromagnetic radiation. *Electromagn Biol Med*, 26(2):141–151.

Balmori A. , (2010): Mobile phone mast effects on common frog (*Rana temporaria*) tadpoles: The city turned into a laboratory. *Electromagn Biol Med*, 29(1–2):31–35.

Banerjee S. , Singh N.N. , Sreedhar G. , Mukherjee S. , (2016): Analysis of the genotoxic effects of mobile phone radiation using buccal micronucleus assay: A comparative evaluation. *J Clin Diagn Res*, 10(3):ZC82-5. <https://doi.org/10.7860/JCDR/2016/17592.7505>.

Barzilay A. , Yamamoto K. , (2004): DNA damage responses to oxidative stress. *DNA Repair (Amst)*, 3(8–9):1109–1115.

Barbier E. , Vetre B. , Dufy B. , (1996): Stimulation of Ca²⁺ influx in rat pituitary cells under exposure to a 50 Hz magnetic field. *Bioelectromagnetics*, 17:303–311.

Basu A.K. , (2018): DNA damage, mutagenesis and cancer. *Int J Mol Sci*, 19(4):970.

Batioglu K. , Uyumlu A.B. , Satilmis B. , Yildirim B. , Yucel N. , Demirtas H. , Onkal R. , Guzel R.M. , Djamgoz M.B. , (2012): Oxidative stress in the in vivo DMBA rat model of breast cancer: Suppression by a voltage-gated sodium channel inhibitor (RS100642). *Basic Clin Pharmacol Toxicol*, 111(2):137–141.

Batellier F. , Couty I. , Picard D. , Brillard J.P. , (2008): Effects of exposing chicken eggs to a cell phone in “call” position over the entire incubation period. *Theriogenology*, 69(6):737–745.

Bawin S.M. , Kaczmarek L.K. , Adey W.R. , (1975): Effects of modulated VHF fields, on the central nervous system. *Ann N Y Acad Sci*, 247:74–81.

Bawin S.M. , Adey W.R. , (1976): Sensitivity of calcium binding in cerebral tissue to weak environmental electric fields oscillating at low frequency. *Proc Natl Acad Sci U S A*, 73(6):1999–2003.

Bawin S.M. , Adey W.R. , Sabbit I.M. , (1978): Ionic factors in release of 45Ca²⁺ from chick cerebral tissue by electromagnetic fields. *Proc Natl Acad Sci U S A*, 75(12):6314–6318.

Becchetti A. , (2011): Ion channels and transporters in cancer. 1. Ion channels and cell proliferation in cancer. *Am J Physiol Cell Physiol*, 301(2):C255–C265.

Bedard K. , Krause K.H. , (2007): The NOX family of ROS-generating NADPH oxidases: Physiology and pathophysiology. *Physiol Rev*, 87(1):245–313. <https://doi.org/10.1152/physrev.00044.2005>.

Belyaev I.Y. , Hillert L. , Protopopova M. , Tamm C. , Malmgren L.O. , Persson B.R. , Selivanova G. , Harms-Ringdahl M. , (2005): 915 MHz microwaves and 50 Hz magnetic field affect chromatin conformation and 53BP1 foci in human lymphocytes from hypersensitive and healthy persons. *Bioelectromagnetics*, 26(3):173–184.

Bernstein C. , Prasad A.R. , Nfonam V. , Bernstein H. , (2013): DNA damage, DNA repair and cancer. In Clarc C. (Ed.), *New research directions in DNA repair*, InTech, Rijeka, 413–465.

Bertagna F. , Lewis R. , Silva S.R.P. , McFadden J. , Jeevaratnam K. , (2021): Effects of electromagnetic fields on neuronal ion channels: A systematic review. *Ann N Y Acad Sci*, 1499(1):82–103.

Blackman C.F. , Benane S.G. , Elder J.A. , House D.E. , Lampe J.A. , Faulk J.M. , (1980): Induction of calcium-ion efflux from brain tissue by radiofrequency radiation: Effect of sample number and modulation frequency on the power-density window. *Bioelectromagnetics*, 1(1):35–43.

Blank M. , and Soo L. , (1990): Ion activation of the Na,K-ATPase in alternating currents. *Bioelectrochem Bioenerg*, 24:51–61.

Blank M. , Goodman R. , (2009): Electromagnetic fields stress living cells. *Pathophysiology*, 16(2–3):71–78.

Blank M. , Goodman R. , (2011): DNA is a fractal antenna in electromagnetic fields. *Int J Radiat Biol*, 87(4):409–415.

Blettner M. , Schlehofer B. , Breckenkamp J. , Kowall B. , Schmiedel S. , Reis U. , Potthoff P. , Schüz J. , Berg-Beckhoff G. , (2009): Mobile phone base stations and adverse health effects: Phase 1 of a population-based, cross-sectional study in Germany. *Occup Environ Med*, 66(2):118–123.

Brookes P.S. , Yoon Y. , Robotham J.L. , Anders M.W. , Sheu S.S. , (2004): Calcium, ATP, and ROS: A mitochondrial love-hate triangle. *Am J Physiol Cell Physiol*, 287(4):C817–C833.

Burlaka A. , Tsybulin O. , Sidorik E. , Lukin S. , Polishuk V. , Tsehmistrenko S. , Yakymenko I. , (2013): Overproduction of free radical species in embryonic cells exposed to low intensity radiofrequency radiation. *Exp Oncol*, 35(3):219–225.

Burney S. , Caulfield J.L. , Niles J.C. , Wishnok J.S. , Tannenbaum S.R. , (1999): The chemistry of DNA damage from nitric oxide and peroxy nitrite. *Mutat Res*, 424 (1–2):37–49.

Cadet J. , Delatour T. , Douki T. , Gasparutto D. , Pouget J.P. , Ravanat J.L. , Sauvaigo S. , (1999): Hydroxyl radicals and DNA base damage. *Mutat Res*, 424(1–2):9–21.

Cadet J. , Wagner J.R. , (2013): DNA base damage by reactive oxygen species, oxidizing agents, and UV radiation. *Cold Spring Harb Perspect Biol*, 5(2):a012559.

Campisi A. , Gulino M. , Acquaviva R. , Bellia P. , Raciti G. , Grasso R. , Musumeci F. , Vanella A. , Triglia A. , (2010): Reactive oxygen species levels and DNA fragmentation on astrocytes in primary culture after acute exposure to low intensity microwave electromagnetic field. *Neurosci Lett*, 473(1):52–55.

Carlberg M. , Hardell L. , (2017): Evaluation of mobile phone and cordless phone use and glioma risk using the Bradford Hill viewpoints from 1965 on association or causation. *BioMed Res Int*, 2017:9218486. <https://doi.org/10.1155/2017/9218486>.

Cecchetto C. , Maschietto M. , Boccaccio P. , Vassanelli S. , (2020): Electromagnetic field affects the voltage-dependent potassium channel Kv1.3. *Electromagn Biol Med*, 39(4):316–322.

Chattipakorn N. , Kumfu S. , Fucharoen S. , Chattipakorn S. , (2011): Calcium channels and iron uptake into the heart. *World J Cardiol*, 3(7):215–218.

Chalidis B. , Sachinis N. , Assiotis A. , Maccauro G. , (2011): Stimulation of bone formation and fracture healing with pulsed electromagnetic fields: Biologic responses and clinical implications. *Int J Immunopathol Pharmacol*, 24(1):17020.

Chavdoula E.D. , Panagopoulos D.J. , Margaritis L.H. , (2010): Comparison of biological effects between continuous and intermittent exposure to GSM-900 MHz mobile phone radiation: Detection of apoptotic cell death features. *Mutat Res*, 700(1–2):51–61.

Cherry N.J. , (2003): Human intelligence: The brain, an electromagnetic system synchronised by the Schumann Resonance signal. *Med Hypo*, 60(6):843–844.

Choi J. , Min K. , Jeon S. , Kim N. , Pack J.K. , Song K. , (2020): Continuous exposure to 1.7 GHz LTE electromagnetic fields increases intracellular reactive oxygen species to decrease human cell proliferation and induce senescence. *Sci Rep*, 10(1):9238. <https://doi.org/10.1038/s41598-020-65732-4>.

Coggle J.E. , (1983): *Biological effects of radiation*, Taylor & Francis, London.

Coghill R.W. , Steward J. , Philips A. , (1996): Extra low frequency electric and magnetic fields in the bed place of children diagnosed with leukaemia: A case-control study. *Eur J Cancer Prev*, 5(3):153–158.

Coleman M.P. , Bell C.M. , Taylor H.L. , Primic-Zakelj M. , (1989): Leukaemia and residence near electricity transmission equipment: A case-control study. *Br J Cancer*, 60(5):793–798.

Cooke M.S. , Evans M.D. , Dizdaroglu M. , Lunec J. , (2003): Oxidative DNA damage: Mechanisms, mutation, and disease. *FASEB J*, 17(10):1195–1214.

Cucurachi S. , Tamis W.L. , Vijver M.G. , Peijnenburg W.J. , Bolte J.F. , de Snoo G.R. , (2013): A review of the ecological effects of radiofrequency electromagnetic fields (RF-EMF). *Environ Int*, 51:116–140.

Daish C. , Blanchard R. , Fox K. , Pivonka P. , Pirogova E. , (2018): The application of pulsed electromagnetic fields (PEMFs) for bone fracture repair: Past and perspective findings. *Ann Biomed Eng*, 46(4):525–542.

Daroit N.B. , Visioli F. , Magnusson A.S. , Vieira G.R. , Rados P.V. , (2015): Cell phone radiation effects on cytogenetic abnormalities of oral mucosal cells. *Braz Oral Res*, 29:1–8.

De Coursey T.E. , (2003): Interactions between NADPH oxidase and voltage-gated proton channels: Why electron transport depends on proton transport. *FEBS Lett*, 555(1):57–61.

De Coursey T. , Morgan D. , Cherny V. , (2003): The voltage dependence of NADPH oxidase reveals why phagocytes need proton channels. *Nature*, 422(6931):531–534.

De Iulius G.N. , Newey R.J. , King B.V. , Aitken R.J. , (2009): Mobile phone radiation induces reactive oxygen species production and DNA damage in human spermatozoa in vitro. *PLOS ONE*, 4(7):e6446.

Delgado J.M.R. , (1985): Biological effects of extremely low frequency electromagnetic fields. *J Bioelectr*, 4(1):75–91.

De Luca C. , Thai J.C. , Raskovic D. , et al., (2014): Metabolic and genetic screening of electromagnetic hypersensitive subjects as a feasible tool for diagnostics and intervention. *Mediators Inflamm*, 2014: 924184

Diem E. , Schwarz C. , Adlkofer F. , Jahn O. , Rudiger H. , (2005): Non-thermal DNA breakage by mobile-phone radiation (1800 MHz) in human fibroblasts and in transformed GFSH-R17 rat granulosa cells in vitro. *Mutat Res*, 583(2):178–183.

Draper G. , Vincent T. , Kroll M.E. , Swanson J. , (2005): Childhood cancer in relation to distance from high voltage power lines in England and Wales: A case-control study. *BMJ*, 330(7503):1290.

D'Silva M.H. , Swer R.T. , Anbalagan J. , Rajesh B. , (2017): Effect of radiofrequency radiation emitted from 2G and 3G cell phone on developing liver of chick embryo - A comparative study. *J Clin Diagn Res*, 11(7):5–9.

Dutta S.K. , Subramaniam A. , Ghosh B. , Parshad R. , (1984): Microwave radiation - Induced calcium ion efflux from human neuroblastoma cells in culture. *Bioelectromagnetics*, 5(1):71–78.

El-Swefy S. , Soliman H. , Huessein M. , (2008): Calcium channel blockade alleviates brain injury induced by long-term exposure to an electromagnetic field, *J Appl Biomed*, 6:153–163.

Everaert J. , Bauwens D. , (2007): A possible effect of electromagnetic radiation from mobile phone base stations on the number of breeding house sparrows (*Passer domesticus*). *Electromagn Biol Med*, 26(1):63–72.

Falcioni L. , Bua L. , Tibaldi E. , Lauriola M. , De Angelis L. , Gnudi F. , Mandrioli D. , Manservigi M. , Manservigi F. , Manzoli I. , Menghetti I. , Montella R. , Panzacchi S. , Sgargi D. , Strollo V. , Vornoli A. , Belpoggi F. , (2018): Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission. *Environ Res*, 165:496–503.

Fenton H.J.H. , (1894): LXXIII.—Oxidation of tartaric acid in presence of iron. *J Chem Soc Trans*, 65:899–911.

Ferreira A.R. , Knakievicz T. , Pasquali M.A. , Gelain D.P. , Dal-Pizzol F. , Fernández C.E. , de Salles A.A. , Ferreira H.B. , Moreira J.C. , (2006): Ultra high frequency-electromagnetic field irradiation during pregnancy leads to an increase in erythrocytes micronuclei incidence in rat offspring. *Life Sci*, 80:43–50.

Feychting M. , Ahlbom A. , (1993): Magnetic fields and cancer in children residing near Swedish high - Voltage power lines. *Am J Epidemiol*, 138(7):467–81.

Feychting M. , Ahlbom A. , (1994): Magnetic fields, leukemia and central nervous system tumors in Swedish adults residing near high - Voltage power lines. *Epidemiology*, 5(5):501–509.

Francis G. , (1960): Ionization phenomena in gases, Butterworths Scientific Publications, London.

Franzellitti S. , Valbonesi P. , Ciancaglini N. , Biondi C. , Contin A. , Bersani F. , Fabbri E. , (2010): Transient DNA damage induced by high-frequency electromagnetic fields (GSM 1.8 GHz) in the human trophoblast HTR-8/SVneo cell line evaluated with the alkaline comet assay. *Mutat Res*, 683(1–2):35–42.

Friedman J. , Kraus S. , Hauptman Y. , Schiff Y. , Seger R. , (2007): Mechanism of short-term ERK activation by electromagnetic fields at mobile phone frequencies. *Biochem J*, 405(3):559–568.

Gaasch J.A. , Geldenhuys W.J. , Lockman P.R. , Allen D.D. , Van der Schyf C.J. , (2007): Voltage-gated calcium channels provide an alternate route for iron uptake in neuronal cell cultures. *Neurochem Res*, 32(10):1686–1693.

Gamaley I. , Augsten K. , Berg H. , (1995): Electrostimulation of macrophage NADPH oxidase by modulated high-frequency electromagnetic fields. *Bioelectrochem Bioenerg*, 38(2):415–418.

Garaj-Vrhovac V. , Horvat D. , Koren Z. , (1990): The effect of microwave radiation on the cell genome. *Mutat Res*, 243(2):87–93.

Garaj-Vrhovac V. , Horvat D. , Koren Z. , (1991): The relationship between colony-forming ability, chromosome aberrations and incidence of micronuclei in V79 Chinese hamster cells exposed to microwave radiation. *Mutat Res*, 263(3):143–149.

Garaj-Vrhovac V. , Fucić A. , Horvat D. , (1992): The correlation between the frequency of micronuclei and specific chromosome aberrations in human lymphocytes exposed to microwave radiation in vitro. *Mutat Res*, 281(3):181–186.

Gobba F. , Malagoli D. , Ottaviani E. , (2003): Effects of 50 Hz magnetic fields on fMLP-induced shape changes in invertebrate immunocytes: the role of calcium ion channels. *Bioelectromagnetics*, 24:277–282.

Görlach A. , Bertram K. , Hudecova S. , Krizanova O. , (2015): Calcium and ROS: A mutual interplay. *Redox Biol*, 6:260–271.

Gomer R. , (1961): Field emission and field ionization, Harvard University Press, Cambridge, Massachusetts.

Goodman E.M. , Greenebaum B. , Marron M.T. , (1995): Effects of electro-magnetic fields on molecules and cells. *Int Rev Cytol*, 158:279–338.

Grassi C. , D'Ascenzo M. , Torsello A. , Martinotti G. , Wolf F. , Cittadini A. , Azzena G.B. , (2004): Effects of 50 Hz electromagnetic fields on voltage-gated Ca²⁺ channels and their role in modulation of neuroendocrine cell proliferation and death. *Cell Calcium*, 35(4):307–315.

Greenland S. , Sheppard A.R. , Kaune W.T. , Poole C. , Kelsh M.A. , (2000): A pooled analysis of magnetic fields, wire codes, and childhood leukemia. Childhood leukemia-EMF Study Group. *Epidemiology*, 11(6):624–634.

Gul A. , Celebi H. , Uğraş S. , (2009): The effects of microwave emitted by cellular phones on ovarian follicles in rats. *Arch Gynecol Obstet*, 280(5):729–733.

Gulati S. , Yadav A. , Kumar N. , Kanupriya, Aggarwal N.K. , Kumar R. , Gupta R. , (2016): Effect of GSTM1 and GSTT1 polymorphisms on genetic damage in humans populations exposed to radiation From mobile towers. *Arch Environ Contam Toxicol*, 70(3):615–625.

Guler G. , Tomruk A. , Ozgur E. , Seyhan N. , (2010): The effect of radiofrequency radiation on DNA and lipid damage in non-pregnant and pregnant rabbits and their newborns. *Gen Physiol Biophys*, 29(1):59–66.

Hallberg O. , Johansson O. , (2002): Melanoma incidence and frequency modulation (FM) broadcasting. *Arch Environ Health*, 57(1):32–40.

Hall E.J. , Giaccia A.J. , (2006): Radiobiology for the radiologist, Lippincott Williams & Wilkins, Philadelphia.

Halliwell B. , (2007): Biochemistry of oxidative stress. *Biochem Soc Trans*, 35(5):1147–1150.

Hanahan D. , Weinberg R.A. , (2000): The hallmarks of cancer. *Cell*, 100(1):57–70.

Hanahan D. , Weinberg R.A. , (2011): The hallmarks of cancer: The next generation. *Cell*, 144(5):646–674.

Hardell L. , Carlberg M. , Söderqvist F. , Mild K.H. , Morgan L.L. , (2007): Long-term use of cellular phones and brain tumours: Increased risk associated with use for > or =10 years. *Occup Environ Med*, 64(9):626–632.

Hardell L. , Carlberg M. , (2009): Mobile phones, cordless phones and the risk for brain tumours. *Int J Oncol*, 35(1):5–17.

Hardell L. , Carlberg M. , Söderqvist F. , Mild K.H. , (2013a): Pooled analysis of case-control studies on acoustic neuroma diagnosed 1997–2003 and 2007–2009 and use of mobile and cordless phones. *Int J Oncol*, 43(4):1036–1044.

Hardell L. , Carlberg M. , Söderqvist F. , Mild K.H. , (2013b): Case-control study of the association between malignant brain tumours diagnosed between 2007 and 2009 and mobile and cordless phone use. *Int J Oncol*, 43(6):1833–1845.

Hardell L. , Carlberg M. , Hansson Mild K. , (2013c): Use of mobile phones and cordless phones is associated with increased risk for glioma and acoustic neuroma. *Pathophysiology*, 20(2):85–110.

Hardell L. , (2018): Effects of mobile phones on children's and adolescents' health: A commentary. *Child Dev*, 89(1):137–140.

Hardell L. , Nyberg R. , (2020): Appeals that matter or not on a moratorium on the deployment of the fifth generation, 5G, for microwave radiation. *Mol Clin Oncol*. <https://doi.org/10.3892/mco.2020.1984>.

Hardell L. , Carlberg M. , (2020): Health risks from radiofrequency radiation, including 5G, should be assessed by experts with no conflicts of interest. *Oncol Lett*, 20(4):15.

Hardell L. , Carlberg M. , (2021): Lost opportunities for cancer prevention: Historical evidence on early warnings with emphasis on radiofrequency radiation. *Rev Environ Health*. <https://doi.org/10.1515/reveh-2020-0168>.

Helleday T. , Loc J. , van Gent D.C. , Engelward B.P. , (2007): DNA double-strand break repair: From mechanistic understanding to cancer treatment. *DNA Repair*, 6(7):923–935.

Henderson L.M. , (2001): NADPH oxidase subunit gp91phox: A proton pathway. *Protoplasma*, 217(1–3):37–42.

Hong R. , Zhang Y. , Liu Y. , Weng E.Q. , (2005): Effects of extremely low frequency electromagnetic fields on DNA of testicular cells and sperm chromatin structure in mice. *Zhonghua Lao Dong Wei Sheng Zhi Ye Bing Za Zhi*, 23(6):414–417.

Hutter H-P. , Moshammer H. , Wallner P. , Kundi M. , (2006): Subjective symptoms, sleeping problems, and cognitive performance in subjects living near mobile phone base stations. *Occup Environ Med*, 63(5):307–313.

IARC , (2002): Non-ionizing radiation, part 1: Static and extremely low-frequency (ELF) electric and magnetic fields, Vol. 80, International Agency for Research on Cancer, Lyon, France.

IARC , (2013): Non-ionizing radiation, part 2: Radiofrequency electromagnetic fields, Vol. 102, International Agency for Research on Cancer, Lyon, France.

ICNIRP , (1998): Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). *Health Phys*, 74(4):494–521.

ICNIRP , (2010): Guidelines for limiting exposure to time-varying electric and magnetic fields (1 Hz to 100 kHz). *Health Phys*, 99(6):818–836.

ICNIRP , (2020): Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz). *Health Phys*, 118(5):483–524.

Inoue M. , Sato E.F. , Nishikawa M. , Park A.M. , Kira Y. , Imada I. , Utsumi K. , (2003): Mitochondrial generation of reactive oxygen species and its role in aerobic life. *Curr Med Chem*, 10(23):2495–2505.

Ischiropoulos H. , Zhu L. , Beckman J.S. , (1992): Peroxynitrite formation from macrophage-derived nitric oxide. *Arch Biochem Biophys*, 298(2):446–451.

Irigaray P. , Caccamo D. , Belpomme D. , (2018): Oxidative stress in electrohypersensitivity self-reporting patients: Results of a prospective in vivo investigation with comprehensive molecular analysis. *Int J Mol Med*, 42(4):1885–1898.

Ivancsits S. , Diem E. , Pilger A. , Rüdiger H.W. , Jahn O. , (2002): Induction of DNA strand breaks by intermittent exposure to extremely-low-frequency electromagnetic fields in human diploid fibroblasts. *Mutat Res*, 519(1–2):1–13.

Ivancsits S. , Diem E. , Jahn O. , Rüdiger H.W. , (2003): Intermittent extremely low frequency electromagnetic fields cause DNA damage in a dose-dependent way. *Int Arch Occup Environ Health*, 76(6):431–436.

Iverson D. , De Chatelet L.R. , Spitznagel J.K. , Wang P. , (1977): Comparison of NADH and NADPH oxidase activities in granules isolated from human polymorphonuclear leukocytes with a fluorometric assay. *J Clin Invest*, 59(2):282–290. <https://doi.org/10.1172/JCI108639>.

Jeong J.H. , Kum C. , Choi H.J. , et al. (2006): Extremely low frequency magnetic field induces hyperalgesia in mice modulated by nitric oxide synthesis. *Life Sci*, 78:1407–1412.

Ji S. , Oh E. , Sul D. , Choi J.W. , Park H. , Lee E. , (2004): DNA damage of lymphocytes in volunteers after 4 hours use of mobile phone. *J Prev Med Public Health*, 37(4):373–380.

Jones P.A. , Laird P.W. , (1999): Cancer epigenetics comes of age. *Nat Genet*, 21(2):163–167.

Kim J.H. , Jeon S. , Choi H.D. , Lee J.H. , Bae J.S. , Kim N. , Kim H.G. , Kim K.B. , Kim H.R. , (2021): Exposure to long-term evolution radiofrequency electromagnetic fields decreases neuroblastoma cell proliferation via Akt/mTOR-mediated cellular senescence. *J Toxicol Environ Health A*:1–12. <https://doi.org/10.1080/15287394.2021.1944944>.

Kheifets L. , Ahlbom A. , Crespi C.M. , Draper G. , Hagihara J. , Lowenthal R.M. , Mezei G. , Oksuzyan S. , Schüz J. , Swanson J. , Tittarelli A. , Vinceti M. , Wunsch Filho V. , (2010): Pooled analysis of recent studies on magnetic fields and childhood leukaemia. *Br J Cancer*, 103(7):1128–1135. Erratum in: *Br J Cancer*, (2011), 104(1):228.

Khurana V.G. , Teo C. , Kundi M. , Hardell L. , Carlberg M. , (2009): Cell phones and brain tumors: A review including the long-term epidemiologic data. *Surg Neurol*, 72(3):205–214.

Knudson A.G. , (1985): Hereditary cancer, oncogenes, and antioncogenes. *Cancer Res*, 45(4):1437–1443.

Koana T. , Okada M.O. , Takashima Y. , Ikehata M. , Miyakoshi J. , (2001): Involvement of eddy currents in the mutagenicity of ELF magnetic fields. *Mutat Res*, 476(1–2):55–62.

Kourie J.I. , (1998): Interaction of reactive oxygen species with ion transport mechanisms. *Am J Physiol*, 275(1) (Cell Physiol. 44):C1–C24.

Kundi M. , Hutter H.P. , (2009): Mobile phone base stations-effects on wellbeing and health. *Pathophysiology*, 16(2–3):123–135.

Lahtz C. , Pfeifer G.P. , (2011): Epigenetic changes of DNA repair genes in cancer. Review. *J Mol Cell Biol*, 3(1):51–58.

- Lai H. , Singh N.P. , (1995): Acute low-intensity microwave exposure increases DNA single-strand breaks in rat brain cells. *Bioelectromagnetics*, 16(3):207–210.
- Lai H. , Singh N.P. , (1996): Single- and double-strand DNA breaks in rat brain cells after acute exposure to radiofrequency electromagnetic radiation. *Int J Radiat Biol*, 69(4):513–521.
- Lai H. , Singh N.P. , (1997): Acute exposure to a 60 Hz magnetic field increases DNA strand breaks in rat brain cells. *Bioelectromagnetics*, 18(2):156–165.
- Lai H. , Singh N.P. , (2004): Magnetic-field-induced DNA strand breaks in brain cells of the rat. *Environ Health Perspect*, 112(6):687–694.
- Lang F. , Föllmer M. , Lang K.S. , Ritter M. , Gulbins E. , Vereninov A. , Huber S.M. , (2005): Ion channels in cell proliferation and apoptotic cell death. *J Membr Biol*, 205(3):147–157.
- La Vignera S. , Condorelli R.A. , Vicardi E. , D'Agata R. , Calogero A.E. , (2012): Effects of the exposure to mobile phones on male reproduction: A review of the literature. *J Androl*, 33(3):350–356.
- Leach V. , Weller S. , Redmayne M. , (2018): A novel database of bio-effects from non-ionizing radiation. *Rev Environ Health*, 33(3): 1–8.
- Lee K.S. , Choi J.S. , Hong S.Y. , Son T.H. , Yu K. , (2008): Mobile phone electromagnetic radiation activates MAPK signaling and regulates viability in *Drosophila*. *Bioelectromagnetics*, 29(5):371–379.
- Lerchl A. , Klose M. , Grote K. , Wilhelm A.F. , Spathmann O. , Fiedler T. , Streckert J. , Hansen V. , Clemens M. , (2015): Tumor promotion by exposure to radiofrequency electromagnetic fields below exposure limits for humans. *Biochem Biophys Res Commun*, 459(4):585–590.
- Lerchl A. , Klose M. , Drees K. , (2020): No increased DNA damage observed in the brain, liver, and lung of fetal mice treated with ethylnitrosourea and exposed to UMTS radiofrequency electromagnetic fields. *Bioelectromagnetics*, 41(8):611–616.
- Li J.M. , Shah A.M. , (2001): Differential NADPH- versus NADH-dependent superoxide production by phagocyte-type endothelial cell NADPH oxidase. *Cardiovasc Res*, 52(3):477–486.
[https://doi.org/10.1016/s0008-6363\(01\)00407-2](https://doi.org/10.1016/s0008-6363(01)00407-2).
- Liburdy R.P. , (1992): Calcium signaling in lymphocytes and ELF fields. *FEBS Lett*, 301(1):53–59.
- Lieber M.R. , (1998): Pathological and physiological double-strand breaks: Roles in cancer, aging, and the immune system. *Am J Pathol*, 153(5):1323–1332.
- Lin-Liu S. , Adey W.R. , (1982): Low frequency amplitude modulated microwave fields change calcium efflux rates from synaptosomes. *Bioelectromagnetics*, 3(3):309–322.
- Lisi A. , Ledda M. , Rosola E. , et al. (2006): Extremely low frequency electromagnetic field exposure promotes differentiation of pituitary corticotrope-derived AtT20 D16V cells. *Bioelectromagnetics*, 27:641–651.
- Liu C. , Gao P. , Xu S.C. , Wang Y. , Chen C.H. , He M.D. , Yu Z.P. , Zhang L. , Zhou Z. , (2013): Mobile phone radiation induces mode-dependent DNA damage in a mouse spermatocyte-derived cell line: A protective role of melatonin. *Int J Radiat Biol*, 89(11):993–1001.
- Lixia S. , Yao K. , Kaijun W. , Deqiang L. , Huajun H. , Xiangwei G. , Baohong W. , Wei Z. , Jianling L. , Wei W. , (2006): Effects of 1.8 GHz radiofrequency field on DNA damage and expression of heat shock protein 70 in human lens epithelial cells. *Mutat Res*, 602(1–2):135–142.
- Lombardi A.A. , Gibb A.A. , Arif E. , Kolmetzky D.W. , Tomar D. , Luongo T.S. , Jadiya P. , Murray E.K. , Lorkiewicz P.K. , Hajnóczy G. , Murphy E. , Arany Z.P. , Kelly D.P. , Margulies K.B. , Hill B.G. , Elrod J.W. , (2019): Mitochondrial calcium exchange links metabolism with the epigenome to control cellular differentiation. *Nat Commun*, 10(1): 1–17.
- López I. , Félix N. , Rivera M. , Alonso A. , Maestú C. , (2021): What is the radiation before 5G? A correlation study between measurements in situ and in real time and epidemiological indicators in Vallecas, Madrid. *Environ Res*, 194:110734.
- Low H. , Crane F.L. , Morre D.J. , (2012): Putting together a plasma membrane NADH oxidase: a tale of three laboratories. *Int J Biochem Cell Biol*, 44(11): 1834–1838
- Lowe S.W. , Lin A.W. , (2000): Apoptosis in cancer. *Carcinogenesis*, 21(3):485–495.
- Lushchak V.I. , (2014): Free radicals, reactive oxygen species, oxidative stress and its classification. *Chem Biol Interact*, 224:164–175.
- Luukkonen J. , Hakulinen P. , Mäki-Paakkanen J. , Juutilainen J. , Naarala J. , (2009): Enhancement of chemically induced reactive oxygen species production and DNA damage in human SH-SY5Y neuroblastoma cells by 872 MHz radiofrequency radiation. *Mutat Res*, 662(1–2):54–58.
- Ma T.H. , Chu K.C. , (1993): Effect of the extremely low frequency (ELF) electromagnetic field (EMF) on developing embryos of the fruit fly (*Drosophila melanogaster* L.). *Mutat Res*, 303(1):35–39.
- Magras I.N. , Xenos T.D. , (1997): RF radiation-induced changes in the prenatal development of mice. *Bioelectromagnetics*, 18(6):455–461.
- Mailankot M. , Kunnath A.P. , Jayalekshmi H. , Koduru B. , Valsalan R. , (2009): Radio frequency electromagnetic radiation (RF-EMR) from GSM (0.9/1.8 GHz) mobile phones induces oxidative stress and reduces sperm motility in rats. *Clin (Sao Paulo)*, 64(6):561–565.
- Manna D. , Ghosh R. , (2016): Effect of radiofrequency radiation in cultured mammalian cells: A review. *Electromagn Biol Med*, 35(3):265–301.

- Marchionni I. , Paffi A. , Pellegrino M. , et al. (2006): Comparison between low-level 50 Hz and 900 MHz electromagnetic stimulation on single channel ionic currents and on firing frequency in dorsal root ganglion isolated neurons. *Biochim Biophys Acta*, 1758:597–605.
- Margaritis L.H. , (1996): *Cell Biology*, Litsas medical publications, Athens [Μαργαρίτης ΛΧ, Κυτταρική Βιολογία, Ιατρικές Εκδόσεις Λίτσας, Γ' έκδοση, Αθήνα]
- Markova E. , Hillert L. , Malmgren L. , Persson B.R. , Belyaev I.Y. , (2005): Microwaves from GSM mobile telephones affect 53BP1 and gamma-H2AX foci in human lymphocytes from hypersensitive and healthy persons. *Environ Health Perspect*, 113(9):1172–1177.
- Mausset-Bonnefont A.L. , Hirbec H. , Bonnefont X. , Privat A. , Vignon J. , de Sèze R. , (2004): Acute exposure to GSM 900-MHz electromagnetic fields induces glial reactivity and biochemical modifications in the rat brain. *Neurobiol Dis*, 17(3):445–454.
- Mihai C.T. , Rotinberg P. , Brinza F. , Vochita G. (2014): Extremely low-frequency electromagnetic fields cause DNA strand breaks in normal cells. *J Environ Health Sci Eng*, 12(1):15.
- Miller A. , To T. , Agnew D.A. , Wall C. , Green L.M. , (1996): Leukemia following occupational exposure to 60-Hz electric and magnetic fields among Ontario electric utility workers. *Am J Epidemiol*, 144(2):150–160.
- Miller A.B. , Morgan L.L. , Udasin I. , Davis D.L. , (2018): Cancer epidemiology update, following the 2011 IARC evaluation of radiofrequency electromagnetic fields (Monograph 102). *Environ Res*, 167:673–683.
- Miller A.B. , Sears M.E. , Morgan L.L. , Davis D.L. , Hardell L. , Oremus M. , Soskolne C.L. , (2019): Risks to health and well-being from radio-frequency radiation emitted by cell phones and other wireless devices. *Front Public Health*, 7:223. <https://doi.org/10.3389/fpubh.2019.00223>.
- Momoli F. , Siemiatycki J. , McBride M.L. , Parent M.É. , Richardson L. , Bedard D. , Platt R. , Vrijheid M. , Cardis E. , Krewski D. , (2017): Probabilistic multiple-bias modeling applied to the Canadian data from the interphone study of mobile phone use and risk of glioma, meningioma, acoustic neuroma, and parotid gland tumors. *Am J Epidemiol*, 186(7):885–893.
- Moon H.K. , Yang E.S. , Park J.W. , (2006): Protection of peroxynitrite-induced DNA damage by dietary antioxidants. *Arch Pharm Res*, 29(3):213–217.
- Morgado-Valle C. , Verdugo-Díaz L. , García D.E. , et al. (1998): The role of voltage-gated Ca²⁺ channels in neurite growth of cultured chromaffin cells induced by extremely low frequency (ELF) magnetic field stimulation. *Cell Tissue Res*, 291:217–230.
- Musset B. , Cherny V.V. , Morgan D. , DeCoursey T.E. , (2009): The intimate and mysterious relationship between proton channels and NADPH oxidase. *FEBS Lett*, 583(1):7–12.
- Nadler D.L. , Zurbenko I.G. , (2014): Estimating cancer latency times using a Weibull model. *Adv Epidemiol*, 2014, 746769.
- Navarro A. , Segura J. , Portolés M. , Gómez-Perretta de Mateo C. , (2003): The microwave syndrome: A preliminary study in Spain. *Electromagn Biol Med*, 22(2–3):161–169.
- Nikolova T. , Czyn J. , Rolletschek A. , Blyszczuk P. , Fuchs J. , Jovtchev G. , Schuderer J. , Kuster N. , Wobus A.M. , (2005): Electromagnetic fields affect transcript levels of apoptosis-related genes in embryonic stem cell-derived neural progenitor cells. *FASEB J*, 19(12):1686–1688.
- Nitahara J.A. , Cheng W. , Liu Y. , Li B. , Leri A. , Li P. , Mogul D. , Gambert S.R. , Kajstura J. , Anversa P. , (1998): Intracellular calcium, DNase activity and myocyte apoptosis in aging Fischer 344 rats. *J Mol Cell Cardiol*, 30(3):519–535.
- NTP (National Toxicology Program) , (2018): Toxicology and Carcinogenesis studies in Hsd: Sprague Dawley SD rats exposed to whole-body Radio Frequency radiation at a frequency (900 MHz) and modulations (GSM and CDMA) used by cell phones, NTP TR 595, Department of Health and Human Services, USA.
- O'Hare Doig R.L. , Chiha W. , Giacci M.K. , Yates N.J. , Bartlett C.A. , Smith N.M. , Hodgetts S.I. , Harvey A.R. , Fitzgerald M. , (2017): Specific ion channels contribute to key elements of pathology during secondary degeneration following neurotrauma. *BMC Neurosci*, 18(1):62.
- Pacher P. , Beckman J.S. , Liaudet L. , (2007): Nitric oxide and peroxynitrite in health and disease. *Physiol Rev*, 87(1):315–424.
- Pall M.L. , (2013): Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects. *J Cell Mol Med*, 17(8):958–965.
- Panagopoulos D.J. , Messini N. , Karabarbounis A. , Filippetti A.L. , Margaritis L.H. , (2000): A mechanism for action of oscillating electric fields on cells. *Biochem Biophys Res Commun*, 272(3):634–640.
- Panagopoulos D.J. , Karabarbounis A. , Margaritis L.H. , (2002): Mechanism for action of electromagnetic fields on cells. *Biochem Biophys Res Commun*, 298(1):95–102.
- Panagopoulos D.J. , Margaritis L.H. , (2003): Theoretical considerations for the biological effects of electromagnetic fields. In Stavroulakis P. (Ed.), *Biological effects of electromagnetic fields*, Springer, Berlin Heidelberg, 5–33.
- Panagopoulos D.J. , Karabarbounis A. , Margaritis L.H. , (2004): Effect of GSM 900-MHz mobile phone radiation on the reproductive capacity of *Drosophila melanogaster*. *Electromagn Biol Med*, 23(1):29–43.
- Panagopoulos D.J. , Chavdoula E.D. , Nezis I.P. , Margaritis L.H. , (2007a): Cell death induced by GSM 900 MHz and DCS 1800 MHz mobile telephony radiation. *Mutat Res*, 626(1–2):69–78.
- Panagopoulos D.J. , Chavdoula E.D. , Karabarbounis A. , Margaritis L.H. , (2007b): Comparison of bioactivity between GSM 900 MHz and DCS 1800 MHz mobile telephony radiation. *Electromagn Biol Med*, 26(1):33–44.

Panagopoulos D.J. , Chavdoula E.D. , Margaritis L.H. , (2010): Bioeffects of mobile telephony radiation in relation to its intensity or distance from the antenna. *Int J Radiat Biol*, 86(5):345–357.

Panagopoulos D.J. , (2012): Effect of microwave exposure on the ovarian development of *Drosophila melanogaster*. *Cell Biochem Biophys*, 63(2):121–132.

Panagopoulos D.J. , (2013): Electromagnetic interaction between environmental fields and living systems determines health and well-being. In Kwang M-H. , and Yoon S-O. (Eds.), *Electromagnetic fields: Principles, engineering applications and biophysical effects*, Nova Science Publishers, New York, 87–130.

Panagopoulos D.J. , Karabarbounis A. , Lioliousis C. , (2013): ELF alternating magnetic field decreases reproduction by DNA damage induction. *Cell Biochem Biophys*, 67(2):703–716.

Panagopoulos D.J. , Johansson O. , Carlo G.L. , (2015a): Real versus simulated mobile phone exposures in experimental studies. *BioMed Res Int*, 2015:607053.

Panagopoulos D.J. , Johansson O. , Carlo G.L. , (2015b): Polarization: A key difference between man-made and natural electromagnetic fields, in regard to biological activity. *Sci Rep*, 5:14914. <https://doi.org/10.1038/srep14914>.

Panagopoulos D.J. , (2017): Mobile telephony radiation effects on insect ovarian cells. The necessity for real exposures bioactivity assessment. The key role of polarization, and the ion forced-oscillation mechanism. In Geddes C.D. (Ed.), *Microwave effects on DNA and proteins*, Springer, Cham, Switzerland, 1–48.

Panagopoulos D.J. , (2018): Man-made electromagnetic radiation is not quantized. In Reimer A. (Ed.), *Horizons in World Physics*. Vol. 296, Nova Science Publishers, New York, 1–57.

Panagopoulos D.J. , (2019a): Comparing DNA damage induced by mobile telephony and other types of man-made electromagnetic fields. *Mutat Res Rev Mutat Res*, 781:53–62.

Panagopoulos D.J. , (2019b): Chromosome damage in human cells induced by UMTS mobile telephony radiation. *Gen Physiol Biophys*, 38(5):445–454.

Panagopoulos D.J. , Chrousos G.P. , (2019): Shielding methods and products against man-made electromagnetic fields: Protection versus risk. *Sci Total Environ*, 667C:255–262.

Panagopoulos D.J. , (2020): Comparing chromosome damage induced by mobile telephony radiation and a high caffeine dose: Effect of combination and exposure duration. *Gen Physiol Biophys*, 39(6):531–544.

Panagopoulos D.J. , Balmori A. , Chrousos G.P. , (2020): On the biophysical mechanism of sensing upcoming earthquakes by animals. *Sci Total Environ*, 717:136989.

Panagopoulos D.J. , Karabarbounis A. , Yakymenko I. , Chrousos G.P. , (2021): Human-made electromagnetic fields: Ion forced-oscillation and voltage-gated ion channel dysfunction, oxidative stress and DNA damage. *Int J Oncol*, 59(5):92.

Panday A. , Sahoo M.K. , Osorio D. , Batra S. , (2015): NADPH oxidases: An overview from structure to innate immunity-associated pathologies. *Cell Mol Immunol*, 12(1):5–23.

Persinger M.A. , (1974): *ELF and VLF electromagnetic fields*, Plenum Press, New York.

Persinger M.A. , (2012): Brain electromagnetic activity and lightning: Potentially congruent scale - Invariant quantitative properties. *Front Integr Neurosci*, 6(19):1–7.

Persinger M.A. , (2014): Schumann resonance frequencies found within quantitative electroencephalographic activity: Implications for earth-brain interactions. *Int Lett Chem Phys Astron*, 11(1):24–32.

Pesnya D.S. , Romanovsky A.V. , (2013): Comparison of cytotoxic and genotoxic effects of plutonium-239 alpha particles and mobile phone GSM 900 radiation in the *Allium cepa* test. *Mutat Res*, 750(1–2):27–33.

Phillips J.L. , Singh N.P. , Lai H. , (2009): Electromagnetic fields and DNA damage. *Pathophysiology*, 16(2–3):79–88.

Piacentini R. , Ripoli C. , Mezzogori D. , Azzena G.B. , Grassi C. , (2008): Extremely low-frequency electromagnetic fields promote in vitro neurogenesis via upregulation of Cav1-channel activity. *J Cell Physiol*, 215(1):129–139.

Pilla A.A. , (1993): State of the art in electromagnetic therapeutics. In Blank M. (Ed.), *Electricity and magnetism in biology and medicine*, San Francisco Press Inc., 17–22.

Pilla A.A. , (2003): Weak time-varying and static magnetic fields: From mechanisms to therapeutic applications. In Stavroulakis P. (Ed.), *Biological effects of electromagnetic fields*, Springer, Berlin, Heidelberg, 34–75.

Pilla A.A. , (2012): Electromagnetic fields instantaneously modulate nitric oxide signaling in challenged biological systems. *Biochem Biophys Res Commun*, 426(3):330–333.

Pratt R.D. , Brickman C.R. , Cottrill C.L. , Shapiro J.I. , Liu J. , (2018): The Na/K-ATPase signaling: From specific ligands to general reactive oxygen species. *Int J Mol Sci*, 19(9):2600.

Ramírez A. , Vázquez-Sánchez A.Y. , Carrión-Robalino N. , Camacho J. , (2016): Ion channels and oxidative stress as a potential link for the diagnosis or treatment of liver diseases. *Oxid Med Cell Longev*, 2016:3928714.

Rodgers K. , McVey M. , (2016): Error-prone repair of DNA double-strand breaks. *J Cell Physiol*, 231(1):15–24.

Ryabi J.T. , (1998): Clinical effects of electromagnetic fields on fracture healing. *Clin Orthop Relat Res*, 355(Suppl. 1):S205–S215.

Sakihama Y. , Maeda M. , Hashimoto M. , Tahara S. , Hashidoko Y. , (2012): Beetroot betalain inhibits peroxynitrite-mediated tyrosine nitration and DNA strand damage. *Free Radic Res*, 46(1):93–99.

Salama O.E. , Abou El Naga R.M. , (2004): Cellular phones: Are they detrimental? *J Egypt Public Health Assoc*, 79(3–4):197–223.

Salsbury G. , Cambridge E.L. , McIntyre Z. , Arends M.J. , Karp N.A. , Isherwood C. , Shannon C. , Hooks Y. , Sanger Mouse Genetics Project, Ramirez-Solis R. , Adams D.J. , White J.K. , Speak A.O. , (2014): Disruption of the potassium channel regulatory subunit KCNE2 causes iron-deficient anemia. *Exp Hematol*, 42(12):1053–1058.

Santini M.T. , Ferrante A. , Rainaldi G. , Indovina P. , Indovina P.L. , (2005): Extremely low frequency (ELF) magnetic fields and apoptosis: A review. *Int J Radiat Biol*, 81(1):1–11.

Santini R. , Santini P. , Danze J.M. , Le Ruz P. , Seigne M. , (2002): Study of the health of people living in the vicinity of mobile phone base stations: I. Influences of distance and sex. *Pathol Biol (Paris)*, 50(6):369–373.

Sarkar S. , Ali S. , Behari J. , (1994): Effect of low power microwave on the mouse genome: A direct DNA analysis. *Mutat Res*, 320(1–2):141–147.

Savitz D.A. , Wachtel H. , Barnes F. , John E.M. , Tvrdik J.G. , (1988): Case-control study of childhood cancer and exposure to 60 Hz magnetic fields. *Am J Epidemiol*, 128(1):21–38.

Schuermann D. , Ziemann C. , Barekati Z. , Capstick M. , Oertel A. , Focke F. , Murbach M. , Kuster N. , Dasenbrock C. , Schär P. , (2020): Assessment of genotoxicity in human cells exposed to modulated electromagnetic fields of wireless communication devices. *Genes*, 11(4):347. <https://doi.org/10.3390/genes11040347>.

Schuermann D. , Mevissen M. , (2021): Manmade electromagnetic fields and oxidative stress—Biological effects and consequences for health. *Int J Mol Sci*, 22(7):3772.

Serpensu E.H. , and Tsong T.Y. , (1984): Activation of electrogenic Rb transport of (Na/K)-ATPase by an electric field. *J Biol Chem*, 259:7155–7162.

Seredenina T. , Demaurex N. , Krause K.H. , (2015): Voltage-gated proton channels as novel drug targets: From NADPH oxidase regulation to sperm biology. *Antioxid Redox Signal*, 23(5):490–513.

Shah D.J. , Sachs R.K. , Wilson D.J. , (2012): Radiation-induced cancer: A modern view. *Br J Radiol*, 85(1020):1166–1173.

Shahin S. , Singh S.P. , Chaturvedi C.M. , (2017): Mobile phone (1800 MHz) radiation impairs female reproduction in mice, *Mus musculus*, through stress induced inhibition of ovarian and uterine activity. *Reprod Toxicol*, 73:41–60. <https://doi.org/10.1016/j.reprotox.2017.08.001>.

Sharma A. , Shrivastava S. , Shukla S. , (2020): Exposure of radiofrequency electromagnetic radiation on biochemical and pathological alterations. *Neurol India*, 68(5):1092–1100. <https://doi.org/10.4103/0028-3886.294554>.

Sharma V.P. , Kumar N.R. , (2010): Changes in honeybee behaviour and biology under the influence of cellphone radiations. *Curr Sci*, 98:1376–1378.

Smith-Roe S.L. , Wyde M.E. , Stout M.D. , Winters J.W. , Hobbs C.A. , Shepard K.G. , Green A.S. , Kissling G.E. , Shockley K.R. , Tice R.R. , Bucher J.R. , Witt K.L. , (2019): Evaluation of the genotoxicity of cell phone radiofrequency radiation in male and female rats and mice following subchronic exposure. *Environ Mol Mutagen*, 1(2):276–290.

Sokolovic D. , Djindjic B. , Nikolic J. , Bjelakovic G. , Pavlovic D. , Kocic G. , Krstic D. , Cvetkovic T. , Pavlovic V. , (2008): Melatonin reduces oxidative stress induced by chronic exposure of microwave radiation from mobile phones in rat brain. *J Radiat Res (Tokyo)*, 49(6):579–586.

Stryer L. , (1995): *Biochemistry*. Freeman, New York.

Svedenstal B.M. , Johanson K.J. , Mild K.H. , (1999): DNA damage induced in brain cells of CBA mice exposed to magnetic fields. *In Vivo*, 13(6):551–552.

Szabo G. , Baehrle S. , (2005): Role of nitrosative stress and poly(ADP-ribose) polymerase activation in myocardial reperfusion injury. *Curr Vasc Pharmacol*, 3(3):215–220.

Tillmann T. , Ernst H. , Streckert J. , Zhouc Y. , Taugner F. , Hansen V. , Dasenbrock C. , (2010): Indication of cocarcinogenic potential of chronic UMTS-modulated radiofrequency exposure in an ethylnitrosourea mouse model. *Int J Radiat Biol*, 86(7):529–541.

Tomruk A. , Guler G. , Dincel A.S. , (2010): The influence of 1800 MHz GSM-like signals on hepatic oxidative DNA and lipid damage in nonpregnant, pregnant, and newly born rabbits. *Cell Biochem Biophys*, 56(1):39–47.

Tsunoda M. , Sakae T. , Naito S. , Sunami T. , Abe N. , Ueno Y. , Matsuda A. , Takénaka A. , (2010): Insights into the structures of DNA damaged by hydroxyl radical: Crystal structures of DNA duplexes containing 5-formyluracil. *J Nucleic Acids*, 2010:107289.

Valko M. , Rhodes C.J. , Moncol J. , Izakovic M. , Mazur M. , (2006): Free radicals, metals and antioxidants in oxidative stress-induced cancer. *Chem Biol Interact*, 160(1):1–40.

Valko M. , Leibfritz D. , Moncol J. , Cronin M.T. , Mazur M. , Telser J. , (2007): Free radicals and antioxidants in normal physiological functions and human disease. *Int J Biochem Cell Biol*, 39(1):44–84.

Verschaeve L. , (2017): *Misleading scientific papers on health effects from wireless communication devices*. In Geddes C.D. (Ed.), *Microwave effects on DNA and proteins*, Springer, Cham, Switzerland.

Viel J.F. , Clerc S. , Barrera C. , Rymzhanova R. , Moissonnier M. , Hours M. , Cardis E. , (2009): Residential exposure to radiofrequency fields from mobile phone base stations, and broadcast transmitters: A population-based survey with personal meter. *Occup Environ Med*, 66(8):550–556.

Villeneuve P.J. , Agnew D.A. , Miller A.B. , Corey P.N. , (2000a): Non-Hodgkin's lymphoma among electric utility workers in Ontario: The evaluation of alternate indices of exposure to 60 Hz electric and magnetic fields. *Occup Environ Med*, 57(4):249–257.

Villeneuve P.J., Agnew D.A., Miller A.B., Corey P.N., Purdham J.T., (2000b): Leukemia in electric utility workers: The evaluation of alternative indices of exposure to 60 Hz electric and magnetic fields. *Am J Ind Med*, 37(6):607–617.

Wade B., (2013): A review of pulsed electromagnetic field (PEMF) mechanisms at a cellular level: A rationale for clinical use. *Am J Health Res*, 1(3):51–55.

Walleczek J., (1992): Electromagnetic field effects on cells of the immune system: The role of calcium signaling. *FASEB J*, 6(13):3177–3185.

Wang Y., Guo X., (2016): Meta-analysis of association between mobile phone use and glioma risk. *J Cancer Res Ther*, 12(Suppl):C298–C300. <https://doi.org/10.4103/0973-1482.200759>.

Wdowiak A., Wdowiak L., Wiktor H., (2007): Evaluation of the effect of using mobile phones on male fertility. *Ann Agric Environ Med*, 14(1):169–172.

Wertheimer N., Leeper E., (1979): Electrical wiring configurations and childhood cancer. *Am J Epidemiol*, 109(3):273–284.

Wever R., (1970): The effects of electric fields on circadian rhythmicity in men. *Life Sci Space Res*, 8:177–187.

Wever R., (1973): Human circadian rhythms under the influence of weak electric fields and the different aspects of these studies. *Int J Biometeorol*, 17(3):227–232.

Wever R., (1974): ELF effects on human circadian rhythms. In Persinger M.A. (Ed.), *ELF and VLF electromagnetic fields*, Plenum Press, New York.

Wever R., (1979): *The circadian system of man: Results of experiments under temporal isolation*, Springer-Verlag, New York.

Winker R., Ivancsits S., Pilger A., Adlkofer F., Rüdiger H.W., (2005): Chromosomal damage in human diploid fibroblasts by intermittent exposure to extremely low-frequency electromagnetic fields. *Mutat Res*, 585(1–2):43–49.

Wood A., Mate R., Karipidis K., (2021): Meta-analysis of in vitro and in vivo studies of the biological effects of low-level millimetre waves. *J Expo Sci Environ Epidemiol*. <https://doi.org/10.1038/s41370-021-00307-7>.

Yadav A.S., Sharma M.K., (2008): Increased frequency of micronucleated exfoliated cells among humans exposed in vivo to mobile telephone radiations. *Mutat Res*, 650(2):175–180.

Yakymenko I., Tsybulin O., Sidorik E., Henshel D., Kyrylenko O., Kyrylenko S., (2016): Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation. *Electromagn Biol Med*, 35(2):186–202.

Yakymenko I., Burlaka A., Tsybulin I., Brieieva I., Buchynska L., Tshmistrenko I., Chekhun F., (2018): Oxidative and mutagenic effects of low intensity GSM 1800 MHz microwave radiation. *Exp Oncol*, 40(4):282–287.

Yan J.G., Agresti M., Bruce T., Yan Y.H., Granlund A., Matloub H.S., (2007): Effects of cellular phone emissions on sperm motility in rats. *Fertil Steril*, 88(4):957–964.

Yao K., Wu W., Wang K., Ni S., Ye P., Yu Y., Ye J., Sun L., (2008): Electromagnetic noise inhibits radiofrequency radiation-induced DNA damage and reactive oxygen species increase in human lens epithelial cells. *Mol Vis*, 19(14):964–969.

Yao Y., Dai W., (2014): Genomic instability and cancer. *J Carcinog Mutagen*, 5. <https://doi.org/10.4172/2157-2518.1000165>.

Yu H., Venkatarangan L., Wishnok J.S., and Tannenbaum S.R., (2005): Quantitation of Four Guanine Oxidation Products from Reaction of DNA with Varying Doses of Peroxynitrite. *Chem Res Toxicol*, 18(12):1849–1857.

Yuan L.Q., Wang C., Lu D.F., Zhao X.D., Tan L.H., Chen X., (2020): Induction of apoptosis and ferroptosis by a tumor suppressing magnetic field through ROS-mediated DNA damage. *Aging (Albany NY)*. 2020 8;12(4):3662–3681. <https://doi.org/10.18632/aging.102836>.

Zalba G., Beaumont F.J., San José G., Fortuño A., Fortuño M.A., Etayo J.C., Díez J., (2000): Vascular NADH/NADPH oxidase is involved in enhanced superoxide production in spontaneously hypertensive rats. *Hypertension*, 35(5):1055–1061. <https://doi.org/10.1161/01.hyp.35.5.1055>.

Zglinicki T., Saretzki G., Ladhoff J., d'Adda di Fagagna F., Jackson S.P., (2005): Human cell senescence as a DNA damage response. *Mech Ageing Dev*, 126(1):111–117.

Zhang D.Y., Xu Z.P., Chiang H., Lu D.Q., Zeng Q.L., (2006): Effects of GSM 1800 MHz radiofrequency electromagnetic fields on DNA damage in Chinese hamster lung cells. *Zhonghua Yu Fang Yi Xue Za Zhi*, 40(3):149–152.

Zhang L., Zhang Z., Guo H., Wang Y., (2008): Na⁺/K⁺-ATPase-mediated signal transduction and Na⁺/K⁺-ATPase regulation. *Fundam Clin Pharmacol*, 22(6):615–621.

Zheng Y., Xia P., Dong L., Tian L., Xiong C., (2021): Effects of modulation on sodium and potassium channel currents by extremely low frequency electromagnetic fields stimulation on hippocampal CA1 pyramidal cells. *Electromagn Biol Med*, 17:1–12.

Zothansiam, Zosangzuali M., Lalramdinpuui M., Jagetia G.C., (2017): Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations. *Electromagn Biol Med*, 36(3):295–305.