

# **5G: Great risk for EU, U.S. and International Health! Compelling Evidence for Eight Distinct Types of Great Harm Caused by Electromagnetic Field (EMF) Exposures and the Mechanism that Causes Them**

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## Preface

The document that follows was, in its original form, sent to many of the authorities of the European Union, in conjunction with other documents sent to the same people by a group of European scientists. It was in response two documents that were, in turn, written by Mr. Ryan and Dr. Vinciūnas responding to a large group of European and other international scientists expressing great concern about the safety of 5G. I was asked by the leaders of the group of scientists to write my own response to those two documents. Mr. Ryan made the statement that “There is consistent evidence presented by national and international bodies (International Commission on Non Ionising Radiation Protection - ICNIRP, Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) that exposure to electromagnetic fields does not represent a health risk, if it remains below the limits set by Council Recommendation 1999/519/EC1.” In fact, that is not either the ICNIRP or SCENIHR position – their position, and similar positions have been taken by the U.S. FCC, FDA and the National Cancer Institute, is that the evidence is inconsistent or conflicting and therefore, in their view, no conclusions can be drawn. Some of these organization have also stated that there is no known mechanism by which effects can be produced. What is shown below is that there is a vast amount of evidence in the independent scientific literature that conflicts with both the conclusion about lack of demonstrated effects and the conclusion about lack of mechanism.

The European Commission, according to the Ryan and Vinciūnas documents and the U.S. National Cancer Institute, according to their web site, are both depending on the SCENIHR 2015 document to make judgments about EMF effects. Consequently, the reliability of SCENIHR 2015 is an essential element in determining the reliability of both of their assessments.

The document that is presented below, differs from the document that was emailed to EU authorities in three different ways: 1. The original document was sent as an email with multiple attachments. In this document attachments are simply provided as citations. The current document is a stand-alone document. 2. Some material is inserted to discuss positions taken by the U.S. FCC, FDA and National Cancer Institute, so as to be particularly relevant to the U.S. situation. 3. Substantial additional evidence is also provided.

The revised document contains six chapters followed by a citation list for the entire document:

Chapter 1: Eight Extremely Well-Documented Effects of Non-Thermal EMF Exposures: Role of Pulsations, Other Factors that Influence EMF Effects

Chapter 2: How Each Such EMF Effect Is Directly Produced via Voltage-Gated Calcium Channel Activation: Role of the Voltage Sensor in Producing the Extraordinary Sensitivity to EMF Effects

Chapter 3. Strong Evidence for Cumulative and Irreversible EMF Effects

Chapter 4. EMFs Including Wi-Fi May Be Particularly Damaging to Young People

Chapter 5: The Importance of the SCENIHR 2015 Document and the Many Omissions, Flaws and Falsehoods in That Document

**Chapter 1. Eight Extremely Well-Documented Effects of Non-Thermal EMF Exposures: Role of Pulsations, Other Factors that Influence EMF Effects**

Both the earlier Ryan document and the more recent Arūnas document each fail to pay any attention to the extensive scientific literature that has been accumulated on non-thermal electromagnetic field (EMF) effects. The scientific consensus of independent scientists based on information accumulated over the last 7 decades is just the opposite of what each of them states. I am copying into this document, at the end of Chapter 1, a series of 8 extremely well-documented effects of such EMF exposure, together with a list of review articles, most of them being peer reviewed articles published in well respected journals in the PubMed database, *that have each reviewed a body of evidence demonstrating the existence of each such effect.*

What are the effects produced by non-thermal exposures to microwave frequency EMFs, where we have an extensive scientific literature? Each of the following effects has been documented in from 11 to 35 reviews, listed at the end of Chapter 1.

1. Three types of cellular DNA attacks, producing single strand breaks in the cellular DNA, double strand breaks in cellular DNA and oxidized bases in cellular DNA. Each of these DNA changes have roles in cancer causation and in producing the most important mutational changes in humans and other animals. Double stranded DNA breaks produce chromosomal breaks, rearrangements, deletions and duplications and copy number mutations; they also produce gene amplification, an important mechanism in cancer causation. Single strand breaks in cellular DNA cause aberrant recombination events leading to copy number mutations. Oxidized bases leading to point mutations. When these occur in somatic cells, they can each have roles in causing cancer. When these occur in germ line cells (and they have been shown to occur in sperm following EMF exposures), they cause the three most important types of mutations in future generations, chromosomal mutations, copy number mutations and point mutations. (19 different reviews documenting these types of cellular DNA damage)
2. A wide variety of changes leading to lowered male fertility, lowered female fertility, increased spontaneous abortion, lowered levels of estrogen, progesterone and testosterone, lowered libido (16 reviews). Human sperm count has dropped to below 50% of what used to be considered normal throughout the technologically advanced countries of the world [1]. Reproductive rates have fallen below replacement levels in every technologically advanced country of the world, with a single exception. These include every EU country, the U.S., Canada, Japan, South Korea, Taiwan, Singapore, Australia and New Zealand. Reproduction averages in these countries is about 73% of replacement levels according to 2015 or 2016 data. A study on mouse reproduction [2] showed that radio/microwave frequency EMF exposure at doses well within our current safety guidelines produced substantial dose-dependent decreases in reproduction within the first set of litters; further exposure produced dose-dependent complete or almost complete sterility that was found to be largely irreversible. When we have a technology that is universally present in these technologically advanced countries, that we know impacts reproduction, and reproduction has already dropped well below replacement levels, and we may be facing a catastrophic and irreversible decline in reproduction and there are more and more plans to expose us still further, don't you think that we should take note of the science? Mr. Ryan and Dr. Vinciūnas seem to be saying not at all. (Please note that the U.S. FCC and FDA also completely ignore this existential threat)
3. Neurological/neuropsychiatric effects (23 reviews). My own paper on this [3] and two earlier reviews cited in it found that there are whole series of repeatedly found EMF effects which have also become extremely widespread complaints in our technologically advanced societies, namely: sleep disturbance/insomnia; fatigue/tiredness; headache; depression/depressive symptoms; lack of concentration/attention/cognitive dysfunction; dizziness/vertigo; memory changes; restlessness/tension/anxiety/stress/agitation; irritability. These findings are not just based

- on epidemiological findings but are also based on profound impacts of EMFs, at levels well within our safety guidelines, on brain structure and function and also on the mechanism of non-thermal EMF action discussed below. When we have these neuropsychiatric effects becoming more and more common in technologically advanced societies all over the world, and *we know each of these is caused EMF exposures*, shouldn't we take note of this relationship?
4. Apoptosis/cell death (13 reviews). The two most important consequences of large increases in apoptosis (programmed cell death) are in causation of the neurodegenerative diseases and lowered reproduction although there are others.
  5. Oxidative stress/free radical damage (17 reviews). Oxidative stress has roles in all or almost all chronic diseases. It is reported to have essential roles in producing the reproductive effects and the attacks on cellular DNA and may also have roles in producing the neurological effects and some of the cancer-causing effects shown to be produced here by EMF exposures.
  6. Widespread endocrine (that is hormonal) effects (11 reviews). The steroid hormone levels drop with EMF exposure, whereas other hormone levels increase with initial exposure. The neuroendocrine hormones and insulin levels often drop with prolonged EMF exposure, possibly due to endocrine exhaustion.
  7. Increases in intracellular calcium ( $[Ca^{2+}]_i$ ) levels following EMF exposure (14 reviews). Calcium signaling also increases following EMF exposure.
  8. Cancer causation (35 reviews). Brain cancer, salivary cancer, acoustic neuromas and two other types of cancer go up with cell phone use. People living near cell phone towers have increased cancer rates. Other types of EMFs are also implicated. Short wave radio, radio ham operators and people exposed to radar all are reported to have increased cancer incidence. Perhaps most telling, heavy-long term cell phone users have the highest incidence of brain cancer and have predominantly cancer increases on the ipsilateral side of the head (the side they use their cell phones), as opposed to the contralateral side. I have an in press paper [7], focused not on whether EMFs cause cancer but rather on *how* they can cause cancer. The paper shows that "downstream effects" of the main target of the EMFs in the cells of our bodies, can cause cancer in 15 different ways, including increases in cancer initiation, promotion and progression. Progression effects include both tissue invasion and metastasis. Each of these cancer causation effects are caused via mechanisms produced by downstream effects of the main non-thermal EMF mechanism, as discussed in Chapter 2.
  9. Therapeutic effects of such EMFs. Such EMFs when focused on a specific region of the body where there is some dysfunction and when used at specific intensities, can have therapeutic effects. In my 2013 paper [4], I cited 12 different reviews where EMF stimulation of bone growth was used therapeutically. There are something like 4000 papers on various therapeutic effects. Strangely, the telecommunications industry does not acknowledge these therapeutic effects, preferring rather to maintain the fiction that there are no non-thermal effects.

There is another set of reviews, 12 in this case, with each showing that pulsed EMFs are, in most cases, much more biologically active than are non-pulsed EMFs. This is particularly important because all wireless communication devices communicate via pulsations, making them potentially much more dangerous. It follows from this that if you wish to study the effects of Wi-Fi, cell phones, cordless phones, cell phone towers, smart meters or 5G, you had better study the real thing or at least something that pulses very much like the real thing. There are many studies that don't do this, but falsely claim to be genuine Wi-Fi, cell phone or cordless phone studies. Other factors that influence the occurrence of non-thermal EMF effects include the frequency being used, the polarization of the EMFs and the cell type being studied [4,5,8-11]. Furthermore there are intensity "windows" that produce maximum biological effects, such that both lower and higher intensities produce much less effect [5,8,9]. These window effect studies clearly show that dose-response curves are both non-linear and non-monotone, such that it is difficult or impossible to predict effects based on relative intensity even when all other factors are the same. The role of each of these factors is completely ignored by ICNIRP, SCENIHR, the U.S. FCC, FDA and National Cancer Institute as well as by many other industry-friendly groups. When each of these organizations concludes that "results are inconsistent" they are comparing studies based on superficial similarities but not on these demonstrated causal factors. What is being observed, therefore, is genuine biological heterogeneity, not inconsistency. It has been known since the beginning of modern science in the 16<sup>th</sup>

century that how you do your studies is important in determining what results are obtained. How is it possible that ICNIRP, SCENIHR, the U.S. FCC, FDA and National Cancer Institute have forgotten this important fact?

The primary literature studies demonstrating roles of pulsation, frequency, polarization, cell type and intensity windows in determining biological effects are entirely dependent on having genuine effects to study. None of these studies could have been done without an effect to study. Consequently, the claims that there are no well-documented EMF effects are nonsense, based not only on the eight extremely well-documented effects summarized above, but also on the entire literature demonstrating the role of pulsation, frequency, polarization, cell type and intensity windows.

Now I haven't said anything about how these non-thermal EMF effects are produced. I am taking much of Chapter 2 from a recent paper [11].

### **Reviews each showing important health-related non-thermal effects of microwave frequency electromagnetic fields (EMFs).**

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Specific effects and reviews each reporting the effect in multiple primary literature studies:

### **Cellular DNA damage: Single strand and double strand breaks in cellular DNA and oxidized bases in cellular DNA, leading to chromosomal and other mutational changes:**

1. Glaser ZR, PhD. 1971 Naval Medical Research Institute Research Report, June 1971. Bibliography of Reported Biological Phenomena ("Effects") and Clinical Manifestations Attributed to Microwave and Radio-Frequency Radiation. Report No. 2 Revised. [https://scholar.google.com/scholar?q=Glaser+naval+medical+microwave+radio-frequency+1972&btnG=&hl=en&as\\_sdt=0%2C38](https://scholar.google.com/scholar?q=Glaser+naval+medical+microwave+radio-frequency+1972&btnG=&hl=en&as_sdt=0%2C38) (Accessed Sept. 9, 2017)
2. Goldsmith JR. 1997 Epidemiologic evidence relevant to radar (microwave) effects. *Environ Health Perspect* 105(Suppl 6):1579-1587.
3. Yakymenko IL, Sidorik EP, Tsybulin AS. 1999 [Metabolic changes in cells under electromagnetic radiation of mobile communication systems]. *Ukr Biokhim Zh* (1999), 2011 Mar-Apr:20-28.
4. Aitken RJ, De Iulii GN. 2007 Origins and consequences of DNA damage in male germ cells. *Reprod Biomed Online* 14:727-733.
5. Hardell, L., Sage, C. 2008. Biological effects from electromagnetic field exposure and public exposure standards. *Biomed. Pharmacother.* 62, 104-109.
6. Hazout A, Menezo Y, Madelenat P, Yazbeck C, Selva J, Cohen-Bacrie P. 2008 [Causes and clinical implications of sperm DNA damages]. *Gynecol Obstet Fertil* ;36:1109-1117.
7. Phillips JL, Singh NP, Lai H. 2009 Electromagnetic fields and DNA damage. *Pathophysiology* 16:79-88.
8. Ruediger HW. 2009 Genotoxic effects of radiofrequency electromagnetic fields. *Pathophysiology.* 16:89-102.
9. Makker K, Varghese A, Desai NR, Mouradi R, Agarwal A. 2009 Cell phones: modern man's nemesis? *Reprod Biomed Online* 18:148-157.
10. Yakymenko I, Sidorik E. 2010 Risks of carcinogenesis from electromagnetic radiation and mobile telephony devices. *Exp Oncol* 32:729-736.
11. Yakimenko IL, Sidorik EP, Tsybulin AS. 2011 [Metabolic changes in cells under electromagnetic radiation of mobile communication systems]. *Ukr Biokhim Zh* (1999). 2011 Mar-Apr;83(2):20-28.
12. Gye MC, Park CJ. 2012 Effect of electromagnetic field exposure on the reproductive system. *Clin Exp Reprod Med* 39:1-9. doi.org/10.5653/cerm.2012.39.1.1

13. Pall, ML. 2013. Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects. *J Cell Mol Med* 17:958-965. doi: 10.1111/jcmm.12088.
14. 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* 3, 99-116. doi: 10.1515/reveh-2015-0001.
15. Houston BJ, Nixon B, King BV, De Iulius GN, Aitken RJ. 2016 The effects of radiofrequency electromagnetic radiation on sperm function. *Reproduction* 152:R263-R276.
16. Batista Napotnik T, Reberšek M, Vernier PT, Mali B, Miklavčič D. 2016 Effects of high voltage nanosecond electric pulses on eukaryotic cells (in vitro): A systematic review. *Bioelectrochemistry*. 2016 Aug;110:1-12. doi: 10.1016/j.bioelechem.2016.02.011.
17. Asghari A, Khaki AA, Rajabzadeh A, Khaki A. 2016 A review on Electromagnetic fields (EMFs) and the reproductive system. *Electron Physician*. 2016 Jul 25;8(7):2655-2662. doi: 10.19082/2655.
18. Pall ML. 2018 How cancer can be caused by microwave frequency electromagnetic field (EMF) exposures: EMF activation of voltage-gated calcium channels (VGCCs) can cause cancer including tumor promotion, tissue invasion and metastasis via 15 mechanisms. Chapter 7 in *Mobile Communications and Public Health*, Marko Markov, Ed., CRC press, pp 167-188.
19. Pall ML. 2018 Wi-Fi is an important threat to human health. *Environ Res* 164:404-416.

**Lowered fertility, including tissue remodeling changes in the testis, lowered sperm count and sperm quality, lowered female fertility including ovarian remodeling, oocyte (follicle) loss, lowered estrogen, progesterone and testosterone levels (that is sex hormone levels), increased spontaneous abortion incidence, lowered libido:**

1. Glaser ZR, PhD. 1971 Naval Medical Research Institute Research Report, June 1971. Bibliography of Reported Biological Phenomena ("Effects") and Clinical Manifestations Attributed to Microwave and Radio-Frequency Radiation. Report No. 2 Revised. [https://scholar.google.com/scholar?q=Glaser+naval+medical+microwave+radio-frequency+1972&btnG=&hl=en&as\\_sdt=0%2C38](https://scholar.google.com/scholar?q=Glaser+naval+medical+microwave+radio-frequency+1972&btnG=&hl=en&as_sdt=0%2C38) (Accessed Sept. 9, 2017)
2. Tolgskaya MS, Gordon ZV. 1973. Pathological Effects of Radio Waves, Translated from Russian by B Haigh. Consultants Bureau, New York/London, 146 pages.
3. Goldsmith JR. Epidemiological evidence relevant to radar (microwave) effects. *Environ Health Perspect* 105(Suppl 6):1579-1587.
4. Aitken RJ, De Iulius GN. 2007 Origins and consequences of DNA damage in male germ cells. *Reprod Biomed Online* 14:727-733.
5. Hazout A, Menezo Y, Madelenat P, Yazbeck C, Selva J, Cohen-Bacrie P. 2008 [Causes and clinical implications of sperm DNA damages]. *Gynecol Obstet Fertil* ;36:1109-1117.
6. Makker K, Varghese A, Desai NR, Mouradi R, Agarwal A. 2009 Cell phones: modern man's nemesis? *Reprod Biomed Online* 18:148-157.
7. Kang N, Shang XJ, Huang YF. 2010 [Impact of cell phone radiation on male reproduction]. *Zhonghua Nan Ke Xue* 16:1027-1030.
8. Gye MC, Park CJ. 2012 Effect of electromagnetic field exposure on the reproductive system. *Clin Exp Reprod Med* 39:1-9. doi.org/10.5653/cerm.2012.39.1.1
9. La Vignera S, Condorelli RA, Vicari E, D'Agata R, Calogero AE. 2012 Effects of the exposure to mobile phones on male reproduction: a review of the literature. *J Androl* 33:350-356.
10. Carpenter DO. 2013 Human disease resulting from exposure to electromagnetic fields. *Rev Environ Health* 2013;28:159-172.
11. Nazıroğlu M, Yüksel M, Köse SA, Özkaya MO. 2013 Recent reports of Wi-Fi and mobile phone-induced radiation on oxidative stress and reproductive signaling pathways in females and males. *J Membr Biol* 246:869-875.
12. Adams JA, Galloway TS, Mondal D, Esteves SC, Mathews F. 2014 Effect of mobile telephones on sperm quality: a systematic review and meta-analysis. *Environ Int* 70:106-112.
13. Liu K, Li Y, Zhang G, Liu J, Cao J, Ao L, Zhang S. 2014 Association between mobile phone use and semen quality: a systematic review and meta-analysis. *Andrology* 2:491-501.

14. K Sri N. 2015 Mobile phone radiation: physiological & pathophysiological considerations. *Indian J Physiol Pharmacol* 59:125-135.
15. Houston BJ, Nixon B, King BV, De Iuliis GN, Aitken RJ. 2016 The effects of radiofrequency electromagnetic radiation on sperm function. *Reproduction* 152:R263-R276
16. Pall ML. 2018 Wi-Fi is an important threat to human health. *Environ Res* 164:404-416.

#### **Neurological/neuropsychiatric effects:**

1. Marha K. 1966 Biological Effects of High-Frequency Electromagnetic Fields (Translation). ATD Report 66-92. July 13, 1966 (ATD Work Assignment No. 78, Task 11). <http://www.dtic.mil/docs/citations/AD0642029> (accessed March 12, 2018)
2. Glaser ZR, PhD. 1971 Naval Medical Research Institute Research Report, June 1971. Bibliography of Reported Biological Phenomena ("Effects") and Clinical Manifestations Attributed to Microwave and Radio-Frequency Radiation. Report No. 2 Revised. [https://scholar.google.com/scholar?q=Glaser+naval+medical+microwave+radio-frequency+1972&btnG=&hl=en&as\\_sdt=0%2C38](https://scholar.google.com/scholar?q=Glaser+naval+medical+microwave+radio-frequency+1972&btnG=&hl=en&as_sdt=0%2C38) (Accessed Sept. 9, 2017)
3. Tolgskaya MS, Gordon ZV. 1973. Pathological Effects of Radio Waves, Translated from Russian by Haigh. Consultants Bureau, New York/London, 146 pages.
4. Bise W. 1978 Low power radio-frequency and microwave effects on human electroencephalogram and behavior. *Physiol Chem Phys* 10:387-398.
5. Raines, J. K. 1981. Electromagnetic Field Interactions with the Human Body: Observed Effects and Theories. Greenbelt, Maryland: National Aeronautics and Space Administration 1981; 116 p.
6. Frey AH. 1993 Electromagnetic field interactions with biological systems. *FASEB J* 7:272-281.
7. Lai H. 1994 Neurological effects of radiofrequency electromagnetic radiation. In: *Advances in Electromagnetic Fields in Living Systems*, Vol. 1, J.C. Lin, Ed., Plenum Press, New York, pp. 27-88.
8. Grigor'ev IuG. 1996 [Role of modulation in biological effects of electromagnetic radiation]. *Radiats Biol Radioecol* 36:659-670.
9. Lai, H 1998 Neurological effects of radiofrequency electromagnetic radiation. [http://www.mapcruzin.com/radiofrequency/henry\\_lai2.htm](http://www.mapcruzin.com/radiofrequency/henry_lai2.htm).
10. Aitken RJ, De Iuliis GN. 2007 Origins and consequences of DNA damage in male germ cells. *Reprod Biomed Online* 14:727-733.
11. Hardell, L., Sage, C. 2008. Biological effects from electromagnetic field exposure and public exposure standards. *Biomed. Pharmacother.* 62, 104-109.
12. Makker K, Varghese A, Desai NR, Mouradi R, Agarwal A. 2009 Cell phones: modern man's nemesis? *Reprod Biomed Online* 18:148-157.
13. Khurana VG, Hardell L, Everaert J, Bortkiewicz A, Carlberg M, Ahonen M. 2010 Epidemiological evidence for a health risk from mobile phone base stations. *Int J Occup Environ Health* 16:263-267.
14. Levitt, B. B., Lai, H. 2010. Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays. *Environ. Rev.* 18, 369-395. doi.org/10.1139/A10-018
15. Carpenter DO. 2013 Human disease resulting from exposure to electromagnetic fields. *Rev Environ Health* 2013;28:159-172.
16. Politański P, Bortkiewicz A, Zmyślony M. 2016 [Effects of radio- and microwaves emitted by wireless communication devices on the functions of the nervous system selected elements]. *Med Pr* 67:411-421.
17. Pall ML. 2016 Microwave frequency electromagnetic fields (EMFs) produce widespread neuropsychiatric effects including depression. *J Chem Neuroanat* 75(Pt B):43-51. doi: 10.1016/j.jchemneu.2015.08.001.
18. Hecht, Karl. 2016 Health Implications of Long-Term Exposures to Electrosmog. Brochure 6 of A Brochure Series of the Competence Initiative for the Protection of Humanity, the Environment and Democracy. [http://kompetenzinitiative.net/KIT/wp-content/uploads/2016/07/KI\\_Brochure-6\\_K\\_Hecht\\_web.pdf](http://kompetenzinitiative.net/KIT/wp-content/uploads/2016/07/KI_Brochure-6_K_Hecht_web.pdf) (accessed Feb. 11, 2018)

19. Sangün Ö, Dündar B, Çömlekçi S, Büyükgebiz A. 2016 The Effects of Electromagnetic Field on the Endocrine System in Children and Adolescents. *Pediatr Endocrinol Rev* 13:531-545.
20. Belyaev I, Dean A, Eger H, Hubmann G, Jandrisovits R, Kern M, Kundi M, Moshammer H, Lercher P, Müller K, Oberfeld G, Ohnsorge P, Pelzmann P, Scheingraber C, Thill R. 2016 EUROPAEM EMF Guideline 2016 for the prevention, diagnosis and treatment of EMF-related health problems and illnesses. *Rev Environ Health* DOI 10.1515/reveh-2016-0011.
21. Zhang J, Sumich A, Wang GY. 2017 Acute effects of radiofrequency electromagnetic field emitted by mobile phone on brain function. *Bioelectromagnetics* 38:329-338. doi: 10.1002/bem.22052.
22. Lai H. 2018. A Summary of Recent Literature (2007–2017) on Neurological Effects of Radio Frequency Radiation. Chapter 8 in *Mobile Communications and Public Health*, Marko Markov, Ed., CRC press, pp 189-224.
23. Pall ML. 2018 Wi-Fi is an important threat to human health. *Environ Res* 164:404-416.

**Apoptosis/cell death** (an important process in production of neurodegenerative diseases that is also important in producing infertility responses):

1. Glaser ZR, PhD. 1971 Naval Medical Research Institute Research Report, June 1971. Bibliography of Reported Biological Phenomena (“Effects”) and Clinical Manifestations Attributed to Microwave and Radio-Frequency Radiation. Report No. 2 Revised. [https://scholar.google.com/scholar?q=Glaser+naval+medical+microwave+radio-frequency+1972&btnG=&hl=en&as\\_sdt=0%2C38](https://scholar.google.com/scholar?q=Glaser+naval+medical+microwave+radio-frequency+1972&btnG=&hl=en&as_sdt=0%2C38) (Accessed Sept. 9, 2017)
2. Tolgskaya MS, Gordon ZV. 1973. Pathological Effects of Radio Waves, Translated from Russian by B Haigh. Consultants Bureau, New York/London, 146 pages.
3. Raines, J. K. 1981. *Electromagnetic Field Interactions with the Human Body: Observed Effects and Theories*. Greenbelt, Maryland: National Aeronautics and Space Administration 1981; 116 p.
4. Hardell L, Sage C. 2008. Biological effects from electromagnetic field exposure and public exposure standards. *Biomed. Pharmacother.* 62:104-109. doi: 10.1016/j.biopha.2007.12.004.
5. Makker K, Varghese A, Desai NR, Mouradi R, Agarwal A. 2009 Cell phones: modern man's nemesis? *Reprod Biomed Online* 18:148-157.
6. Levitt, B. B., Lai, H. 2010. Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays. *Environ. Rev.* 18, 369-395. doi.org/10.1139/A10-018
7. Yakymenko I, Sidorik E. 2010 Risks of carcinogenesis from electromagnetic radiation and mobile telephony devices. *Exp Oncol* 32:729-736.
8. Yakimenko IL, Sidorik EP, Tsybulin AS. 2011 [Metabolic changes in cells under electromagnetic radiation of mobile communication systems]. *Ukr Biokhim Zh* (1999). 2011 Mar-Apr;83(2):20-28.
9. Pall, ML. 2013. Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects. *J Cell Mol Med* 17:958-965. doi: 10.1111/jcmm.12088.
10. Pall ML. 2016 Microwave frequency electromagnetic fields (EMFs) produce widespread neuropsychiatric effects including depression. *J Chem Neuroanat* 75(Pt B):43-51. doi: 10.1016/j.jchemneu.2015.08.001.
11. Batista Napotnik T, Reberšek M, Vernier PT, Mali B, Miklavčič D. 2016 Effects of high voltage nanosecond electric pulses on eukaryotic cells (in vitro): A systematic review. *Bioelectrochemistry*. 2016 Aug;110:1-12. doi: 10.1016/j.bioelechem.2016.02.011.
12. Asghari A, Khaki AA, Rajabzadeh A, Khaki A. 2016 A review on Electromagnetic fields (EMFs) and the reproductive system. *Electron Physician*. 2016 Jul 25;8(7):2655-2662. doi: 10.19082/2655.
13. Pall ML. 2018 Wi-Fi is an important threat to human health. *Environ Res* 164:404-416.

**Oxidative stress/free radical damage** (important mechanisms involved in almost all chronic diseases; direct cause of cellular DNA damage):

1. Raines, J. K. 1981. *Electromagnetic Field Interactions with the Human Body: Observed Effects and Theories*. Greenbelt, Maryland: National Aeronautics and Space Administration 1981; 116 p.

2. Hardell, L., Sage, C. 2008. Biological effects from electromagnetic field exposure and public exposure standards. *Biomed. Pharmacother.* 62, 104-109.
3. Hazout A, Menezo Y, Madelenat P, Yazbeck C, Selva J, Cohen-Bacrie P. 2008 [Causes and clinical implications of sperm DNA damages]. *Gynecol Obstet Fertil* ;36:1109-1117
4. Makker K, Varghese A, Desai NR, Mouradi R, Agarwal A. 2009 Cell phones: modern man's nemesis? *Reprod Biomed Online* 18:148-157.
5. Desai NR, Kesari KK, Agarwal A. 2009 Pathophysiology of cell phone radiation: oxidative stress and carcinogenesis with focus on the male reproductive system. *Reproduct Biol Endocrinol* 7:114.
6. Yakymenko I, Sidorik E. 2010 Risks of carcinogenesis from electromagnetic radiation and mobile telephony devices. *Exp Oncol* 32:729-736.
7. Yakymenko IL, Sidorik EP, Tsybulin AS. 2011 [Metabolic changes in cells under electromagnetic radiation of mobile communication systems]. *Ukr Biokhim Zh* (1999). 2011 Mar-Apr;83(2):20-28.
8. Consales, C., Merla, C., Marino, C., et al. 2012. Electromagnetic fields, oxidative stress, and neurodegeneration. *Int. J. Cell Biol.* 2012: 683897.
9. LaVignera et al 2012 La Vignera S, Condorelli RA, Vicari E, D'Agata R, Calogero AE. 2012 Effects of the exposure to mobile phones on male reproduction: a review of the literature. *J Androl* 33:350-356.
10. Pall, ML. 2013. Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects. *J Cell Mol Med* 17:958-965. doi: 10.1111/jcmm.12088.
11. Nazıroğlu M, Yüksel M, Köse SA, Özkaya MO. 2013 Recent reports of Wi-Fi and mobile phone-induced radiation on oxidative stress and reproductive signaling pathways in females and males. *J Membr Biol* 246:869-875.
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**Increased intracellular calcium:** intracellular calcium is maintained at very low levels (typically about  $2 \times 10^{-9}$  M) except for brief increases used to produce regulatory responses, such that sustained elevation of intracellular calcium levels produces many pathophysiological (that is disease-causing) responses).

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**Pulsed EMFs are, in most cases much more biologically active than are non-pulsed EMFs.** This is important because all wireless communication devices communicate via pulsations and because the “smarter” the devices are, the more they pulse because the pulsations convey the information. What should be obvious is that you cannot study such pulsation roles if there were no biological effects produced by such EMFs. *The pulsation studies alone tell us that there are many such EMF effects.*

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Each of these reviews, typically cite from 5 to over 100 primary literature citations, each showing that non-thermal EMF exposures produce the effect under which they are listed. It follows from this, that there are not only 11 or more reviews documenting each of these effects, but there is also a massive primary literature documenting these effects as well. It follows from this that the ICNIRP, FCC and International Safety Guidelines, which are entirely based only on thermal effects are inadequate and there have been petitions and other statements of international groups of scientists expressing great concern about this. *It follows that the ICNIRP, FCC and International safety guidelines are completely unscientific and cannot be relied upon to protect our safety.*

**Chapter 2: How Each Such EMF Effect Is Produced via Voltage-Gated Calcium Channel Activation: Role of the Voltage Sensor in Producing the Extraordinary Sensitivity to EMF Effects**

The Pall, 2013 [4] study showed that in 24 different studies (there are now a total of 26 [5]), effects of low-intensity EMFs, both microwave frequency and also lower frequency EMFs, could be blocked by calcium channel blockers, drugs that are specific for blocking voltage-gated calcium channels (VGCCs). There were 5 different types of calcium channel blockers used in these studies each thought to be highly specific, each structurally distinct and each binding to a different site on the VGCCs. *In studies where multiple effects were studied, all studied effects were blocked or greatly lowered by calcium channel blockers.* These studies show that EMFs produce diverse non-thermal effects via VGCC activation in many human and animal cells and even in plant cells where some similar calcium channels are involved [6]. Furthermore, many different effects shown to be produced in repeated studies by EMF exposures, including the effects discussed above, can each be produced by downstream effects of VGCC activation, via increased intracellular calcium [Ca<sup>2+</sup>]<sub>i</sub>, as discussed below.

Various EMFs act via VGCC activation, as shown by calcium channel blocker studies. These include microwave frequency EMFs, nanosecond pulse EMFs, intermediate frequency EMFs, extremely low frequency EMFs and even static electrical fields and static magnetic fields.

It is important to discuss why the VGCCs are so sensitive to activation by these low-intensity EMFs. Each of the VGCCs have a voltage sensor which is made up of 4 alpha helices, each designated as an S4 helix, in the plasma membrane. Each of these S4 helices has 5 positive charges on it, for a total of 20 positive charges making up the VGCC voltage sensor [5,8]. Each of these charges is within the lipid bilayer part of the plasma membrane. The electrical forces on the voltage sensor are extraordinarily high for three distinct reasons [5,8]. 1. The 20 charges on the voltage sensor make the forces on voltage sensor 20 times higher than the forces on a single charge. 2. Because these charges are within the lipid bilayer section of the membrane where the dielectric constant is about 1/120<sup>th</sup> of the dielectric constant of the aqueous parts of the cell, the law of physics called Coulomb's law, predicts that the forces will be approximately 120 times higher than the forces on charges in the aqueous parts of the cell. 3. Because the plasma membrane has a

high electrical resistance whereas the aqueous parts of the cell are highly conductive, the electrical gradient across the plasma membrane is estimated to be concentrated about 3000-fold. The combination of these factors means that comparing the forces on the voltage sensor with the forces on singly charged groups in the aqueous parts of the cell, the forces on the voltage sensor are approximately  $20 \times 120 \times 3000 = 7.2$  million times higher [5,8]. The physics predicts, therefore, extraordinarily strong forces activating the VGCCs via the voltage sensor. It follows that the biology tells us that the VGCCs are the main target of the EMFs and the physics tells us why they are the main target. *Thus the physics and biology are pointing in exactly the same direction.*

We have, then, very strong arguments that the EMFs act directly on the voltage-sensor to activate the VGCCs. There are several other types of evidence, each providing important evidence supporting this view:

1. In a study published by Pilla [12], it was found that pulsed EMFs produced an “instantaneous” increase in calcium/calmodulin-dependent nitric oxide synthesis in cells in culture. What this study [12] showed was that following EMF exposure, the cells in culture, must have produced a large increase in  $[Ca^{2+}]_i$ , this in turn produced a large increase in nitric oxide synthesis, the nitric oxide diffused out of the cells and out of the aqueous medium above the cells into the gas phase, where the nitric oxide was detected by a nitric oxide electrode. This entire sequence occurred in less than 5 seconds. This eliminates almost any conceivable indirect effect, except possibly via plasma membrane depolarization. Therefore, it is likely that the pulsed EMFs are acting directly on the voltage sensors of the VGCCs and possibly the voltage-gated sodium channels, to produce the  $[Ca^{2+}]_i$  increase.

2. There are also additional findings pointing to the voltage sensor as the direct target of the EMFs. In addition to the VGCCs, there are also voltage-gated sodium, potassium and chloride channels, with each of these having a voltage sensor similar to those found in the VGCCs. Lu et al [13] reported that voltage gated sodium channels, in addition to the VGCCs were activated by EMFs. Tabor et al [14] found that Mauthner cells, specialized neurons with special roles in triggering rapid escape mechanisms in fish, were almost instantaneously activated by electrical pulses, which acted via voltage-gated sodium channel activation to subsequently produce large  $[Ca^{2+}]_i$  increases. Zhang et al [15] reported that in addition to the VGCCs, potassium and chloride channels were each activated by EMFs, although these other voltage-gated ion channels had relatively modest roles, compared with the VGCCs, in producing biological effects. Each of these three studies [13-15] used specific blockers for these other voltage-gated ion channels to determine their roles. The Tabor et al [14] study also used genetic probing to determine the role of the voltage-gated sodium channels. Lu et al [13] also used whole cell patch clamp measurements to measure the rapid influx of both sodium and calcium into the cell via the voltage-gated channels following EMF exposure. Sodium influx, particularly in electrically active cells, acts in the normal physiology to depolarize the plasma membrane, leading to VGCC activation such that the voltage-gated sodium channels may act primarily via indirect activation of the VGCCs. In summary then, we have evidence that in animal including human cells, seven distinct classes of voltage-gated ion channels are each activated by EMF exposures: From Ref. [4], four classes of voltage-gated ion channels were shown from calcium channel blocker studies, to be activated by EMFs, L-type, T-type, N-type and P/Q –type VGCCs. In this paragraph we have evidence that three other channels are also activated, voltage-gated sodium channels, voltage-gated potassium channels and voltage-gated chloride channels. Furthermore the plant studies strongly suggest that the so called TPC channels, which contain a similar voltage sensor, are activated in plants allowing calcium influx into plants to produce similar EMF-induced responses [6]. In summary, then we have evidence for eight different ion channels being activated by EMF exposure, four classes of VGCCs, one class each of voltage-gated sodium, potassium and chloride channels and also one class of plant channel, with each of these channels having a similar voltage-sensor regulating its opening. One can put those observations together with the powerful findings from the physics, that the electrical forces on the voltage-sensor are stunningly strong, something like 7.2 million times stronger than the forces on the singly charged groups in the aqueous phases of the cell. Now you have a stunningly powerful argument that the voltage sensor is the predominant direct target of the EMFs.

3. The most important study on this subject, was published by Tekieh et al [16]. It showed that microwave frequency EMFs directly activate the VGCCs in isolated membranes. A variety of microwave frequencies

were used in these studies and each such frequency produced VGCC activation in a completely cell-free system. This study clearly shows that the EMF activation of the VGCCs is direct and not due to some indirect regulatory effect.

How then does the estimated sensitivity of the voltage-sensor, about 7.2 million times greater forces than the forces on singly charged groups, compare with previous estimates of levels of EMF exposure needed to produce biological effects? The ICNIRP 2009 [17] safety guidelines allowed for 2 to 10 W/m<sup>2</sup> exposure, depending upon frequency. In contrast, the Bioinitiative Working Group 2007 [18] proposed a precautionary target level of 3 to 6 μW/m<sup>2</sup> or about a million-fold lower, using a safety factor of 10. If one uses a more commonly used safety factor of 50 to 100, then the 7.2 million-fold sensitivity of the voltage-sensor, predicted by the physics, falls right in the middle of the Bioinitiative Working Group 2007 calculations. So again, it can be argued that the physics and the biology are pointing in the same direction, in this case pointing to the same approximate range of sensitivity.

You may be wondering why I am spending so much time and space going through each of these studies. The answer is that a well over a trillion dollar (or trillion euro) set of industries, the telecommunications industry, has been putting out propaganda for over two decades, arguing that there cannot be a mechanism of action of these non-thermal EMFs to produce biological effects; and that these EMFs are too weak to do anything and that there only thermal effects are documented. It is essential to dot every *i* and cross every *t* with regard to the main mechanism of action of non-thermal effects. That is exactly what has been done here.

How Can the Diverse Effects of Such EMF Exposures Be Produced by VGCC Activation?

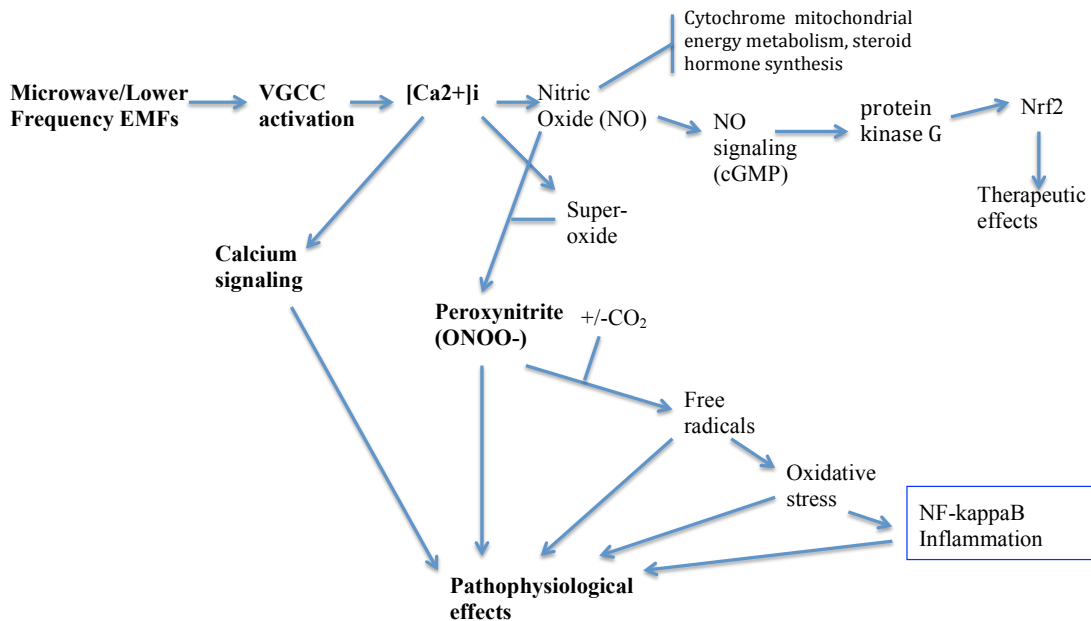


Fig. 1 How EMFs Act via VGCC Activation to Produce Various Effects

The mechanisms by which various effects can be generated by VGCC activation are outlined in Fig. 1. Going across the top of Fig. 1, it can be seen that increased intracellular calcium [Ca<sup>2+</sup>]<sub>i</sub> can increase nitric oxide (NO) synthesis, stimulating the NO signaling pathway (going to the right from top, center), to produce therapeutic effects. NO (very top) can also bind to cytochromes and inhibit their activity. NO binding to the terminal oxidase in the mitochondria inhibits energy metabolism and lowers, therefore, ATP. NO binding to cytochrome P450s, lowers synthesis of steroid hormones, including estrogen, progesterone and testosterone. The P450 lowering also lowers detoxification and vitamin D activity. Most of the

pathophysiological effects are produced by the peroxynitrite/free radical/oxidative stress pathway center to lower right (Fig. 1) and also by excessive calcium signaling pathway (slightly left of center, Fig. 1). Some of the ways these are thought to produce various well-established EMF effects are outlined in Table 1.

**Table 1. How Eight Established Effects of Wi-Fi and Other EMFs Can Be Produced by VGCC Activation**

<b>EMF effect</b>	<b>Probable mechanism(s)</b>
Oxidative stress	Produced by elevated levels of peroxynitrite and the free radical breakdown products of peroxynitrite and its CO <sub>2</sub> adduct. Four studies of EMF exposure, cited in [4] showed that oxidative stress following exposure was associated with major elevation of 3-nitrotyrosine, a marker of peroxynitrite, thus confirming this interpretation. Two other studies each found 3-nitrotyrosine elevation, both following 35 GHz exposures [19,20].
Lowered male/female fertility, elevated spontaneous abortion, lowered libido	Both the lowered male fertility and lowered female fertility are associated with and presumably caused by the oxidative stress in the male and female reproductive organs. Spontaneous abortion is often caused by chromosomal mutations, so the germ line mutations may have a causal role. Lowered libido may be caused by lowered estrogen, progesterone and testosterone levels. It seems likely that these explanations may be oversimplified. One additional mechanism that may be important in producing lowered fertility is that VGCC activation and consequent high [Ca <sup>2+</sup> ] <sub>i</sub> levels is known to have a key role in avoiding polyspermy. Consequently, if this is triggered before any fertilization of an egg has occurred, it may prevent any sperm from fertilizing and egg.
Neurological/neuropsychiatric effects	Of all cells in the body, the neurons have the highest densities of VGCCs, due in part to the VGCC role and [Ca <sup>2+</sup> ] <sub>i</sub> role in the release of every neurotransmitter in the nervous system. Calcium signaling regulates synaptic structure and function in 5 different ways, each likely to be involved here. Oxidative stress and apoptosis are both thought to have important roles. Lowered sleep and increased fatigue are likely to involve lowered nocturnal melatonin and increased nocturnal norepinephrine.
Apoptosis	Apoptosis can be produced by excessive Ca <sup>2+</sup> levels in the mitochondria and by double strand breaks in cellular DNA; it seems likely that both of these mechanisms are involved following EMF exposure. A third mechanism for triggering apoptosis, endoplasmic reticulum stress (see bottom row in this Table), may also be involved.
Cellular DNA damage	Cellular DNA damage is produced by the free radical breakdown products of peroxynitrite directly attacking the DNA [7].
Changes in non-steroid hormone levels	The release of non-steroid hormones is produced by VGCC activation and [Ca <sup>2+</sup> ] <sub>i</sub> elevation. The immediate effects of EMF exposures is to increase hormone release and to raise, therefore, hormone levels. However many hormone systems become “exhausted” as a consequence of chronic EMF exposures. The mechanism of exhaustion is still uncertain, but it may involve oxidative stress and inflammation.
Lowered steroid hormone	Steroid hormones are synthesized through the action of cytochrome P450 enzymes; activity of these hormones is inhibited by binding of high levels of nitric oxide (NO) leading to lowered hormone synthesis.
Calcium overload	Produced by excessive activity of the VGCCs; secondary calcium overload is produced by oxidative stress activation of TRPV1, TRPM2 and possibly some other TRP receptors, opening the calcium channel of these receptors.
Heat shock protein induction	There is a large literature showing that excessive [Ca <sup>2+</sup> ] <sub>i</sub> induces very large increases in heat shock proteins. This is thought to be produced by complex calcium signaling changes involving the endoplasmic reticulum, mitochondria and the cytosol and also involving excessive [Ca <sup>2+</sup> ] <sub>i</sub> producing increasing

	protein misfolding [21-23]. It should be noted that some calcium is essential for proper protein folding in the endoplasmic reticulum such that only excessive calcium leads to misfolding and consequent endoplasmic reticulum stress.
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Each of the seven established EMF effects, discussed above, can be generated through the mechanisms outlined in Fig. 1, as shown by Table 1. An eighth, heat shock protein induction can also be so explained (Table 1). Several other such effects, including EMF causation of cataracts, breakdown of the blood-brain barrier, lowered nocturnal melatonin as discussed earlier [5]. The primary mechanism for therapeutic effects was discussed in [4,24,25]. Each of these also shown to be generated via such VGCC downstream effects. Fifteen mechanisms for EMF cancer causation are described in ref [7]; these are far too complex to describe in this document so the reader is referred to ref [7].

*It can be seen, in summary, that we are far beyond the issue whether there are non-thermal EMF effects. Rather many researchers have identified many established effects of EMF exposure. The main direct targets of non-thermal EMF exposure, the VGCCs have also been identified and how these get activated by EMF exposure acting on the VGCC voltage-sensor has also been determined. And finally we have identified how a wide variety of these effects can be generated via downstream effects produced by such VGCC activation.*

Our current safety guidelines are based only on heating (thermal) effects. Heating is produced predominantly by forces on singly charged groups in the aqueous phases of the cell but the forces on the voltage sensor are approximately 7.2 million times higher. Therefore, our current safety guidelines are allowing us to be exposed to EMFs that are approximately 7.2 million times too strong. That 7.2 million figure is somewhat similar to the estimate given by the Bioinitiative Report and by the Building Biologists, based on completely different considerations.

It should be obvious, that non-thermal EMFs:

1. Attack our nervous systems including our brains leading to widespread neuropsychiatric effects and possibly many other effects. This nervous system attack is of great concern.
2. Attack our endocrine (that is hormonal) systems. In this context, the main things that make us functionally different from single celled creatures are our nervous system and our endocrine systems – even a simple planaria worm needs both of these. Thus the consequences of the disruption of these two regulatory systems is immense, such that it is a travesty to ignore these findings.
3. Produce oxidative stress and free radical damage, which have central roles in all common chronic diseases.
4. Attack the DNA of our cells, producing single strand and double strand breaks in cellular DNA and oxidized bases in our cellular DNA. These in turn produce both cancer and mutations in germ line cells with germ line mutations producing mutations impacting future generations.
5. Produce elevated levels of apoptosis (programmed cell death), events especially important in causing both neurodegenerative diseases and infertility.
6. Lower male and female fertility, lowered sex hormones, lowered libido, increased levels of spontaneous abortion and, as already stated, attacks on the DNA in sperm cells.
7. Produce excessive intracellular calcium [Ca<sup>2+</sup>]<sub>i</sub> and increased calcium signaling.
8. Act in the cells of our bodies via 15 different mechanisms to cause cancer.

By attacking all of these important systems in the body, EMFs attack everything we care about including our health (in many ways), our reproductive systems, the integrity of our genomes and our ability to produce healthy offspring.

There are 77 different reviews listed at the end of Chapter 1, with each documenting the existence of one or more of these various non-thermal EMF effects. What, then, do the two organization reports that the EU authorities and U.S. authorities rely upon, ICNIRP and SCENIHR 2015, have to say about these



independent reviews. The answer is absolutely nothing! Neither one of them uses any of these independent reviews to assess EMF effects. This whole area is discussed in much more detail in Chapter 5, below.

### **Chapter 3. Strong Evidence for Cumulative and Irreversible EMF Effects**

Two questions that must be raised about the effects of these low-intensity EMFs producing biological effects is are they cumulative and are they reversible? I am aware of several different types of evidence for cumulative effects and also for irreversible effects.

Three of the human occupational exposure studies from the 1970's reviewed in the Raines, National Aeronautics and Space Administration (NASA) study [26], showed that effects increased substantially with increasing time of exposure to a particular type and intensity of EMF. While these three studies each show cumulative effects but they provide no data on possible irreversibility of these neurological/neuropsychiatric effects. However the largest review of such occupational exposures (Hecht [28]) does provide substantial evidence on the cumulative nature and irreversibility of these neurological/neuropsychiatric effects.

Hecht [28] reviewed 60 different studies of occupational exposures that were done between 1960 and 1990 in the Soviet Union and East Germany. These were occupational exposure studies of over 3500 people, who were exposed to microwave frequency EMFs at intensities of less than 1/1000<sup>th</sup> of our safety guidelines. These studies [28] found that these EMFs produced neuropsychiatric effects similar to those found in my much more recent study [3], listed in Chapter 1 as well as on cardiac effects. Neither the neuropsychiatric findings nor the cardiac findings were unique however. Similar neuropsychiatric effects have been found to be caused by low intensity EMF exposures [27,29-34]. Cardiac effects have also been found in humans [26,29,30,32,34,35] similar to those found by Hecht [28].

Hecht [28] reports that exposures at those very low intensities for up to 3 years produced increased sympathetic nervous system activity, apparently in response to the EMF stress, following the classic stress sequence described by Hans Selye in 1953. No other effects were apparent during this circa 3 year period. However longer exposure produced observable neurological/neuropsychiatric and cardiac effects as well as other effects which were initially modest. Exposures of 3 to 5 years typically produced effects that could be largely reversed after 2 to 3 years in a no-EMF exposure environment. Hecht states that "if detected early, effective therapy is possible." However longer than 4 to 5 years exposures produced more severe effects which did not reverse when the persons were subsequently put into a no-EMF exposure environment. These and other effects continued to worsen with 10 years of exposure or longer. This cumulative nature of such EMF exposures was noted in two earlier reviews cited by Hecht et al [36,37]. These studies, then, provide very large amounts of evidence both for the cumulative nature of these neuropsychiatric effects, as well as the apparent irreversibility of these effects as they become more severe. Hecht also notes that "decline in health status increasingly amplifies EMF effects." This a pattern of increasing apparent sensitivity produced by previous exposure is similar to that described in the Western literature on electromagnetic hypersensitivity (EHS), something that Hecht recognizes [28]. EHS something that is discussed very briefly below in this section.

There are strong similarities between the Hecht [28] findings on microwave frequency EMFs in humans and the impacts of such EMFs on cellular and organ histology in rodents, as were reviewed in Tolgskaya and Gordon [38] and discussed in Pall [3]. In rodents, initially non-thermal exposures over periods of 1 to 2 months produced modest changes in structure of the brain and of the neurons. When such exposures ceased, most of the structural changes disappeared – that is the changes were largely reversible when the animals were place back into a no-EMF environment. However more months of exposure produced much more severe impacts on brain and neuronal structure and these were irreversible [38, 3]. More recent, Western country and other country studies cited in [3], provide much further support for brain impacts similar to those found in Soviet and also other country brain studies reviewed by Tolgskaya and Gordon[38]. Tolgskaya and Gordon [38.3] also reported findings that in histological studies, the nervous system was the most sensitive organ in the body, followed closely by effects on the heart and the testis, although many other organs were also impacted. Thus, the Tolgskaya and Gordon review [38,3] provides

very important support for the findings of neurological/neuropsychiatric effects, the cardiac effects, discussed immediately above and below, and the reproductive effects discussed in Chapter 1. By comparing the animal studies with the human studies, one can see the striking similarities, with the major difference being that the effects in rodents are much more rapid than the effects on humans. Given the much higher metabolic rates in rodents and much lower life spans in rodents, the timing difference is not surprising. With regard to the issues of cumulative nature and irreversibility, both rodent and human studies provide strong support for both neurological and neuropsychiatric effects showing both cumulative nature and irreversibility and show a similar pattern of cumulative effects with the cardiac effects.

What are the cardiac effects discussed briefly above, that are produced by non-thermal microwave frequency EMF exposures? The effects include tachycardia (rapid heartbeat) where some people with apparent EHS, on blinded exposure to cordless phone radiation have instantaneous tachycardia, an effect that is also essentially instantaneously reversible on cessation of exposure [28,35,36]. So tachycardia can be an almost instantaneous response to EMFs and it is sometimes also found with arrhythmia. Prolonged exposures produce both arrhythmias and bradycardia (slow heart beat) [26-30,32]. Similar EMF cardiac effects were seen in animal studies, with the earliest of these going back to the late 1960s. Arrhythmias, especially when they are accompanied by bradycardia, are often associated with sudden cardiac death. We are having an epidemic of young, apparently healthy athletes dying in the middle of an athletic competition of apparent sudden cardiac death, which may, therefore be possibly caused by EMF exposures [39]. Some of these individuals have been saved from death [39] and subsequently found to be suffering from bradycardia and arrhythmias. Another type of cardiac effect is that when apparent EHS people are exposed to Wi-Fi, cell phone, cell phone tower or smart meter radiation, they are reported to suffer from heart palpitations. Each of these four types of cardiac effects, tachycardia, arrhythmias, bradycardia and heart palpitations involve aberrations in the electrical control of the heartbeat. How can these be produced?

The heartbeat is controlled by pacemaker cells in what is called the sino-atrial node of the heart. Those pacemaker cells have been shown to have very high densities of the T-type VGCCs which may make these cells particularly susceptible to direct effects of the EMFs (recall that EMFs act via VGCC activation). The T-type and the L-type types of VGCCs have essential roles in controlling the heartbeat. It follows that EMF exposures, acting directly on the pacemaker cells of the heart, can produce tachycardia responses. Furthermore, gene mutations in a VGCC gene that produce increased VGCC activity can produce both tachycardia and arrhythmia in young babies carrying those mutations; these young children die of sudden cardiac death at a very young age. How then do we get bradycardia? Bradycardia is produced when heart failure impacts the sino-atrial node, such that the dysfunction involved in heart failure, which is very complex, produces dysfunction of the pacemaker cells of the heart, producing bradycardia [40]. It follows from this that EMF-produced bradycardia and chronic arrhythmias are likely to be caused by heart-failure-like changes that particularly impact the sino-atrial node of the heart, including the tissue remodeling found in heart failure. This model has been confirmed by the findings of Liu et al [41], who found that pulsed microwave frequency EMF produced tissue remodeling that specifically impacted the sino-atrial node of the heart with remodeling changes similar to those found in heart failure [40]. Because heart failure develops in a cumulative fashion and is based on current medicine at least, an irreversible process involving tissue remodeling and a large number of other biochemical and physiological changes [41], it seems likely, therefore, that the EMF effects on the heart are both cumulative and irreversible.

You will recall, from the discussion at the beginning of Chapter 1, that there are 16 reviews documenting that EMF produces lowered fertility and that these act via diverse mechanisms. These include tissue remodeling changes in the testis, lowered sperm count and sperm quality, lowered female fertility including ovary remodeling and oocyte apoptosis, lowered estrogen, progesterone and testosterone levels (that is sex hormone levels), increased spontaneous abortion incidence, and lowered libido. We already have sperm count drops to below 50% of normal in every technologically advanced country on earth. We also have fertility drops to well below replacement levels in every technologically advanced country on earth, with one exception. Clinical observations argue that while there are sometimes technical fixes that allow some reproduction, infertility appears to be inherently irreversible. The Magras and Xenos [2] in mice, also discussed in Chapter 1 shows that radiofrequency radiation exposures well below our safety guidelines, produce immediate drops in mouse reproduction in the first litter. Further exposures to the same EMF

levels produced a crash in reproduction essentially to zero, a crash that appeared to be essentially irreversible.

We don't know that humans will behave similarly to mice, although we do know that the EMFs produce the diverse effects on human reproduction listed in the previous paragraph. My prediction is that even if exposures level off where they are now, we will start seeing crashes in reproduction within about 5 years. If we go ahead with 5G, that crash may be almost instantaneous.

Mutation accumulation produced by cellular DNA damage is likely to be both cumulative and irreversible, as well, because later mutations are highly unlikely to reverse previously occurring mutations. It has been estimated that all we need to have is an increase in germ line mutation of 2 ½ to 3-fold, to become over time, extinct from the very high levels of mutations in each newborn. From the high levels of DNA damage produced in human sperm from common EMF exposures, we may be already well above that level.

It follows from this that we already face four existential threats produced by microwave frequency EMF exposures to the survival of every technologically advanced society on earth:

1. Cumulative and irreversible neurological/neuropsychiatric effects.
2. Cumulative and irreversible reproductive effects.
3. Cumulative and irreversible cardiac effects, leading to sudden cardiac death.
4. DNA effects in germ line, including sperm cells, leading to major impacts on our gene pool and high mutation frequencies.

Any one of these can destroy us on its own and with the ever increasing exposures and especially the vast increases in exposure that the 5G rollout will inevitably produce, that destruction is likely to be imminent. These don't even take into consideration the cancer effects, the hormonal effects or other effects produced by increased oxidative stress or increased apoptotic cell death. There is extraordinary evidence for each of these effects of EMF exposure which I have documented in 8 of these effects with the massive numbers of reviews documenting each of them.

The following information is derived from an abstract that I used for a talk at the Neuroscience 2016 meeting in Los Angeles, a meeting that was focused on Alzheimer's disease and similar dementias. The discussion here raises the question of whether Alzheimer's and other dementias may be still another set of irreversible diseases where cumulative effects of microwave frequency EMFs may have important causal roles. Dementias and other types of neurological deaths have had unexplained rapid recent increases [42-44]. The parallel between these increases and the increases in cell phone and other EMF exposures suggested that such exposures may cause dementia increases [45]. Reports show people circa age 30 developing Alzheimer's or other very early onset dementias and even younger people are reported to develop digital dementias, dementias caused by heavy use of digital devices [46-48]. One of the questions being raised here, is whether digital dementias are caused, at least in part, by the EMF exposures produced by these digital devices and the Wi-Fi fields involved in their usage, rather than solely by such things as screen time, as is often assumed. As you have seen in chapter 2, microwave and lower frequency EMFs act via activation of the VGCCs, leading to increases in intracellular calcium ([Ca<sup>2+</sup>]<sub>i</sub>) and downstream effects including increased Ca<sup>2+</sup> signaling, NO, superoxide, peroxynitrite, free radicals, oxidative stress, NF-kappaB and mitochondrial dysfunction. Each of these downstream effects have been shown to have important roles in causing Alzheimer's disease and other neurodegenerative diseases [49-51]. These all suggest plausible mechanisms for action for EMFs causing Alzheimer's disease. Furthermore the amyloid-beta protein (Aβ) which has a specific causal role in AD is produced in increasing amounts by elevated [Ca<sup>2+</sup>]<sub>i</sub>, and small Aβ aggregates form Ca<sup>2+</sup> channels in the plasma membrane and aggregates also raise [Ca<sup>2+</sup>]<sub>i</sub> via increased VGCC and RYRr activity, suggesting a vicious cycle between Aβ and [Ca<sup>2+</sup>]<sub>i</sub> in Alzheimer's disease. This argues that increased intracellular calcium levels, produced by the EMFs increases Aβ and increased Aβ increases intracellular calcium, quite possibly the central mechanism in causing Alzheimer's disease.

Five rodent studies support an EMF role in Alzheimer's disease. A series of short pulses of EMFs in young rats, produced the following in the equivalent of middle aged rats: elevated brain Aβ and oxidative stress;

lowered cognition and memory [52,53]. 900 MHz exposures produces oxidative stress, increased A $\beta$  and lowered miR-107, all found in AD brains [52-55]. There are many animal studies showing roles for [Ca<sup>2+</sup>]<sub>i</sub> through both VGCCs and RYRs in causing Alzheimer's disease in rodent models; these include studies with calcium channel blockers and studies of transgenic mice with varying VGCC and RYR expression. Very low EMF exposures can produce, however, protective responses [56,57]; this is not surprising because EMF therapy is thought to act via NO signaling and protein kinase G (see Fig.1, Chapter 2) and this pathway is reported to protect from Alzheimer's disease. Epidemiological studies have shown that exposure of humans of 50/60 Hz EMFs, which also act via VGCC activation, can cause elevated AD incidence [58,59]. However we have no similar studies for exposures to microwave/radiofrequency EMFs. In conclusion, a wide range of studies support the view that low intensity microwave frequency exposures acting via VGCC activation and [Ca<sup>2+</sup>]<sub>i</sub>, can produce increases in A $\beta$  and other causal factors of Alzheimer's disease in humans and in animals and EMFs have been shown to produce Alzheimer's effects in rats.

These various findings on EMFs and Alzheimer's disease, the increasingly early onset of dementias and the occurrence of digital dementias, all suggest we may have another very high level threat caused by EMF exposures, possibly involving cumulative EMF effects and leading to severe, irreversible brain damage.

#### **Chapter 4 EMFs Including Wi-Fi May Be Particularly Damaging to Young People**

Most arguments that have been made that microwave frequency EMFs may be much more damaging to young children have centered on the much smaller skulls and skull thickness in young children, increasing the exposure of their brains to EMFs [60, 61]. However there are other arguments to be made. EMFs have been shown to be particularly active in producing effects on embryonic stem cells [62-71]. Because such stem cells occur at much higher cell densities in children, with stem cell densities the highest in the fetus and decreasing with increasing age [62, 63], impacts on young children are likely to be much higher than in adults. The decreased DNA repair and increased DNA damage following EMF exposure, in conjunction with the increased cell division in young children, strongly suggest that young children may be increasingly susceptible to cancer following such exposures [62-64, 71]. Two reviews discussed in the next chapter provide further evidence on higher cancer susceptibility of children. EMF action on stem cells may also cause young children to be particularly susceptible to disruption of brain development [66,71], something that may be relevant to autism causation. It is my belief that the role of [Ca<sup>2+</sup>]<sub>i</sub> in synapse development is also relevant to the possible EMF causation of autism. The Hecht review of Soviet occupational exposure studies [28] reports that "younger persons show a greater sensitivity to electromagnetic fields than adults." These are all very problematic issues and we cannot rule out the possibility that there are other problematic issues as well. Redmayne and Johansson [72] reviewed the literature showing that there are age-related effects, such that young people are more sensitive to EMF effects. It follows from these various findings that the placement of Wi-Fi into schools around the country and the not uncommon placing of cell phone towers on schools may well both be a high level threats to the health of our children as well being a threat to teachers and any very sensitive fetuses teachers may be carrying, as well. Mr. Barrie Trower, a retired military intelligence expert from the U.K. has been going around the world, at his expense, speaking against Wi-Fi in schools. His knowledge on this is based in part on classified information which he is unable to discuss, but has given him great concern.

#### **Chapter 5: The Importance of the SCENIHR 2015 Document and the Many Omissions, Flaws and Falsehoods in That Document**

One thing that I think we can all agree upon, is that the SCENIHR 2015 [73] document is an important document. The reason for its importance is that previous industry-friendly documents, and there have been many of them, have only reviewed very limited amounts of the literature on EMF effects. Consequently all of these other documents are open to the criticism that they have cherry picked what little data they have chosen to discuss. SCENIHR 2015 [73] has a reference list of almost 48 pages in length, going from page 233 to 280. So it appears that SCENIHR 2015 may have done a much more thorough and defensible review of the literature. Our assessment of SCENIHR 2015 [73] is important because of the confidence expressed in this document both by Mr. Ryan and Dr. Vinciuonas and also by the U.S. National Cancer

Institute. The question that is being raised here is whether SCENIHR 2015 is thorough and defensible or not.

#### The Speit/Schwarz Controversy: How SCENIHR Has Put Out Seven Falsehoods in Support of the Industry Propaganda Position

I am going to start by discussing a single particularly important issue. At the end of Table 5 there is a claim that a 2013 study by Speit et al [74] was unable to replicate the findings of a 2008 study published by Schwarz et al [75]. In Table 5 they state further that Speit et al found “No effect on DNA integrity (MN) and DNA migration (comet); Repetition study of Schwarz et al, 2008.” What is called loss of DNA integrity here, measured by formation of micronuclei (MN), is caused by the formation of double strand breaks in cellular DNA. The comet assay measures single strand breaks in cellular DNA. Schwarz et al [75] found strong evidence that there were large increases in both single strand and double strand breaks in cellular DNA following very low intensity exposures to a cell phone-like pulsed radiation, but SCENIHR claims that Speit et al [74] were unable to repeat the earlier study. Elsewhere (p.89, bottom) SCENIHR states that “By using the same exposure system and the same experimental protocols as the authors of the original study, they failed to confirm the results. They did not find any explanation for these conflicting results (Speit et al, 2013).” A careful examination of both [74] and [75] finds the following: 1. Speit et al [74] used a lymphocytic cell line, HL-60; Schwarz et al [75] studied human fibroblasts. This is a big difference because, as we have already said, different cell types behave differently. 2. Speit used 1800 MHz radiation; Schwarz used 1950 MHz radiation (the frequency of UMTS, also called 3G). Again we have a potentially important difference because effects are influenced by the frequency used. 3. Speit used a continuous wave EMF; Schwarz used a highly pulsed EMF, with high levels of both KHz and MHz pulsations to mimic the pulsation pattern of 3G cell phones. This is expected to produce very large differences between the two studies. 4. Speit used a reverberation exposure chamber; Schwarz did not use any exposure chamber. This could be another very large difference between the two studies, a difference that will be discussed toward the end of this chapter. 5. So where did the claim come from that Speit was trying to repeat the Schwarz study? Speit says in their paper that they were trying to repeat another study (not Schwarz) that was described in a report but was never published. 6. Speit does not even cite the Schwarz et al [75] paper, so obviously they did not intend to repeat Schwarz. We have then SCENIHR 2015 stating three multifaceted falsehoods that Speit et al [74] tried to repeat the earlier studies of Schwarz et al [75], that they were unable to repeat those Schwarz studies and that they used identical methodology to that used by Schwarz et al [75]. In addition to those three are four underlying falsehoods – namely that the two studies used very different methodologies, notably differing in the cell type studied, differing in the frequency used, differing widely in the in pulsations used and differing in the use of an exposure chamber. Each of these falsehoods are SCENIHR’s not Speit’s, *each of them can be easily seen to be false by even a superficial reading of these two papers.*

As you might guess, there is a major story behind all of this. The very low intensity exposure used in the Schwarz et al [75] study produced large numbers of DNA breaks, larger than that produced by 1600 chest X-rays. This conclusion can be made by comparing the results of Schwarz et al [75] with the earlier study of Lutz and Adlkofer [76]. From this comparison, it seems clear that non-ionizing radiation similar to 3G radiation can be much more dangerous to the DNA of our cells than is similar energy of ionizing radiation. When this was found, the industry went into attack mode, attacking the two Professors who collaborated in [75], Prof. Franz Adlkofer in Germany and Prof. Hugo Rüdinger in Austria. The first couple of years of these attacks have been described in some detail on pp 117-131 in Dr. Devra Davis’ book Disconnect [77]. Before the SCENIHR 2015 document was drafted, it was clear that the publishers who had published Adlkofer’s and Rüdinger’s work, not just the Schwarz et al [75] study but other papers by the same research group, had long since rejected the industry propaganda claims. In addition, Adlkofer had won a lawsuit in the German courts against his main accuser. He has subsequently since won a second such lawsuit. The last paragraph on p.89 in SCENIHR 2015 is word for word industry propaganda. What is clear is that SCENIHR is wittingly or unwittingly serving as a propagandist for the industry in and that process, SCENIHR has no difficulty in putting forth seven obvious, individually important falsehoods.

One question that needs to be raised is how is it possible for microwave frequency EMFs to produce much more cellular DNA damage than a comparable energy level of ionizing radiation? Both ionizing radiation

and microwave/lower frequency EMFs act via free radicals to attack the DNA. If you examine Fig. 2, Chapter 2, you will see how low intensity microwave frequency EMFs can act (circa p. 14). The free radicals that attack the DNA are breakdown products peroxy nitrite. The sequence of events leading to those free radicals starts, of course with the extraordinarily high sensitivity of the VGCC voltage sensor to the electrical forces of the EMFs that open the VGCC calcium channels. Following that there are three steps in the process leading to peroxy nitrite elevation *each of which have high levels of amplification*. The first of these is that when the VGCC channels are open, they allow the influx of about a million calcium ion per second into the cell. The second amplification is that elevated intracellular calcium  $[Ca^{2+}]_i$  activates the synthesis of both nitric oxide (NO) and superoxide. The third amplification is that the formation of peroxy nitrite is proportional to the product of nitric oxide concentration *times* the superoxide concentration. When you have three sequential amplification mechanisms, you can get a very large response, in this case free radical attack on cellular DNA, from a very small initial signal. That is where much of the existential crises are coming are from, with EMFs threatening the survival of every technologically advanced country on earth.

Going back to falsehoods perpetrated by SCENIHR regarding Speit/Schwarz, here are two possible interpretations for those seven falsehoods. One is that SCENIHR is simply an industry propaganda organ. The second is that we have a group of scientists SCENIHR who are largely incompetent and that it is just coincidence that these seven falsehoods serve the industry propaganda case. Either of these interpretations completely destroy the claims of confidence in SCENIHR that Mr. Ryan and Dr. Vinciuonas made in the documents they wrote that were referred to in the Preface of this document.

I have written here more than another 20 pages critiquing the SCENIHR 2015 [73] document. If you are already convinced that the SCENIHR claims that there are no established non-thermal EMF effects are false and that we have eight extremely well documented effects (Chapter 1) and that we have detailed mechanisms of how these effects are produced (Chapter 2), then I suggest you skip to the summary of this Chapter 5 starting on p. 44 and then go on to the consider 5G in Chapter 6. If, however, you are not so convinced, you need to read the intervening 20 plus pages..

22 Reviews on EMF Effects, 20 of Which Are Ignored by SCENIHR, Two of Which Are Discussed in [73] but Essentially Dismissed

Now let's go on to consider how SCENIHR 2015 [73] considers the many independent reviews, listed in Chapter 1, which disagree with them and also fall into the 2009 through 2013 period that SCENIHR claims to have thoroughly considered. See Table 2.

**Table 2: 2009 to 2013 Reviews that Should Have Been Cited and Discussed in SCENIHR 2015**

Citation	Brief Summary	What does SCENIHR 2015 say about it?
[78] Khurana VG, Teo C, Kundi M, Hardell L, Carlberg M. 2009 Cell phones and brain tumors: a review including the long-term epidemiologic data. Surg Neurol 72:205-214.	Meta-analysis study of cell phone usage and brain cancer. The results indicate that using a cell phone for > or = 10 years approximately doubles the risk of being diagnosed with a brain tumor on the same ("ipsilateral") side of the head preferred for cell phone use. The data achieve statistical significance for glioma and acoustic neuroma but not for meningioma. CONCLUSION: The authors conclude that there is adequate epidemiologic evidence to suggest a link between prolonged cell phone usage and the development of an ipsilateral brain tumor.	Nothing. Review is not cited and not discussed.
[79] Desai NR, Kesari KK, Agarwal A. 2009 Pathophysiology of cell	This review identifies the plasma membrane as a target of RF-EMW. In addition, the effects of RF-EMW on plasma membrane structures (i.e. NADH oxidase,	Nothing. Review is not cited and not

<p>phone radiation: oxidative stress and carcinogenesis with focus on the male reproductive system. <i>Reproduct Biol Endocrinol</i> 7:114.</p>	<p>phosphatidylserine, ornithine decarboxylase) and voltage-gated calcium channels are discussed. We explore the disturbance in reactive oxygen species (ROS) metabolism caused by RF-EMW and delineate NADH oxidase mediated ROS formation as playing a central role in oxidative stress (OS) due to cell phone radiation (with a focus on the male reproductive system). This review also addresses: 1) the controversial effects of RF-EMW on mammalian cells and sperm DNA as well as its effect on apoptosis, 2) epidemiological, in vivo animal and in vitro studies on the effect of RF-EMW on male reproductive system.</p>	<p>discussed.</p>
<p>[80] Makker K, Varghese A, Desai NR, Mouradi R, Agarwal A. 2009 Cell phones: modern man's nemesis? <i>Reprod Biomed Online</i> 18:148-157.</p>	<p>Effects of cell phone exposure on the cardiovascular system, sleep and cognitive function, as well as localized and general adverse effects, genotoxicity potential, neurohormonal secretion and tumour induction. The proposed mechanisms by which cell phones adversely affect various aspects of human health, and male fertility in particular, are explained, and the emerging molecular techniques and approaches for elucidating the effects of mobile phone radiation on cellular physiology using high-throughput screening techniques, such as metabolomics and microarrays, are discussed. A novel study is described, which is looking at changes in semen parameters, oxidative stress markers and sperm DNA damage in semen samples exposed in vitro to cell phone radiation.</p>	<p>Nothing. Review is not cited and not discussed.</p>
<p>[81] Ruediger HW. 2009 Genotoxic effects of radiofrequency electromagnetic fields. <i>Pathophysiology</i>. 16:89-102.</p>	<p>101 publications are exploited which have studied genotoxicity of radiofrequency electromagnetic fields (RF-EMF) in vivo and in vitro. Of these 49 report a genotoxic effect and 42 do not. In addition, 8 studies failed to detect an influence on the genetic material, but showed that RF-EMF enhanced the genotoxic action of other chemical or physical agents. Variation in results may in part be explained by the different cellular systems and from the variety of analytical methods being used. Taking altogether there is ample evidence that RF-EMF can alter the genetic material of exposed cells in vivo and in vitro and in more than one way. This genotoxic action may be mediated by microthermal effects in cellular structures, formation of free radicals, or an interaction with DNA-repair mechanisms.</p>	<p>Nothing. Review is not cited and not discussed.</p>
<p>[82] Phillips JL, Singh NP, Lai H. 2009 Electromagnetic fields and DNA damage. <i>Pathophysiology</i> 16:79-88.</p>	<p>A major concern of the adverse effects of exposure to non-ionizing electromagnetic field (EMF) is cancer induction. Since the majority of cancers are initiated by damage to a cell's genome, studies have been carried out to investigate the effects of electromagnetic fields on DNA and chromosomal structure. Additionally, DNA damage can lead to changes in cellular functions and cell death. Single cell gel electrophoresis, also known as the 'comet assay', has been widely used in EMF research to determine DNA damage, reflected as single-strand breaks, double-strand breaks, and crosslinks. Studies have also been carried out to investigate chromosomal conformational changes and micronucleus formation in cells after exposure to EMF. This review describes the comet assay and its utility to qualitatively and quantitatively assess DNA damage, reviews studies that have investigated DNA strand breaks</p>	<p>Nothing. Review is not cited and not discussed.</p>

	and other changes in DNA structure, and then discusses important lessons learned from our work in this area.	
[83] Davanipour Z, Sobel E. 2009 Long-term exposure to magnetic fields and the risks of Alzheimer's disease and breast cancer: Further biological research. Pathophysiology 16:149-156.	Extremely low frequency (ELF) and radio frequency (RF) magnetic fields (MFs) pervade our environment. Whether or not these magnetic fields are associated with increased risk of serious diseases, e.g., cancers and Alzheimer's disease, is thus important when developing a rational public policy. Our objective was to provide an unbiased review of the current knowledge and to provide our general and specific conclusions. RESULTS: The evidence indicates that long-term significant occupational exposure to ELF MF may certainly increase the risk of both Alzheimer's disease and breast cancer. There is now evidence that two relevant biological processes (increased production of amyloid beta and decreased production of melatonin) are influenced by high long-term ELF MF exposure that may lead to Alzheimer's disease. There is further evidence that one of these biological processes (decreased melatonin production) may also lead to breast cancer. Finally, there is evidence that exposures to RF MF and ELF MF have similar biological consequences. CONCLUSION: It is important to mitigate ELF and RF MF exposures through equipment design changes and environmental placement of electrical equipment.	Nothing. Review is not cited and not discussed.
[84] Yakymenko I, Sidorik E. 2010 Risks of carcinogenesis from electromagnetic radiation and mobile telephony devices. Exp Oncol 32:729-736.	Latest epidemiological data reveal a significant increase in risk of development of some types of tumors in chronic (over 10 years) users of mobile phone. It was detected a significant increase in incidence of brain tumors (glioma, acoustic neuroma, meningioma), parotid gland tumor, seminoma in long-term users of mobile phone, especially in cases of ipsilateral use (case-control odds ratios from 1.3 up to 6.1). Two epidemiological studies have indicated a significant increase of cancer incidence in people living close to the mobile telephony base station as compared with the population from distant area. These data raise a question of adequacy of modern safety limits of electromagnetic radiation (EMR) exposure for humans. For today the limits were based solely on the conception of thermal mechanism of biological effects of RF/MW radiation. Meantime the latest experimental data indicate the significant metabolic changes in living cell under the low-intensive (non-thermal) EMR exposure. Among reproducible biological effects of low-intensive MWs are reactive oxygen species overproduction, heat shock proteins expression, DNA damages, apoptosis. Practical steps must be done for reasonable limitation of excessive EMR exposure, along with the implementation of new safety limits of mobile telephony devices radiation, and new technological decisions, which would take out the source of radiation from human brain.	Nothing. Review is not cited and not discussed.
[85] Carpenter DO. 2010 Electromagnetic fields and cancer: the cost of doing nothing.	Concern of health hazards from EMFs has increased as the use of cell phones and other wireless devices has grown in all segments of society, especially among children. While there has been strong evidence for an association between	Nothing. Review is not cited and not discussed.



<p>Rev Environ Health 25:75-80.</p>	<p>leukemia and residential or occupational exposure to ELF EMFs for many years, the standards in existence are not sufficiently stringent to protect from an increased risk of cancer. For RF EMFs, standards are set at levels designed to avoid tissue heating, in spite of convincing evidence of adverse biological effects at intensities too low to cause significant heating. Recent studies demonstrate elevations in rates of brain cancer and acoustic neuroma only on the side of the head where individuals used their cell phone. Individuals who begin exposure at younger ages are more vulnerable. These data indicate that the existing standards for radiofrequency exposure are not adequate. While there are many unanswered questions, the cost of doing nothing will result in an increasing number of people, many of them young, developing cancer.</p>	
<p>[86] Giuliani L, Soffritti M (Eds). 2010 NON-THERMAL EFFECTS AND MECHANISMS OF INTERACTION BETWEEN ELECTROMAGNETIC FIELDS AND LIVING MATTER, RAMAZZINI INSTITUTE EUR. J. ONCOL. LIBRARY Volume 5, National Institute for the Study and Control of Cancer and Environmental Diseases “Bernardino Ramazzini” Bologna, Italy 2010, 400 page monograph.</p>	<p>Contains entire articles on: 1. Influence of mobile phone radiation on cognitive function. 2. Impact of DECT cordless phone radiation on heart rate variability and on the autonomic nervous system. 3 &amp; 4. Two articles on the impact of radiofrequency radiation on the blood-brain barrier. 5 &amp; 6. Two articles on microwave/radiofrequency radiation and cancer causation. 7. Epidemiological studies of EMF impact on human reproduction.</p>	<p>Nothing. Review is not cited and not discussed.</p>
<p>[87] Khurana, V. G., Hardell, L., Everaert, J., Bortkiewicz, A., Carlberg, M., Ahonen, M. 2010 Epidemiological evidence for a health risk from mobile phone base stations. Int. J. Occup. Environ. Health 16, 263-267.</p>	<p>We identified a total of 10 epidemiological studies that assessed for putative health effects of mobile phone base stations (cell phone antennae). Seven of these studies explored the association between base station proximity and neurobehavioral effects and three investigated cancer. We found that eight of the 10 studies reported increased prevalence of adverse neurobehavioral symptoms or cancer in populations living at distances &lt; 500 meters from base stations. None of the studies reported exposure above accepted international guidelines, suggesting that current guidelines may be inadequate in protecting the health of human populations. We believe that comprehensive epidemiological studies of long-term mobile phone base station exposure are urgently required to more definitively understand its health impact.</p>	<p>Nothing. Review is not cited and not discussed.</p>
<p>[88] Levitt, B. B., Lai, H. 2010. Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other</p>	<p>Both anecdotal reports and some epidemiology studies, reviewed in this study, have found headaches, skin rashes, sleep disturbances, depression, decreased libido, increased rates of suicide, concentration problems, dizziness, memory changes, increased risk of cancer, tremors, and other neurophysiological effects in populations near base stations.</p>	<p>Nothing. Review is not cited and not discussed.</p>

<p>antenna arrays. Environ. Rev. 18, 369-395. doi.org/10.1139/A10-018</p>	<p>Cardiac effects were also reported. Symptoms reported may be classic microwave sickness, first described in 1978. Nonionizing electromagnetic fields are among the fastest growing forms of environmental pollution. Some extrapolations can be made from research other than epidemiology regarding biological effects from exposures at levels far below current exposure guidelines.</p>	
<p>[89] Kang N, Shang XJ, Huang YF. 2010 [Impact of cell phone radiation on male reproduction]. Zhonghua Nan Ke Xue 16:1027-1030.</p>	<p>With the popularized use cell phones, more and more concern has been aroused over the effects of their radiation on human health, particularly on male reproduction. Cell phone radiation may cause structural and functional injuries of the testis, alteration of semen parameters, reduction of epididymal sperm concentration and decline of male fertility. This article presents an overview on the impact of cell phone radiation on male reproduction.</p>	<p>Nothing. Review is not cited and not discussed.</p>
<p>[90] 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.</p>	<p>The carcinogenic effect of MW irradiation is typically manifested after long term (up to 10 years and more) exposure. Nevertheless, even a year of operation of a powerful base transmitting station for mobile communication reportedly resulted in a dramatic increase of cancer incidence among population living nearby. In addition, model studies in rodents unveiled a significant increase in carcinogenesis after 17-24 months of MW exposure both in tumor-prone and intact animals. To that, such metabolic changes, as overproduction of reactive oxygen species, 8-hydroxi-2-deoxyguanosine formation, or ornithine decarboxylase activation under exposure to low intensity MW confirm a stress impact of this factor on living cells. We also address the issue of standards for assessment of biological effects of irradiation. It is now becoming increasingly evident that assessment of biological effects of non-ionizing radiation based on physical (thermal) approach used in recommendations of current regulatory bodies, including the International Commission on Non-Ionizing Radiation Protection (ICNIRP) Guidelines, requires urgent reevaluation. We conclude that recent data strongly point to the need for re-elaboration of the current safety limits for non-ionizing radiation using recently obtained knowledge. We also emphasize that the everyday exposure of both occupational and general public to MW radiation should be regulated based on a precautionary principles which imply maximum restriction of excessive exposure.</p>	<p>Nothing. Review is not cited and not discussed.</p>
<p>[91] Yakimenko IL, Sidorik EP, Tsybulin AS. 2011 [Metabolic changes in cells under electromagnetic radiation of mobile communication systems]. Ukr Biokhim Zh (1999). 2011 Mar-Apr;83(2):20-28.</p>	<p>Review is devoted to the analysis of biological effects of microwaves. The results of last years' researches indicated the potential risks of long-term low-level microwaves exposure for human health. The analysis of metabolic changes in living cells under the exposure of microwaves from mobile communication systems indicates that this factor is stressful for cells. Among the reproducible effects of low-level microwave radiation are overexpression of heat shock proteins, an increase of reactive oxygen species level, an increase of intracellular Ca<sup>2+</sup>, damage of DNA, inhibition of DNA reparation, and induction of apoptosis. Extracellular-signal-regulated kinases ERK and stress-related kinases p38MAPK are involved in metabolic</p>	<p>Nothing. Review is not cited and not discussed.</p>

	changes. Analysis of current data suggests that the concept of exceptionally thermal mechanism of biological effects of microwaves is not correct. In turn, this raises the question of the need to reevaluation of modern electromagnetic standards based on thermal effects of non-ionizing radiation on biological systems.	
[92] Gye MC, Park CJ. 2012 Effect of electromagnetic field exposure on the reproductive system. Clin Exp Reprod Med 39:1-9. doi.org/10.5653/cerm.2012.39.1.1 . Clin Exp Reprod Med 39:1-9. doi.org/10.5653/cerm.2012.39.1.1	The safety of human exposure to an ever-increasing number and diversity of electromagnetic field (EMF) sources both at work and at home has become a public health issue. To date, many <i>in vivo</i> and <i>in vitro</i> studies have revealed that EMF exposure can alter cellular homeostasis, endocrine function, reproductive function, and fetal development in animal systems. Reproductive parameters reported to be altered by EMF exposure include male germ cell death, the estrous cycle, reproductive endocrine hormones, reproductive organ weights, sperm motility, early embryonic development, and pregnancy success. At the cellular level, an increase in free radicals and [Ca(2+)]i may mediate the effect of EMFs and lead to cell growth inhibition, protein misfolding, and DNA breaks. The effect of EMF exposure on reproductive function differs according to frequency and wave, strength (energy), and duration of exposure. In the present review, the effects of EMFs on reproductive function are summarized according to the types of EMF, wave type, strength, and duration of exposure at cellular and organism levels.	Nothing. Review is not cited and not discussed.
[93] La Vignera S, Condorelli RA, Vicari E, D'Agata R, Calogero AE. 2012 Effects of the exposure to mobile phones on male reproduction: a review of the literature. J Androl 33:350-356.	The use of mobile phones is now widespread. A great debate exists about the possible damage that the radiofrequency electromagnetic radiation (RF-EMR) emitted by mobile phones exerts on different organs and apparatuses. The aim of this article was to review the existing literature exploring the effects of RF-EMR on the male reproductive function in experimental animals and humans. Studies have been conducted in rats, mice, and rabbits using a similar design based upon mobile phone RF exposure for variable lengths of time. Together, the results of these studies have shown that RF-EMR decreases sperm count and motility and increases oxidative stress. In humans, 2 different experimental approaches have been followed: one has explored the effects of RF-EMR directly on spermatozoa and the other has evaluated the sperm parameters in men using or not using mobile phones. The results showed that human spermatozoa exposed to RF-EMR have decreased motility, morphometric abnormalities, and increased oxidative stress, whereas men using mobile phones have decreased sperm concentration, decreased motility (particularly rapid progressive motility), normal morphology, and decreased viability. These abnormalities seem to be directly related to the duration of mobile phone use.	Nothing. Review is not cited and not discussed.
[94] Bioinitiative Working Group, David Carpenter and Cindy Sage (eds). 2012 Bioinitiative 2012: A	Sections on EMF effects: SECTION 4: EVIDENCE FOR INADEQUACY OF THE STANDARDS SECTION 5: EVIDENCE FOR EFFECTS ON GENE AND PROTEIN EXPRESSION	Nothing. Review is not cited and not discussed.

<p>rationale for biologically-based exposure standards for electromagnetic radiation.  <a href="http://www.bioinitiative.org/participants/why-we-care/">http://www.bioinitiative.org/participants/why-we-care/</a></p>	<p>SECTION 6: EVIDENCE FOR GENOTOXIC EFFECTS – RFR AND ELF DNA DAMAGE  SECTION 7: EVIDENCE FOR STRESS RESPONSE (STRESS PROTEINS)  SECTION 8: EVIDENCE FOR EFFECTS ON IMMUNE FUNCTION  SECTION 9: EVIDENCE FOR EFFECTS ON NEUROLOGY AND BEHAVIOR  SECTION 10: EFFECTS OF EMF FROM WIRELESS COMMUNICATION UPON THE BLOOD-BRAIN BARRIER  SECTION 11: EVIDENCE FOR BRAIN TUMORS AND ACOUSTIC NEUROMAS  SECTION 12: EVIDENCE FOR CHILDHOOD CANCERS (LEUKEMIA)  SECTION 13: EVIDENCE FOR EFFECTS ON MELATONIN: ALZHEIMER’S DISEASE AND BREAST CANCER  SECTION 14: EVIDENCE FOR BREAST CANCER PROMOTION  SECTION 15: EVIDENCE FOR DISRUPTION BY THE MODULATING SIGNAL  SECTION 16: PLAUSIBLE GENETIC AND METABOLIC MECHANISMS FOR BIOEFFECTS OF VERY WEAK ELF MAGNETIC FIELDS ON LIVING TISSUE  SECTION 17 EVIDENCE BASED ON EMF MEDICAL THERAPEUTICS  SECTION 18: FERTILITY AND REPRODUCTION EFFECTS OF EMF  SECTION 19: FETAL AND NEONATAL EFFECTS OF EMF  SECTION 20: FINDINGS IN AUTISM CONSISTENT WITH EMF AND RFR</p>	
<p>[4] Pall, ML. 2013. Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects. J Cell Mol Med 17:958-965. doi: 10.1111/jcmm.12088.</p>	<p>The direct targets of extremely low and microwave frequency range electromagnetic fields (EMFs) in producing non-thermal effects have not been clearly established. However, studies in the literature, reviewed here, provide substantial support for such direct targets. Twenty-three studies have shown that voltage-gated calcium channels (VGCCs) produce these and other EMF effects, such that the L-type or other VGCC blockers block or greatly lower diverse EMF effects. Furthermore, the voltage-gated properties of these channels may provide biophysically plausible mechanisms for EMF biological effects. Downstream responses of such EMF exposures may be mediated through Ca(2+)/calmodulin stimulation of nitric oxide synthesis. Potentially, physiological/therapeutic responses may be largely as a result of nitric oxide-cGMP-protein kinase G pathway stimulation. A well-studied example of such an apparent therapeutic response, EMF stimulation of bone growth, appears to work along this pathway. However, pathophysiological responses to EMFs may be as a result of nitric oxide-peroxynitrite-oxidative stress pathway of action. A single such well-documented</p>	<p>This was cited. Sole statement is: “(see Pall, 2013 for a review of studies suggesting effects through voltage-gated calcium channels).” None of the important implications listed on the left are used in any way in the rest of the SCENIHR 2015 document See text for</p>

	example, EMF induction of DNA single-strand breaks in cells, as measured by alkaline comet assays, is reviewed here. Such single-strand breaks are known to be produced through the action of this pathway. Data on the mechanism of EMF induction of such breaks are limited; what data are available support this proposed mechanism. Other Ca(2+) - mediated regulatory changes, independent of nitric oxide, may also have roles. This article reviews, then, a substantially supported set of targets, VGCCs, whose stimulation produces non-thermal EMF responses by humans/higher animals with downstream effects involving Ca(2+) /calmodulin-dependent nitric oxide increases, which may explain therapeutic and pathophysiological effects.	further discussion..
[95] Nazıroğlu M, Yüksel M, Köse SA, Özkaya MO. 2013 Recent reports of Wi-Fi and mobile phone-induced radiation on oxidative stress and reproductive signaling pathways in females and males. J Membr Biol 246:869-875.	The aim of the study was to discuss the mechanisms and risk factors of EMR changes on reproductive functions and membrane oxidative biology in females and males. It was reported that even chronic exposure to EMR did not increase the risk of reproductive functions such as increased levels of neoantigens abort. However, the results of some studies indicate that EMR induced endometriosis and inflammation and decreased the number of follicles in the ovarium or uterus of rats. In studies with male rats, exposure caused degeneration in the seminiferous tubules, reduction in the number of Leydig cells and testosterone production as well as increases in luteinizing hormone levels and apoptotic cells. In some cases of male and female infertility, increased levels of oxidative stress and lipid peroxidation and decreased values of antioxidants such as melatonin, vitamin E and glutathione peroxidase were reported in animals exposed to EMR. In conclusion, the results of current studies indicate that oxidative stress from exposure to Wi-Fi and mobile phone-induced EMR is a significant mechanism affecting female and male reproductive systems.	This was listed on p.285 under <b>Literature identified but not cited.</b> SCENIHR chose not to cite or discuss this paper, although they had identified it.
[96] Ledoigt G, Belpomme D. 2013 Cancer induction molecular pathways and HF-EMF irradiation. Adv Biol Chem 3:177-186.	The response of cells to different types of electromagnetic fields can be induced by low-level (athermal) high frequency (HF) electromagnetic fields (EMFs) exposure associated with mobile phone technologies. There are many examples of biological effects involving the epigenome. EMFs could trigger protein activation mediated by ligands, such as Ca <sup>2+</sup> , that alter the conformation of binding proteins, especially the NADPH plasmic membrane oxidase, so inducing increased formation of reactive oxygen species (ROS) that may alter proteomic functions. Classical anti-apoptotic and procarcinogenic signaling pathways that are commonly found activated in human malignancies and in inflammation mainly involve the transcription factor NF-κB. The microenvironment that exists during chronic inflammation can contribute to cancer progression. The data support the proposition that long term HF-EMF exposure associated with improper use of cell phones can potentially cause cancer.	Nothing. Review is not cited and not discussed.
[97] Hardell L, Carlberg M. 2013 Using the Hill viewpoints from 1965 for	BACKGROUND: Wireless phones, i.e., mobile phones and cordless phones, emit radiofrequency electromagnetic fields (RF-EMF) when used. An increased risk of brain tumors is a	Nothing. Review is not cited and not

<p>evaluating strengths of evidence of the risk for brain tumors associated with use of mobile and cordless phones. Rev Environ Health 28:97-106. doi: 10.1515/reveh-2013-0006.</p>	<p>major concern. The International Agency for Research on Cancer (IARC) at the World Health Organization (WHO) evaluated the carcinogenic effect to humans from RF-EMF in May 2011. It was concluded that RF-EMF is a group 2B, i.e., a "possible", human carcinogen. Bradford Hill gave a presidential address at the British Royal Society of Medicine in 1965 on the association or causation that provides a helpful framework for evaluation of the brain tumor risk from RF-EMF.</p> <p>METHODS: All nine issues on causation according to Hill were evaluated. Regarding wireless phones, only studies with long-term use were included. In addition, laboratory studies and data on the incidence of brain tumors were considered.</p> <p>RESULTS: The criteria on strength, consistency, specificity, temporality, and biologic gradient for evidence of increased risk for glioma and acoustic neuroma were fulfilled. Additional evidence came from plausibility and analogy based on laboratory studies. Regarding coherence, several studies show increasing incidence of brain tumors, especially in the most exposed area. Support for the experiment came from antioxidants that can alleviate the generation of reactive oxygen species involved in biologic effects, although a direct mechanism for brain tumor carcinogenesis has not been shown. In addition, the finding of no increased risk for brain tumors in subjects using the mobile phone only in a car with an external antenna is supportive evidence. Hill did not consider all the needed nine viewpoints to be essential requirements.</p> <p>CONCLUSION: Based on the Hill criteria, glioma and acoustic neuroma should be considered to be caused by RF-EMF emissions from wireless phones and regarded as carcinogenic to humans, classifying it as group 1 according to the IARC classification. Current guidelines for exposure need to be urgently revised.</p>	<p>discussed. The Hill criteria are THE well-accepted way of analyzing biological plausibility of epidemiological evidence. It is unacceptable for SCENIHR not to consider this review when attempting to analyze epidemiological evidence of EMF cancer causation.</p>
<p>[98] 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 2013;20(2):85-110.</p>	<p>The International Agency for Research on Cancer (IARC) at WHO evaluation of the carcinogenic effect of RF-EMF on humans took place during a 24-31 May 2011 meeting at Lyon in France. The Working Group consisted of 30 scientists and categorised the radiofrequency electromagnetic fields from mobile phones, and from other devices that emit similar non-ionising electromagnetic fields (RF-EMF), as Group 2B, i.e., a 'possible', human carcinogen. The decision on mobile phones was based mainly on the Hardell group of studies from Sweden and the IARC Interphone study. We give an overview of current epidemiological evidence for an increased risk for brain tumours including a meta-analysis of the Hardell group and Interphone results for mobile phone use. Results for cordless phones are lacking in Interphone. The meta-analysis gave for glioma in the most exposed part of the brain, the temporal lobe, odds ratio (OR)=1.71, 95% confidence interval (CI)=1.04-2.81 in the ≥10 years (&gt;10 years in the Hardell group) latency group. Ipsilateral mobile phone use ≥1640h in total gave OR=2.29, 95% CI=1.56-3.37. The</p>	<p>This paper is cited and discussed very briefly. See text for discussion.</p>

	<p>results for meningioma were OR=1.25, 95% CI=0.31-4.98 and OR=1.35, 95% CI=0.81-2.23, respectively. Regarding acoustic neuroma ipsilateral mobile phone use in the latency group <math>\geq 10</math> years gave OR=1.81, 95% CI=0.73-4.45. For ipsilateral cumulative use <math>\geq 1640</math>h OR=2.55, 95% CI=1.50-4.40 was obtained. Also use of cordless phones increased the risk for glioma and acoustic neuroma in the Hardell group studies. Survival of patients with glioma was analysed in the Hardell group studies yielding in the <math>&gt;10</math> years latency period hazard ratio (HR)=1.2, 95% CI=1.002-1.5 for use of wireless phones. This increased HR was based on results for astrocytoma WHO grade IV (glioblastoma multiforme). Decreased HR was found for low-grade astrocytoma, WHO grades I-II, which might be caused by RF-EMF exposure leading to tumour-associated symptoms and earlier detection and surgery with better prognosis. Some studies show increasing incidence of brain tumours whereas other studies do not. It is concluded that one should be careful using incidence data to dismiss results in analytical epidemiology. The IARC carcinogenic classification does not seem to have had any significant impact on governments' perceptions of their responsibilities to protect public health from this widespread source of radiation.</p>	
<p>[99] Davis DL, Kesari S, Soskolne CL, Miller AB, Stein Y. 2013 Swedish review strengthens grounds for concluding that radiation from cellular and cordless phones is a probable human carcinogen. Pathophysiology 20:123-129.</p>	<p>Mobile phones are two-way microwave radios that also emit low levels of electromagnetic radiation. Inconsistent results have been published on potential risks of brain tumors tied with mobile phone use as a result of important methodological differences in study design and statistical power. Some studies have examined mobile phone users for periods of time that are too short to detect an increased risk of brain cancer, while others have misclassified exposures by placing those with exposures to microwave radiation from cordless phones in the control group, or failing to attribute such exposures in the cases. In 2011, the World Health Organization, International Agency for Research on Cancer (IARC) advised that electromagnetic radiation from mobile phone and other wireless devices constitutes a "possible human carcinogen," 2B. Recent analyses not considered in the IARC review that take into account these methodological shortcomings from a number of authors find that brain tumor risk is significantly elevated for those who have used mobile phones for at least a decade. Studies carried out in Sweden indicate that those who begin using either cordless or mobile phones regularly before age 20 have greater than a fourfold increased risk of ipsilateral glioma. Given that treatment for a single case of brain cancer can cost between \$100,000 for radiation therapy alone and up to \$1 million depending on drug costs, resources to address this illness are already in short supply and not universally available in either developing or developed countries. Significant additional shortages in oncology services are expected at the current growth of cancer. No other environmental carcinogen has produced evidence of an increased risk in just one decade. Empirical</p>	<p>Nothing. Review is not cited and not discussed.</p>

	<p>data have shown a difference in the dielectric properties of tissues as a function of age, mostly due to the higher water content in children's tissues. High resolution computerized models based on human imaging data suggest that children are indeed more susceptible to the effects of EMF exposure at microwave frequencies. If the increased brain cancer risk found in young users in these recent studies does apply at the global level, the gap between supply and demand for oncology services will continue to widen. Many nations, phone manufacturers, and expert groups, advise prevention in light of these concerns by taking the simple precaution of "distance" to minimize exposures to the brain and body. We note that brain cancer is the proverbial "tip of the iceberg"; the rest of the body is also showing effects other than cancers.</p>	
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Of these 22 reviews, 19 are found in the PubMed database, the most widely used medical database in the world, so there is no excuse for not discussing these 19, but only two of them were discussed (see below). With regard to the eight different types of effects that I consider established non-thermal EMF effects, each of them were reviews in multiple studies described in Table 2 as follows: Cancer 12 reviews [78,82,83,84,85,86,87,90,94,96,97,98]; Oxidative stress/free radicals 8 reviews [79,80,84,90,92,93,95,96]; Cellular DNA damage 10 review [4,79,80,81,82,84,90,91,92,94]; Apoptosis/cell death 3 reviews [79,82,91]; Lowered fertility 7 reviews [80,86,89,92,93,94,95]; Neurological/neuropsychiatric effects 4 reviews [80,87,88,94]; Calcium overload 4 reviews [4,91,92,96]; Endocrine effects 2 reviews [92,95]. It is not clear why so many important reviews on effects are not found in SCENIHR 2015 [73]. What is perhaps surprising, is that these reviews also document many other effects, none of which are clearly acknowledged by SCENIHR. These include stress responses; breakdown of the blood-brain barrier; fetal and neonatal effects; therapeutic effects; Alzheimer’s disease; increased nitric oxide; endometriosis; changes in protein levels (proteomics) and changes in gene expression; NF-kappaB elevation; increased suicide; changes in protein kinase activity including ERK and p32MAPK; mechanisms associated with oxidative stress including elevated NADPH/NADH oxidase increased lipid peroxidation and decreased enzymatic antioxidant activity, increased ornithine decarboxylase; and autism. It can be seen from this that the SCENIHR 2015 document seems to be systematically avoiding considering substantial bodies of evidence regarding a very large range of repeatedly reported EMF effects, each of which challenges the SCENIHR position that no effects are established.

Three specific issues regarding apparent cancer causation by EMFs need to be discussed here. Five of these reviews each review a body of evidence showing that cancer rates are higher on the side of the head where people use their cell phones and cordless phones, the ipsilateral side, as opposed to the opposite side of the head, called the contralateral side [78,84,85,98,99]. These are very important studies because they are not likely to be affected by how complete the reporting data are, or whether there are affects produced by chemicals, ionizing radiation or other EMFs; each of these factors should not be specific for the side of the head impacted. The contralateral side of the head serves as a control that can be compared with the ipsilateral side of the head. What is strange about the SCENIHR 2015 document, is that it avoids discussing all of these data presented in these five reviews. That is even true for [98] which is discussed very briefly in SCENIHR 2015. Only one body of evidence from [98] is discussed in SCENIHR 2015 but several others are not discussed, including the two bodies of evidence which each find statistically significant rises in ipsilateral cancer as compared with contralateral cancer. The ipsilateral findings produce very strong arguments that cell phones and/or cordless phones do cause brain cancer. The best evidence suggests that both cell phones and cordless phones do cause cancer. What does SCENIHR 2015 say about ipsilateral cancer? The document states, on p. 74 that “ORs for glioma were higher in subjects who reported phone use mostly on the same side of the head (ipsilateral) as their tumour than for use on the opposite side (contralateral). For meningioma, ORs for temporal lobe tumours were slightly lower than for other locations, while a similar pattern as for glioma of higher ipsilateral ORs compared to contralateral ORs was seen.” On p. 76, SCENIHR states that “Afterwards, in an attempt to quantify the relationship, Interphone and the Hardell studies were analysed in a meta-analytical approach (Hardell et al., 2013a), an



OR of 1.71 (CI: 1.04-2.81) was found for temporal glioma among ipsilateral mobile phone users of 10+ years of use....” On p. 77, regarding a study designed to assess the reliability of self-reported cell phone usage in young brain cancer patients, a study **not** designed to assess ipsilateral effects in patients whose cancer cases may likely have been caused by cell phone usage, the SCENIHR 2015 document states “No clear patterns were seen when comparing ipsilateral and contralateral use.” That is not surprising. It can be seen from this that 2 out of 3 studies that SCENIHR discussed argue that there is increased ipsilateral cancer and argue therefore that cell phones or cordless phones do cause cancer. Furthermore, they ignore large amounts of data, cited in [78,84,85,98,99] that provide further support for this view. When SCENIHR wishes to take the opposite position from that taken in these reviews, it is incumbent on SCENIHR to cite them, to discuss the data and opinion presented in those reviews and then and only then can they argue for their position. Having failed to do those things, SCENIHR loses credibility in any argument that they are doing what they can to protect our health. The same is true for all of the other effects where they similarly fail to cite large numbers of obviously relevant reviews, each arguing for various health effects produced by EMF exposures.

Two other findings from these reviews are important in assessing EMF cancer causation. Refs. [85 and 99] each provide evidence that younger people are more susceptible to cancer causation by EMFs than are adults. SCENIHR takes the opposite view but cannot argue credibly without considering those who differ. The other finding found in [97] is that the epidemiological evidence on cancer causation by microwave frequency EMFs satisfies most of the Hill criteria. The Hill criteria are the well-accepted criteria that allow one to distinguish chance associations from causal roles in epidemiology. Because epidemiology is the main basis for the arguments that SCENIHR makes against the conclusion that EMFs cause cancer, it is essential that SCENIHR carefully examine the Hill criteria. They fail to do so. They also ignored this study where these criteria were examined and where it was concluded that the majority of the Hill criteria argue that EMFs do cause cancer. This again, undercuts any claim that SCENIHR has carefully considered critically important findings with regard to EMF health effects.

There are several places in the SCENIHR 2015 document, where they state that no mechanisms have been identified by which claimed effects of EMFs can be produced. These can be found by searching the SCENIHR 2015 document using “mechanism” as the search term. However [4] clearly states that the VGCC activation mechanism triggered by EMF exposure can produce, via this mechanism, cellular DNA damaging effects, can produce therapeutic effects and can produce oxidative stress effects. It can be seen, therefore that SCENIHR has no problem making repeated claims that have been falsified by information that they presumably have examined. It also can be seen from this, that even in the cases where SCENIHR cites and very briefly discusses a review that disagrees with them, one can have no assurance that the information is used by SCENIHR in its assessment of health impacts. The causation of cellular DNA damage by EMFs acting via VGCC activation also has important implications with regard to cancer causation. Because almost all cases of cancer start with mutagenic DNA damage in the cell destined to become a cancer cell, this shows how EMFs can initiate the process of carcinogenesis.

It is clear that the SCENIHR 2015 document neither cited nor discussed 20 out of 22 reviews that have documented non-thermal effects of EMFs. In addition, the most important findings of the two that were cited in the document were ignored in the document as well. Therefore SCENIHR has systematically avoided discussing the most important implications of reviews that fell into the time frame they purport to have studied and disagreed with SCENIHR on the existence of important effects. The question can be raised, however, as to whether the SCENIHR has done a better job in its consideration of primary literature citations. To answer that question, I am using a database of important primary literature, regarding effects of cell phone EMFs that we are commonly exposed to.

### 23 Genuine Cell Phone Studies, Each of Which Should Be Discussed in SCENIHR 2015, 21 of Which Are Not.

Panagopoulos et al [100] showed that whereas 46 out of 48 studies on genuine cell phone radiation showed health-related effects, the majority of studies on simulated cell phones reported no statistically significant effects. They [100] interpreted the difference of results as having been caused by the lowered pulsation

rate of the “simulated” cell phone exposures. While I am sure that is part of the explanation, there may be other possible differences that are discussed later in this chapter.

Of those 48 genuine cell phone studies, 23 fell into the time frame (Jan. 2009 through Dec. 2013) reviewed in SCENIHR, 2015. Because of the importance of cell phones and therefore cell phone radiation in our lives, I am using these 23 as a database of primary literature studies that should all be covered in the SCENIHR 2015 [73] document. How many of these 23 were reviewed and cited in SCENIHR 2015? The answer is four (17%) and I will discuss how each of them were discussed below. I have inserted 17 of these into Table 3 below, but six were left out, because they are easy to summarize. These six are all *Drosophila* studies, none of which were discussed in SCENIHR 2015 [73] but are easy to summarize. All six *Drosophila* studies were focused on lowered fertility following EMF exposure, with the majority of these focused on female fertility. Four of the six found increased apoptosis following cell phone EMF exposure and four of the six also found cellular DNA damage following exposure. These are important because of the similarities of each of these effects to effects found in mammals. They are also important because they found DNA damage in *Drosophila* eggs, whereas mammalian eggs no similar studies have been done because of the difficulty in doing so. In mammals there are many studies showing DNA damage in sperm following EMF exposure. This DNA damage in germ line cells is particularly important because of the importance of mutations passed onto progeny. Two of the *Drosophila* studies show a clear window of effect at quite low intensity, where the effects seen were much higher than those found with either lower or higher intensities. Table 32 summarizes the other 17 genuine cell phone radiation findings that SCENIHR 2015 [73] should be discussing, 15 of which were not discussed or cited in SCENIHR 2015.

**Table 3: Genuine Cell Phone Studies that Fell into the 2009 through 2013 SCENIHR 2015 period**

Citation studied	Cell Phone Effects Reported	SCENIHR comments
1. Mailankot M, Kunnath AP, 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 (Sao Paulo) 64:561-565.	The present study was designed to evaluate the effects of RF-EMR from mobile phones on free radical metabolism and sperm quality. MATERIALS AND METHODS: Male albino Wistar rats (10-12 weeks old) were exposed to RF-EMR from an active GSM (0.9/1.8 GHz) mobile phone for 1 hour continuously per day for 28 days. Controls were exposed to a mobile phone without a battery for the same period. The phone was kept in a cage with a wooden bottom in order to address concerns that the effects of exposure to the phone could be due to heat emitted by the phone rather than to RF-EMR alone. Animals were sacrificed 24 hours after the last exposure and tissues of interest were harvested. RESULTS: One hour of exposure to the phone did not significantly change facial temperature in either group of rats. No significant difference was observed in total sperm count between controls and RF-EMR exposed groups. However, rats exposed to RF-EMR exhibited a significantly reduced percentage of motile sperm. Moreover, RF-EMR exposure resulted in a significant increase in lipid peroxidation and low GSH content in the testis and epididymis. CONCLUSION: Given the results of the present study, we speculate that RF-EMR from mobile phones negatively affects semen quality and may impair male fertility.	Listed under literature identified but not cited. SCENIHR knew about this paper but decided not to discuss it.
2. Gul A, Celebi H, Uğraş S. 2009 The effects of microwave emitted by cellular phones on ovarian follicles in rats. Arch Gynecol Obstet	The aim of this study was to investigate whether there were any toxic effects of microwaves of cellular phones on ovaries in rats. METHODS: In this study, 82 female pups of rats, aged 21 days (43 in the study group and 39 in the control group) were used. Pregnant rats in the study group were exposed to mobile phones that were placed beneath the polypropylene cages during the whole period of pregnancy. The cage was free from all kinds of	Not cited and not discussed by SCENIHR.

<p>280:729-733. doi: 10.1007/s00404-009-0972-9.</p>	<p>materials, which could affect electromagnetic fields. A mobile phone in a standby position for 11 h and 45 min was turned on to speech position for 15 min every 12 h and the battery was charged continuously. On the 21st day after the delivery, the female rat pups were killed and the right ovaries were removed. The volumes of the ovaries were measured and the number of follicles in every tenth section was counted. RESULTS: The analysis revealed that in the study group, the number of follicles was lower than that in the control group. The decreased number of follicles in pups exposed to mobile phone microwaves suggest that intrauterine exposure has toxic effects on ovaries. CONCLUSION: We suggest that the microwaves of mobile phones might decrease the number of follicles in rats by several known and, no doubt, countless unknown mechanisms.</p>	
<p>3. Imge EB, Kiliçoğlu B, Devrim E, Cetin R, Durak I. 2010 Effects of mobile phone use on brain tissue from the rat and a possible protective role of vitamin C - a preliminary study. Int J Radiat Biol 86:1044-1049. doi: 10.3109/09553002.2010.501838.</p>	<p>To evaluate effects of mobile phone use on brain tissue and a possible protective role of vitamin C. MATERIALS AND METHODS: Forty female rats were divided into four groups randomly (Control, mobile phone, mobile phone plus vitamin C and, vitamin C alone). The mobile phone group was exposed to a mobile phone signal (900 MHz), the mobile phone plus vitamin C group was exposed to a mobile phone signal (900 MHz) and treated with vitamin C administered orally (per os). The vitamin C group was also treated with vitamin C per os for four weeks. Then, the animals were sacrificed and brain tissues were dissected to be used in the analyses of malondialdehyde (MDA), antioxidant potential (AOP), superoxide dismutase, catalase (CAT), glutathione peroxidase (GSH-Px), xanthine oxidase, adenosine deaminase (ADA) and 5'nucleotidase (5'-NT). RESULTS: Mobile phone use caused an inhibition in 5'-NT and CAT activities as compared to the control group. GSH-Px activity and the MDA level were also found to be reduced in the mobile phone group but not significantly. Vitamin C caused a significant increase in the activity of GSH-Px and non-significant increase in the activities of 5'-NT, ADA and CAT enzymes. CONCLUSION: Our results suggest that vitamin C may play a protective role against detrimental effects of mobile phone radiation in brain tissue.</p>	<p>Not cited and not discussed by SCENIHR.</p>
<p>4. Sharma VP, Kumar NR. 2010 Changes in honeybee behavior under the influence of cell phone radiation. Curr Science 98: 1376-1378.</p>	<p>Honeybee behaviour and biology has been affected by electrosmog since these insects have magnetite in their bodies which helps them in navigation. There are reports of sudden disappearance of bee populations from honeybee colonies. The reason is still not clear. We have compared the performance of honeybees in cellphone radiation exposed and unexposed colonies. A significant (<math>p &lt; 0.05</math>) decline in colony strength and in the egg laying rate of the queen was observed. The behaviour of exposed foragers was negatively influenced by the exposure, there was neither honey nor pollen in the colony at the end of the experiment.</p>	<p>Not cited and not discussed by SCENIHR.</p>
<p>5. Vecchio F, Babiloni C, Ferreri F, Buffo P, Cibelli G, Curcio G, van Dijkman S, Melgari JM, Giambattistelli F, Rossini PM. 2010 Mobile phone emission</p>	<p>It has been reported that GSM electromagnetic fields (GSM-EMFs) of mobile phones modulate--after a prolonged exposure--inter-hemispheric synchronization of temporal and frontal resting electroencephalographic (EEG) rhythms in normal young subjects [Vecchio et al., 2007]. Here we tested the hypothesis that this effect can vary on physiological aging as a sign of changes in the functional organization of cortical neural synchronization.</p>	<p>Was cited and discussed – see text.</p>

<p>modulates inter-hemispheric functional coupling of EEG alpha rhythms in elderly compared to young subjects. Clin Neurophysiol 121:163-171. doi: 10.1016/j.clinph.2009.11.002.</p>	<p><b>METHODS:</b> Eyes-closed resting EEG data were recorded in 16 healthy elderly subjects and 5 young subjects in the two conditions of the previous reference study. The GSM device was turned on (45 min) in one condition and was turned off (45 min) in the other condition. Spectral coherence evaluated the inter-hemispheric synchronization of EEG rhythms at the following bands: delta (about 2-4 Hz), theta (about 4-6 Hz), alpha 1 (about 6-8 Hz), alpha 2 (about 8-10 Hz), and alpha 3 (about 10-12 Hz). The aging effects were investigated comparing the inter-hemispheric EEG coherence in the elderly subjects vs. a young group formed by 15 young subjects (10 young subjects of the reference study; Vecchio et al., 2007). <b>RESULTS:</b> Compared with the young subjects, the elderly subjects showed a statistically significant (<math>p &lt; 0.001</math>) increment of the inter-hemispheric coherence of frontal and temporal alpha rhythms (about 8-12 Hz) during the GSM condition. <b>CONCLUSIONS:</b> These results suggest that GSM-EMFs of a mobile phone affect inter-hemispheric synchronization of the dominant (alpha) EEG rhythms as a function of the physiological aging. <b>SIGNIFICANCE:</b> This study provides further evidence that physiological aging is related to changes in the functional organization of cortical neural synchronization.</p>	
<p>6. Kumar NR, Sangwan S, Badotra P. 2011 Exposure to cell phone radiations produces biochemical changes in worker honey bees. Toxicol Int. 2011 Jan;18(1):70-2. doi: 10.4103/0971-6580.75869.</p>	<p>The present study was carried out to find the effect of cell phone radiations on various biomolecules in the adult workers of <i>Apis mellifera</i> L. The results of the treated adults were analyzed and compared with the control. Radiation from the cell phone influences honey bees' behavior and physiology. There was reduced motor activity of the worker bees on the comb initially, followed by en masse migration and movement toward "talk mode" cell phone. The initial quiet period was characterized by rise in concentration of biomolecules including proteins, carbohydrates and lipids, perhaps due to stimulation of body mechanism to fight the stressful condition created by the radiations. At later stages of exposure, there was a slight decline in the concentration of biomolecules probably because the body had adapted to the stimulus.</p>	<p>Not cited and not discussed by SCENIHR.</p>
<p>7. Favre D. 2011 Mobile phone-induced honeybee worker piping. Apidologie 42:270-279.</p>	<p>Electromagnetic waves originating from mobile phones were tested for potential effects on honeybee behavior. Mobile phone handsets were placed in the close vicinity of honeybees. The sound made by the bees was recorded and analyzed. The audiograms and spectrograms revealed that active mobile phone handsets have a dramatic impact on the behavior of the bees, namely by inducing the worker piping signal. In natural conditions, worker piping either announces the swarming process of the bee colony or is a signal of a disturbed bee colony.</p>	<p>Not cited and not discussed by SCENIHR.</p>

<p>8. Cammaerts MC, Debeir O, Cammaerts R. 2011. Changes in <i>Paramecium caudatum</i> (protozoa) near a switched-on GSM telephone. <i>Electromagn Biol Med.</i> 2011 Mar;30(1):57-66. doi: 10.3109/15368378.2011.566778.</p>	<p>The protozoan <i>Paramecium caudatum</i> was examined under normal conditions versus aside a switched-on GSM telephone (900 MHz; 2 Watts). Exposed individuals moved more slowly and more sinuously than usual. Their physiology was affected: they became broader, their cytopharynx appeared broader, their pulse vesicles had difficult in expelling their content outside the cell, their cilia less efficiently moved, and trichocysts became more visible. All these effects might result from some bad functioning or damage of the cellular membrane. The first target of communication electromagnetic waves might thus be the cellular membrane.</p>	<p>Listed under literature identified but not cited. SCENIHR knew about this paper but decided not to discuss it.</p>
<p>9. Çam ST, Seyhan N. 2012 Single-strand DNA breaks in human hair root cells exposed to mobile phone radiation. <i>Int J Radiat Biol</i> 88:420-424. doi: 10.3109/09553002.2012.666005.</p>	<p>To analyze the short-term effects of radiofrequency radiation (RFR) exposure on genomic deoxyribonucleic acid (DNA) of human hair root cells. <b>SUBJECTS AND METHODS:</b> Hair samples were collected from eight healthy human subjects immediately before and after using a 900-MHz GSM (Global System for Mobile Communications) mobile phone for 15 and 30 min. Single-strand DNA breaks of hair root cells from the samples were determined using the 'comet assay'. <b>RESULTS:</b> The data showed that talking on a mobile phone for 15 or 30 min significantly increased (<math>p &lt; 0.05</math>) single-strand DNA breaks in cells of hair roots close to the phone. Comparing the 15-min and 30-min data using the paired t-test also showed that significantly more damages resulted after 30 min than after 15 min of phone use. <b>CONCLUSIONS:</b> A short-term exposure (15 and 30 min) to RFR (900-MHz) from a mobile phone caused a significant increase in DNA single-strand breaks in human hair root cells located around the ear which is used for the phone calls.</p>	<p>Not cited and not discussed by SCENIHR.</p>
<p>10. Vecchio F, Tombini M, Buffo P, Assenza G, Pellegrino G, Benvenga A, Babiloni C, Rossini PM. 2012 Mobile phone emission increases inter-hemispheric functional coupling of electroencephalographic <math>\alpha</math> rhythms in epileptic patients. <i>Int J Psychophysiol</i> 84:164-171. doi: 10.1016/j.ijpsycho.2012.02.002.</p>	<p>It has been reported that GSM electromagnetic fields (GSM-EMFs) of mobile phones modulate - after a prolonged exposure - inter-hemispheric synchronization of temporal and frontal resting electroencephalographic (EEG) rhythms in normal young and elderly subjects (Vecchio et al., 2007, 2010). Here we tested the hypothesis that this can be even more evident in epileptic patients, who typically suffer from abnormal mechanisms governing synchronization of rhythmic firing of cortical neurons. Eyes-closed resting EEG data were recorded in ten patients affected by focal epilepsy in real and sham exposure conditions. These data were compared with those obtained from 15 age-matched normal subjects of the previous reference studies. The GSM device was turned on (45 min) in the "GSM" condition and was turned off (45 min) in the other condition ("sham"). The mobile phone was always positioned on the left side in both patients and control subjects. Spectral coherence evaluated the inter-hemispheric synchronization of EEG rhythms at the following frequency bands: delta (about 2-4 Hz), theta (about 4-6 Hz), alpha1 (about 6-8 Hz), alpha2 (about 8-10 Hz), and alpha3 (about 10-12 Hz). The effects on the patients were investigated comparing the inter-hemispheric EEG coherence in the epileptic patients with the control group of subjects evaluated in the previous reference studies. Compared with the control subjects, epileptic patients showed a statistically significant higher inter-hemispheric coherence of temporal and frontal alpha rhythms (about 8-12 Hz) in the GSM than "Sham" condition. These</p>	<p>Was cited and discussed – see text.</p>

	<p>results suggest that GSM-EMFs of mobile phone may affect inter-hemispheric synchronization of the dominant (alpha) EEG rhythms in epileptic patients. If confirmed by future studies on a larger group of epilepsy patients, the modulation of the inter-hemispheric alpha coherence due to the GSM-EMFs could have clinical implications and be related to changes in cognitive-motor function.</p>	
<p>11. Al-Damegh MA. 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 67:785-792</p>	<p>OBJECTIVE: The aim of this study was to investigate the possible effects of electromagnetic radiation from conventional cellular phone use on the oxidant and antioxidant status in rat blood and testicular tissue and determine the possible protective role of vitamins C and E in preventing the detrimental effects of electromagnetic radiation on the testes.</p> <p>MATERIALS AND METHODS: The treatment groups were exposed to an electromagnetic field, electromagnetic field plus vitamin C (40 mg/kg/day) or electromagnetic field plus vitamin E (2.7 mg/kg/day). All groups were exposed to the same electromagnetic frequency for 15, 30, and 60 min daily for two weeks. RESULTS: There was a significant increase in the diameter of the seminiferous tubules with a disorganized seminiferous tubule sperm cycle interruption in the electromagnetism-exposed group. The serum and testicular tissue conjugated diene, lipid hydroperoxide, and catalase activities increased 3-fold, whereas the total serum and testicular tissue glutathione and glutathione peroxidase levels decreased 3-5 fold in the electromagnetism-exposed animals.</p> <p>CONCLUSION: Our results indicate that the adverse effect of the generated electromagnetic frequency had a negative impact on testicular architecture and enzymatic activity. This finding also indicated the possible role of vitamins C and E in mitigating the oxidative stress imposed on the testes and restoring normality to the testes.</p>	<p>Listed under literature identified but not cited. SCENIHR knew about this paper but decided not to discuss it.</p>
<p>12. Aldad TS, Gan G, Gao X-B, Taylor HS. 2012 Fetal radiofrequency radiation from 800-1900 MH-rated cellular telephone affects neurodevelopment and behavior in mice. Scientific Rep 2, article 312.</p>	<p>Neurobehavioral disorders are increasingly prevalent in children, however their etiology is not well understood. An association between prenatal cellular telephone use and hyperactivity in children has been postulated, yet the direct effects of radiofrequency radiation exposure on neurodevelopment remain unknown. Here we used a mouse model to demonstrate that in-utero radiofrequency exposure from cellular telephones does affect adult behavior. Mice exposed in-utero were hyperactive and had impaired memory as determined using the object recognition, light/dark box and step-down assays. Whole cell patch clamp recordings of miniature excitatory postsynaptic currents (mEPSCs) revealed that these behavioral changes were due to altered neuronal developmental programming. Exposed mice had dose-responsive impaired glutamatergic synaptic transmission onto layer V pyramidal neurons of the prefrontal cortex. We present the first experimental evidence of neuropathology due to in-utero cellular telephone radiation. Further experiments are needed in humans or non-human primates to determine the risk of exposure during pregnancy.</p>	<p>Was cited and discussed, see text.</p>
<p>13. Liu C, Gao P, Xu SC, Wang Y, Chen CH, He MD, Yu ZP, Zhang L, Zhou Z. 2013</p>	<p>A mouse spermatocyte-derived GC-2 cell line was exposed to a commercial mobile phone handset once every 20 min in standby, listen, dialed or dialing modes for 24 h. DNA damage was determined using an alkaline comet assay. RESULTS: The</p>	<p>Not cited and not discussed by</p>

<p>Mobile phone radiation induces mode-dependent DNA damage in a mouse spermatocyte-derived cell line: a protective role of melatonin. <i>Int J Radiat Biol.</i> 2013. 89: 993-1001. doi: 10.3109/09553002.2013.811309.</p>	<p>levels of DNA damage were significantly increased following exposure to MPR in the listen, dialed and dialing modes. Moreover, there were significantly higher increases in the dialed and dialing modes than in the listen mode. Interestingly, these results were consistent with the radiation intensities of these modes. However, the DNA damage effects of MPR in the dialing mode were efficiently attenuated by melatonin pretreatment. CONCLUSIONS: These results regarding mode-dependent DNA damage have important implications for the safety of inappropriate mobile phone use by males of reproductive age and also suggest a simple preventive measure: Keeping mobile phones as far away from our body as possible, not only during conversations but during 'dialed' and 'dialing' operation modes. Since the 'dialed' mode is actually part of the standby mode, mobile phones should be kept at a safe distance from our body even during standby operation. Furthermore, the protective role of melatonin suggests that it may be a promising pharmacological candidate for preventing mobile phone use-related reproductive impairments.</p>	<p>SCENIHR.</p>
<p>14. Koca O, Gökçe AM, Öztürk MI, Ercan F, Yurdakul N, Karaman MI. 2013 Effects of intensive cell phone (Philips Genic 900) use on the rat kidney tissue. <i>Urol J.</i> 2013 Spring;10:886-891.</p>	<p>To investigate effects of electromagnetic radiation (EMR) emitted by cell phones on the rat kidney tissue. MATERIALS AND METHODS: Twenty-one male Albino rats were divided into 3 groups, each comprising 7 rats. Group 1 was exposed to a cell phone in speech mode for 8 hours/day for 20 days and their kidneys were removed. Group 2 was exposed to EMR for 20 days and then their kidneys were removed after an interval of 20 days. Cell phone used in the present study was Philips Genie 900, which has the highest specific absorption rate on the market. RESULTS: Light microscopic examination of the kidney tissues obtained from the first group of rats revealed glomerular damage, dilatation of Bowman's capsule, formation of large spaces between the tubules, tubular damage, perivascular edema, and inflammatory cell infiltration. The mean severity score was <math>4.64 \pm 1.7</math> in group 1, <math>4.50 \pm 0.8</math> in group 2, and 0 in group 3. While there was no significant difference between group 1 and group 2 (<math>P &gt; .05</math>), the mean severity scores of groups 1 and 2 were significantly higher than that of the control group (<math>P = .001</math> for each). CONCLUSION: Considering the damage in rat kidney tissue caused by EMR-emitting cell phones, high-risk individuals should take protective measures.</p>	<p>Not cited and not discussed by SCENIHR.</p>
<p>15. Meo SA, Al Rubeaan K. 2013 Effects of exposure to electromagnetic field radiation (EMFR) generated by activated mobile phones on fasting blood glucose. <i>Int J Occup Med Environ Health</i> 26:235-241. doi: 10.2478/s13382-013-0107-1.</p>	<p>Extensive use of mobile phones has been accompanied by a common public debate about possible adverse effects on human health. No study has been published so far to establish any association between the fastest growing innovation of mobile phone and fasting blood glucose. The aim was to determine the effects of exposure to electromagnetic field radiation generated by mobile phones on fasting blood glucose in Wistar Albino rats. MATERIALS AND METHODS: 40 Male Albino rats (Wistar Strain) were divided into 5 equally numerous groups. Group A served as the control one, group B received mobile phone radiation for less than 15 min/day, group C: 15-30 min/day, group D: 31-45 min/day, and group E: 46-60 min/day for a total period of 3 months. Fasting blood glucose was determined by using Spectrophotometer and serum insulin by Enzyme-linked Immunosorbent Assay (ELISA). The Homeostatic Model</p>	<p>Not cited and not discussed by SCENIHR.</p>

	<p>(HOMA-B) was applied for the assessment of <math>\beta</math>-cell function and (HOMA-IR) for resistance to insulin. RESULTS: Wister Albino rats exposed to mobile phone radiation for longer than 15 min a day for a total period of 3 months had significantly higher fasting blood glucose (<math>p &lt; 0.015</math>) and serum insulin (<math>p &lt; 0.01</math>) compared to the control group. HOMA-IR for insulin resistance was significantly increased (<math>p &lt; 0.003</math>) in the groups that were exposed for 15-30 and 46-60 min/day compared to the control rats. CONCLUSION: The results of the present study show an association between long-term exposure to activated mobile phones and increase in fasting blood glucose and serum insulin in Albino rats.</p>	
<p>16. Tsybulin O, Sidorik E, Brieva O, Buchynska L, Kyrylenko S, Henshel D, Yakymenko I. 2013 GSM 900 MHz cellular phone radiation can either stimulate or depress early embryogenesis in Japanese quails depending on the duration of exposure. Int J Radiat Biol 89:756-763. doi: 10.3109/09553002.2013.791408.</p>	<p>Our study was designed to assess the effects of low intensity radiation of a GSM (Global System for Mobile communication) 900 MHz cellular phone on early embryogenesis in dependence on the duration of exposure. MATERIALS AND METHODS: Embryos of Japanese Quails were exposed in ovo to GSM 900 MHz cellular phone radiation during initial 38 h of brooding or alternatively during 158 h (120 h before brooding plus initial 38 h of brooding) discontinuously with 48 sec ON (average power density 0.25 <math>\mu\text{W}/\text{cm}^2</math>), specific absorption rate 3 <math>\mu\text{W}/\text{kg}</math>) followed by 12 sec OFF intervals. A number of differentiated somites were assessed microscopically. Possible DNA damage evoked by irradiation was assessed by an alkaline comet assay. RESULTS: Exposure to radiation from a GSM 900 MHz cellular phone led to a significantly altered number of differentiated somites. In embryos irradiated during 38 h the number of differentiated somites increased (<math>p &lt; 0.001</math>), while in embryos irradiated during 158 h this number decreased (<math>p &lt; 0.05</math>). The lower duration of exposure led to a significant (<math>p &lt; 0.001</math>) decrease in a level of DNA strand breaks in cells of 38-h embryos, while the higher duration of exposure resulted in a significant (<math>p &lt; 0.001</math>) increase in DNA damage as compared to the control. CONCLUSION: Effects of GSM 900 MHz cellular phone radiation on early embryogenesis can be either stimulating or deleterious depending on the duration of exposure.</p>	<p>Listed under literature identified but not cited. SCENIHR knew about this paper but decided not to discuss it.</p>
<p>17. Luo Q, Jiang Y, Jin M, Xu J, Huang HF. 2013 Proteomic analysis on the alteration of protein expression in the early-stage placental villous tissue of electromagnetic fields associated with cell phone exposure. Reprod Sci 20:1055-1061. doi: 10.1177/1933719112473660.</p>	<p>To explore the possible adverse effects and search for cell phone electromagnetic field (EMF)-responsive proteins in human early reproduction, a proteomics approach was employed to investigate the changes in protein expression profile induced by cell phone EMF in human chorionic tissues of early pregnancy in vivo. METHODS: Volunteer women about 50 days pregnant were exposed to EMF at the average absorption rate of 1.6 to 8.8 W/kg for 1 hour with the irradiation device placed 10 cm away from the umbilicus at the midline of the abdomen. The changes in protein profile were examined using 2-dimensional electrophoresis (2-DE). RESULTS: Up to 15 spots have yielded significant change at least 2- to 2.5-folds up or down compared to sham-exposed group. Twelve proteins were identified- procollagen-proline, eukaryotic translation elongation factor 1 delta, chain D crystal structure of human vitamin D-binding protein, thioredoxin-like 3, capping protein, isocitrate dehydrogenase 3 alpha, calumenin, Catechol-O-methyltransferase protein, proteinase inhibitor 6 (PI-6; SerpinB6) protein, 3,2-trans-enoyl-CoA isomerase protein,</p>	<p>Listed under literature identified but not cited. SCENIHR knew about this paper but decided not to discuss it.</p>



	<p>chain B human erythrocyte 2,3-bisphosphoglycerate mutase, and nucleoprotein.</p> <p>CONCLUSION: Cell phone EMF might alter the protein profile of chorionic tissue of early pregnancy, during the most sensitive stage of the embryos. The exposure to EMF may cause adverse effects on cell proliferation and development of nervous system in early embryos. Furthermore, 2-DE coupled with mass spectrometry is a promising approach to elucidate the effects and search for new biomarkers for environmental toxic effects.</p>	
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If you look through the studies described in Table 3, you will see multiple studies in oxidative stress/free radical damage, on changes in tissue structure (sometimes called remodeling), on cellular DNA damage, on male fertility (and also one on female fertility), on behavioral changes and on neurological changes. There is also one study on insulin/type 2 diabetes (hormonal effect). It follows from this that five of the effects that were extensively documented in large numbers of reviews (Chapter 1) are further demonstrated in these studies. In addition the tissue remodeling and proteomic changes discussed in Chapter 3 are also further demonstrated here. One question that needs to be raised with regard to SCENIHR is why so many clearly important primary literature studies of cell phone radiation (perhaps the most important source of human microwave irradiation) are not discussed in SCENIHR 2015. I will discuss certain particular articles that I think are particularly important for *particular reasons*. Subsequently, I will discuss the three articles that SCENIHR does discuss.

One of the more interesting studies not discussed by SCENIHR, is #11 in Table 3. This was published by a woman scientist in Saudi Arabia. What it shows is that 15, 30 or 60 minutes per day of cell phone radiation disrupts the structure of the rat testis and also produces high levels of oxidative stress as shown by measuring 5 different markers of oxidative stress. Such studies have been done for several decades, with oxidative stress having been shown in many different organs following EMF exposures. What is particularly important in this study is that high levels of two different antioxidants, vitamin C and vitamin E, were each shown to produce substantial protection of the testis structure from the EMF effects while partially normalizing the oxidative stress elevation. What this clearly shows is that the oxidative stress causes the testis tissue disruption. So we don't just have evidence for two effects, testis disruption and oxidative stress but we have strong evidence that one causes the other. It is exactly these connections that are essential for the progression of the science!

# 13 is another study not discussed by SCENIHR which is also particularly important. It looks at cell phone radiation DNA damage produced in a mouse spermatocyte-derived cell line. What it finds is that DNA damage is particularly high when the cell phone is in the dialed or dialing mode, as opposed to a listen mode. They also state that the radiation levels in the three modes correspond, at least roughly, to the DNA damage effects seen. They also show that pretreatment with melatonin (which is known to have antioxidant effects) greatly lowers the DNA damage produced by the cell phone EMF exposures. This is similar to the study discussed immediately above because it again shows that one effect, DNA damage is produced by another effect, namely oxidative stress/free radical elevation. You will recall that as discussed in Chapter 2, cellular DNA damage following EMF exposure is produced by the attacks by on the DNA by peroxy nitrite derived free radicals. This study provides confirmation for that mechanism.

#14 is another study not discussed by SCENIHR which is also particularly important. It looks at the impact of cell phone radiation on kidney structure of rats, using six different measures of kidney structure. There were two groups of rats that were exposed to cell phone radiation which were both compared with each other and with normal unexposed control rats. The two exposed groups differed from each other in one group the kidney structure was assessed immediately following the 20 day exposure period. The second exposure group was also exposed for 20 days but was given 20 days subsequently with no exposure to see if the kidney structure spontaneously recovered. There was no recovery seen in the second group, showing that the kidney damage was effectively irreversible. In Chapter 3, several tissue remodeling type effects produced by EMF exposure appeared to be irreversible. Study #14 may add an additional such effect to that list.

#15 is another study not discussed by SCENIHR which is also particularly important. In this study control (unexposed) rats were compared with rats exposed to cell phone radiation for: less than 15 minutes per day, 15 to 30 minutes per day, 31 to 45 minutes per day or 45 to 60 minutes per day. Rats exposed to over 15 minutes per day of cell phone radiation showed type 2 diabetes onset-like effects, with higher fasting glucose levels and higher serum insulin levels. This appears to be, therefore a study showing important hormone dysfunction. It should be noted that the same research group has found similar changes in people living near cell phone towers [101]. Consequently, this is still another situation where findings in experimental animal studies appear to be directly applicable to humans.

Of the papers that were discussed, it is my opinion that the Aldad et al paper (#12, Table 4) is perhaps the most important. The paper starts out discussing the very large increase in ADHD that we have had in recent years, an increase which suggests that one or more environmental changes must be involved. This paper is from a distinguished laboratory, Hugh Taylor's laboratory at Yale, and was published in one of the highly respected Nature journals and the paper at this writing has been cited 89 times, showing a high level of scientific interest in it. The paper showed that prenatal exposure of pregnant mice to cell phone radiation produced three highly statistically significant changes in the adult mice. These were a decrease in measured memory function, increase in hyperactivity and increase in anxiety. They also showed that there was a dose dependent decrease in an important neurological parameter, the frequency of miniature excitatory postsynaptic currents, allowing the authors to conclude "that these behavioral changes were due to altered neuronal developmental programming." SCENIHR states the following about this study: "Neurodevelopment from a functional point of view was studied by Aldad et al. (2012) who exposed mice in utero and investigated them as adults for certain behavioural traits and electrophysiological characteristics. Exposure is poorly described but is reported to be to a muted telephone (900-1800 MHz) during the entire gestation period. After blinded investigations, the authors concluded that exposed animals displayed hyperactivity, memory deficiencies, decreased anxiety, and impaired glutamatergic transmission. Although the study employs relevant biological end-points, it cannot be used for any conclusions regarding pre-natal mobile phone exposure and functional development of the brain." SCENIHR fails to tell us why they claim the exposures were poorly described nor do they provide any reasoning on why "it cannot be used for any conclusions regarding pre-natal mobile phone exposure and development of the brain." It is hard to see how such results could be found unless there are substantial effects of pre-natal exposure. Because the study used genuine cell phone radiation, the effects seen are disturbing. It would be reasonable for SCENIHR to call for more studies of this type to see if they can be replicated. Having said that there have been five subsequent studies that I found where pre-natal mouse exposure to non-thermal EMFs produced substantial and somewhat similar adult neurological effects and or behavioral effects [102-106]. These five included exposures to Wi-Fi and to DECT (cordless phone) EMFs. It is common for SCENIHR and other industry friendly organizations to treat experimental studies as if they had the weaknesses of epidemiological studies. They don't because they can and do in these cases, directly demonstrate causation. In epidemiology, causation can be inferred but not directly demonstrated. What about epidemiological evidence with regard to EMF causation of ADHD? There are two such studies that each provide evidence for an association between prenatal cell phone exposures and development of ADHD [107,108]. SCENIHR knew about both of these, since it discusses one of them which is, in turn, based on the earlier one. Why then did SCENIHR not make the connection of those two studies with at Aldad study (#12 in Table 4)? That is of course an important failure, given that the Aldad study greatly strengthens the argument for EMF causation of ADHD.

Given the current situation where there are a total of 6 studies showing that EMFs, including cell phone, Wi-Fi and cordless phone EMFs can cause ADHD-like effects in mice and two human epidemiological studies suggesting a similar mechanism in humans and the parallel between the huge increase in ADHD and the huge increase in microwave frequency EMF exposures, is there any other type of evidence that supports a causal role for EMFs? It turns out there is. EMFs, of course, act primarily via VGCC activation and genetic polymorphism studies show that elevated VGCC activity has a role in causing ADHD [109], acting to a substantial extent prenatally. This is the way real science works. It is not the way that SCENIHR works.

The Vecchio et al 2010 paper (#5, Table 4) was discussed in SCENIHR 2015 as follows: "A study by Vecchio et al. (2010) analysed age-dependent EMF effects on alpha activity in waking EEGs in 16 older

(47-84 years) and 15 younger subjects (20-37 years). Participants were exposed to a GSM signal (902.40 MHz, modulation frequencies: 8.33 and 217 Hz) for 45 min with a maximum SAR of 0.5 W/kg emitted by a commercially available mobile phone which was set using a test card in a double-blind cross-over paradigm. EEG was recorded for 5 min prior to and following exposure at 19 electrodes. The authors found an increased inter-hemispheric coherence of frontal alpha EEG activity after GSM exposure which was statistically significant for the elderly subjects but not for the young ones. This might point to a GSM-EMF related inter-hemispheric synchronization of alpha rhythms as a function of physiological aging.” Another related study (#by the same research group was also cited and discussed SCENIHR 2015 [73] as follows: “Vecchio et al. (2012a) used the same study design to investigate an exposure effect in patients with epilepsy. Data from 10 patients were compared to results from 15 age- matched controls from previous studies. Patients showed a statistically significant higher inter-hemispheric coherence of temporal and frontal alpha-rhythms under exposure as compared to control subjects. According to the authors, these results might indicate a GSM exposure effect on inter-hemispheric synchronization of the dominant (alpha) EEG rhythms in epileptic patients.”

What do I have to say about the two Vecchio studies? They are both based on an earlier 2007 study which showed that increased EEG coherence between the two hemispheres of the brain produced by genuine cell phone EMF exposure. What the 2010 study (#5 in Table 3) shows is that the EMF-induced increased coherence is much higher in older adults than it is in younger adults. What the 2012 study (#10 in Table 3) shows is that the EMF-induced coherence seen in people with epilepsy is also much higher than in people without epilepsy. These three studies then provide large amounts of evidence for a neurological effect of cell phone radiation that is influenced by two variables, age and epilepsy. These findings should be looked at the context of the 23 reviews, listed in Chapter 1, each showing that EMFs produce both neurological and/or neuropsychiatric impacts on the brain. Here we have still another neurological effect, one that is influenced by age and epileptic condition. There are, then three important findings in these studies. One is that while we have had quite lot of evidence showing that children are more sensitive to EMF effects than adults, this is the first clear finding, to my knowledge, that suggests that older people may be more sensitive to a neurological effect. The linkage to epilepsy should not be surprising as some EHS people are reported to have seizures triggered by very low intensity EMF exposures. Finally, the communication between the two hemispheres of the brain has been known for over half a century to be through what is called the corpus callosum, a structure deeply buried in the middle of the brain, linking the two hemispheres. These effects increasing the coherence between the two hemispheres are probably produced, therefore, through the impact of the EMFs on the corpus callosum. That implies, in turn, that the EMFs act much more deeply in the brain than the industry claims is possible.

The problem with SCENIHR is that it lives in a totally fictional universe where none of those EMF effect reviews exist or at least none of them have any relevance to the SCENIHR world. Neither of the two Vecchio et al studies, discussed in the previous two paragraphs, are used by SCENIHR [73] to make any conclusions about EMF effects or lack thereof – they are only cited in the quote that I gave you. We know that because because the citations are by author’s last name and are, therefore easily searchable. Similarly, the Aldad study discussed two paragraphs further up, was also never cited except in the quotation given. So none of these three papers are used to assess any effects of EMFs or lack of effects. The same thing is true of the two reviews from Table 2 that were cited and discussed in [73]. They also were only cited in the quoted section and are never used to assess EMF effects or the mechanism of EMF action. As previously noted, there are several statements in SCENIHR 2015 [73] regarding lack of any available mechanism to explain claimed EMF effects, something that is directly contradicted by one of those cited and discussed reviews [4]. The consequence of all of that is that we have two very large and very consequential bodies of literature, the reviews on EMF effects and the literature on cell phone radiation effects, which are entirely missing from any SCENIHR 2015 [73] conclusion.

#### Is There Another Systematic Effort by Industry to Corrupt the Literature that Has Been Followed to Some Extent by SCENIHR?

The important roles of pulsation, window effects, frequency, cell type and polarization in determining biological activity of EMFs were discussed in Chapter 1, where it was noted that SCENIHR fails to pay attention to any of these roles. That failure shows up in many places in the document. In Tables 5, 6, 7, 8,

9, 10, 11, 12, 13 and 14 of SCENIHR 2015 [73], the discussion of each table centers on how many studies found apparent effects and how many did not. But these numbers are irrelevant to the issue of whether there are effects or not. In fact one can argue that the industry, knowing about the roles of each of these factors, could fund any number of studies designed to give apparent negative results just by manipulating these factors to minimize responses and by only studying tiny numbers of individuals to produce low statistical power. This approach closely describes the approach used in seven studies of what were claimed to be genuine Wi-Fi studies that were described by Foster and Moulder [110] in Table 4 of their paper. Those seven studies were shown [11] to all have used an EMF that was not genuine Wi-Fi, despite claims to the contrary. They all used one of two types of reverberation exposure chamber for their rodent exposures, with each type of chamber greatly lowering the polarization of the EMFs [11] and also generating some level of destructive interference from variable path lengths produced by the reverberations. Each of these changes from genuine Wi-Fi is predicted to lower effects. Foster and Moulder [110] concluded that there was no effect in any of these studies. However tiny numbers of rodents were studied, typically between 3 and 15 in each class, such that these studies have very low statistical power to conclude anything substantive.

It is not possible to conclude no effect even with large studies. At most one can claim that there is no statistically significant evidence of an effect. With tiny numbers, a claim of no effect is complete nonsense. This problem with “no effect” claims is documented in a section of Rothman et al., *Modern Epidemiology*, 3rd Edition, a highly respected source of information, cited over 19,000 times according to the Google Scholar database. It states (p. 151, bottom) that: “A common misinterpretation of significance tests is that there no difference between two observed groups because the null test is not statistically significant, in that P is greater than the cutoff for declaring statistical significance (again, usually 0.05). This interpretation confuses a descriptive issue (whether two observed groups differ) with an inference about the superpopulation. The significance test refers only to the superpopulation, not the observed groups. To say that the difference is not statistically significant means only that one cannot reject the null hypothesis that the superpopulation groups are the same; it does not imply that the two groups are the same.” All such claims of “no effect” are, therefore flawed. When they are made regarding very small studies with very low statistical power, they are particularly deeply flawed.

Were these seven studies designed to fail? I don't think we can say for certain but they certainly *look* as if they may have been. They also raise the serious question about whether the industry may be corrupting the science, by using their knowledge of the roles of pulsation, window effects, frequency, cell type and polarization.

The SCENIHR 2015 document has 127 places in the 221 pages of text where the term “no effect” was found (these can be easily found by searching the document using “no effect” for the search terms (that also picks up “no effects” statements. The first two of these 127 places are used properly, to describe the null hypothesis. *Each of the other 125 should not be there*, with each of those 125 overstating the case and therefore, improperly supporting the industry propaganda case.

In any case, the only way to show that there are inconsistencies or conflicts in the EMF literature is to carefully repeat studies finding such effects, not to flood the literature with studies done under other conditions. The logic used throughout SCENIHR 2015 [73] of just counting numbers of studies is deeply flawed.

#### Summary of Flaws in SCENIHR 2015

The first set of flaws, is that SCENIHR is perfectly willing to make statements which they know or should have known are false. The most egregious example of this is the Speit/Schwarz controversy described at the beginning of this chapter where there are seven clear falsehoods *created by SCENIHR*, each of which greatly strengthens the telecommunications industry propaganda positions. There are many others, described in this chapter that are substantive, but less egregious than the Speit/Schwarz falsehoods.

There is a vast literature, both in the review literature and in the primary literature studies, that disagree strongly with the SCENIHR positions and are completely ignored by SCENIHR. In a few cases, such

studies are cited and very briefly discussed by SCENIHR but then they have no impact on the assessments that SCENIHR makes in the SCENIHR 2015 document [73]. The situation here is similar to an organization that has two sets of books, the fake books that are used in public and then a genuine set of books that includes all of the data that are too inconvenient to be included in the fake set of books.

The finally, we have three additional considerations which interact with each other to produce the completely bogus logic used by SCENIHR and by other organizations that have taken positions similar those taken by SCENIHR. One of those considerations comes from our knowledge that pulsation pattern, cell type, polarization and frequency can all influence biological effects and that there are exposure windows that produce much larger effects than are seen with either lower or higher intensities. Our knowledge of these factors mean that it is possible for the telecommunications industry to foster any number of studies where it is unlikely that statistically significant evidence of effects will be seen. I have presented examples where this may have been done. SCENIHR has often falsely stated that these studies show no effects as opposed to lack of statistical significance of any effects. SCENIHR 2015 document has 125 places where such bogus claims of “no effect” are found. They repeatedly claim the literature is inconsistent but studies done under different conditions are *not* inconsistent because they are more likely to be due to genuine biological heterogeneity of responses. The false logic described here is used, in turn, to support another highly pervasive false logic. I’ve documented where SCENIHR has simply counted numbers of studies showing so many findings of effects and some other number of findings of “no effect.” But these numbers are meaningless, when the studies are done under different conditions and where the “no effect” numbers can easily be inflated by studies designed to produce such results. They are also, of course, meaningless, when large numbers of studies that show effects are eliminated by SCENIHR by the simple process of pretending they don’t exist. You can see from this, that the entire logical framework behind the SCENIHR 2015 [73] document is completely bogus.

Lastly, before going on to 5G, there is one other thing I want to state here. In 2005, Dr. Jared Diamond published a book [111] entitled “Collapse: How Societies Choose to Fail or Succeed.” In it he documents how each society that “chose to fail,” chose paths that had some short term gains but also had much more severe longer-term consequences. This is exactly what we have been doing with the EMFs, except that the consequences are much more severe than the collapse of one society – here all of the advanced technology societies on earth are at great risk.

## **Chapter 6: The Great Risks of 5G: What We Know and What We Don’t Know**

We have already discussed two issues that are essential to understanding 5G. One is that pulsed EMFs are, in most cases, much more biologically active than are non-pulsed (often called continuous wave) EMFs. A second is that the EMFs act by putting forces on the voltage sensor of the VGCCs, opening these calcium channels and allowing excessive calcium ions to flow into the cell. The voltage sensor is extraordinarily sensitive to those electrical forces, such that the safety guidelines are allowing us to be exposed to EMFs that are something like 7.2 million times too high.

The reason that the industry has decided to go to the extremely high frequencies of 5G is that with such extremely high frequencies, it is possible to carry much more information via much more pulsation than it is possible to carry with lower frequencies even in the microwave range. We can be assured, therefore, that 5G will involve vastly more pulsation than do EMFs that we are currently exposed to. It follows from that, that any biological safety test of 5G must use the very rapid pulsations including whatever very short term spikes may be present, that are to be present in genuine 5G. There is an additional process that is planned to be used in 5G: phased arrays ([https://en.wikipedia.org/wiki/Phased\\_array](https://en.wikipedia.org/wiki/Phased_array)). Here multiple antenna elements act together to produce highly pulsed fields which are designed for 5G, to produce increased penetration. 5G will entail particularly powerful pulsations to be used, which may, therefore, be particularly hazardous.

The only data we have, to my knowledge, used *non-pulsed EMFs in the frequency range of 5G, not genuine 5G*. Any such data tells us almost nothing useful about 5G. I take it that from their statements, that both Mr. Ryan and Dr. Vinciūnas are ready to put out 10s of millions of 5G antennae to afflict every single person in the EU with 5G radiation without even a single biological test of safety of genuine 5G. (Note: the

FCC has taken an identical position' in parts of the U.S. 5G antennae are already being installed). In a world where shocking behavior has become less and less shocking, I consider their views to be genuinely shocking. The U.S. situation is mass insanity. I would have hoped that the Europeans, who think of themselves as being much more thoughtful than Americans, would have been genuinely more thoughtful.

Why does 5G need such high numbers of antennae? It is because the 5G radiation is much more absorbed as it enters various materials. The approach is to use many more antennae with one found every few houses, such that 5G can sufficiently penetrate local walls. Such absorption usually involves the interaction with electrically charged groups, such that such absorption is likely to involve placing forces on electrically charged groups. Because such forces are the way in which EMFs activate the VGCCs, it seems highly likely, therefore, that 5G radiation will be particularly active in VGCC activation.

In summary, then, 5G is predicted to be particularly dangerous for each of four different reasons: 1. The extraordinarily high numbers of antennae that are planned. 2. The very high energy outputs which will be used to ensure penetration. 3. The extraordinarily high pulsation levels. 4. The apparent high level interactions of the 5G frequency on charged groups presumably including the voltage sensor charged groups.

Now what the telecommunications industry argues is that 5G radiation will be mostly absorbed in the outer 1 or 2 mm of the body, such that they claim that we don't have to worry about the effects. There is some truth to that, but there are also some caveats that make any conclusions made from that, much more suspect. In any case, these surface effects of 5G will have especially strongly impact organisms with much higher surface to volume ratios. Consequently, I predict that many organisms will be much more impacted than we will. This includes insects and other arthropods, birds and small mammals and amphibia. It includes plants and even large trees, because trees have leaves and reproductive organs that are highly exposed. I predict there will be major ecological disasters as a consequence of 5G. This will include vast conflagrations because EMF exposures make plants much more flammable.

But let's get back to humans. The industry has also made claims that more conventional microwave frequency EMFs are limited in effect to the outer 1 cm of the body. We know that is not true, however because of the effects deep in the human brain, on the heart and on hormone systems. Perhaps the most important two studies demonstrating effects deep within the body are the studies of Professor Hässig and his colleagues in Switzerland on cataract formation in calves [112,113]. These two studies clearly show that when pregnant cows are grazing near mobile phone base stations (sometimes called cell phone towers), the calves are born with very greatly increased incidences of cataracts. It follows from these findings that even though the developing fetuses are very deep in the body of the mother and should be highly protected from the EMF exposures, they are not so protected. And because the EMF safety guidelines in Switzerland are 100 times more stringent than are the safety guidelines in most of the rest of Europe, the more general safety guidelines allow greatly excessive exposures. The claims of industry that microwave frequency EMFs only act in the outer centimeter of the body are clearly false.

How then can both conventional microwave frequency EMFs and 5G radiation act deeply within the body? You may correctly observe that the electrical effects of the EMFs activate the voltage sensor and that the direct electrical forces are rapidly attenuated in the body. So how can we get deep effects? I think the answer is that the magnetic parts of the EMFs have been known for decades to penetrate much more deeply than do the electrical parts. The magnetic fields put forces on mobile electrically charged groups dissolved in the aqueous phases of the body and small individual movements of the charged groups can regenerate electric fields that are essentially identical to the electric fields of the original EMFs, carrying the same frequency and same pulsation pattern, although with lower intensity. An example of this is given in the Lu and Ueno [114] study. Because the voltage sensor is so stunningly sensitive to electrical forces and part of the reason for that is the very high level of amplification of the electrical field across the plasma membrane, we have an almost perfect way in which to produce EMF effects deeply within our bodies.

This brings us back to the earlier point. The only way to do 5G safety testing is to do genuine 5G biological safety testing. I have published on how this can be done relatively easily at relatively low costs in any comparison with the gigantic risks that will be taken if we fail to do those tests. Those tests must be

done by organizations completely independent of industry and that leaves out both ICNIRP and SCENIHR and a lot of other organizations.

Dr. Vinciūnas' last full paragraph reads as follows: "The recourse to the EU's precautionary principle to stop distribution of 5G products appears too drastic a measure. We need first to see how this technology will be applied and how the scientific evidence will evolve. Please be assured that the Commission will keep abreast of the scientific evidence in view of safeguarding the health of European citizens at the highest level possible and in line with its mandate."

Article 191 defines the **Precautionary Principle** as follows:

"According to the European Commission the precautionary principle may be invoked when a phenomenon, **product or process may have a dangerous effect**, identified by a **scientific and objective evaluation**, **if this evaluation does not allow the risk to be determined with sufficient certainty**.

Recourse to the principle belongs in the general framework of **risk analysis** (which, besides risk evaluation, includes risk management and risk communication), and more particularly in the context of **risk management** which corresponds to the decision-making phase.

The Commission stresses that the precautionary principle may only be invoked in the event of a potential risk and that it can never justify arbitrary decisions.

The precautionary principle may only be invoked when the **three preliminary conditions** are met:

identification of potentially adverse effects;  
evaluation of the scientific data available;  
the extent of scientific uncertainty."

We know that there is a massive literature, providing a high level of scientific certainty, for each of these pathophysiological effects caused by non-thermal EMF exposures. This is shown in from 11 to 35 reviews on each specific effect, with each review listed in Chapter 1, providing a extremely large body of evidence on the existence of each effect.

1. Attack our nervous systems including our brains leading to widespread neuropsychiatric effects and possibly many other effects. This nervous system attack is of great concern.
2. Attack our endocrine (that is hormonal) systems. In this context, the main things that make us functionally different from single celled creatures are our nervous system and our endocrine systems – even a simple planaria worm needs both of these. Thus the consequences of the disruption of these two regulatory systems is immense, such that it is a travesty to ignore these findings.
3. Produce oxidative stress and free radical damage, which have central roles in essentially all chronic diseases.
4. Attack the DNA of our cells, producing single strand and double strand breaks in cellular DNA and oxidized bases in our cellular DNA. These in turn produce cancer and also mutations in germ line cells which produce mutations in future generations.
5. Produce elevated levels of apoptosis (programmed cell death), events especially important in causing both neurodegenerative diseases and infertility.
6. Lowers male and female fertility, lowers sex hormones, lowers libido and increases levels of spontaneous abortion and, as already stated, attacks on the DNA in sperm cells.
7. Produces excessive intracellular calcium [Ca<sup>2+</sup>]<sub>i</sub> and increased calcium signaling.
8. Attacks the cells of our bodies to cause cancer. Such attacks are thought to act via 15 different mechanisms during cancer causation.

Of course, the Commission has done nothing to protect European citizens from any of these very serious health hazards and the U.S. FCC, FDA, EPA and National Cancer Institute have done nothing to protect American citizens.

The question now is what about 5G? Here we have strong suspicions of similar or more severe risk than those listed immediately above but we have no biological safety testing of genuine 5G radiation. Therefore, we have no risk analysis or risk management because we have no risk assessment whatsoever on 5G. So here we have Dr. Vinciūnas arguing that the request for precautionary principle application is premature. But it is not the request for the use of the precautionary principle that is premature, it is the Commission's claim that it has done the required risk analysis and risk assessment. This is the bizarre world that we live in.

Let me close, as follows. There have been certain points in our history where people have stood up to strong destructive forces against what often appeared to be insurmountable odds. Those people are THE most honored people in our history. The people who failed to do so are among the most despised people in our history. I am not at all sure we will have historians to record us 100 years from now or even 30 years from now, given the direction in which we are heading. But if we do, rest assured that these are the standards by which you will be judged.

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