

# Scientific Panel on Electromagnetic Field Health Risks: Consensus Points, Recommendations, and Rationales

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Adamantia Fragopoulou,<sup>1</sup> Yuri Grigoriev,<sup>2</sup> Olle Johansson,<sup>3</sup> Lukas H Margaritis,<sup>1</sup>  
Lloyd Morgan,<sup>4</sup> Elihu Richter<sup>5</sup> and Cindy Sage<sup>6</sup>

<sup>1</sup>University of Athens, Athens, Greece; <sup>2</sup>Russian National Committee on Non-Ionizing Radiation Protection, Moscow (Russian Federation); <sup>3</sup>Karolinska Institute and The Royal Institute of Technology, Stockholm, Sweden; <sup>4</sup>Bioelectromagnetics Society, Berkeley, CA, USA; <sup>5</sup>Hebrew University-Hadassah School of Medicine, Jerusalem (Israel); <sup>6</sup>Sage Associates, Santa Barbara, CA, USA

**Summary:** In November, 2009, a scientific panel met in Seletun, Norway, for three days of intensive discussion on existing scientific evidence and public health implications of the unprecedented global exposures to artificial electromagnetic fields (EMF). EMF exposures (static to 300 GHz) result from the use of electric power and from wireless telecommunications technologies for voice and data transmission, energy, security, military and radar use in weather and transportation. The Scientific Panel recognizes that the body of evidence on EMF requires a new approach to protection of public health; the growth and development of the fetus, and of children; and argues for strong preventative actions. New, biologically-based public exposure standards are urgently needed to protect public health worldwide.

**Keywords:** EMF, wireless telecommunications technology, radiofrequency, non-ionizing radiation, non-thermal effects, long-term effects, public exposure guidelines, public health

**Correspondence:** Professor Olle Johansson, The Experimental Dermatology Unit, Department of Neuroscience, Karolinska Institute, 171 77 Stockholm, and The Royal Institute of Technology, 100 44, Stockholm (Sweden). E-mail: olle.johansson@ki.se

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## BACKGROUND

In November, 2009, a scientific panel met in Seletun, Norway, for three days of intensive discussion on existing scientific evidence and public health implications of the unprecedented global exposures to artificial electromagnetic fields (EMF).

EMF exposures (static to 300 GHz) result from the use of electric power and from wireless telecommunications technologies for voice and data transmission, energy, security, military and radar use in weather and transportation.

The Scientific Panel recognizes that the body of evidence on EMF requires a new approach to

protection of public health; the growth and development of the fetus, and of children; and argues for strong preventative actions. These conclusions are built upon prior scientific and public health reports /1-6/ documenting the following:

- 1) *Low-intensity (non-thermal) bioeffects and adverse health effects are demonstrated at levels significantly below existing exposure standards.*
- 2) *ICNIRP and IEEE/FCC public safety limits are inadequate and obsolete with respect to prolonged, low-intensity exposures.*

3) *New, biologically-based public exposure standards are urgently needed to protect public health world-wide.*

4) *It is not in the public interest to wait.*

Strong concern has been voiced by the public, and by scientists as well as public health and environmental policy experts, that the deployment of technologies that expose billions of people worldwide to new sources of EMF may pose a pervasive risk to public health. Such exposures did not exist before the “age of industry and information”. Prolonged exposure appears to disrupt biological processes that are fundamental to plant, animal and human growth and health. Life on earth did not evolve with biological protections or adaptive biological responses to these EMF exposures. Exceptionally small levels of EMF from earth and space existed during the time that all life evolved on earth on the order of less than a billionth to one ten-billionth of a Watt per meter squared. A rapidly accumulating body of scientific evidence of harm to health and well-being constitute warnings that adverse health effects can occur with prolonged exposures to very low-intensity EMF at biologically active frequencies or frequency combinations.

The Seletun Scientific Panel has adopted a Consensus Agreement that recommends preventative and precautionary actions that are warranted now, given the existing evidence for potential global health risks. We recognize the duty of governments and their health agencies to educate and warn the public, to implement measures balanced in favor of the Precautionary Principle, to monitor compliance with directives promoting alternatives to wireless, and to fund research and policy development geared toward prevention of exposures and development of new public safety measures.

#### POINTS OF AGREEMENT

- Global populations are not sufficiently protected from electromagnetic fields (EMF)

from emerging communication and data transmission technologies that are being deployed worldwide, affecting billions of people;

- Sensitive populations (for example, the elderly, the ill, the genetically and/or immunologically challenged) and children and fetuses may be additionally vulnerable to health risks; their exposures are largely involuntary and they are less protected by existing public safety standards;
- It is well established that children are more vulnerable to health risks from environmental toxins in general;
- It is established that the combined effects of chemical toxins and EMF together is greater than either exposure alone;
- The Seletun Scientific Panel takes note of international scientific reviews, resolutions and recommendations documenting scientific and public health evidence on EMF exposures;
- The Seletun Scientific Panel notes that complete “*consistency*” of study findings is not to be expected, and it should not be interpreted as a necessary pre-condition for a consensus linking EMF exposure to health impacts. “*Consistency in nature does not require that all or even a majority of studies find the same effect. If all studies of lead showed the same relationship between variables, one would be startled, perhaps justifiably suspicious*” /7/;
- The Seletun Scientific Panel acknowledges that some, but not all, of these exposures support preventative and precautionary action, and the need for more stringent public health limits;
- The Panel takes note of international scientific resolutions and expressions of concern including the Salzburg, Catania, Freiburger Appeal, Helsinki, Irish Doctors (IDEA), Benevento, Venice, London, and Porto Alegre Resolutions (2000-2009);
- The Panel is guided by previously recommended target limits for EMF exposure

in the BioInitiative Report (2007) and the London Resolution (2009);

- The Panel urges governments to adopt an explicit statement that “the standard for judging and acting on the scientific evidence shall be based on prudent public health planning principles rather than scientific certainty of effect (causal evidence)”. Actions are warranted based on limited or weak scientific evidence, or a sufficiency of evidence – rather than a conclusive scientific evidence (causation or scientific certainty) where the consequence of doing nothing in the short term may cause irreparable public health harm, where the populations potentially at risk are very large, where there are alternatives without similar risks, or where the exposures are largely involuntary;
- The Seletun Scientific Panel urges governments to make explicit that the burden of proof of safety rests with the producers and providers of EMF-producing technologies, not with the users and consumers.

**THE SELETUN SCIENTIFIC PANEL  
UNANIMOUSLY ENDORSES THESE GENERAL  
AGREEMENTS AND GENERAL AND SPECIFIC  
RECOMMENDATIONS**

**General Agreements from the Seletun Scientific Panel**

- The Seletun Scientific Panel has identified specific scientific and public health benchmarks for numeric limits and preventative action that are justified now based on the existing body of evidence;
- The Panel is relying on scientific evidence as the basis for identifying scientific benchmarks establishing EMF levels associated with adverse health effects. The Panel notes that radiofrequent (RF) levels in some regions may

already exceed scientific benchmarks for health harm identified here, but political expediency is not the guiding criterion in this assessment;

- EMF exposures should be reduced now rather than waiting for proof of harm before acting. This recommendation is in keeping with traditional public health principles, and is justified now given abundant evidence that biological effects and adverse health effects are occurring at exposure levels many orders of magnitude below existing public safety standards around the world;
- SAR (Specific Absorption Rate) is not an adequate approach to predict many important biologic effects in studies that report increased risks for cancer, neurological diseases, impairments to immune function, fertility and reproduction, and neurological function (cognition, behaviour, performance, mood status, disruption of sleep, increased risk for auto collisions, etc);
- SAR fails to adequately address known effects from modulation.

**General Recommendations from the Seletun Scientific Panel**

- The Seletun Scientific Panel recommends an international registry be established to track time-trends in incidence and mortality for cancers and neurological and immune diseases. Tracking effects of EMF on children and sensitive EHS populations is a high priority. There should be open access to this information;
- The Panel recommends existing brain tumour registries provide timely age-specific incidence rates. An early indication of brain tumors from mobile (cell) phone use could be in the younger age-specific incidence rates. Where such brain tumors registries to not exist, they should be established;

- Intervention-related epidemiological studies are needed to track the efficacy of intervention(s) that reduce or eliminate exposures to EMF;
- There is a need for mandatory pre-market assessments of emissions and risks before deployment of new wireless technologies. There should be convincing evidence that products do not cause health harm before marketing;
- For occupational exposures, there has been epidemiological evidence as well as clusters and case reports which state the ‘case for action’ and stringent control measures based on classic industrial hygiene principles (separation, distancing and enclosure). Further, there is need for surveillance markers of hematologic, immunotoxic and chromosome aberrations;
- The Panel discourages use of more lenient safety standards for workers, as compared to the general public. Separate safety limits are not ethically acceptable. Workers include women of childbearing age and men who wish to retain their fertility. Occupational environments where wireless exposures are common may be potentially hazardous to fertility and reproduction (retail and restaurant workers, transit workers, telecommunications and broadcast workers, medical workers, educators, administrators, etc) and those with other exposures or special health risks;
- The Panel strongly recommends that persons with electrohypersensitivity symptoms (EHS) be classified as functionally impaired rather than with ‘idiopathic environmental disease’ or similar indistinct categories. This terminology will encourage governments to make adjustments in the living environment to better address social and well-being needs of this subpopulation of highly sensitive members of society.

### **General Research Recommendations from the Seletun Scientific Panel**

- Research funding is urgently needed for assays for biological markers [*EMF bioassays as biological markers of EMF dose*] which show promise to measure adverse health effects, and biological effects that, with prolonged or repetitive exposure, can reasonably be presumed to lead to harmful health consequences (biomarkers from cerebrospinal fluid, saliva, immune function changes, and DNA damage to name some);
- The Scientific Panel recommends research funding for studies on bioactive modulation which may, based on current knowledge, cause major consequences at far lower exposure levels based on different exposure parameters including modulation, frequency windows, intensity windows, duration, geomagnetic field and other factors;
- Research is urgently recommended for effects of prolonged or repetitive wireless exposure on children (cancers, neurological diseases, and impairment of cognition, behavior, performance and mood status, and disruption of sleep, etc) ;
- Research in SAR refinements is given a low priority. The scientific panel is in unanimous agreement that SAR is a poor measurement tool. Yet SARs have been used in many key studies reporting increased risk of DNA damage, increased risk for brain cancer, increased risk for acoustic neuroma, and reduced sperm quality parameters, among others. SAR measures only one aspect of exposure and ignores other critical aspects, such as biologically active frequencies (and modulations) that is essential information needed to understand the biological responses induced by EMF over short and long term exposures (e.g., nervous system response and

tissue/organ development, respectively) that does not cause thermal damage so that effective, biologically protective limits can be developed.

### **Specific Recommendations from the Seletun Scientific Panel**

#### *Extremely Low Frequency (Fields from Electrical Power)*

- Based on the available evidence, the Seletun Scientific Panel recommends a 0.1 uT (1 mG) exposure limit for all new installations based on findings of risk for leukemia, brain tumours, Alzheimer's, ALS, sperm damage and DNA strand breaks. This exposure limit does not include a safety margin;
- For all newly installed, or newly upgraded electrical power distribution, the Panel recommends a 0.1 uT (1 mG) set-back distance, from residences, hospitals, schools, parks, and playgrounds schools (and similar locations occupied by children) [A 0.1 uT (1 mG) time-weighted average (TWA) using peak loading for transmission lines to ensure that average is about half of this for typical exposures; or equivalent for long-term exposure in interior EMF environments (wiring, trans-formers, appliances, others).];
- For all newly constructed residences, offices, schools (and other facilities with children), and hospitals there shall be a 0.1 uT (1 mG) max. 24 hour average exposure limit;
- For all new equipment (e.g. transformers, motors, electronic products), where practical, the Panel recommends a 0.1 uT (1 mG) max. 24 hour average exposure limit. Where not practical (e.g. large power transformers), there should be a fence, or boundary marker, with clearly written warning labels that states that within the boundary area the 0.1 uT (1 mG) maximum, 24 hour average exposure limit is exceeded;

- The Panel recommends all countries should adopt electrical code requirements to disallow conduction of high-frequency voltage transients back into electrical wiring systems;
- All new electronic devices including compact fluorescent lamps (CFLs) should be constructed with filters to block high-frequency voltage transients from being conducted back onto electrical wiring systems;
- The Panel recommends electric field reductions from electrical wiring in buildings based on evidence of increased cancer risk from prolonged or repetitive electric field exposure. The United States National Electrical Code (NEC) and other governmental codes relating to building design and construction should be revised so that all new electrical wiring is enclosed in a grounded metal shield;
- The United States NEC and other governmental codes that disallow net current on electrical wiring should be better enforced, and ground fault interrupters (GFIs) should be installed on all electrical circuits in order to reduce net current.

#### *Radiofrequency/Microwave Radiation Exposure Limit Recommendations*

Present guidelines, such as IEEE, FCC, and ICNIRP, are not adequate to protect humans from harmful effects of chronic EMF exposure. The existing scientific knowledge is, however, not sufficient at this stage to formulate final and definite science-based guidelines for all these fields and conditions, particularly for such chronic exposure as well as contributions of the different parameters of the fields, e.g. frequency, modulation, intensity, and window effects. The values suggested below are, thus, provisional and may be altered in the future.

- For whole-body (in vivo experiments) or cell culture-based exposure, the Seletun Scientific Panel finds sufficient evidence to establish a

scientific benchmark for adverse health effect at 0.0166 W/kg based on at least 32 scientific studies reporting low-intensity effects (defined as studies reporting effects at exposures of 0.1 W/kg or lower) /8-39/.

- The Panel recommends a provisional whole-body limit of 0.00033 W/kg by incorporation of an additional 50-fold safety margin applied to the scientific benchmark of 0.0166 W/kg. This is consistent with both ICNIRP and IEEE/FCC safety factors. An additional 10-fold reduction is applied to take prolonged exposure into account (because 29 of the 32 studies are acute exposure only), giving a final whole-body limit of 0.000033 W/kg (33  $\mu$ W/kg). No further safety margin or provision for sensitive populations is incorporated. This may need to be lowered in the future.
- Based on power density measurements, the Seletun Scientific Panel finds sufficient evidence for a whole-body scientific benchmark for adverse health effect exists down to 85 mW/m<sup>2</sup> (0.0085 mW/cm<sup>2</sup> or 8.5  $\mu$ W/cm<sup>2</sup>) based on at least 17 scientific studies reporting low-intensity effects on humans. Taking more recent human studies conducted near base stations, or at base-station RF levels, Kundi and Hutter /57/ report that the levels must exceed 0.5-1.0 mW/m<sup>2</sup> (0.05 to 0.1  $\mu$ W/cm<sup>2</sup>) for effects to be seen; /40-57/.
- The Panel recommends a provisional whole-body (far-field) limit of 1.7 mW/m<sup>2</sup> (also = 0.00017 mW/cm<sup>2</sup> = 0.17  $\mu$ W/cm<sup>2</sup>) by incorporation of an additional 50-fold safety margin applied to the scientific benchmark of 85 mW/m<sup>2</sup>. This is consistent with both ICNIRP and IEEE/FCC safety factors. This may need to be lowered in the future.
- It can be argued that a further 10-fold reduction is not justified since 13 of the 17 studies are already testing for long-term RF exposure. However, considering that the latest human population studies as reported by Kundi & Hutter (2009) do not show effects

below 0.5-1.0 mW/m<sup>2</sup>, it can also then be argued that an additional 10-fold reduction on precautionary grounds is justified. If another 10-fold reduction is applied, the recommended level would then be 0.17 mW/m<sup>2</sup> (also 0.000017 mW/cm<sup>2</sup> = 0.017  $\mu$ W/cm<sup>2</sup>);

- The Seletun Scientific Panel recommends these numeric limits to governments and health agencies for adoption in place of ICNIRP, IEEE/FCC and other outdated public safety guidelines and limits in use around the world. This approach is based on traditional public health principles that support taking actions to protect public health when sufficient evidence is present. Sufficient scientific evidence and public health concern exist today based on increased risk for cancer, adverse fertility and reproductive outcomes, immune disruption, neurological diseases, increased risk of road collisions and injury-producing events, and impairment of cognition, behaviour, performance, mood status, and disruption of sleep;
- Numeric limits recommended here do not yet take into account sensitive populations (EHS, immune-compromised, the fetus, developing children, the elderly, people on medications, etc). Another safety margin is, thus, likely justified further below the numeric limits for EMF exposure recommended here;
- The Scientific Panel acknowledges that numeric limits derived here for new biologically-based public exposure standards are still a billion times higher than natural EMF levels at which all life evolved.

*Specific Recommendations for mobile (cell) and cordless phone use*

- The Seletun Scientific Panel recommends that users keep mobile (cell) phones away from head and body;
- The Seletun Scientific Panel recommends that users keep mobile (cell) phones and PDAs\* switched off if worn or carried in a pocket or

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holster, or on a belt near the body.

\*PDA is generic for any type of Personal Digital Assistant or hand-held computer device;

- The Panel strongly recommends against the use of mobile (cell) and cordless phones and PDAs by children of any age;
- The Panel strongly recommends against the use of mobile (cell) and cordless phones and PDAs by pregnant women;
- The Panel recommends that use of mobile (cell) and cordless phones and PDAs be curtailed near children or pregnant women, in keeping with preventative and precautionary strategies. The most vulnerable members of society should have access to public places without fear of harm to health;
- Public access to public places and public transportation should be available without undue risk of EMF exposure, particularly in enclosed spaces (trains, airplanes, buses, cars, etc) where the exposure is likely to be involuntary;
- The Panel recommends wired internet access in schools, and strongly recommends that schools do not install wireless internet connections that create pervasive and prolonged EMF exposures for children;
- The Panel recommends preservation of existing land-line connections and public telephone networks;
- The Panel recommends against the use of cordless phones (DECT phones) and other wireless devices, toys and baby monitors, wireless internet, wireless security systems, and wireless power transmitters in SmartGrid-type

connections that may produce unnecessary and potentially harmful EMF exposures;

- The Panel recognizes that wired internet access (cable modem, wired Ethernet connections, etc) is available as a substitute;
- The Panel recommends use of wired headsets, preferably with hollow-tube segments;
- The Panel recommends avoidance of wireless (Bluetooth-type) headsets in general;
- The Panel encourages the removal of speakers from headsets on wireless phones and PDAs;
- The Panel encourages ‘auto-off switches’ for mobiles (cells) and PDAs that automatically turn off the device when placed in a holster;
- The Panel strongly discourages the technology that allows one mobile (cell) phone to act as a repeater for other phones within the general area. This can increase exposures to EMF that are unknown to the person whose phone is “piggy-backed” upon without their knowledge or permission;
- The Panel recommends the use of telephone lines (land-lines) or fiber optic cables for SmartGrid type energy conservation infrastructure. Utilities should choose options that do not create new, community-wide exposures from wireless components of SmartGrid-type projects. Future health risks from prolonged or repetitive wireless exposures of SmartGrid-type systems may be avoided by using telephone lines or fiber-optic cable. The Panel endorses energy conservation but not at the risk of exposing hundreds of millions of families in their homes to a new, involuntary source of wireless radiofrequency radiation.

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The undersigned recognize the duty of governments and their health agencies to educate and warn the public, to implement measures balanced in favor of the Precautionary Principle, to monitor compliance with directives promoting alternatives to wireless, and to fund research and policy development geared toward prevention of exposure.

The undersigned urge governments and their health agencies to adopt new interim numeric limits and new timetables for implementation of biologically-based precautionary action to limit exposures to EMF.

### **Agreed 19 November 2009**

(as revised through April 20, 2010)

(*in alphabetical order*)

Adamantia Fragopoulou, Greece	Yuri Grigoriev, Russia
Olle Johansson, Sweden	Lukas H Margaritis, Greece
Lloyd Morgan, USA	Elihu Richter, Israel
Cindy Sage, USA	

### **Affiliations**

(*in alphabetical order*)

Adamantia Fragopoulou, Ph.D. Candidate, Department of Cell Biology and Biophysics, Faculty of Biology, University of Athens, Athens (Greece)

Yury Grigoriev, Professor, Dr of Med Sci, Chairman of Russian National Committee on Non-Ionizing Radiation Protection, Moscow (Russian Federation)

Olle Johansson, professor, The Experimental Dermatology Unit, Department of Neuroscience, Karolinska Institute, and The Royal Institute of Technology, Stockholm (Sweden)

Lukas H Margaritis, professor, Department of Cell Biology and Biophysics, Faculty of Biology, University of Athens, Athens (Greece)

Lloyd Morgan, Bioelectromagnetics Society, 2022 Francisco Street, Berkeley, CA 94709, USA

Elihu D Richter, Professor, Unit of Occupational and Environmental Medicine, Hebrew University-Hadassah School of Medicine, Jerusalem (Israel)

Cindy Sage, MA, Sage Associates, Santa Barbara, CA, USA

### **REFERENCES**

1. Pathophysiology 2009; 16
2. European Parliament, Mid-Term Review of the European Environmental and Health Action Plan 2009; [http://www.europarl.europa.eu/news/expert/briefing\\_page/33692-245-09-36-20080708BRI33691-01-09-2008-2008/default\\_p001c023\\_en.htm](http://www.europarl.europa.eu/news/expert/briefing_page/33692-245-09-36-20080708BRI33691-01-09-2008-2008/default_p001c023_en.htm)
3. European Environmental Agency 2007. <http://www.eea.europa.eu/highlights/radiation-risk-from-everyday-devices-assessed>
4. Blackman CF, Blank M, Kundi M, Sage C, Carpenter DO, Davanipour Z, et al. The Bioinitiative Report—A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF). <http://www.bioinitiative.org, 2007>.
5. European Commission Health and Consumer Protection Directorate-General Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR), Possible Effects of Electromagnetic Fields (EMF on Human Health 2007 (Sections on scientific evidence).
6. REFLEX Consortium, Risk evaluation of potential environmental hazards from low energy electromagnetic field exposure using sensitive in vitro methods. A project funded by the European Union under the 5<sup>th</sup> Framework Programme.



- Contract QLK4-CT-1999-01574, 2004; 292 pp, <http://www.verum-foundation.de/reflex>
7. Needleman HL. Making models of real world events: the use and abuse of inference. *Neurotoxicol Teratol* 1995;17: 241-2; discussion 249-51
  8. Belyaev IY, Hillert L, Protopopova M, Tamm C, Malmgren LO, Persson BR, Selivanova G, et al. 915 MHz microwaves and 50 Hz magnetic field affect chromatin conformation and 53BP1 foci in human lymphocytes from hypersensitive and healthy persons. *Bioelectromagnetics* 2005;26: 173-184.
  9. Belyaev IY, Markovà E, Hillert L, Malmgren LO, Persson BR. Microwaves from UMTS/GSM mobile phones induce long-lasting inhibition of 53BP1/gamma-H2AX DNA repair foci in human lymphocytes. *Bioelectromagnetics* 2009;30:129-41.
  10. Capri M, Scarcella E, Fumelli C, Bianchi E, Salvioli S, Mesirca P, et al. In vitro exposure of human lymphocytes to 900 MHz CW and GSM modulated radiofrequency: studies of proliferation, apoptosis and mitochondrial membrane potential. *Radiat Res* 2004; 162: 211-218.
  11. de Pomerai DI, Smith B, Dawe A, North K, Smith T, Archer DB, et al. Microwave radiation can alter protein conformation without bulk heating. *FEBS Lett* 2003; 543: 93-97.
  12. D'Inzeo G, Bernardi P, Eusebi F, Grassi F, Tamburello C, Zani BM. Microwave effects on acetylcholine-induced channels in cultured chick myotubes. *Bioelectromagnetics* 1988; 9: 363-372.
  13. Dutta SK, Ghosh B, Blackman CF. Radiofrequency radiation-induced calcium ion efflux enhancement from human and other neuroblastoma cells in culture. *Bioelectromagnetics* 1989; 10: 197-202.
  14. Forgacs Z, Somosy Z, Kubinyi G, Bakos J, Hudak A, Surjan A, et al. Effect of whole-body 1800MHz GSM-like microwave exposure on testicular steroidogenesis and histology in mice. *Reprod Toxicol* 2006; 22: 111-117.
  15. Ivaschuk OI, Jones RA, Ishida-Jones T, Haggren W, Adey WR, Phillips JL. Exposure of nerve growth factor-treated PC12 rat pheochromocytoma cells to a modulated radiofrequency field at 836.55 MHz: effects on c-jun and c-fos expression. *Bioelectromagnetics* 1997; 18: 223-9.
  16. Jech R, Sonka K, Ruzicka E, Nebuzelsky A, Bohm J, Juklickova M, et al. Electromagnetic field of mobile phones affects visual event related potential in patients with narcolepsy. *Bioelectromagnetics* 2001; 22: 519-28.
  17. Kesari KK, Behari J. Fifty-gigahertz microwave exposure effect of radiations on rat brain. *Appl Biochem Biotechnol* 2009; 158: 126-139.
  18. Kwee S, Raskmark P, Velizarov P. Changes in cellular proteins due to environmental non-ionizing radiation. I. Heat-shock proteins. *Electro- and Magnetobiology* 2001; 20: 141-152.
  19. Lerchl A, Krüger H, Niehaus M, Streckert JR, Bitz AK, Volkert Hansen V. Effects of mobile phone electromagnetic fields at nonthermal SAR values on melatonin and body weight of Djungarian hamsters (*Phodopus sungorus*), *J Pineal Res* 2008; 44: 267-272.
  20. Markovà E, Hillert L, Malmgren L, Persson BR, Belyaev IY. Microwaves from GSM mobile telephones affect 53BP1 and gamma-H2AX foci in human lymphocytes from hypersensitive and healthy persons. *Environ Health Perspect* 2005; 113: 1172-1177.
  21. Marinelli F, La Sala D, Ciccio G, Cattini L, Trimarchi C, Putti S, et al. Exposure to 900 MHz electromagnetic field induces an unbalance between pro-apoptotic and pro-survival signals in T-lymphoblastoid leukemia CCRF-CEM cells. *J Cell Physiol* 2004; 198: 324-332.
  22. Navakatikian MA, Tomashevskaya LA. Phasic behavioral and endocrine effects of microwaves of nonthermal intensity. In: Carpenter DO, ed. *Biological effects of electric and magnetic fields*, Volume 1. San Diego, CA: Academic Press, 1994;333-342.
  23. Nittby H, Grafström G, Tian DP, Malmgren L, Brun A, Persson BR, et al. Cognitive impairment in rats after long-term exposure to GSM-900 mobile phone radiation. *Bioelectromagnetics* 2007; 29: 219-232.
  24. Pérez-Castejón C, Pérez-Bruzón RN, Llorente M, Pes N, Lacasa C, Figols T, Lahoz M, et al. Exposure to ELF-pulse modulated X band microwaves increases in vitro human astrocytoma cell proliferation. *Histol Histopathol* 2009;24:1551-61.
  25. Persson BRR, Salford LG, Brun A. Blood-brain barrier permeability in rats exposed to electromagnetic fields used in wireless communication. *Wireless Network* 1997; 3: 455-461.
  26. Phillips JL, Ivaschuk O, Ishida-Jones T, Jones RA, Campbell-Beachler M, Haggren W. DNA damage in Molt-4 T-lymphoblastoid cells exposed to cellular telephone radiofrequency fields in vitro. *Bioelectrochem Bioenerg* 1998;

- 45: 103-110.
27. Pырpasopoulou A, Kotoula V, Cheva A, Hytiroglou P, Nikolakaki E, Magras IN, et al. Bone morphogenetic protein expression in newborn rat kidneys after prenatal exposure to radiofrequency radiation. *Bioelectromagnetics* 2004; 25: 216-227.
  28. Salford LG, Brun AR, Eberhardt JL, Malmgren L, Persson BRR, Nerve cell damage in mammalian brain after exposure to microwaves from GSM mobile phones. *Environ Health Persp* 2003; 111: 881-883.
  29. Sarimov R, Malmgren LO, Markova E, Persson BR, Belyaev IY. Nonthermal GSM microwaves affect chromatin conformation in human lymphocytes similar to heat shock. *IEEE Trans Plasma Sci* 2004; 32: 1600-1608.
  30. Schwartz JL, House DE, Mealing GA. Exposure of frog hearts to CW or amplitude-modulated VHF fields: selective efflux of calcium ions at 16 Hz. *Bioelectromagnetics* 1990; 11: 349-358.
  31. Schwarz C, Kratochvil E, Pilger A, Kuster N, Adlkofer F, Rüdiger HW. Radiofrequency electromagnetic fields (UMTS, 1,950 MHz) induce genotoxic effects in vitro in human fibroblasts but not in lymphocytes. *Int Arch Occup Environ Health* 2008; 81: 755-767.
  32. Somosy Z, Thuroczy G, Kubasova T, Kovacs J, Szabo LD. Effects of modulated and continuous microwave irradiation on the morphology and cell surface negative charge of 3T3 fibroblasts. *Scanning Microsc* 1991; 5: 1145-1155.
  33. Stagg RB, Thomas WJ, Jones RA, Adey WR. DNA synthesis and cell proliferation in C6 glioma and primary glial cells exposed to a 836.55 MHz modulated radiofrequency field. *Bioelectromagnetics* 1997; 18: 230-236.
  34. Stankiewicz W, Dąbrowski MP, Kubacki R, Sobiczewska E, Szmigielski S, Immunotropic influence of 900 MHz microwave GSM signal on human blood immune cells activated in vitro. *Electromagn Biol Med* 2006; 25: 45-51.
  35. Tattersall JE, Scott IR, Wood SJ, Nettell JJ, Bevir MK, Wang Z, et al. Effects of low intensity radiofrequency electromagnetic fields on electrical activity in rat hippocampal slices. *Brain Res* 2001; 904: 43-53.
  36. Velizarov S, Raskmark P, Kwee S, The effects of radiofrequency fields on cell proliferation are non-thermal. *Bioelectrochem Bioenerg* 1999; 48: 177-180.
  37. Veyret B, Bouthet C, Deschaux P, de Seze R, Geffard M, Jousset-Dubien J, et al. Antibody responses of mice exposed to low-power microwaves under combined, pulse-and-amplitude modulation, *Bioelectromagnetics* 1991; 12: 47-56.
  38. Wolke S, Neibig U, Elsner R, Gollnick F, Meyer R. Calcium homeostasis of isolated heart muscle cells exposed to pulsed high-frequency electromagnetic fields. *Bioelectromagnetics* 1996; 17:144-153.
  39. Yurekli AI, Ozkan M, Kalkan T, Saybasili H, Tuncel H, Atukeren P, et al. GSM base station electromagnetic radiation and oxidative stress in rats, *Electromagn Biol Med* 2006; 25: 177-188
  40. Boscol P, Di Sciascio MB, D'Ostilio S, Del Signore A, Reale M, Conti P, et al. Effects of electromagnetic fields produced by radiotelevision broadcasting stations on the immune system of women, *Sci Total Environ* 2001; 273: 1-10.
  41. Chiang H, Yao GD, Fang QS, Wang KQ, Lu DZ, Zhou YK. Health effects of environmental electromagnetic fields. *J Bioelectricity* 1989;8:127-31.
  42. D'Inzeo G, Bernardi P, Eusebi F, Grassi F, Tamburello C, Zani BM. Microwave effects on acetylcholine-induced channels in cultured chick myotubes. *Bioelectromagnetics* 1988; 9: 363-372.
  43. Fesenko EE, Makar VR, Novoselova EG, Sadovnikov VB. Microwaves and cellular immunity. I. Effect of whole body microwave irradiation on tumor necrosis factor production in mouse cells. *Bioelectrochem Bioenerg* 1999; 49: 29-35.
  44. Hjøllund NH, Bonde JP, Skotte J. Semen analysis of personnel operating military radar equipment. *Reprod Toxicol* 1997; 11: 897.
  45. Hutter H-P, Moshammer H, Wallner P, Kundi M. Subjective symptoms, sleeping problems, and cognitive performance in subjects living near mobile phone base stations. *Occup Environ Med* 2006; 63: 307-313.
  46. Kolodynski AA, Kolodynska VV. Motor and psychological functions of school children living in the area of the Skrunda Radio Location Station in Latvia. *Sci Total Environ* 1996; 180: 87-93.
  47. Lebedeva NN, Sulimov AV, Sulimova OP, Kotrovskaya TI, Gailus T. Cellular phone electromagnetic field effects on bioelectric activity of human brain. *Crit Rev Biomed Eng* 2000; 28: 323-337.
  48. Magras IN, Xenos TD. RF radiation-induced changes in the prenatal development of mice. *Bioelectromagnetics* 1997; 18: 455-461.

49. Mann K, Wagner P, Brunn G, Hassan F, Hiemke C, Roschke J. Effects of pulsed high-frequency electromagnetic fields on the neuroendocrine system. *Neuroendocrinology* 1998; 67: 139-144.
50. Navarro EA, Segura J, Portoles M, Gomez-Perretta de Mateo C. The microwave syndrome: a preliminary study in Spain. *Electromag Biol Med* 2003; 22: 161-169.
51. Novoselova EG, Fesenko EE, Makar VR, Sadovnikov VB. Microwaves and cellular immunity. II. Immunostimulating effects of microwaves and naturally occurring antioxidant nutrients. *Bioelectrochem Bioenerg* 1999; 49: 37-41.
52. Novoselova EG, Ogay VB, Sorokina OV, Glushkova OV, Sinotova OA, Fesenko EE. The production of tumor necrosis factor in cells of tumor-bearing mice after total-body microwave irradiation and antioxidant diet. *Electromag Biol Med* 2004; 23: 167-180.
53. Oberfeld G, Enrique NA, Manuel P, Ceferino M, Gomez-Perretta C. The microwave syndrome—further aspects of a Spanish study, 3<sup>rd</sup> International Workshop on Biological Effects of Electromagnetic Fields, Kos, Greece, 2004.
54. Pologea-Moraru R, Kovacs E, Iliescu KR, Calota V, Sajin G. The effects of low level microwaves on the fluidity of photoreceptor cell membrane. *Bioelectrochemistry* 2002; 56: 223-225.
55. Thomas S, Kühnlein A, Heinrich S, Praml G, Nowak D, von Kries R, et al. Personal exposure to mobile phone frequencies and well-being in adults: a cross-sectional study based on dosimetry. *Bioelectromagnetics* 2008;29:463-70.
56. Zwamborn AP, Vossen SH, van Leersum BJ, Ouwens MA, Mäkel WN. Effects of global communication system radiofrequency fields on well being and cognitive functions of human subjects with and without subjective complaints, TNO-report FEL-03-C148 2003; 148: 1-89
57. Kundi M Hutter HP. Mobile phone base stations—Effects on wellbeing and health. *Pathophysiology* 2009; 16: 123-35.