

**1st HELLENIC CONGRESS ON THE EFFECTS OF
ELECTROMAGNETIC RADIATION WITH INTERNATIONAL
PARTICIPATION**



May 24-25, 2008

Thessaloniki, Greece

Proceedings

**Under the Auspices: Ministry of Education and Religion and the Municipality of
Thessaloniki**

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**Comercial and Industrial Chamber of Commerce
Tsimiski 29, Thessaloniki**

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P R E F A C E

The concept for organizing this conference arose gradually and on the occasion of the continuous and rapid, the last years, drifts in the research for the venturous ness of the non-ionizing radiation. The accumulated and sometimes contradicted information-papers-statements in conferences or at the Press have created confusion at both scientists and citizens- the final receivers of the services provided by devices that create the non-ionizing radiation. The radiation that in some cases is an end product in itself, e.g. mobile phones, wireless phones, wireless networks, and other cases is the by-product that comes from the function of devices, e.g. magnetic field from transportation and consumption of electric power. In our country there is sufficient information towards the citizens for these matters, mostly by the media that indeed buckle extensively and regularly with this topic. At the same time, there is in our country the critical mass of scientists relevant to the subject of radiation, so that a constructive dialogue can be actualized whenever it comes up. On the other hand, the government has voted recently on the “acceptable – safety - limits of exposure” with a law that was passed in the Parliament (law 4331/2006). The law states these limits at 70% and in some cases at 60% of those proposed by the World Health Organization. But because in many other countries these limits are stricter, there is a continuous disquiet from the citizens regarding the venturous ness of the radiation from radio-TV stations and especially that from the mobile phone base stations. This disquiet in connection to the constantly rising appeals the scientists for wise use of mobile phones by children, but with the given relevant research that we conduct in Greece as well, has driven us to the decision to organize this Conference. Our major issue has been the invitation of leading scientists in the field of electromagnetic biology, for the first time in our country in order to testify their point of view for the findings of their research. In this attempt we have been supported by the Ministry of Education, the University of Athens, the Municipality of Thessalonica and the Prefecture of Thessalonica to whom we express our thanks.

We hope that the findings of this Conference will be proven useful for both the citizens- receivers of the radiation technology, and the government in order to reconsider the safety guidelines.

On behalf of the Organizing Committee

Lukas H. Margaritis
Professor of Cell Biology and Radiobiology
Faculty of Biology
Athens University

PROGRAMME

SATURDAY, MAY 24th 2008

Moderators: L. H. Margaritis, K. Triantafillidis

- 19:00-19:20** Opening Remarks and Greetings
- 19:20-19:40** Non ionized electromagnetic radiation. Benefits and risks.
L. H. Margaritis
- 19:40-20:00** Biological effects of high voltage lines's electromagnetic fields.
K. Triantafillidis
- 20:00-20:20** Are the basic restrictions as suggested by ICNIRP, WHO and the EN50166-2 really safe?
T. Xenos
- 20:20-20:35** **Break**
- 20:35-20:50** Data analysis on the research of EMF effects in human health
O. Konstanti
- 20:50-21:00** The implementation by the Greek Public Administration of the new legal framework concerning the mobile base stations. The experience of the Greek Ombudsman.
J. Koufakis
- 21:00-21:10** The Precautionary Principle and the formation of jurisprudence.
K. N. Papadopoulos
- 21:10-21:20** Mobile base stations and the problems in application of the procedure.
K. Diakos
- 21:20-21:30** Presentations by Social Groups
- 21:30** **Discussion and conclusions**

SUNDAY, 25th May 2008

Moderators: Th. Xenos, I. Magras

10:30-10:40 Welcome Address by the Chairman of the Organizing Committee

10:40-11:10 Electromagnetic Fields: A Priority for Public Health

Gerd Oberfeld

11:10-11:40 Is the electromagnetic pollution necessary in urban areas?

L. Giuliani

11:40-11:50 The Functional Impairment Electrohypersensitivity and Health Effects of Modern Life-Electromagnetic Fields: A Neuroscientist's Views

O. Johansson

11:50-12:20 EMR as a synergen in Neurological Disease: Autism as a case study.

G. Carlo

12:20-13:15 **Break-light lunch**

Moderators: L.H. Margaritis, S. Zinelis

13:15-13:45 Problems in assessment of risks from exposures to microwaves of mobile communication.

I. Belyaev

13:45-14:15 More probable than unlikely, that non-thermal electromagnetic fields from mobile phones and base stations do have effects upon the human brain.

L. Salford

14:15-14:35 Precautions suggested for the use of cell phones, especially for children, based on a series of bioelectromagnetic experiments.

I. Magras

14:35-14:55 Action Mechanism of electromagnetic fields on cells. A pathway to cell death.

D. J. Panagopoulos

14:55-15:05 How does the electromagnetic radiation disturbs the release of calcium from cell membranes and can have a such a wide variety of effects from asthma to electro-hyper-sensitivity syndrome and autism.

A. Goldsworthy

15:05-15:20 Is the scientific knowledge influenced by external pressures? Are the Organization's Resolutions independent?

S. A. Zinelis

15:20-15:50 Review of our recent experiments-Suggestions for a safe use of the radiation producing apparatuses.

L. H. Margaritis

Discussion-conclusions and closing remarks.

Non ionizing electromagnetic radiation: Risks and benefits

Lukas H. Margaritis

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Electromagnetic radiation spectrum includes the ionizing and the non ionizing radiation. The latter extends from the extremely low frequencies (ELF) up to the far ultraviolet. These man-made sources of radiation include the radiowaves of Radio and TV broadcasting as well as the mobile telephony frequencies. Besides their beneficial role the non ionizing radiation can affect cells and human health in a variety of ways. Since the non ionizing form of radiation did not take part during evolution in the planet earth, it has been considered that “safety levels” are difficult to establish as in the case of the ionizing radiation in which the background radioactivity from minerals, body radionuclides and cosmic radiation, establish a known value. Therefore it makes sense to speak about safety level since evolution took place in the presence of these radiation levels.

Non ionizing man-made radiation started in the beginning of the 20th century with the telecommunications taking a major part of applications. Satellite assisted communication, overseas communication, wireless networks and mobile telephony being the most widely used forms of this type of electromagnetic radiation. Initially it was considered safe to be exposed to low levels of such radiation at least below the so-called “thermally induced” changes in the cells. However it has been realized that “non-thermal” molecular and cellular changes are very serious under low level exposures. Therefore the “safety guideless” suggested by WHO several years ago need to be re-considered.

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BIOLOGICAL EFFECTS FROM THE EXPOSURE TO ELECTROMAGNETIC FIELDS PRODUCES BY HIGH VOLTAGE LINES

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The electric power system produces extremely low frequency electric and magnetic fields. There has been concern that these fields may be associated with various biological effects, including cancer. Although there are contradictory opinions, various new studies found that children living in homes with 24 hour average near high voltage power lines may have an increased risk of development cancer. Specifically:

- A U.K. study¹ of 29081 children with cancer, including 9700 cases of leukaemia, found a raised risk (1.69) of childhood leukaemia in children who lived within 200 m of high voltage lines at birth compared with those who lived beyond 600 m.
- A recent study² found that adults who had lived within 300 m of a high voltage lines had a raised risk (1.30), compared with those who had always lived in distances higher than 300 m from a line.
- The overall results indicate an association between childhood leukaemia and proximity of home address at birth to high voltage power lines.

Having in mind the above mentioned results, the following suggestions could be made:

- To increase the permissible distance from the high voltage lines from 30 to 200 m.
- To decrease the limits of exposure to electromagnetic fields produced by the high voltage lines about 15 times.
- The undergrowing of the overhead power lines that exists in residential regions of the country should be considered.

Literature

¹ Draper G., T. Vincent, M. Kroll, J. Swanson, (2005) *Childhood cancer in relation to distance from high voltage power lines in England and Wales: a case-control study*, *British Medical Journal*, 330:1290.

² Lowenthal RM et al. 2007. *Residential exposure to electric power transmission lines and risk of lymphoproliferative and myeloproliferative disorders: a case control study*. *Intern Med. J.* 37: 614-619.

Data analysis on the research of EMF effects in human health

Ourania Konstanti Ph.D.

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Radiofrequency (RF) waves have long been used for different types of information exchange via the air waves--wireless Morse code, radio, television, and wireless telephone. Increasingly larger numbers of people rely on mobile telephone technology, and health concerns about the associated RF exposure have been raised, particularly because the mobile phone handset operates in close proximity to the human body, and also because large numbers of base station antennas are required to provide widespread availability of service to large populations. Worldwide many studies have been performed to investigate the state of cellular-telephone health consequences, and this article brings together several of the key points that were addressed according to the published data using the Biolab Experiment Assistant software. The possibility of electromagnetic fields (EM) health effects has been investigated in epidemiology studies of cellular telephone users and workers in RF occupations, in experiments with animals exposed to cell-phone RF, and via biophysical consideration of cell-phone RF electric-field intensity and the effect of EM modulation schemes. As summarized here, these separate avenues of scientific investigation provide support for adverse health effects (genes - diseases) arising from RF exposure at levels below current international standards. The majority of the current scientific data are consistent with the conclusion that public exposures to permissible EM levels from mobile telephone and base stations are likely to adversely affect human health.

THE PRECAUTIONARY PRINCIPLE AND THE FORMATION OF JURISPRUDENCE

Konstantinos N. Papadopoulos

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Legal Advisor to Municipality of Pilea.

The precautionary principle is presented for the first time in the German Law in the decade 1970. In the International Law report is done in the Chart of United Nations Organisation for Nature (1982). In the European Community Law it is presented with the Treaty of Maastricht. Report of the principle is done so much in the Statement of Rio, as in the Protocol of Karthagenis.

Unfortunately even among lawyers prevails confusion between the precautionary principle and that of prevention.

The precautionary principle imposes taking protective measures even when there is not complete scientific certainty and proof for the unfavourable environmental consequences of an activity. The existence of serious indications on possible environmental damage is enough.

On the contrary the precautionary principle contributes in the confrontation of technological dangers, provided that it is possible to localise and evaluate those dangers.

In the society of endangerment where the technological progress precedes the knowledge of potential consequences the precautionary principle is a necessary tool of environmental law that exceeds the narrower limits of the prevention principle.

Intense is the engrossment from the potential dangers of electromagnetic radiation and especially from the mobile telephony antennas.

The jurisprudence presents dissension as it followed the refuted scientific opinions.

ELECTROMAGNETIC FIELDS

Gerd Oberfeld Dr. M.D.

Public Health Department Salzburg, AUSTRIA

EMF (electric fields, magnetic fields, electromagnetic waves) is one of the grossly overlooked issues in environmental and public health especially when it comes to children. EMF is also one of the strongest growing sources of environmental exposure worldwide. Millions of people expose themselves and others day by day for minutes to hours with microwaves from mobile phones. Millions of people are exposed for hours up to the whole day to microwaves from mobile phone base stations, cordless telephone base stations, wireless local area network access points (WLAN) etc.. In addition due to electronic devices and sources in our electricity network the principal frequency of 50/60 Hz shows increasing harmonics and kHz waves called “dirty electricity” or “dirty power”. All around the globe citizen groups in part supported by physician groups report distinct symptoms or illnesses they relate to our electromagnetic environment. The response of public health authorities to this problem is very different but shows a growing awareness. There is insufficient knowledge about EMF in society, public health and politics. There is an urgent need:

to adopt the ALARA and ALATA Principle to EMF,
to implement EMF Public Health Research,
to implement an EMF Education Plan,
to implement an EMF Prevention Plan,
to implement EMF Exposure and Health Monitoring.

IS ELECTROMAGNETIC POLLUTION NECESSARY IN URBAN AREAS?

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Livio Giuliani**

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Since 2002, studies on various Italian cities and towns have been done to evaluate the level of public exposure to electrical and magnetic fields and electromagnetic radiation present in the ambient environment, particularly in homes. These studies have applied different calculus models, to each city, according to size, level of urban development, and population densities, found in each study location. The results show that the maximum EMF level is above 3 V/m, even if all the available power, provided by all the antennas in the neighbourhood are employed. The most recent study considered a new wireless telephony network system architecture, based on consolidated technologies and in this study we deduced that the Italian legal exposure-limit of 6 V/m can be reduced without affecting network deployment effectiveness. The development of new networks, due to the introduction of new technologies and standards, will cause, in the near future, an increase in electromagnetic exposure levels. To minimize the potential health risks due to chronic EMF exposure, we studied how the use of networks of radio microcells connected by optoelectronic hubs to a net of optical fibres could substitute for the conventional network formed with “warm cell” or macroplants.

There are three mainly considerations that justify this approach:

1. Coverage is guaranteed by a minimum signal level in support of the service; starting from the link budget (we consider the threshold, for downlink of UMTS, GSM e DCS at 66, 69, 72 dB μ V/m re” here) respectively; thus, it is possible to keep the environmental level of the electric field low;
2. The use of microcells reduce power in the antenna needed for uplink connections from the handy and avoid high EMF exposure to the individual user;
3. Indoor coverage can be made by bringing the signal over fibres, employing only picocells for wireless home connections; thus, it is not necessary to spread the signal from powerful antennas that are able to pass through the buildings to reach users on the road; this alternative model would avoid much of the causes of electromagnetic urban pollution.

At the request of the City of Venice we developed a study to compare the environmental pollution due to a conventional use of co-location antennas BTSs by three Italian providers, operating in GSM, DCS and UMTS, and the pollution caused by a microcell based network able to produce the same coverage in the same neighborhood in Venice. The environmental levels of the produced electric field were compared using a software simulator employing the ray-tracing algorithm (Fig. 1 and 2). The results suggest that the choices made for wireless telephony signal deployment in Italy during the 1990s needs to be reconsidered.

THE FUNCTIONAL IMPAIRMENT ELECTROHYPERSENSITIVITY AND HEALTH EFFECTS OF MODERN-LIFE ELECTROMAGNETIC FIELDS: A NEUROSCIENTIST'S VIEWS

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In Sweden, electrohypersensitivity (EHS) is an officially fully recognized functional impairment (i.e., it is not regarded as a disease). Survey studies show that somewhere between 230,000–290,000 Swedish men and women – out of a population of 9,000,000 - report a variety of symptoms when being in contact with electromagnetic field (EMF) sources.

The electrohypersensitive people have their own handicap organization, The Swedish Association for the Electrohypersensitive (<http://www.feb.se>; the website has an English version). This organization is included in the Swedish Disability Federation (Handikappförbundens SamarbetsOrgan; HSO). HSO is the unison voice of the Swedish disability associations towards the government, the parliament, and national authorities, and is a cooperative body that today consists of 43 national disability organizations (where The Swedish Association for the Electrohypersensitive is 1 of these 43 organizations) with all together about 500,000 individual members. You can read more on <http://www.hso.se> (the site has an English short version).

Swedish municipalities, of course, have to follow the UN 22 Standard Rules on the equalization of opportunities for people with disabilities (“Standardregler för att tillförsäkra människor med funktionsnedsättning delaktighet och jämlikhet”; about the UN 22 Standard Rules, see website: <http://www.un.org>; since 2007 they have been upgraded into the UN Convention on Human Rights for Persons with Functional Impairments). All people with disabilities shall, thus, be given the assistance and service they have the right to according to the Swedish Act concerning Support and Service for Persons with Certain Functional Impairments (“LSS-lagen”) and the Swedish Social Services Act (“Socialtjänstlagen”). People with disabilities, thus, have many different rights and can get different kinds of support. The purpose of those rights and the support is to give every person the chance to live like everyone else. Everyone who lives in the Swedish municipalities shall be able to lead a normal life and the municipalities must have correct knowledge and be able to reach the people who need support and service. People with disabilities shall be able to get extra support so that they can live, work, study, or do things they enjoy in their free time. The municipalities are responsible for making sure that everyone gets enough support. Everyone shall show respect and remember that such men and women may need individual and different kinds of support.

In Sweden, impairments are viewed from the point of the environment. No human being is in itself impaired, there are instead shortcomings in the environment that cause the impairment (as the lack of ramps for the person in a wheelchair or rooms electro-sanitized for the person with electrohypersensitivity). This environment-related impairment view, furthermore, means that even though one does not have a scientifically based complete explanation for the impairment electrohypersensitivity and in contrast to disagreements in the scientific society, the person with electrohypersensitivity shall always be met in a respectful way and with all necessary

support with the goal to eliminate the impairment. This implies that the person with electrohypersensitivity shall have the opportunity to live and work in an electrosanitized environment.

This view can fully be motivated in relation to the present national and international handicap laws and regulations, including the UN 22 Standard Rules/UN Convention and the Swedish action plan for persons with impairments (prop. 1999/2000:79 “Den nationella handlingplanen för handikappolitiken – Från patient till medborgare”). Also, the Human Rights Act in the EU fully applies.

It may also be noted that a unique conference recently was held in Stockholm in May, 2006. The theme for the conference was “The right for persons with the impairment electrohypersensitivity to live in a fully accessible society”. The conference was organized by the Stockholm City municipality and the Stockholm County Council and dealt with the most recent measures to make Stockholm fully accessible for persons with the impairment electrohypersensitivity. Among such measures are to offer home equipment adjustments and through electrosanitized hospital wards. The conference was documented on film.

The effects of various forms of electromagnetic fields are also discussed within areas of medicine, such as cancer. One issue that is very much addressed in the public as well as in the scientific literature is the question about the effect(s) of mobile phone radiation on health. Ten years of intensively increasing mobile phone usage have passed. According to some, it has facilitated our lifestyle, but more and more people are nowadays concerned about the lack of knowledge regarding the effects of short- and long-term radiation on health. For instance, it may be noted that mobile and DECT telephones are among the worst sources of problems for electrohypersensitive persons. In addition, it is now a well-known and fully accepted fact that mobile phone usage causes injuries in traffic and during work.

Mobile telephony-related risks may be divided between effects of radiation (microwaves, low-frequency magnetic fields) from the hand-held mobile telephone and radiation (microwaves) from remote base stations mounted on roofs, walls, towers, masts, etc.

There is still insufficient contemporary proof with regard to increased cancer risk to change adult mobile phone usage. However, signs of degrading general health in sparsely populated areas suggest that the use of mobile phones at high output power levels should be avoided. Therefore, it is now of paramount importance that epidemiological research should be supplemented with prospective studies and quality exposure data (standardization). Continuous surveillance is also needed. In the meantime, children and adolescents should definitely be discouraged to use mobile phones.

At an early stage I brought the question up as to whether there is any guarantee that it is wise and safe to subject ourselves to whole-body radiation, 24 hours a day, wherever we are, with the same mobile radiation which has been shown in laboratory studies to cause serious injuries and effects. Also at an early stage, I urged responsible persons to think seriously about the full-scale experiment which is now in progress with us as the laboratory animals. Since then, many other persons have borrowed the forms of expression I had coined for use in their own articles and books and the waves of debate are now high throughout the world. Very recently, 31 researchers, in connection with a scientific conference in Italy, agreed together to raise a warning voice, inter alia regarding mobile telephony and the risks for childhood cancer (the Benevento Resolution of September 19, 2006; after The International Commission for

Electromagnetic Safety (ICEMS) had held an international conference entitled “The Precautionary EMF Approach: Rationale, Legislation and Implementation”, hosted by the City of Benevento, Italy, on February 22–24, 2006).

Furthermore, a very large number of studies have shown that mobile radiation affects the regional blood-flow in the brain, the brain EEG, short-term memory, the ability to concentrate, and also the duration and quality of dream-sleep - the portion of our sleep in which much of our normal recovery should take place. In addition, ecological studies point to the fact that in areas with poor mobile coverage, i.e. where the transmitter levels are high - such as in countrified areas, it is here that health is deteriorating most rapidly just at present. The fact that mobile radiation also causes direct injuries to our genetic material (i.e. breaks in the DNA molecule), amongst other places in the nerve cells of the brain, can only be seen as making the situation even more alarming.

Already many years ago I felt, as early as in the late 1980ties and even more so after the above-mentioned Benevento meeting, that there was a great need for a truly independent analysis and summary of the available science. I had put forward this idea for more than 20 years, and most recently it became a reality in the form of The BioInitiative Report of 2007 (<http://www.bioinitiative.org>; see below).

The very first bullet point in the Benevento Resolution is “More evidence has accumulated suggesting that there are adverse health effects from occupational and public exposures to electric, magnetic, and electromagnetic fields, or EMF, at current exposure levels. What is needed, but not yet realized, is a comprehensive, independent, and transparent examination of the evidence pointing to this emerging, potential public health issue.”

Furthermore, point no. 6 says “We encourage governments to adopt a framework of guidelines for public and occupational EMF exposure that reflect the Precautionary Principle (The Precautionary Principle states that when there are indications of possible adverse effects, though they remain uncertain, the risks from doing nothing may be far greater than the risks of taking action to control these exposures. The Precautionary Principle shifts the burden of proof from those suspecting a risk to those who discount it) — as some nations have already done. Precautionary strategies should be based on design and performance standards and may not necessarily define numerical thresholds because such thresholds may erroneously be interpreted as levels below which no adverse effect can occur.”

You often hear about “safe levels” of exposure and that there is “no proof of health effects”, but my personal response to these seemingly reassuring statements is that it is very important to realize, from a consumer's point of view, that “no accepted proof for health effects” is not the same as “no risk”. Too many times, 'experts' have claimed to be experts in fields where actually the only expert comment should have been: “I/we just do not know”. Such fields were e.g. the DDT, X-ray, radioactivity, smoking, asbestos, BSE, heavy metal exposure, depleted uranium, etc., etc., etc., ones where the “no risk”-flag was raised before true knowledge came around. Later on, the same flag had to be quickly lowered, many times after enormous economic costs and suffering of many human beings. Along those lines, it is now (regarding “the protection from exposure to electromagnetic fields” issue) very important to clearly identify the background and employment (especially if they sit, at the same time, on the industry's chairs) of every 'expert' in different scientific committees, and likewise. It is, of course, very important (maybe even more important?) to also let 'whistleblowers' speak at conferences, to support them with equal amounts (or even

more?) of economical funding as those scientists and other 'experts' who, already from the very beginning, have declared a certain source or type of irradiation, or a specified product, to be 100% safe.

In the case of “protection from exposure to electromagnetic fields”, it is thus of paramount importance to act from a prudence avoidance/precautionary principle point of view. Anything else would be highly hazardous! Total transparency of information is the key sentence here, I believe consumers are very tired of always having the complete truth revealed years after a certain catastrophe already has taken place. For instance, it shall be noted, that today's recommendation values for mobile telephony, e.g. the SAR-value, are just recommendations, and not safety levels. Since scientists observe biological effects at as low as 20 microWatts/kg, is it then really safe to irradiate humans with 2 W/kg (i.e., with 100,000 times stronger radiation!), which is the recommendation level for us? And, furthermore, it is very strange to see, over and over again, that highly relevant scientific information is suppressed or even left out in various official documents, as high up as at the governmental level of society. This is not something that the consumers will gain anything good from, and, still, the official declaration or explanation (from experts and politicians) very often is: “If we (=the experts) would let everything out in the open, people would be very scared and they would panic.” Personally, I have never seen this happen, but instead I have frequently seen great disappointment from citizens who afterwards have realized they have been fooled by their own experts and their own politicians...

Another misunderstanding is the use of scientific publications (as the tobacco industry did for many years) as 'weights' to balance each other. But you can NEVER balance a report showing a negative health effect with one showing nothing! This is a misunderstanding which, unfortunately, is very often used both by the industrial representatives as well as official authorities. The general audience, naturally, easily is fooled by such an argumentation, but if you are bitten by a deadly poisonous snake, what good does it make for you that there are 100 million harmless snakes around?

As mentioned above, an international working group of scientists, researchers and public health policy professionals (The BioInitiative Working Group) released its report on electromagnetic fields and health by August 31, 2007 (see <http://www.bioinitiative.org>). It raises serious concern about the safety of existing public limits that regulate how much EMFs is allowable from power lines, cell phones, and many other sources of EMF exposure in daily life. Electromagnetic radiation from such sources as electric power lines, interior wiring and grounding of buildings and appliances are linked to increased risks for childhood leukemia and may set the stage for adult cancers later in life.

The report provides detailed scientific information on health impacts when people are exposed to electromagnetic radiation hundreds or even thousands of times below limits currently established by the Federal Communications Commission (US FCC) and the International Commission for Non-Ionizing Radiation Protection in Europe (ICNIRP). We, the authors, reviewed more than 2,000 scientific studies and reviews, and concluded that the existing public safety limits are inadequate to protect public health. From a public health policy standpoint, new public safety limits, and limits on further deployment of risky technologies are warranted based on the total weight of evidence.

The report documents scientific evidence raising worries about childhood leukemia (from power lines and other electrical exposures), brain tumours and

acoustic neuromas (from cell and cordless phones) and Alzheimer's disease. There is evidence that EMF is a risk factor for both childhood and adult cancers. Public health expert and co-editor of the Report Dr. David Carpenter, Director, Institute for Health and the Environment at the University of Albany, New York says "*This report stands as a wake-up call that long-term exposure to some kinds of EMF may cause serious health effects. Good public health planning is needed now to prevent cancers and neurological diseases linked to exposure to power lines and other sources of EMF. We need to educate people and our decision-makers that "business as usual" is unacceptable.*"

Health questions about power line EMFs were initially raised by Nancy Wertheimer, a Colorado public health expert, and Ed Leeper, an electrical engineer, in 1979. Wertheimer noticed that children who were twice or three times as likely to have leukemia tended to live in homes in the Denver city areas close to power lines and transformers. Now, there are dozens of studies confirming this link, but a public health response has been slow in coming, and new standards to protect the public are necessary.

Brain tumours normally take a long time to develop, on the order of 15 to 20 years. Use of a cell or cordless phone is linked to brain tumours and acoustic neuromas (tumour of the auditory nerve in the brain) and are showing up after only 10 years (a shorter time period than for most other known carcinogens). A summary of all studies on brain tumours shows overall a 20% increased risk of brain tumour (malignant glioma) with ten years of use. But the risk increases to 200% (a doubling of risk) for tumours on the same side of the brain as mainly used during cell phone calls.

Wireless technologies that rely on microwave radiation to send e-mails and voice communication are thousands of times stronger than levels reported to cause some health impacts. Prolonged exposure to radiofrequency and microwave radiation from cell phones, cordless phones, cell towers, Wi-Fi, and other wireless technologies have been linked to physical symptoms including headache, fatigue, sleeplessness, dizziness, changes in brainwave activity, and impairment of concentration and memory. Scientists report that these effects can occur with even very small levels of exposure, if it occurs on a daily basis. Children in particular are vulnerable to harm from environmental exposures of all kinds.

It is clear from the report that the existing FCC, ICNIRP and other international limits for public and occupational exposure to low-frequency electromagnetic fields and radiofrequency radiation are not protective of public health. New *biologically-based public and occupational exposure limits* are recommended to address bioeffects and potential adverse health effects of chronic exposure. These effects are now widely reported to occur at exposure levels significantly below most current national and international limits.

Such biologically-based exposure standards are needed to prevent disruption of normal body processes. Effects are reported for DNA damage (genotoxicity that is directly linked to integrity of the human genome), cellular communication, cellular metabolism and repair, cancer surveillance within the body; and for protection against cancer and neurological diseases. Also reported are neurological effects including changes in brainwave activity during cell phone calls, impairment of memory, attention and cognitive function; sleep disorders, cardiac effects; and changes in immune function (allergic and inflammatory responses).

Contributing author Dr. Martin Blank, Columbia University professor and

researcher in bioelectromagnetics (who wrote the chapter on stress proteins) says *“Cells in the body react to EMFs as potentially harmful, just like to other environmental toxins, including heavy metals and toxic chemicals. The DNA in living cells recognizes electromagnetic fields at very low levels of exposure; and produces a biochemical stress response. The scientific evidence tells us that our safety standards are inadequate, and that we must protect ourselves from exposure to EMF due to powerlines, cell phones, and the like.”*

In many commentaries, debate articles and public lectures - for the last 20-30 years – I have urged that completely independent research projects must be inaugurated immediately to ensure our public health! These projects must be entirely independent of all types of commercial interests; public health cannot have a price-tag! It is also of paramount importance that scientists involved in such projects must be free of any carrier considerations and that the funding needed is covered to 100%, not 99% or less. This is the clear responsibility of the democratically elected body of every country!

At the present time I do not know whether the radiation has damaged our immune defence or what is happening. On the other hand it is quite clear that something serious has happened and is happening. We can no longer ignore this fact and my colleagues and I have therefore repeatedly exhorted responsible authorities and politicians to take action. Do not allow this question to become another long-drawn example of non-action – like the global greenhouse warming effect; take action while there is still time!

It is a true *must* that fully financed, truly independent research projects immediately should be initiated to ascertain the public health. They shall be completely devoid of commercial interests of any sort. This is the responsibility of each elected government in each country, and is of special importance for people with the functional impairment electrohypersensitivity.

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[For additional reading and references to the relevant scientific literature, please, contact the author at < olle.johansson@ki.se >.]

EMR AS A SYNERGEN IN NEUROLOGICAL DISEASE: AUTISM AS A CASE STUDY

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Recent integrative research has elucidated mechanisms of interaction between exposures to unnatural or man-made electro-magnetic fields and normal human physiologic systems. This research shows that electro-magnetic radiation (EMR) affects cell membrane chemical and vibrational receptors; sympathetic/parasympathetic balance; active transport; cellular energy processes, including mitochondrial function; mRNA/DNA transcription interface; normal DNA repair; intracellular physiology; intercellular communication; as well as tissue, organ and physiologic system function.

Myriad published epidemiological and toxicological studies have identified the primary etiologic role of EMR in a number of diseases. Underlying pathological mechanisms include: disruption of intracellular physiology and normal cellular function leading to conditions such as leakage in the blood brain barrier; disruption of DNA repair and formation of micronuclei contributing to tumorigenesis; and disruption of intercellular communication which compromises tissue and organ function leading to immune, neurological and endocrine system dysfunction. The emerging science leaves little doubt that man-made EMR has become a major public health threat.

There are four different EMR effect windows of primary importance from a pathological mechanism perspective: ionizing radiation, raw microwaves, information carrying radio waves (ICRW) and extremely low frequency waves (ELF). The pathological mechanisms in each effect window are distinct, and range from breakage of chemical bonds through ionization to direct magnetic interference with gap-junction neurotransmission. Most importantly, it is now clear that all but the ICRW window have thresholds for effects. There is no clinical or biological effect threshold for ICRW because the pathological mechanism involves a seconds-long physical trigger that leads to an irreversible biological response cascade. From a practical perspective, this mechanistic reality suggests that there is no truly safe level of exposure to ICRWs which are the predominant exposure in all types of wireless technology. With near four billion mobile phones now active globally, along with millions of WiFi devices and the necessary wireless infrastructure to support them, it is now the case that ICRWs are ubiquitous and that exposure for most people in populated areas is unavoidable.

There has been little published work focused on how ubiquitous exposure to ICRW impacts populations from the perspectives of etiologic interactions including antagonism and synergy, as well as therapeutic clinical intervention. This paper presents a review of what is known regarding EMR interactions in neurological disease and considers the recent epidemic of Autism as a case study.

PROBLEMS IN ASSESSMENT OF RISKS FROM EXPOSURES TO MICROWAVES OF MOBILE COMMUNICATION

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Since pioneering investigations published in the beginning of 1970th, various biological responses to non-thermal (NT) microwaves (MWs) including adverse health effects have been described by many groups over the world. There is strong evidence that the NT MW biological effects depend on several physical parameters and biological variables, which must be controlled in replication studies. Despite of considerable body of studies with NT MWs in biology, only few studies were performed to replicate the original data on the NT MW effects. It should be noted, that these “replications” are usually not comparable with the original studies because of either missing description of important parameters of exposure or significant differences in these parameters between original study and replication.

Apart from fundamental importance, the development of comprehensive mechanisms for the NT MW effects is socially important. The effects of MWs of mobile communications such as GSM and UMTS are of major concern because of increased exposure in many countries. It has been shown that adverse effects of NT MWs from GSM/UMTS mobile phones on human lymphocytes from healthy and hypersensitive to EMF persons depend on carrier frequency and type of signal. Further investigations with human primary cells, animals and volunteers are needed to elucidate possible adverse effects of MW signals of various kinds that are used in wireless communication such GSM/UMTS mobile phones and base stations/masts, WLAN, WPAN, DECT wireless phones. Identification of those types and frequency channels/bands for mobile communication, which do not affect human cells, is urgently needed as the high priority task for development of safe mobile communication. Because NT MWs affect cells of various types including blood cells, skin fibroblasts, stem cells, reproductive organs the using of hands-free cannot minimize all adverse health effects. Possibilities to minimize the adverse effects of NT MWs using various approaches should be studied.

Numerous data on the NT MW effects clearly indicate that the thermal SAR-concept that has been adopted by the ICNIRP and some national authorities cannot underlie the safety guidelines for chronic exposures to MWs from mobile communication and other approaches are needed for development of safety regulation.

**MORE PROBABLE THAN UNLIKELY, THAT NON-THERMAL
ELECTROMAGNETIC FIELDS FROM MOBILE PHONES AND BASE
STATIONS DO HAVE EFFECTS UPON THE HUMAN BRAIN.**

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The world's largest biological experiment ever? This was one of my messages in a lecture to the European Parliament in 2000 when the number of mobile phone users approached one fourth of the World's population (Salford et al 2001). Today one third relies for the daily communication on mobile phones and base stations which send their energy into our bodies. Is this only of good? Or might it impose effects upon biology. Effects that we must anticipate and evaluate as far as possible, and if needed, reduce or avoid!

Life on earth was formed during billions of years, exposed to, and shaped by the original physical forces such as gravitation, cosmic irradiation, atmospheric electric fields and the terrestrial magnetism. The existing organisms are created to function in harmony with these forces. However, in the late 19th century mankind introduced the use of electricity, and high frequency RF was introduced in the 1950-ies as FM and television and during the very last decades, microwaves of the modern communication society spread around the world. Until then microwaves had principally never been experienced on Earth.

Since 1988 our group has studied the effects upon the mammalian blood-brain barrier (BBB) in rats by non-thermal radio frequency electromagnetic fields (RF-EMF). These have been shown to cause significantly increased leakage of the rats' own blood albumin through the BBB of exposed rats, at energy levels of 1W/kg and below, as compared to non-exposed animals—in a total series of about two thousand animals (Salford et al. 2007).

It should be noted that all our work and other work, here referred to, exclusively deals with *non-thermal* effects for EMF.

One remarkable observation is the fact that the lowest energy levels, with whole-body average power densities below 10mW/kg, give rise to the most pronounced albumin leakage. If mobile communication, even at extremely low energy levels, causes the users' own albumin to leak out through the BBB, also other unwanted and toxic molecules in the blood, may leak into the brain tissue and concentrate in and damage the neurons and glial cells of the brain. **The SAR value of around 1 mW/kg exists at a distance of more than one meter away from the mobile phone antenna and at a distance of about 150 - 200 meters from a base station.** This was described as the “passive mobile phoning” of the bystanders (Salford et al. 2001)

Another remarkable observation in our studies is the fact that a significant (p<0.002)

neuronal damage is seen in rat brains 50 days after a 2 hour exposure to GSM at SAR values 200, 20 and 2 mW/kg (Salford et al. 2003). We have followed up this observation in a study where 96 animals were sacrificed 14 and 28 days respectively after an exposure for 2 hours to GSM mobile phone electromagnetic fields at SAR values 0 (controls), 200, 20, 2 and now also 0.2 mW/kg. Significant neuronal damage is seen after 28 days and albumin leakage after 14. Our findings may support the hypothesis that albumin leakage into the brain is the cause for the neuronal damage observed after 28 and 50 days. (Submitted manuscript)

In the majority of our studies, EMF exposure of the animals has been performed in transverse electromagnetic transmission line chambers (TEM-cells) (Salford et al. 2007). These TEM-cells are known to generate uniform electromagnetic fields for standard measurements. The experimental model allows the animals, which are unanaesthetized during the whole exposure, to move and turn around in the exposure chamber, thus minimising the effects of stress induced immobilization.

In our continued research, also the non-thermal effects on tissue structure and memory function of long-term exposure have been studied. Fischer 344 rats were exposed for 2 hours to GSM 900, and sham exposed in our TEM-cells once a week for 13 months. After this they were studied for cognitive functions and compared to cage controls. Significant effects of exposure upon episodic memory function were demonstrated. The GSM-exposed rats had significantly impaired memory for objects and their temporal order of presentation ($p=0.02$). (Nittby et al. 2008a).

We have also performed micro-array analysis of brains from rats exposed alive to short term GSM both at 1,800 MHz and at 900MHz and have found significant effects upon gene expression of membrane associated genes as compared to control animals (Belyaev et al. 2006, Nittby et al. 2008b).

Most of our findings thus support that living organisms are affected by the non-thermal radio frequency fields. The fact that gene expression is significantly influenced may also support the recent epidemiological studies that indicate that long term exposure (10 years mobile phone use) increases the risk for developing tumours in the exposed brain hemisphere, both the benign vestibular schwannoma arising from the balance nerve and the highly malignant glioblastoma multiforme (Lönn et al., 2004; for a review see Kundi et al. 2004, Hardell et al. 2006a). Regarding the development of vestibular schwannoma, the relative risk seen ten years after the start of mobile phone use, was 1.9 (with confidence interval 0.9-4.1) (Lönn et al. 2004). When only tumours occurring at the same side of the head as the mobile phone had been normally used, the relative risk increased to 3.9 (with confidence interval 1.6-9.5). In a pooled analysis of case-controlled studies on malignant brain tumours, cumulative life use of > 2, 000 hours of mobile phoning revealed an odds ratio of 3.7 (confidence interval of 1.7-7.7) (Hardell et al. 2006b).

The mechanisms by which the EMFs may alter BBB permeability are not well understood. At low field strengths, the effects on body temperature are negligible and thus heating effects are not involved. A change in the physicochemical characteristics of membranes has been suggested as a cause (Shivers et al. 1987).

We have performed experiments to verify a quantum mechanical model for interaction with protein-bound ions. Our results show that controlled frequency and amplitude of ELF EM fields upon spinach plasma vesicles can steer transport over the membrane (Bauréus-Koch et al. 2003). This may be a first proof of a resonance phenomenon where appropriate levels of frequency and amplitude in the right

combination have the potency to communicate with the biology of membranes and transport systems.

Concluding remarks:

The mammalian BBB is anatomically the same in the human as the rat's brain. Enzymatic functions in the BBB may be different between the species, even if very little is known about this.

With a long series of significant effects of RF-EMF demonstrated in the animal models, it is my sincere belief, that it is more probable than unlikely, that non-thermal electromagnetic fields from mobile phones and base stations do have effects upon the human brain and finally I will try to answer the specific questions raised by the First Hellenic conference on the effects of non ionizing radiation May 2008:

Q: Can we extrapolate from animal or cell culture studies into effects on humans?

A: As stated above: More probable than unlikely.

Q. How harmful are the base stations when located near houses and schools.

A. If our results, which show effects at even less than 1mW/kg SAR value, are valid also for the human brain, even distances 100 m or more from the base station (in the beam from the tower) are not safe.

Q: Are the so called "safety levels" as suggested by ICNIRP and WHO really safe or does every country have to follow Salzburg's values of 0,2 volts/meter?

A: If our results, which show effects at even less than 1mW/kg SAR value, are valid also for the human brain, these "safety levels" are still not safe.

Q: Are there strong scientific evidence supporting the notion that long term exposure of people in eclectic field values below ICNIRP standards is dangerous for public health?

A: Very little scientific evidence is collected so far. But as we notified in Environmental Health Perspectives 2003: "If mobile communication, even at extremely low SAR values, causes the users' own albumin to leak out through the BBB, which is meant to protect the brain, also other unwanted and toxic molecules in the blood, may leak into the brain tissue and concentrate in and damage the neurones and glial cells of the brain. It can not be excluded that this, (especially after many years intense use) may promote the development of autoimmune and neuro-degenerative diseases, and we conclude that the suppliers of mobile communication – and our politicians – have an extensive responsibility to support the exploration of these possible risks for the users and the society". (Salford et al. 2003).

Q. Are children in schools more susceptible to the effects of nearby masts even if they do not spend the whole day in school?

A: It is generally held that the young, developing brain is more vulnerable than the adult brain. Concerning the masts placed on the school houses, it should be kept in mind, that it is the directed beam from the mast that carries the microwaves and that in many instances, the beam is directed above the school houses and yard to reach mobile phone users at distance from the mast itself.

Q: What is the case with other sources of radiation including the wireless phones, the wifi computer communication, the metropolitan internet access wireless network, the power lines, the domestic appliances.

A: All these systems add to the microwave environment and produce SAR values that may be harmful if our and other scientist's results from in vitro and in vivo experiments in animals are translatable to humans.

Q: Are cell phones harmful and which precaution measures should we suggest that users should take and especially children?

A: Cell phones have been proven harmful to experimental animals. According to our opinion, it is reasonable to believe that the results can be translated to the human situation – even if this is not proven!

Therefore we believe that the use of mobile phones and other microwave producing devices should be minimized as much as possible. The good old telephones working through electrical cords should if possible be spared! The use of hands-free devices reduces the SAR values reaching the brain – but it should be remembered that the values of 1mW/kg which reach the most central portion of the human brain when the mobile phone antenna is held 1.5 cm from the head, by the use of a hands-free kept 1 meter away, still reaches into the brain, but now more superficial areas!

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PRECAUTIONS SUGGESTED FOR THE USE OF CELL PHONES, ESPECIALLY FOR EMBRYOS AND CHILDREN, BASED ON A SERIES OF BIO-ELECTROMAGNETIC EXPERIMENTS

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During the last twenty years, a series of experimental works carried out on various experimental animals (mice, rats, quails and chicken) for comparative reasons, to show the sensitivity of their embryos to the radiofrequency radiation. These works were performed and published in cooperation with Prof. Th. Xenos (Department of Electrical and Computer Engineering, A.U.Th).

The first experimental study that took place, about 20 years ago, around the "antenna park" of Hortiatis, arose strong indications on the potential adverse effects from the non ionizing radio-frequency radiation on the prenatal development of the experimental mice. Twelve pairs of mice were placed in locations of different power densities of 168-1053 nW/cm² and repeatedly mated five times. The 118 collected newborns were examined macro- and microscopically. A progressive decrease in the number of newborns per dam was observed, which ended in irreversible infertility. These results were strong indication of the embryo-toxicity from radio-frequency radiation sources. The "experiment of Hortiatis", performed in situ, was attended by a series of experimental studies in labo. Some of them are presenting following in brief: (a) Two groups of 12 pregnant rats were continuously irradiated to non thermal pulsed microwaves, to a power density of 5.0 μ W/cm², at 9.35 GHz. The first group was irradiated during 1st-3rd day after fertilization and the second during 4th-9th day of the gestation. The 58 % of the dams of the first group and 50 % of the second did not give birth. The uteri of these dams presented traces of embryonic absorption. These results support the aspect that very low power density microwaves, applied in pregnant rats, during embryogenesis and organogenesis, may cause adverse effects on their embryos. (b) Six groups of 40 quail embryos, in ovo, were exposed to different degrees of low power radio-waves radiation at 95 MHz, during the first three incubation days. A 17.91 % of embryonic and fetal deaths were observed among the exposed embryos, in relation to a 3.33 % among the controls. (c) Sixty quail embryos, in ovo, were exposed to a very low power density of 5.0 μ W/cm² pulse modulated microwave radiation, at 9.31 GHz, during the three incubation days. An abnormally high rate of embryonic and fetal deaths (65 %) was observed among the exposed embryos, in relation to 11.7 % among the controls. (d) Three groups of 54 chicken embryos, in ovo, were exposed, for 16 hours daily, to non thermal low power densities, at 95 MHz, of VHF radio-waves during 3rd-10th day of incubation (the first group in power densities of 30 μ W/cm² and the second and third group 150 mW/cm²). Embryonic deaths and congenital malformations have been observed, 27.7 % in the first group, 33.3 % in the second and 38.8 % in the third, instead of 1.7 % in the control group. (e) 380 chicken embryos, in ovo, were exposed to non-thermal very low power density radiation of 8.8 μ W/cm² at 9.152 GHz (172 embryos in pulse modulated and 208 in non-modulated microwaves), during 3rd-10th incubation day. Developmental retardation, grave malformations, stillborns, embryonic deaths and

fetal deaths were found in 62.78 % of the first group, 47.12 % of the second and only 3.44 % of the controls. These results supported the aspect that very low power density microwaves, applied to chicken embryos, in ovo, during organogenesis, cause abnormal development. The high sensitivity of the mouse, rat, chicken and quail embryos to the low power density microwaves is a strong indication of corresponding high sensitivity of higher mammalian or human embryos, because of their similarities on the initial stages of their prenatal development. According to the results from our experimental studies, as well as to the precautionary principle, every possible precaution from the radiofrequency radiation, as those of the cell phones, is suggested for the human embryos as well as for the children.

Action Mechanism of Electromagnetic Fields on Cells. A pathway to Cell Death

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According to our theory on the mechanism of action of electromagnetic fields on cells, [Panagopoulos et al 2000; 2002; Panagopoulos and Margaritis 2003], which is considered until now as the most valid one from all the proposed theories, [Creasey and Goldberg, 2001], even very weak low frequency electric fields of the order of 10^{-2} V/m, are theoretically able to change the intracellular ionic concentrations. This is due to the fact that any external oscillating electric or magnetic field, induces forced-vibrations on the free ions that exist in large concentrations within and outside of all cell membranes. When the amplitude of this forced-vibration exceeds some critical value, the electrostatic force exerted by the oscillating ions' charge on the electric sensors of voltage-gated membrane ion channels, can irregularly gate these channels, resulting to changes of intracellular ionic concentrations. In the case of high frequency-microwave fields, whenever these fields are pulsed or modulated on low frequencies as happens in the most cases like in mobile telephony radiations, again our theory explains successfully the biological action of these radiations. As is well known, the low frequency pulses on digital mobile telephony radiations are necessary for the transmission of information by these signals and therefore they are intimately bound with the nature of these radiations.

The changes of intracellular ionic concentrations especially calcium, can lead to cell death either through apoptosis or necrosis, [Santini et al. 2005]. A common event preceding cell death, is the increase of mitochondrial calcium ion concentration released by endoplasmic reticulum, [Armstrong 2006]. The mitochondrial concentration of calcium ions can be increased by irregular uptake due to direct action of the external field on calcium channels of the mitochondrial membrane, or indirectly due to increased calcium release in the cytoplasm by endoplasmic reticulum membrane or by plasma membrane. Cell death induction, as it was shown in recent experiments of ours, is the reason for the decrease in the reproductive capacity of insects caused by mobile telephony radiations and power line fields, [Panagopoulos et al 2007]. Since an external oscillating field or wave can irregularly change the intracellular ionic concentrations by inducing ionic forced-vibration, it is able under certain conditions to lead to cell death. Thus it can be explained according to our theory the induction of cell death by mobile telephony radiations, found in recent experiments.

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THE CELL PHONE AND THE CELL

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Electromagnetic fields have effects at the cell level

Weak non-ionising radiation, such as that from mobile (cell) phones has biological effects, ranging from changes in brain function to the exacerbation of allergies and the induction and promotion of cancer. There have been many attempts to find the mechanisms and hundreds of scientific papers have been written about the changes they cause in the physiology and biochemistry of a wide range of living organisms (www.bioinitiative.org). These include plants, animals and even single cells such as yeast and diatoms. This means that least some of the effects must be occurring at the level of individual cells. There is more than one mechanism, but the one I will discuss here is the electromagnetic removal of calcium ions from cell membranes, which makes them become porous and leak. This simple observation can explain almost all of the known biological effects of weak electromagnetic radiation (Goldsworthy 2007).

Our bodies make good antennas

The biological effects of electromagnetic radiation probably begin with the organism acting like the antenna of a radio. The radiation generates eddy currents flowing through it and (in the case of cell cultures) also through the surrounding medium. When they impinge on the delicate membranes that surround its individual cells, they disturb their ionic structure and destabilise them. The same is true of the membranes that divide cells into their various internal compartments and organelles.

The human body makes a good antenna since blood vessels, which are low resistance pathways filled with a highly conductive salty fluid, connect virtually all of its parts. Even cell membranes, which have a high resistance to DC, allow radio-frequencies through because of their high capacitance. So when you use a mobile phone, its signal will be transmitted to all parts of your body; nowhere is safe.

Radiation increases membrane permeability

Many scientific studies suggest that the first effect of the eddy currents is to generate small alternating voltages across the cell membranes, which increase their permeability. This can have serious metabolic consequences as unwanted substances diffuse into and out of cells unhindered, and materials in different parts of the cell, that should be kept separate, become mixed. But how do these tiny alternating voltages increase membrane permeability?

The answer lies in their ability to remove calcium ions from the membrane surface. We have known since the work of Suzanne Bawin and her co-workers (Bawin *et al.* 1975) that electromagnetic radiation that is far too weak to cause significant heating

can nevertheless remove radioactively labelled calcium ions from cell membranes. Later, Carl Blackman showed that this occurs only with weak radiation, and then only within one or more “*amplitude windows*”, above and below which there is little or no effect (Blackman *et al.* 1982; Blackman 1990).

How weak fields remove calcium ions from membranes

Calcium ions are positively charged calcium atoms. Free calcium ions normally occur in calcium salts but, like other positive ions, they can also bind to the negatively charged membranes of living cells. These membrane-bound ions are in chemical equilibrium with the corresponding free ions in the surrounding medium, but there is a disproportionately large amount of calcium because it has two positive charges (i.e. it is *divalent*), which attracts it more strongly to the negative membrane. Most of the other readily available ions in living cells (e.g. potassium) have only one charge (i.e. they are *monovalent*). However, the extra charges on the divalent ions such as calcium and magnesium are literally their undoing. They let weak alternating electromagnetic fields remove them selectively from the membrane, which can have dire metabolic consequences.

The apple harvester

A simple way to explain the selective removal of divalent ions is to imagine trying to harvest ripe apples by shaking the tree. If you don't shake it hard enough, no apples fall off, but if you shake it too hard, they all fall off. However, if you get it just right, only the ripe ones fall off and are “selectively harvested”.

We can apply the same logic to the positive ions bound to cell membranes. Alternating voltages try to drive these ions off and then back onto the membranes with each half cycle. If the voltage is too low, nothing happens. If it is too high, all the ions fly off, but return when the voltage reverses. However, if it is of just the right, it will tend to remove only the more strongly charged ones, such as divalent calcium with its double charge. Since at least some of these divalent ions will probably be replaced at random by other ions when the field reverses, there will be a net removal of divalent ions. However this occurs only within a narrow range of field strength to give an *amplitude window*.

There may be more than one window. Blackman discovered at least two for calcium removal from brain tissue. This may be because not all membranes are alike; for example, some may hold their calcium more firmly and need a stronger field to remove them. Also, the local availability of other ions to replace the calcium may affect the ease with which it is removed. Nevertheless, the general effect is that electromagnetic exposure within an amplitude window reduces the amount of calcium bound to the membrane.

Frequency effects

If they are to remove calcium in this way, the fields must be alternating. Low frequencies work best because they allow more time for dislodged calcium ions to diffuse clear of the cell membrane and be replaced by different ions, before the field

reverses. Pulses are more effective than smooth sine waves because their rapid rise and fall times catapult the ions quickly away from the membrane and leave even more time for them to be replaced by different ions before the field reverses. This is probably why the pulsed radiation from mobile phones can be particularly damaging.

Radio waves

High frequency electromagnetic fields such as radio waves have relatively little biological effect unless they are *amplitude modulated* with a low biologically-active frequency. In amplitude modulation, the signal strength of the radio wave rises and falls in time with the low modulating frequency, but this has much the same effect in dislodging calcium ions as the raw low frequency.

Ion cyclotron resonance

Some low frequencies are unusually effective, either on their own or when used to modulate radio waves. This may be due to resonance. An example is 16Hz, which is the ion cyclotron resonance frequency of potassium ions in the Earth's magnetic field.

Cyclotron resonance occurs when ions move in a steady magnetic field such as that of the Earth. They go into orbit around its lines of force at a characteristic frequency, which depends on the charge to mass ratio of the ion and the strength of the steady field (see Liboff *et al.* 1990). If they are simultaneously exposed to an alternating field at this frequency, they absorb its energy and increase the diameter of their orbits, which also increases their energy of motion and chemical activity.

Potassium resonance is particularly important because potassium is by far the most abundant positive ion in the cytosols of living cells, where it outnumbers calcium by about ten thousand to one. It is therefore the ion most likely to replace any calcium that has been lost by electromagnetic exposure. An increase in the chemical activity of potassium will therefore have a major impact on its ability to replace calcium. Consequently, calcium loss is enhanced at the resonant frequency for potassium. Also, any metabolic consequences of this calcium loss may be similarly enhanced. So if we discover bioelectromagnetic responses that peak or trough at 16Hz this is evidence that it may stem from divalent ion depletion in membranes.

In fact, many biological responses appear to peak at around the resonant frequency for potassium. These include stimulations of the growth of yeast (Mehedintu & Berg 1997) and higher plants (Smith *et al.* 1993), changes in rate of locomotion in diatoms (McLeod *et al.* 1987), and the especially severe neurophysiological symptoms reported by electrosensitive people exposed to the radiation from TETRA handsets (which is pulsed at 17.6Hz). All of this supports the notion that a large number of the biological responses to weak electromagnetic radiation stem from the loss of calcium (and possibly other divalent ions) from cell membranes.

Calcium removal makes cell membranes leak

Positive ions strengthen cell membranes because they help bind together the negatively-charged phospholipid molecules that form a large part of their structure.

Calcium ions are particularly good at this because their double positive charge enables them to bind more strongly to the surrounding negative phospholipids and hold them together like a cement. However, monovalent ions are less able to do this (Steck *et al.* 1970; Lew *et al.* 1998; Ha 2001). Therefore, when electromagnetic radiation replaces calcium with monovalent ions, it weakens the membrane and makes it more likely to tear and form pores, especially under the stresses and strains imposed by the moving cell contents. Normally, small pores in phospholipid membranes are self-healing (Melikov *et al.* 2001) but, while they remain open, the membrane will have a greater tendency to leak.

Metabolic consequences of membrane leakage

Membrane leakage can explain almost all of the adverse effects of electromagnetic radiation, including those from mobile phones and their base stations. I will describe just a few and explain how they can occur.

Mobile phone radiation can damage DNA

Lai and Singh (1995) were the first to show this in cultured rat brain cells, but it has since been confirmed by many other workers. The most comprehensive study on this was in the Reflex Project, sponsored by the European Commission and replicated in laboratories in several European countries. They found that radiation like that from GSM mobile phone handsets caused both single and double stranded breaks in the DNA of cultured human and animal cells. Not all cell types were equally affected and some, such as lymphocytes, seemed not to be affected at all (Reflex Report 2004). However, in susceptible cells, the degree of damage depended on the duration of the exposure. With human fibroblasts, it reached a maximum at around 16 hours (Diem *et al.* 2005).

Because of the very high stability of DNA molecules, they are unlikely to be damaged directly by weak radiation. The most plausible mechanism is that DNAase (an enzyme that destroys DNA), and possibly other digestive enzymes, were leaking through the membranes of lysosomes (organelles that digest waste) that had been damaged by the radiation. If so, there is also likely to be considerable collateral damage to other cellular systems.

If similar DNA fragmentation were to occur in the whole organism, we would expect a reduction in male fertility from damage to the DNA of developing sperm, an increased risk of cancer from DNA damage in other cells (this may take many years to appear) and genetic mutations that will appear in future generations. It would be unwise to assume that exposures of less than 16 hours are necessarily safe, since covert DNA damage could give genetically aberrant cells long before it becomes obvious under the microscope. It would also be unwise to assume that the damage would be restricted to the immediate vicinity of the handset since the signal is transmitted easily through the human body and only very weak fields are needed to give these non-thermal effects. Nowhere is safe, not even the sex organs.

Mobile phones can reduce fertility

We might expect DNA damage in the cells of the germ line to result in a loss of fertility. Several studies have shown significant reductions in sperm motility, viability and quantity in men using mobile phones for more than a few hours a day (Fejes *et al.* 2005; Agarwal *et al.* 2006; Agarwal *et al.* 2007), so it is advisable for men to keep their mobile calls to a minimum. We do not yet know the effects of mobile phone use on female fertility since the eggs are formed in the unborn foetus and we will have to wait until the child reaches puberty, to see the effects of her mother's mobile phone use.

So far, similar investigations have not been performed with the radiation from mobile phone base stations, but we cannot assume that they are necessarily safe just because they are further away. Radiation levels, even hundreds of metres from the mast, can still give biological effects and living near one will involve a considerably longer exposure than from just making the occasional phone call.

Radiation and allergies

The current massive increase in allergies and allergy-related illnesses can be attributed to our rising exposure to electromagnetic radiation. By increasing the permeability of the barriers that normally protect all of our body surfaces, it enhances the penetration of foreign chemicals and allergens and increases our sensitivity to them.

Electromagnetic exposure disrupts tight junction barriers

We might expect radiation that is strong enough to disrupt lysosomes also to be strong enough to disrupt the outer membranes of living cells so that these too become more permeable to large molecules. The effects of this would be most serious in the cells of the "tight-junction" barriers that protect many parts of our bodies. These normally give extra protection because the gaps between their cells are sealed with impermeable materials to restrict the passage of unwanted substances around their sides. An example is the blood-brain barrier, which normally prevents foreign materials in the bloodstream from entering the brain. The radiation from mobile phones can increase the permeability of this barrier, even to protein molecules as large as albumin (Persson *et al.* 1997) and this can damage the neurones beneath (Salford *et al.* 2003).

Calcium ions control barrier tightness

The loss in "tightness" of the blood-brain barrier could be due to an increase in membrane leakiness and/or to a disruption of the tight junctions themselves. Either of these could be triggered by an electromagnetically-induced loss of calcium. The central role of calcium in controlling the "tightness" of these layers is supported by an observation by Chu *et al.* (2001) on respiratory epithelia (which also have tight junctions). They found that either low levels of external calcium or the addition of EGTA (a substance that removes calcium ions from surfaces) caused massive

increases in its electrical conductance (a measure of its permeability to ions) and to its permeability to much larger virus particles.

We have many tight junction barriers

One of these is the protective layer in the skin called the *stratum granulosum*, which is the outermost layer of *living* skin cells, where the cells are connected by tight junctions (Borgens *et al.* 1989; Furuse *et al.* 2002). In addition to this, virtually all of our other body surfaces are protected by cells with tight junctions, including the nasal mucosa (Hussar *et al.* 2002), the lungs (Weiss *et al.* 2003) and the lining of the gut (Arrieta *et al.* 2006). An electromagnetically-induced increase in the permeability of any of these would allow the more rapid entry into the body of a whole range of foreign materials, including allergens, toxins and carcinogens.

Loss of tightness can exacerbate many illnesses

Electromagnetically induced losses of barrier tightness at our body surfaces can explain how the general increase in public exposure to electromagnetic fields may be responsible for our ever-increasing susceptibility to various allergies, multiple chemical sensitivities, asthma, skin rashes and bowel cancer to name just a few. In addition, a non-specific increase in the permeability of the gut has been linked to type-1 diabetes, Crohns disease, celiac disease, multiple sclerosis, irritable bowel syndrome and a range of others (Arrieta *et al.* 2006). The list is truly horrendous and points to a very real need to reduce our exposure to non-ionising radiation.

Electrosensitivity

Electrosensitivity (alias electromagnetic hypersensitivity or EHS) is a condition in which some people experience a wide range of unpleasant symptoms when exposed to weak non-ionising radiation. Only a small proportion of the population is electrosensitive (currently estimated at around three percent) and an even smaller proportion is so badly affected that they can instantly tell whether a radiating device is switched on or off. At the other end of the scale, there are people who may be electrosensitive but do not know it, because they are chronically exposed to electromagnetic fields and accept their symptoms as being perfectly normal. Electrosensitivity is in fact a continuum and there is no clear cut-off point.

Causes and symptoms of electrosensitivity

Why some people are particularly susceptible to this condition is uncertain and not everyone shows the same symptoms. However, they seem to be characterised by having skins that have an unusually high electrical conductance (Eltiti *et al.* 2007, Table 5). This is consistent with them having a *stratum granulosum*, in their skins that is abnormally leaky, and may account for the high incidence of allergies and chemical sensitivities commonly found in this group.

One explanation for their sensitivity to the radiation is that they normally have low levels of calcium and/or magnesium in their blood. This gives low concentrations of these ions on their cell membranes, so that that less has to be removed by

electromagnetic exposure to produce biological effects. The range of electromagnetically-induced symptoms reported by electrosensitives (which includes skin disorders, pins and needles, numbness, burning sensations, fatigue, muscle cramps, cardiac arrhythmia, and gastro-intestinal problems) is remarkably similar to those from hypocalcaemia (low blood calcium) (<http://tinyurl.com/2dwwps>) and hypomagnesaemia (low blood magnesium) (<http://tinyurl.com/3ceevs>). This suggests that they share a common aetiology, that being that there are inadequate concentrations of these divalent ions on the cell membranes to maintain stability. This promotes the formation of pores and gives rise to an unregulated flow of materials across them.

Ordinary people are affected too

Even people not suffering from EHS show changes in brain function in response to the radiation from mobile phones and their base stations. These include reacting more quickly to simple stimuli but having a poorer performance in more complex tasks (Abdel-Rassoul *et al.* 2007). Among the detrimental effects, is that on our ability to drive motor vehicles. According to the Royal Society for the Prevention of Accidents, we are four times more likely to have an accident while talking on a mobile phone, regardless of whether it is a hands-free type, whereas talking to a passenger has little or no effect.

All of this can be explained as a result of membrane leakage in neurones (highly branched brain cells, which behave like telephone exchanges that can transmit information to up to thousands of others). An essential part in the transmission of signals from one neurone to another is the release of calcium ions through membranes into the cytosol (the main part of the cell) in the transmitting neurone. This then triggers the secretion of chemical neurotransmitters that carry the signal to its neighbours via the synapses (where their branches make close contact). Because electromagnetically induced membrane leakage will give a higher background concentration of calcium in the cytosol, the neurones will respond sooner to stimulation and give a faster reaction time for the whole organism.

However, they will also be more likely to generate spurious nerve impulses that reduce the signal to noise ratio of the brain and create a mental fog. This will make weaker signals less discernible and result in more errors when performing complex tasks such as driving car. This can be thought of as a special case of electromagnetically-induced Attention Deficit Hyperactivity Syndrome (ADHS).

Autism

There has been a 6000 percent increase in autism in recent years, which corresponds in time to the proliferation of mobile telecommunications, Wifi and microwave ovens. We can also explain this in terms of electromagnetically-induced membrane leakage leading to brain hyperactivity.

Just after its birth, a child's brain is essentially a blank canvas, and it goes through an intense period of learning to become aware of the significance of all of its new sensory inputs, e.g. to recognise its mother's face, her expressions and eventually

other people and their relationship to him (Hawley & Gunner 2000). During this process, the neurones in the brain make countless new connections, the patterns of which store what the child has learnt. However, after a matter of months, connections that are rarely used are pruned automatically (Huttenlocher & Dabholkar 1997) so that those that remain are hard-wired into the child's psyche. The electromagnetic production of spurious action potentials during this period will generate frequent random connections, which will also not be pruned, even though they may not make sense. It may be significant that autistic children tend to have slightly larger heads, possibly to accommodate unpruned neurones (Hill & Frith 2003).

Because the pruning process in electromagnetically-exposed children may be more random, it could leave the child with a defective hard-wired mind-set for social interactions, which may then contribute to the various autistic spectrum disorders. These children are not necessarily unintelligent; they may even have more brain cells than the rest of us, and some may actually be savants. They may just be held back from having a normal life by a deficiency in the dedicated hard-wired neural networks needed for efficient communication with others.

A useful homology might be in the socialisation of dogs. If puppies do not meet and interact with other dogs within the first four months of their life, they too develop autistic behaviour. They become withdrawn, afraid of other dogs and strangers, and are incapable of normal "pack" behaviour. Once this four-month window has passed, the effect seems to be irreversible (just like autism). If this homology is correct, it suggests that experiments on dogs could hold the key to the investigation of autism and its possible links with electromagnetic exposure.

Defence mechanisms

The body is well able to detect weak non-ionising radiation and the resulting damage. This ability probably evolved over countless millions of years to mitigate the effects of the wideband radiation from lightning during thunderstorms. We already know how some of them work. These are as follows.

Calcium expulsion.

The concentration of free calcium in the cytosols of living cells is normally kept extremely low by metabolically-driven ion pumps in the cell membrane. Under normal circumstances, the entry of free calcium ions is carefully regulated and small changes in their concentration play a vital role in controlling many aspects of metabolism. These processes can be disrupted if electromagnetically-induced membrane leakage lets extra and unscheduled amounts of calcium into the cell, either from the outside or from calcium stores inside. To compensate for this, the mechanism that normally pumps surplus calcium out can go into overdrive. However, its capacity to do this is limited because, if the pumping were too effective, it would hide the small changes in calcium concentration that normally control metabolism.

Ornithine decarboxylase (ODC)

The activation of the enzyme *ornithine decarboxylase* is triggered by calcium leaking into cells through damaged membranes and by nitric oxide produced by damaged mitochondria (membrane-bound particles that provide most of a cell's energy). This enzyme leads to the production of chemicals called *polyamines* that help protect DNA, and the other nucleic acids needed for protein synthesis.

Heat-shock proteins

These are perhaps wrongly named because they can also be produced directly in response to *electromagnetic radiation* at levels millions of times lower than those that generate significant heat (Blank & Goodman 2000). We even know the base sequence of the DNA that senses the radiation. The job of these heat-shock proteins is to combine with vital enzymes, putting them into a sort of cocoon that protects them from damage. However, this also stops them working properly, so it isn't an ideal solution.

As we can see, these defence mechanisms are triggered either by radiation-damage or by the radiation itself. Their role is to try to limit the damage, but they cannot be deployed without using extra energy and disrupting the cell's normal functions. Consequently, they are programmed not to cut in until the damage approaches intolerable levels. This effect will maintain the damage and observable symptoms close to the levels at which they cut in over a wide range of radiation intensities. Consequently, electrosensitive individuals may find that their symptoms (such as headaches and dizziness) from distant mobile phone masts and local handsets may be approximately the same, at least in the short term.

Long-term effects

These defence mechanisms originally evolved to protect living organisms from weak natural radiation, such as that from thunderstorms. However, they were "designed" only for intermittent use because they disrupt normal metabolism and are expensive in bodily resources and energy. These resources have to come from somewhere. Some may be drawn from our physical energy, making us feel tired. Some may come from our immune system, making us less resistant to disease and cancer. There is no hidden reserve. As it is, our bodies are constantly juggling resources to put them to best use. For example, during the day, they are directed towards physical activity but during the night, they are diverted to the repair of accumulated damage and to the immune system. Day and night irradiation from mobile phone masts (which run continuously) will affect both, with little or no chance to recover. In the long term, this is likely to cause chronic fatigue, serious immune dysfunction (leading to an increased risk of disease and cancer) and many of the neurological symptoms frequently reported by people living close to mobile phone base stations (see Abdel-Rassoul *et al.* 2007).

DECT phones and Wifi may be just as bad

There is a growing number of anecdotal reports that the continuous radiation from DECT phone base stations and Wifi routers can have similar effects to mobile phone

base stations; so these too should be considered as potentially unsafe. We should perhaps add to these the growing use of DECT cordless baby alarms. Although to date there is no firm evidence of adverse effects, these devices irradiate the baby continuously at close range and, to the best of my knowledge, they have not been tested for electromagnetic safety. It is ironic that any proposal to test them with real children would probably be turned down as being unethical. Nevertheless, they are on the market and the exposed child will probably be too young to report any symptoms. One symptom to look for would be a delay in the onset of sleep due to brain hyperactivity; this could be an early warning of potential damage that may not become apparent until later life. Bearing in mind a possible link between electromagnetic exposure during early childhood and autism, it might be a wise precaution to stick to the old-fashioned wired baby alarm.

Why we are not all affected

This is due to natural biological variability and is quite normal. For example, not everyone who smokes dies of cancer; it just increases the risk. Similarly, not everyone will be equally affected by non-ionising radiation. There could be many reasons for this; some people may have higher levels of calcium in their blood, which will help stabilise their cell membranes. Others may have more effective natural defence mechanisms or mechanisms that cut in at different levels. Still other people may have had their defence systems impaired, either by illness or prolonged electromagnetic exposure. Many more may actually be affected but have just put it down to the general stress of modern living and have not yet made the link between their symptoms and our now almost universal electromagnetic exposure.

However, even if you are one of the lucky ones who suffer no obvious short-term adverse effects from electromagnetic radiation, there is no cause for complacency. There is no guarantee that you will not suffer long-term effects or that the apparent lack of effect will continue as the general levels of electromagnetic exposure rise and our steadily aging bodies become less and less able to cope. In many ways, the effects of electromagnetic exposure may resemble those of premature aging.

What can we do about it?

Very few people would want to give up their mobile phones, but if you have one, for your own personal safety, it is best to keep your calls on it short and relatively infrequent so that your body has a chance to recover in between times. Use text (which takes seconds to transmit) rather than voice calls and avoid making unnecessary downloads from the Internet. The choice is yours, but spare a thought for the people living near the base stations. Some of them may be badly affected by their continuous irradiation but they have no choice. Your mobile calls will contribute to their problems, so your restraint may help them too.

Dangerous water towers

There is a growing tendency to mount mobile phone base station antennas on water towers. This may seem convenient, but it carries a hidden risk because the radiation may also affect the water to make it *biologically active*.

Weak pulsed radiation is routinely used in “electronic” water conditioners to remove lime scale from plumbing. The mechanism of the conditioning effect is still controversial but it depends on the presence of impurities and does not work with all water supplies. It appears to involve changes in the pattern of ions bound to colloids, which alter their surface charge and make them more attractive to calcium ions.

However, the treated water has biological effects similar to those from exposure to weak electromagnetic radiation, perhaps due to its removing calcium ions from cell membranes, just as it removes lime scale from water pipes and boilers.

Laboratory experiments with yeast cultured in electromagnetically conditioned water showed that its biological effects depended on the length of time for which the water was conditioned. In our hands, treating London tap water for 30 seconds or less (as it would be when passing through a domestic water conditioner) resulted in its stimulating cell division in yeast but caused no obvious harm. However, treatment for longer than this (as it would be if a water storage tank were to be irradiated) inhibited cell division, suggesting that it may now be toxic (Goldsworthy *et al.* 1999).

If a similar effect were to occur in water towers fitted with mobile phone antennas, it could have adverse effects on public health. Because the conditioning effect on water can last up to several days, this gives ample time for it to be distributed widely through the water mains and so present an even greater threat to the public than the antennas themselves. This needs urgent attention by the water companies since, unlike the mobile phone operators, they have no legal immunity from prosecution for distributing a potentially toxic product.

Postscript

At present, legislation by many governments (presumably at the request of the mobile phone operators) prevents anyone objecting to the location of base stations on health grounds, and governments have been advised not to recognise the problem. I hope that this article may go some way to achieving this much-needed recognition. The problem is far more serious than anyone has previously imagined. The effects on people with EHS and allergy-related conditions are bad enough in their own right but, with about half the world’s population already owning a mobile phone, the resulting widespread genetic damage threatens the future of the entire human race.

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**IS THE SCIENTIFIC KNOWLEDGE INFLUENCED BY EXTERNAL
PRESSURES? ARE THE ORGANIZATION'S RESOLUTIONS
INDEPENDENT?**

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In recent years, technology, with the use of electromagnetic radiation, advances at a fast rate. However, this advancement creates a public concern about the potential effects of the electromagnetic radiation. Are the Resolutions by International Independent Bodies, concerning the protection of public health, really independent? Is scientific knowledge influenced by external factors?

Today's exposure levels were formed in 1997 (published 1998) from the Committee ICNIRP based on the increase body temperature. They did not take into consideration the effects caused by the chronic exposure and non thermal mechanisms.

More than half of the members and the consultants of ICNIRP are also members in other organizations. Even though these organizations should be independent, we see three EU Committee members being also in ICNIRP and a member declares interests (declared interests).

The design of the studies is another problem which causes concern. For example, The Denmark study ((2006), which was based in the study of 2001, had an inclusion criterion, if someone<<ever>> used a mobile phone during the period 1982-1995. The group of subscribers (200 507) who had the telephone from their company (corporate customers) were the most likely heavy users, but were excluded from the study.

Hardell and others sent a letter to the editor about the problems of the study, but it was not accepted for publication. An author of the study was also a member of the Editorial Body of the journal.

The published article by Hardell (2007) << Secret ties to industry and conflicting interests in cancer research>> reports the relationship between industry and funding research. Also Huss (2007) reported, that in order to evaluate a study for electromagnetic radiation we must take into consideration the funding source. Studies that were funded by the industry were less likely to report statistical significant results.

In conclusion, we see that Organizations are not independent from each other and that scientific knowledge can be influenced by external factors with consequences in public health.

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**REVIEW OF OUR RECENT EXPERIMENTS –
SAFE USE OF RADIATION – CREATING APPARATUSES**

Lukas H Margaritis and collaborators: (Panagopoulos D., Argyri E., Katsarou A., Kefalos P., Kokkaliaris K., Kontogianni G., Korre P., Kotsila P., Koumpou A., Kourouzidou A., Savvaki M., Stavropoulou E., Sykioti V., Schiza D., Fragopoulou A., Chavdoula E.)

Published experiments from our laboratory have shown that the electromagnetic radiation emitted by mobile phones of the GSM system, 900MHz, modulated by human voice (calling transmission), causes reduction in the reproductive capacity of the insect *D. melanogaster* after 6min exposure per day for 5 days. This reduction has been found to be due to the increased amount of cell death at the follicles during oogenesis that is normally observed as a control mechanism. The initial results based on counting of the daughter pupae that arise after fertilization, as well as in detecting DNA fragmentation in the follicles, have shown that the intermittent exposure has approximately the same effects as the continuous, which potentially indicates that for the specific biologic system of oogenesis in insects runs a mechanism of cumulative effect. Likewise, an explicit increase of cell death during oogenesis was found in insects that were exposed in increased duration of mobile phone radiation, as compared to the numbers in insects that were not irradiated.

In another experimental line we found a) a 40% reduction in fertility of individuals exposed to Bluetooth and a 20% reduction of the exposed to mobile phone in correspondence to control individuals, b) small increase of apoptotic follicles. Thus, it could be considered that the use of Bluetooth is not as safe when it placed in direct contact with the ear and therefore wired Bluetooth is recommended as safer.

The wireless phone DECT (digital enhanced cordless telephones) technology is not free from consequences since a decrease in reproductive capacity due to irradiation exposure was found in our experiments. Furthermore after an ovarian anatomy performed in insects that were exposed in DECT radiation for three days with 6 minutes exposure every day a DNA fragmentation was observed in follicles as a result of the induced cell death.

Recently our activities were expanded in experiments in the mice *Mus musculus*, Balb/c, which are irradiated with both mobile phone and wireless phone, in an attempt to examine the full scaled effects, from the reproductive capacity to the learning and memory skills, development falsification, thermal shock and induction of cell death.

The preliminary results so far, point to a change in behavior (predicament at labyrinth exploration) and ossification abnormalities at infants as such influence towards the ability to recall the position of a sunken platform in a Morris tank, which suggests that the capacity of storage or/and information withdrawal have been probably disturbed. In future experiments the molecular mechanisms and potentially the cellular changes that are under these macroscopic changes in behavior will be inquired.

At the framework of our research group's contribution in affronting the problem of habitants and pupils (elementary and high school) being irradiated we conducted intensity measurements of both electromagnetic radiation that comes from base stations and of magnetic field that comes from power suppliers of medium, high and ultra high voltage as such and in Public Power Corporation substations with specialized field meters, in houses and schools inside the country of Attica and elsewhere as well. In accordance to the distance from the base station and its "transmission lobe(s)" the values of electromagnetic radiation were reaching up to 6,5 V/m inside some houses and up to 3,5 V/m in some classrooms. The values of magnetic fields were from 10-15mG inside School departments and close to 50mG in some

residences' yards. These levels of radiation are considered to be in the long run dangerous for people that accept that kind of radiation for many hours every day and especially for the children.

As a consequence of our research activity and of the continuous exchange of prospects with foreign scientists, we can suggest solutions for the safe use of radiation transmitting devices that modern people use, as following :

- Mobile phone : Use with wired Bluetooth, keeping the mobile phone away from the body (even from bystanders) or inside a special case. Particular caution should be taken in the car and in closed places, always keeping in mind that the radiation is transmitted from the mobile phone and must have access to open space in order to escape.
- Wireless phone : The base of modern wireless phones transmits continuously and therefore it must be kept away from any human presence (especially that from children or infants) and if possible to keep it closed during sleep. Because the earpiece transmits radiation (but only during conversation) it must be used barely minimum and thereafter use stable phone.
- Wireless network : Placement as far as possible away from places of human activity.
- Microwave oven and all kind of electric devices : Safety comes from the distance : the further the better
- Supervision devices for infants: keep them at a distance of at least 2 meters away from the infant.

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