

Noise Field Research Summary
June 1999
Dr. Thomas Magnussen, EMX Corporation

- How do EMFs affect us?
- What can be done about it?

Noise Field EMF Bioprotection™ technology and EMX Noise Field Technology (EMX Noise) is based upon research originated by the U.S. Army, Walter Reed Army Institute in 1986, initially performed by the Catholic University of America (CUA) in Washington D.C., Departments of Physics, Biology and Institute for Biomolecular Studies; principal investigator Dr. T.A. Litovitz, and replicated by six other Universities in three different continents from 1993 to 2002. Technology available at EMX Corporation <http://www.icswebsite.com/s-whatnews.htm>

This paper is extracted from: <http://www.icswebsite.com/emf/emfissues.html>

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0. SUMMARY OF EMF ISSUES

0.1. Introduction

In response to a growing body of scientific evidence, the existence of health and biological effects associated with exposures to EMFs is becoming more widely known and accepted. More and more scientists now believe that the existence of significant non-thermal effects induced by low-level non-ionizing EMF are a reality.

For example, on Wednesday, July 24, 1998, a 28 member panel convened by the National Institute of Environmental Health Sciences (NIEHS) decided that extremely low frequency (ELF) electromagnetic fields should be regarded as possible carcinogens.

The final vote of the panel was 19 to 9 in favor of categorizing ELF EMFs, such as those from power lines and electrical appliances, as possible carcinogens. The vote followed one year of study including three major, multi-day symposia and a final 10 day intensive meeting of scientists to review and debate the scientific and medical literature.

In October 1998 at the University of Vienna Workshop on Possible Biological and Health Effects of Radio Frequency (RF/MW) Electromagnetic Fields, the following resolution was made by the participating scientists (the "Vienna Resolution"):

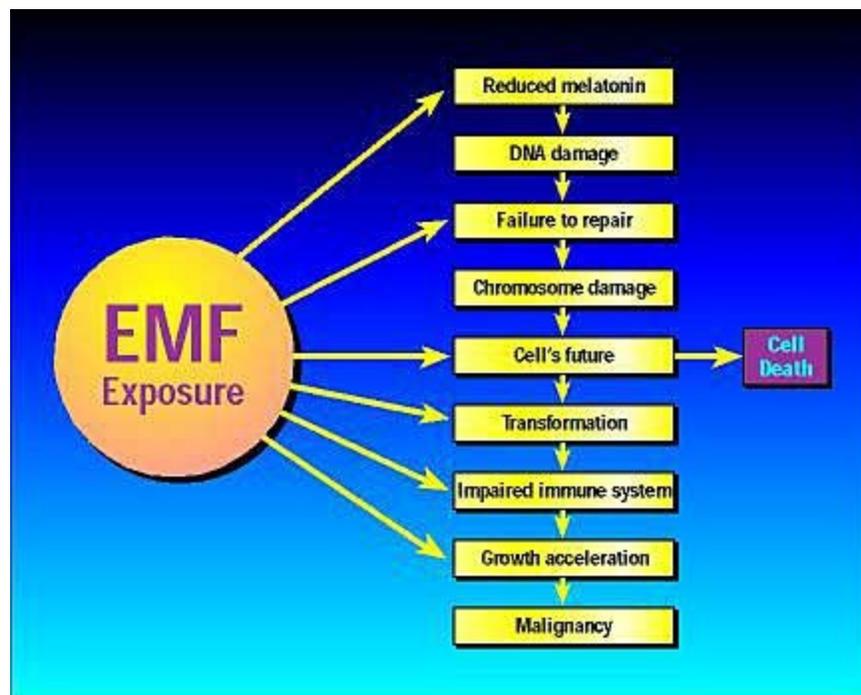
"The participants agreed that biological effects from low-intensity exposures are scientifically established. However, the current state of scientific consensus is inadequate to derive reliable exposure standards. The existing evidence demands an increase in the research efforts on possible health impact and on adequate exposure and dose assessment."

In conclusion, scientists working in the field of "bioelectromagnetics" are now convinced that man-

made EMFs disturb biological processes (induce biological effects). Some of the biological effects seen in the laboratories are similar to biochemical mechanisms believed to be responsible for neurological effects like short term memory loss, whereas others are believed to be involved in the development of serious disorders like cancer, Alzheimer's and Parkinson's.

There is no definitive conclusion whether this may lead to these serious diseases, and research will not be able to provide unequivocal answers until the causes of these diseases have been identified completely. Should we know one day what role low-level non-ionizing EMFs play in cancer, it will only be because we will also know what causes cancer. Until such time, science will have no choice but to continue advancing, studying and rejecting new hypotheses until finally, from many individual findings, a conclusive overall picture of cancer and other diseases emerges.

However, the conclusion mentioned above, formulated by the 28 person scientific work group under NIEHS stating that EMFs should be regarded as possible carcinogens, is a warning; already, a substantial body of scientific evidence do point to a relation between EMFs and cancer. Below is shown a summary of scientific findings on EMF-induced biological effects related to the cascade of events believed to be significant in the development of cancer:



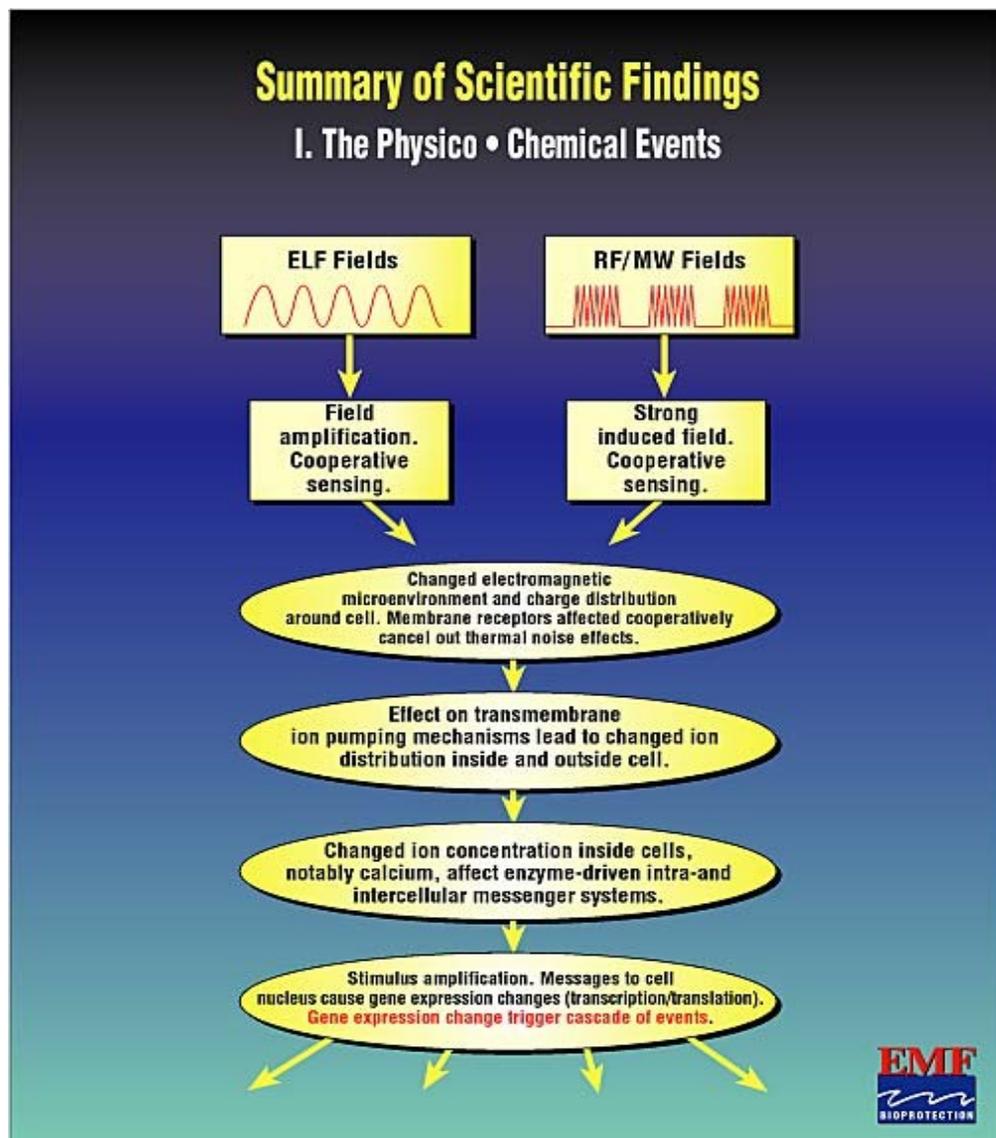
Dr. Neil Cherry of Lincoln University, New Zealand, in a recent report concluded:

"Scientific studies at the cellular level, whole animal level and involving human populations, show compelling and comprehensive evidence that RF/MW exposure down to very low levels, levels which are a minute fraction of present "safety standards", result in altered brain function, sleep disruption, depression, chronic fatigue, headache, impaired memory and learning, adverse reproductive outcomes including miscarriage, still birth, cot death, prematurely and birth deformities. Many other adverse

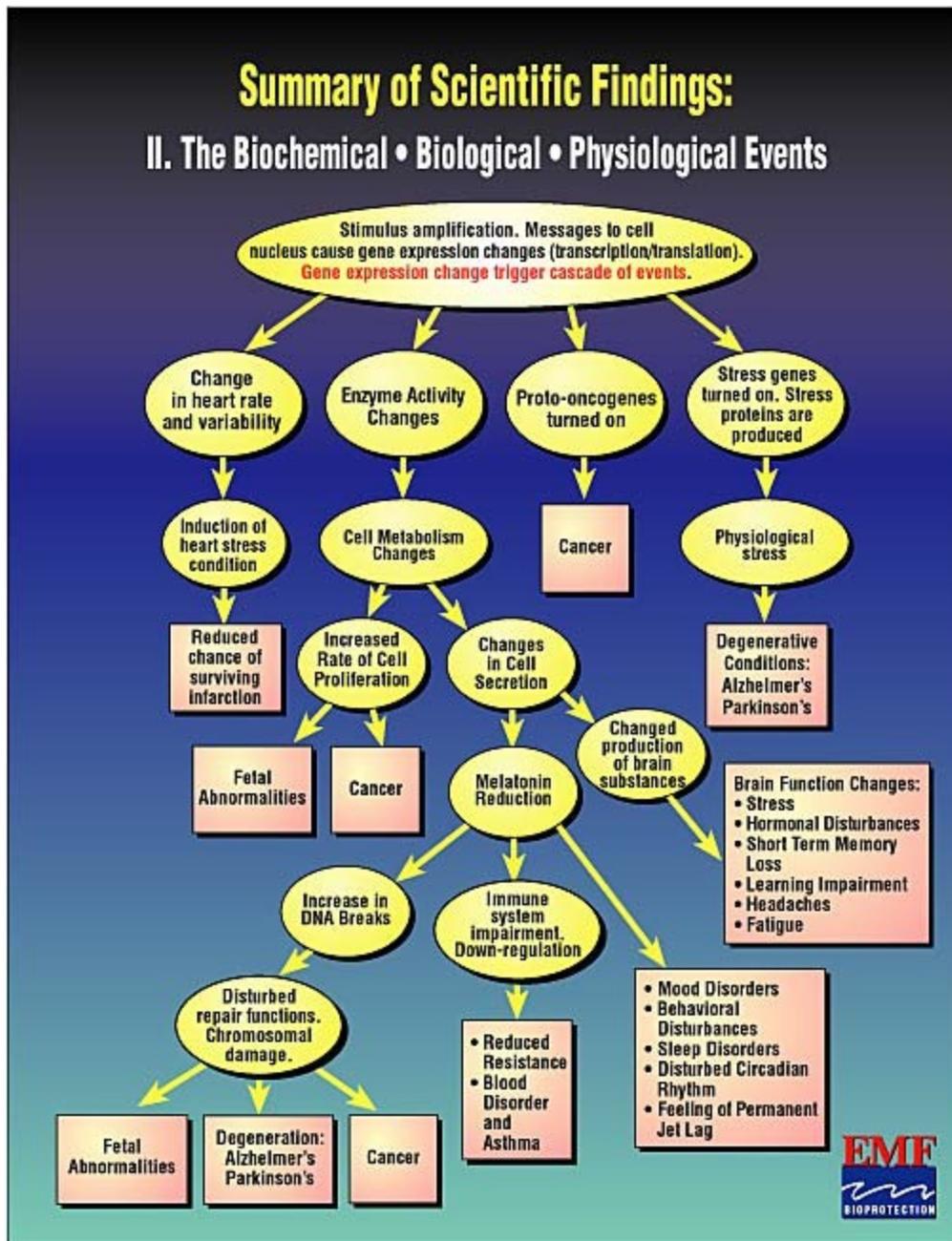
health effects have been found, predominantly cancer of many organs, especially brain cancer, leukemia, breast cancer and testicular cancer. Studies have also found that RF/MW exposed parents have more children with CNS cancers and other health defects. These effects are consistent with genetic damage caused by RF/MW. Many scientific studies have found chromosome aberrations and DNA damage with RF/MW exposure, the first being published in 1959. Two primary biological mechanisms are linked to these effects, calcium ion efflux and melatonin reduction. With melatonin reduction, there is a rise in serotonin which is associated with awakesness, alertness, anxiety, anger, rage and violence depending on the serotonin level, the person and the circumstances.

Hence, there is a strong evidence that ELF and RF/MW is associated with accelerated aging (enhanced cell death and cancer) and moods, depression, suicide, anger, rage and violence, primarily through alteration of cellular calcium ions and the melatonin/serotonin balance."

Cell phones emit both microwave radiation (MW) from the antenna and extremely low frequency (ELF) fields from the body of the phone. Both types of emissions have been consistently and repetitively shown to induce significant biological effects.



Below is shown a summary of the biological effects which have been found in peer-reviewed and published scientific studies. It is also shown how these biological effects may lead to physiological Summary of scientific findings: II. Biochemical/biological/physiological events conditions and potential disease. This summary is not exhaustive, and much more research will be needed in the future to expand and refine the picture.



0.2. A scientific solution to the EMF problem

The EMF Bioprotection™ technology is a scientifically developed solution to the EMF problem. The technology is peer-reviewed and published in a series of publications, and its ability to neutralize biological effects induced by EMF-exposures has been tested and confirmed by five laboratories in North America and Europe independently.

The technology was developed in a large, still on-going research project at the Catholic University of America (CUA), Department of Physics in Washington, D.C. The research project was initiated in 1986 and funded in its first five years by the U.S. Army, Walter Reed Army Institute Department of Microwave Engineering.

The background for the project was worries in the U.S. Army about the biological effects and potential health consequences to personnel exposed to EMFs. Since World War II, the U.S. Army has been the world's largest user of electrical, electronic, and telecommunication equipment and was the first to recognize effects induced by EMFs on military personnel (radar operators on WW II battleships).

The EMF Bioprotection™ technology is patented in the U.S.A., and applications have been branched out in the rest of the world. The patent application for the technology is endorsed by the U.S. Army; the U.S. government owns all non-commercial rights to the technology, whereas non-commercial rights belong to the company EMX Corporation which will shortly be introducing products in the marketplace providing protection for consumers worried about potential health effects of EMF exposures.

The EMF Bioprotection™ technology is designed to prevent non-thermal biological effects of EMF exposures. When the biological effects are prevented, there can not possibly be any health effects associated with these biological effects. The EMF Bioprotection™ technology consists of a device which emits a random EMF "noise" field, superimposed on the EMF which cause biological disturbances.

The technology is believed to work by blocking the EMF-induced physical-chemical interactions around cell membrane receptors, probably by preventing cooperative sensing from happening. In this way, the cascade of biochemical events which would result inside the cell as a function of membrane receptors sensing the constant, oscillating EMF, is prevented from being triggered. The EMF Bioprotection™ technology re-establishes the situation around the cell as if it was non-exposed. This is illustrated in the figure below:

The efficacy of the EMF Bioprotection™ technology in preventing EMFs from causing biological effects has been tested at five different laboratories independently on numerous biological systems and markers; in all tests, EMF-induced biological effects were effectively eliminated, and it has also been tested that the bioprotection noise field does not in itself induce any biological effects, which is logical, as it simulates natural fields.

Laboratories that have tested the efficacy of the EMF Bioprotection™ technology:

1. Department of Physics, and Department of Biology and Institute for Biomolecular studies, Catholic University of America, Washington, D.C. Att.: Dr. T.A. Litovitz.

2. Department of Anatomy, The University of Western Ontario, and Departments of Biochemistry, Victoria Hospital, London, Ontario, Canada. Att.: Dr. A.H. Martin.
3. Department of Pathology, College of Physicians and Surgeons, Columbia University, New York. Att.: Dr. R. Goodman.
4. Institute of Communication Technology, Aalborg University, Denmark, and Institute of Medical Biochemistry, University of Aarhus, Denmark. Att.: Dr. S. Kwee.
5. Bioelectromagnetics Research laboratory, Center for Bioengineering, University of Washington, Seattle. Att.: Dr. Henry Lai.

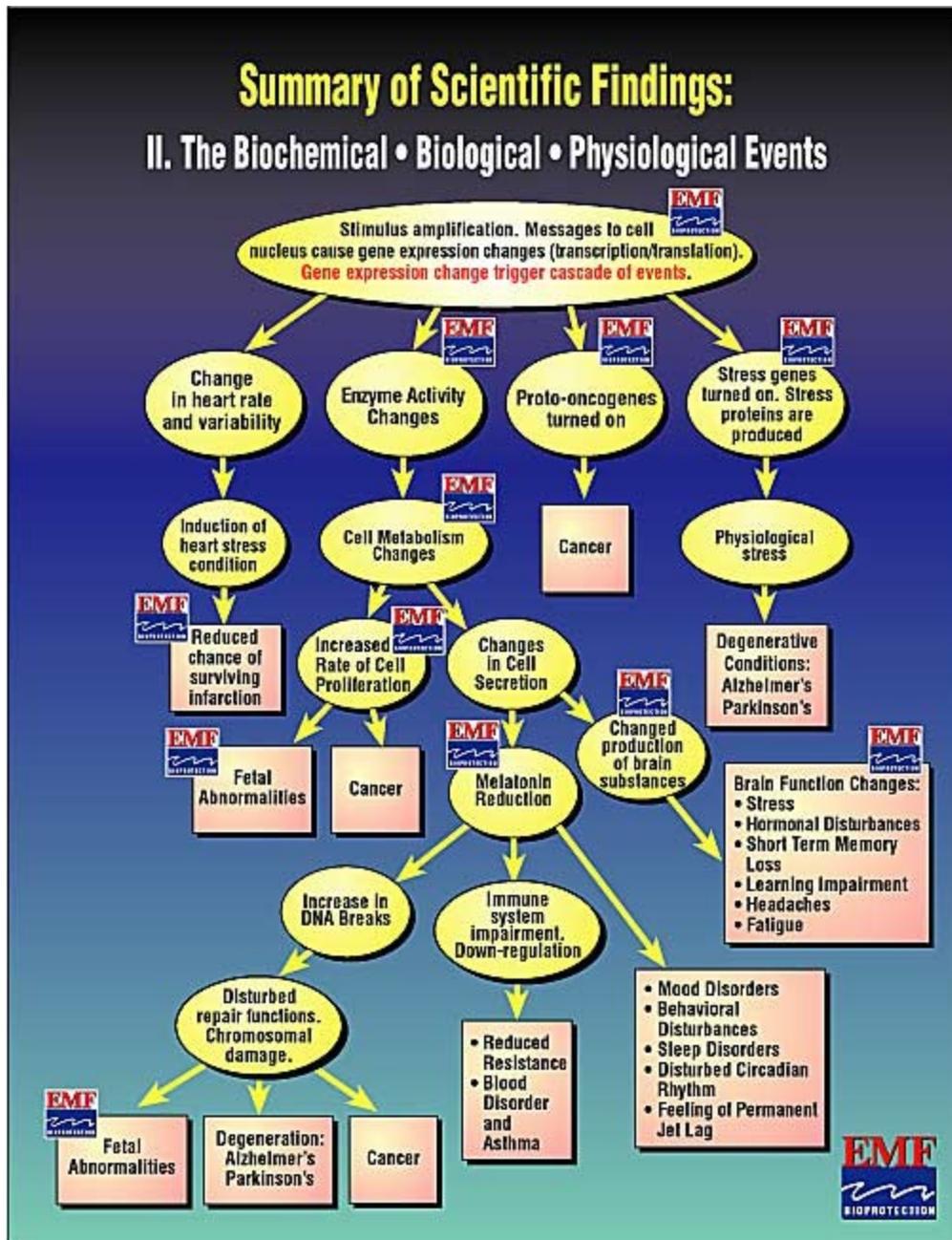
The test studies of the EMF Bioprotection™ technology are summarized below, organized according to biological effects and potential health conditions induced by EMFs. Specific biological effects that have been eliminated in the laboratories are "flagged".

The research conducted provide ample support for the hypothesis that the superimposed EMF noise field functions by preventing the fundamental sensing mechanisms situated in the receptors of the cell from reacting to the constantly oscillating EMF stimulus. This blocks the triggering effect in the cascade of events leading to significant biological effects and potentially adverse health effects.

EMX Corporation has developed a microchip-based implementation of the EMF Bioprotection™ technology. This platform allows easy integration of bioprotection in a wide variety of systems, products and devices emitting bioeffecting EMFs.

The first products to be installed with the EMF Bioprotection™ microchip are mobile phone batteries. EMX Corporation has entered into a cooperation agreement with Alexander Technologies of USA to supply bioprotected batteries for mobile phones.

A mobile phone user who is concerned about the biological effects induced by the emissions of his phone can purchase a bioprotected battery. The installed microchip will emit a a random noise field which blocks the non-thermal biological effects induced by the cell phone EMF. The biological effects shown to be eliminated by the EMF Bioprotection™ technology are marked with the EMF Bioprotection™ logo.



As it appears from this overview, the EMF Bioprotection™ technology has proven its ability to eliminate a broad variety of EMF induced biological effects, along any of four critical pathways of biological events:

- Gene expression is the fundamental starting point of all metabolic processes in the cell, if you fiddle with that, anything can happen. Gene expression changes caused by external factors can be very adverse, triggering unpredictable cascades of undesirable biological events leading to such different conditions as cancer, Alzheimer's, Parkinson's, brain and heart functional impairment, blood disorders, allergies and asthma, mood and behavioral disorders, sleep

disturbances, headaches, fatigue, circadian rhythm disorders, etc. It has been demonstrated that the EMF Bioprotection™ technology eliminates EMF-induced gene expression changes related to cancer and biological stress.

- There is epidemiological as well as laboratory evidence that EMFs change the function of the heart and induce stress which may lead to down-regulation of critical defense and repair mechanisms. This has been shown to adversely affect the mortality rate related to infarctions. It has been shown on live chicken embryos that the EMF Bioprotection™ technology eliminates the EMF-induced impairment of heart defense and repair mechanisms.
- There is laboratory evidence that EMFs significantly change the activity of important enzymes related to growth and development of nerve and brain tissue and cancer cells, causing changes in metabolism and cell proliferation which may lead to cancer or fetal abnormalities. The EMF Bioprotection™ technology has been shown to eliminate such effects in cells and chicken embryos. The EMF-induced changes in cell metabolism may lead to changes in the production and secretion of critical endocrine and brain hormones and neural substances (neurotransmitters), which are vital to the proper functioning of brain, nerves and organs, and important to the body's defense against cancer. EMF Bioprotection™ technology has been shown to eliminate EMF-induced changes in the production of such substances, and to normalize EMF-induced changes in brain function of rats.
- There is laboratory evidence of EMF-induced stress in cells, organs and animals. This is expressed as a change in cell metabolism triggering production of stress proteins, the universal response of a cell exposed to a potentially adverse insult. Stress in short periods is actually beneficial to the organism; however, if the stressful condition persists, such as in the chronic or repetitive exposure to electromagnetic fields, the mechanism of down-regulation comes into play. This may lead to situations where the cells are not prepared for life-threatening stressors such as chemical toxins, bacterial or viral attack, ionizing radiation, anoxia, etc. The consequence of such situations may be excessive cell death, leading to degeneration of tissue in the brain or nerves (Alzheimer's and Parkinson's). The EMF Bioprotection™ technology has been shown to eliminate EMF-induced stress responses.

0.3. Providing products with the EMF Bioprotection™ technology

The development and testing of the EMF Bioprotection™ technology has been going on since 1986 by the team of around 15 scientists at CUA. The testings will continue, and more laboratories will be involved in this work in addition to the five laboratories already involved.

The development and testing was initiated and funded in the first five years by the U.S. Army. In 1991, a research and development company called EMX Corporation was founded to continue the funding of the research, and to develop a technological platform for providing protection to consumers with the EMF Bioprotection™ technology.

EMX Corporation with offices in London, New York and San Jose has developed and tested a microchip-based implementation of the EMF Bioprotection™ technology. This will allow manufacturers and distributors of electric, electronic and telecommunication systems, devices and appliances to offer their customers protection against biological effects induced by the EMFs emitted

from their products.

EMX Corporation will work with these companies to help them practically and cost-efficiently to integrate EMF Bioprotection™ technology in their products.

The first product incorporating EMF Bioprotection™ is aimed at the mobile phone market. EMX Corporation has entered into an agreement with a large mobile phone battery manufacturer, incorporating EMF Bioprotection™ in their product line. These products are offered existing users of mobile phones. To obtain protection, users of mobile phones just have to buy a new battery for their phone with the EMF Bioprotection™ technology incorporated.

EMX Corporation will be working together with other companies, providing bioprotection to users of hair dryers, electric hand tools, vacuum cleaners, computers, microwave ovens, etc.

1. THE NATURE OF ELECTROMAGNETIC FIELDS

Around a permanent magnet there is something that make an iron particle jump through space to the magnet. Obviously, there is an invisible entity, a phenomenon that exerts a force on the iron, but as to just what it consists of, nobody knows; the phenomenon is called a magnetic field. A different, but analogous phenomenon extends outward from electrically charged objects, exerting a force on other charged objects; this is called an electric field.

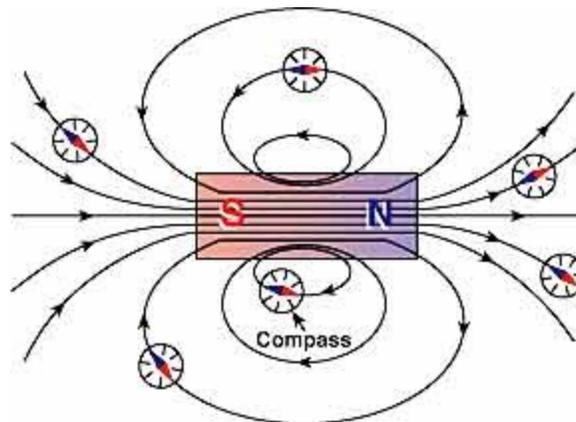


Fig. 1a: Magnetic field lines may be found by using a small compass. The north pole of the compass points in the direction of the field at any point

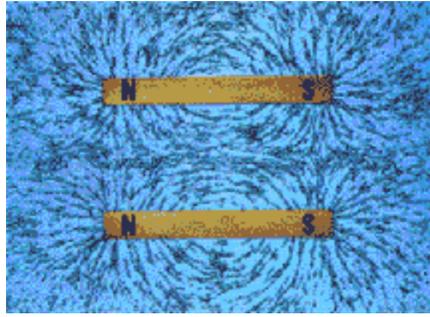


Fig. 1b: Iron filings become induced magnets and conveniently outline the pattern of magnetic field

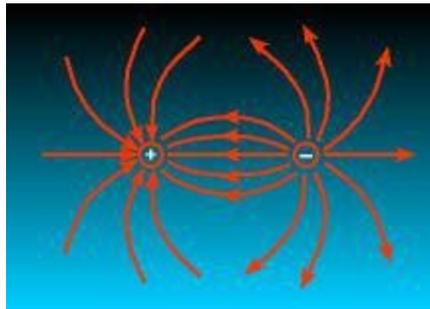


Fig. 2: Electric field.

Both electric and magnetic fields are really just abstractions scientists have made up to try to understand the actions of electricity and magnetism at a distance, produced by no known intervening material or energy, a phenomenon that used to be considered impossible until it became undeniable. Physicists have been trying for generations to solve the fundamental mysteries of electromagnetism, and no one, not even Einstein, has yet succeeded.

There is a relation between the two types of fields; when an electrically charged particle is moving, a magnetic field is created around it in addition to the existing electric field. The combination of an electric and a magnetic field is called an electromagnetic field, or EMF.

When the factor of time is introduced, by varying the intensity of the field as in a radio antenna or in a wire conducting an alternating current (AC), the phenomenon of a time varying EMF is generated. The fluctuations (time variance) in the field radiate outward from the antenna or wire (transmitter) as waves of energy. Sometimes these waves of energy behave as streams of massless, chargeless particles called photons. This is especially the case when the frequency is high. Photons are also called quanta of energy.

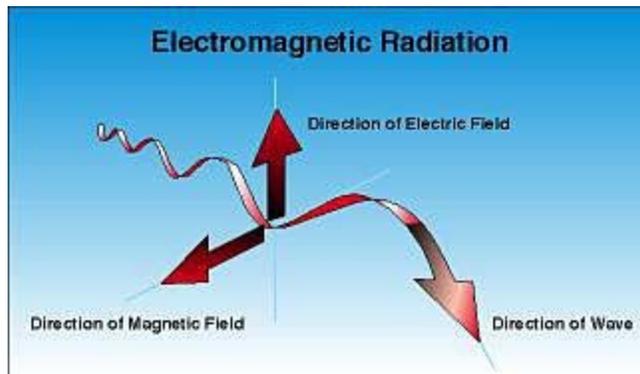


Fig. 3: Electromagnetic wave.

2. THE ELECTROMAGNETIC SPECTRUM

An important property of the time varying EMF is its frequency as measured in hertz (Hz, number of oscillations per second). EMFs are sometimes called radiation when the frequency is measured in kilohertz and above. EMFs are categorized, according to their frequency or wavelength, in the electromagnetic spectrum. The spectrum spans an enormous range of frequencies.

The lowest frequency EMFs (below 3000 Hz, or 3 kHz) are called extremely low frequency (ELF) fields. They are mainly generated by AC current devices and power lines and usually have a frequency of 60 Hz (North America) or 50 Hz (elsewhere).

Frequencies in the kHz (thousand hertz) and low MHz (megahertz, million hertz) region are called radio frequency (RF) fields or radiation and are used for radio and TV broadcasting and two-way radio systems. The RF region is – arbitrarily – broken up into a further alphabet of frequencies like EHF, SHF, UHF, VHF, HF, MF, LF and VLF. In addition to radio transmitter equipment, also computer displays radiate RF waves in the kHz region in addition to the ELF fields associated with their AC power supply.

Frequencies in the high MHz and the GHz (gigahertz, billion hertz) region are called microwave (MW) fields or radiation and are used for cell phones, personal communication systems, microwave ovens and radar systems.

Frequencies above microwave and below visible light (10^{12} – 10^{14} Hz) are called infrared radiation. This type of EMF is radiant heat emitted from hot objects like ovens.

Visible light is a narrow band of frequencies around 10^{15} Hz. Visible light is emitted from atoms when electrons in their outer shells change orbits around the nucleus of the atom.

Frequencies in the spectral region above visible light are - according to increasing frequencies - ultraviolet, X-rays, gamma rays and nuclear radiation. These types of radiation are categorized as ionizing radiation, whereas all frequencies below ultraviolet are called non-ionizing radiation.

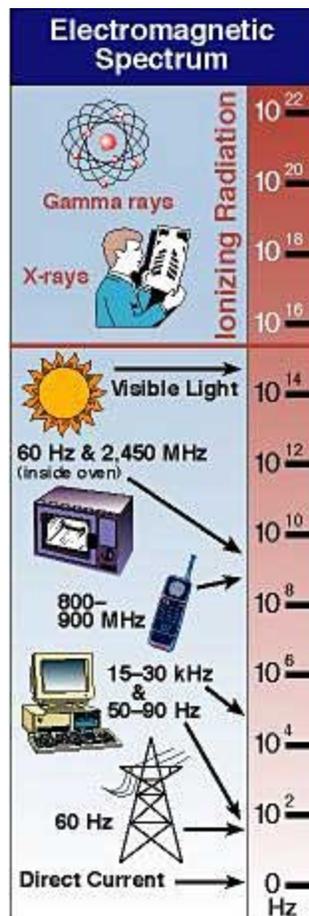
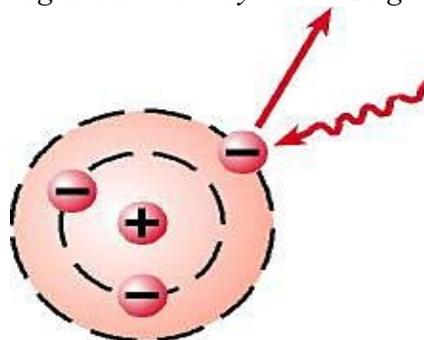


Fig. 4 The Electro Magnetic Spectrum

3. IONIZING VERSUS NON-IONIZING RADIATION

Ionizing radiation contains so much energy in its individual quanta of energy - photons - that it is able to knock out electrons from their orbits in the atom shells. This creates free radicals in living matter, increasing the risk of chromosomal damage, fetal abnormalities and cancer. These health consequences of ionizing radiation were disputed since the beginning of the 20th century and became generally accepted by the middle of the century

Fig. 5: An atom with an electron being knocked out by an ionizing electromagnetic wave



Non-ionizing radiation contains too little individual photon energy to knock out electrons from their

orbits in the atoms. If non-ionizing radiation has health effects, there is some other mechanism in play. However, scientific studies have shown that non-ionizing radiation indirectly may lead to increases in the level of free radicals in tissue, potentially leading to the same consequences as ionizing radiation.

If the intensity of non-ionizing radiation is large enough, it may cause damage by heating tissue. This happens for example in a microwave oven, and the mechanism behind these effects are easy to comprehend.

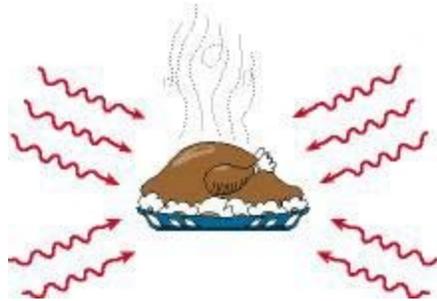


Fig. 6: Microwaves cooking a turkey

Research has revealed that there are significant biological effects of low-level (low intensity) non-ionizing radiation not related to heating, so-called athermal effects. The mechanisms responsible for athermal effects of low-intensity radiation or fields are just beginning to be understood by scientists, and there is an intensive discussion amongst scientists over the potential health effects. This paper deals with the athermal effects of low-level EMF in the non-ionizing spectral region.

4. NATURAL VERSUS MAN MADE EMF IN THE NON-IONIZING SPECTRAL REGION

Few people realize how much and how abruptly we have changed the non-ionizing electromagnetic environment in less than a century; actually, most of the changes have happened in the last few decades, and this development is accelerating at an exponential growth rate.

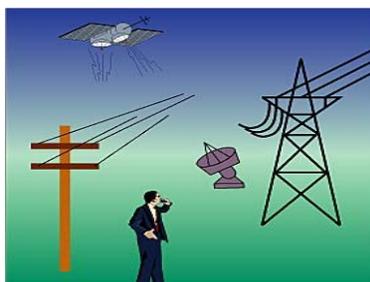


Fig. 7: All living things are subject to million of times more radiation than 50 years ago

For billions of years, the electromagnetic environment was virtually "silent" in the spectral region below visible light which was the most abundant source of electromagnetic energy.



Fig. 8: We will never be able to experience this silent world again

Terrestrial biology has evolved in the long standing near-static magnetic field of the earth and the static electric field produced between the upper-atmospheric ionosphere and the earth.

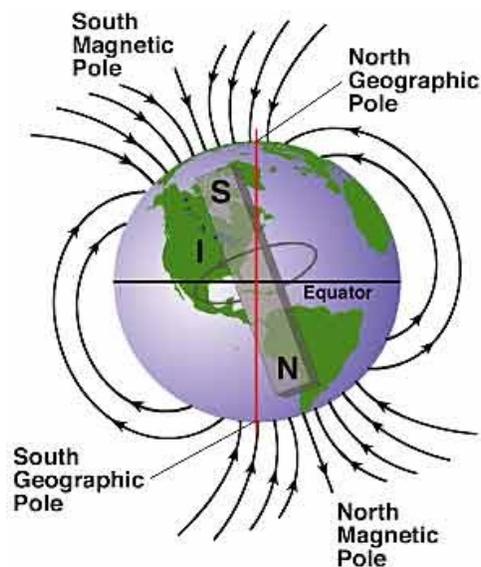


Fig. 9: The earth's natural magnetic field

Nature's sources of oscillating low frequency EMFs are few and extremely weak; the only sources are the sun, distant radio stars and other cosmic RF sources, and the terrestrial sources originating from lightning primarily in the tropics. Even the sun can not be considered a strong source of energy in the non-ionizing spectral region, making natural ambient levels so low that the possibilities of biological or even health effects are negligible [ref.1].

We will never experience that "quiet" world again. The greatest changes have all come after World War II with a trend towards the use of higher energy radiowaves for long-distance communication and electronic devices of all types. Since then nearly every human action has involved an electrical appliance, and today we are all awash in a sea of artificial electromagnetic energies living species have

never experienced before.

The human species has changed its electromagnetic exposures more than any other aspect of the environment. For example, with the explosion in radio and TV broadcasting stations, radio telephone networks, cordless phones and cell phones, the density of radio waves and microwaves around us is now many millions of times higher than the natural levels in the same spectral region

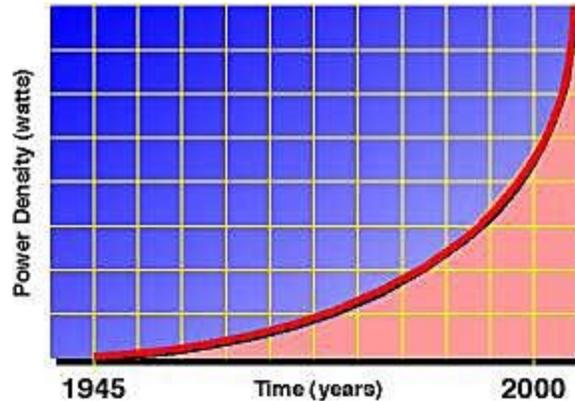


Fig. 10: Exponential growth in background non-ionizing radiation

Grave concern was expressed by the European Parliament after a series of hearings on the matter of RF/MW frequency EMF health effects (Resolution B3-0280/92):

"Thus in the frequency range 100 kHz to 300 GHz, 50 years ago it was scarcely possible to measure 10 pW/cm² (10-12 W/cm²) on the ground in our countries. Today, depending on the location, values one million to one thousand million times higher are recorded because of the explosion of telecommunications".

The same applies to ELF fields produced by the dozens of electrical appliances owned by each household in the industrialized world and the power lines feeding those devices. Industrialized countries in North America, Western Europe and China emit so much ELF energy that it can be sensed by satellites in space.

Perhaps even more important than the increase in EMF densities, most man made EMFs differ in one important aspect from natural EMFs: man made sources radiate constant, regular oscillations or pulses of electromagnetic energy with distinct properties, whereas natural sources of EMFs are oscillating at random with mixed, irregular frequencies and amplitudes. For example, AC powered devices emit highly regular, sinusoidal ELF fields at a constant amplitude and frequency of 50 Hz (Europe) or 60 Hz (North America), and digital mobile phones expose the heads of users to pulses of microwave, with carrier wave frequencies of around 900 or 1800 megahertz and modulation frequencies of 11, 22, 50 or 217 Hz.



Fig. 11: Examples of EMFs emitted by typical devices like hair dryers and cell phone

5. FIELD STRENGTH, SAFETY STANDARDS AND SOURCES OF MAN MADE ELF FIELDS

Extremely low frequency (ELF; frequencies below 3 kHz) field strengths are measured in terms of the individual electric and magnetic components.

Electric ELF fields are related to the voltage in conductors and are measured in volts per meter (V/m). Electric fields are present even if there is no current flowing. For example, an electric blanket will generate an electric field if plugged in, even if it is not turned on.

Magnetic fields are generated by the flow of current through conductors – the stronger the current the stronger the magnetic field. Magnetic field strengths are measured in the unit of milligauss (mG, 1/1000 of a gauss) since the gauss is a very big unit. Some scientists prefer another unit of measure called microtesla (mT, one millionth of a tesla); mG and mT relate to one another as follows: one mT equals 10 mG.

Most of the debate going on over acceptable thresholds of ELF fields is expressed in terms of magnetic field strengths. This is because the principal concern over the potential health effects relates to the magnetic component of the field. It's virtually impossible to shield, even with materials such as bricks, concrete, lead and earth. It penetrates deeply into cells, tissues, organs and the body of any person exposed. This is why placing electrical transmission lines underground will not in itself reduce magnetic field exposures unless special engineering and design (shielding, phase cancellation, etc) are employed. The electric field, on the other hand, is much more effectively shielded; a house will shield out around 90 % of an electric field.

ELF fields envelop the surrounding space of a conductor or electrical device in the same way as the earth's magnetic field surrounds the planet. EMFs are not limited to power lines – they surround us in our work environment and homes, generated by hundreds of different appliances such as mobile phones and cordless phones, computers, laser printers, photocopiers, radar equipment, halogen and fluorescent lighting, hair dryers, vacuum cleaners, TV sets and stereo equipment, electronic games, electric shavers, electric blankets and heaters, food processors, coffee grinders, refrigerators, washers, tumble dryers, microwave ovens, and so on. ELF field strength can be measured with a gaussmeter, a fairly inexpensive device which can usually be purchased. Most utility companies are now willing to come to your home without charge to test EMF levels with a gaussmeter.

ELF field strengths drop off quickly with distance, and exposures to many appliances may be brief. However, research has indicated that even weak and short exposures have an effect, the effects seem to be cumulative, and multiple on/off exposures may induce stronger effects than continuous exposures.

Table 1 shows the international standards and safety guidelines established by the International Commission on Non-Ionizing Radiation Protection.

International Commission on Non-Ionizing Radiation Protection		
Exposure (50/60 Hz)	Electric Field	Magnetic Field
Occupational: Whole working day Short term For limbs	10 kV/m 30 kV/m -	5 G (5,000 mG) 50 G (50,000 mG) 250 G (250,000 mG)
General Public: Up to 24 hours per day Few hours per day	5 kV/m 10 kV/m	1 G (1,000 mG) 10 G (10,000 mG)
<small>^a For electric fields of 10-30 kV/m, field strength (kV/m) x hours of exposure should not exceed 60 for the whole working day. Whole-body exposure to magnetic fields up to 2 hours per day should not exceed 50 G.</small>		<small>SOURCE: IIRPA / INIRC 1995</small>

Table 1: ELF safety standards.

These exposure standards were established in 1990, more or less arbitrarily. The problem with these standards is that numerous scientific studies have shown significant biological effects induced by EMF at field strengths thousands of times below these safety standards.

Epidemiologic studies have reported a substantially increased risk of cancer at much lower field strengths. In two Swedish residential studies published in 1993 and 1994, up to 3.8 times the expected rate of cancer was found in persons residing near power lines with time-weighted exposures of up to 4 mG [ref. 2 and 3]. In a Danish residential study published in 1994, up to five times the expected rate of all cancers was found in people residing near power lines [ref. 4]. In a Swedish occupational study, up to 5 times the expected rate of cancer was found in persons exposed to EMFs on the job.

On the weight of these studies, **the Swedish government has stated that it will act on the assumption that a relationship exists between EMF exposure and childhood cancer, and a safety standard of 2 mG has been suggested.**

To the average person, household and office appliances represent a more significant source of EMF exposure than power lines. Table 2 below show some examples of ELF field levels emitted from appliances and devices.

As it appears from this table, many appliances emit EMFs at intensities well above the 2 mG limit considered the defacto safety standard by Swedish authorities.

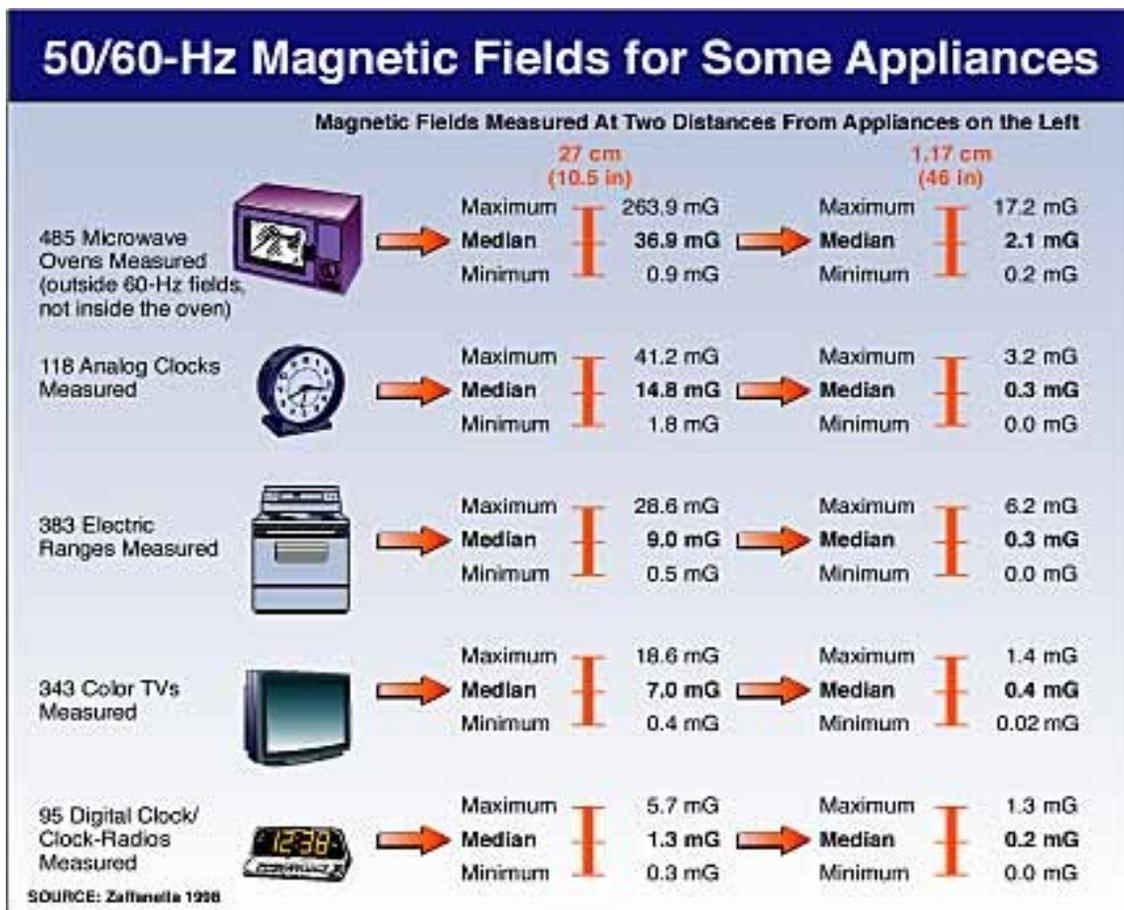


Table 2: Typical ELF levels in mG (50/60 Hz) emitted by appliances and devices

6. FIELD STRENGTH, SAFETY STANDARDS AND SOURCES OF MAN MADE RF FIELDS

Radio frequency (RF) and microwave (MW) field intensities are usually measured in milliwatts per square centimeter (mW/cm²). However, the intensity provides little information on the biological consequence unless the amount of energy absorbed by the irradiated object is known. This is generally given as the specific absorption rate (SAR), which is the rate of energy absorbed by a unit mass (e.g., one kg or one g of tissue) of the object. The unit of measurement for the SAR is watts per kg (W/kg).

The rate of absorption and distribution of RF/MW energies depend on many factors like type and shape of tissue, orientation relative to the radiation, type and parameters of the radiation, etc. The distribution of absorbed energy in an irradiated organism is extremely complex and non-uniform, and may lead to the formation of so called "hot spots" of concentrated energy in the tissue.

Present US safety standards related to RF/MW EMF are based on thermal (heating) effects. The first standard adopted was derived largely from the work of the engineer Herman Schwan who, although not a biologist, assumed that heating was the only effect EMFs would have on living tissue. In the 1950s Schwan worked for the US Department of Defense, estimating danger levels based on how much radar

MW energy was needed to measurably heat metal balls and beakers of salt water, which he used to represent the size and presumed electrical characteristics of various animals.

Appreciable heating occurred in these models only at levels of 100 mW/cm² or above, so, incorporating a safety factor of ten, Schwan in 1953 proposed an exposure limit of 10 mW/cm² for humans. No one ever tested for subtler effects, and the 10 mW/cm² level was uncritically accepted on an informal basis by industry and the military. In 1966 the American National Standards Institute (ANSI) recommended it as a guideline for worker safety [ref. 5].

Later, in the late 1980s and the early 1990s, the models used for establishing safety standards became more sophisticated, but the safety limits did not change much. In the UK, the 10 mW/cm² still applies at a distance of 5 cm from the source for up to 2 minutes in any one hour – or a short term exposure of 25 mW/cm². In the US, the following power density standards have been defined: around 0.579 mW/cm² for 800-900 MHz cell phones, 1 mW/cm² for PCS (public exposure), and 5 mW/cm² for PCS (occupational exposure). The US ANSI/IEEE applicable standard measured in SAR is, for one gram of tissue, 1.6 W/Kg for "uncontrolled" (general public) environments, and 8 W/Kg for "controlled" (workplace) environments. In Europe the standard limit is 2 W/kg for the general public. In Japan the standard is 8 W/kg for the general public.

Although it may be more relevant to use SAR, it is much more difficult to measure and control, requiring the use of "phantom-heads", models of human heads. Of course, these can never be identical to "real" human heads.

Also for RF/MW exposures, research has demonstrated significant RF/MW induced effects on cells and animals at exposure intensities thousands of times below the various standard safety limits. Some examples: in 1997 the Danish scientists Kwee and Raskmark [ref. 6] reported changes in human cell proliferation rates at SARs of 0.000021-0.0021 W/kg; Magras and Xenos in 1997 reported a decrease in reproductive functions in mice exposed to RF/MW of intensity at 0.00016-0.001053 mW/cm² [ref. 7]; Ray and Behari (1990) reported decrease in eating and drinking behavior in rats exposed to 0.0317 W/kg [ref. 8]; Dutta et al. (1989) reported changes in calcium metabolism in cells exposed to 0.05-0.005 W/kg [ref. 9]; and Phillips et al. (1998) observed DNA damage at 0.024-0.0024 W/Kg [ref. 10].

In December 1998, Dr. Hyland of the University of Warwick, UK, at the International Institute of Biophysics, Neuss-Holzheim, Germany, [ref.11] presented an attempt to draw attention to "a multitude of frequency-specific, non-thermal bioeffects – induced in living systems by ultra-low-intensity microwave radiation – the existence of which is not currently taken into account in the formulation of the safety limits to which microwave devices must conform".

Other scientists representing decades of practical experience within the field of RF/MW induced biological effects, Dr. Henry Lai of University of Washington, Seattle and Dr. Neil Cherry of Lincoln University, New Zealand, have found low-level effects and have reviewed the scientific literature, addressing a multitude of scientific evidence of low-level RF/MW induced bioeffects in cells and animals, neurological effects in humans and elevated risks of cancer in humans. The scientists setting the standard safety limits have chosen to disregard such evidence, showing that EMF induced effects may be cumulative, (DNA damage).

The primary sources of RF/MW exposures are mobile phones, personal communication systems (PCS),

mobile phone and PCS antenna towers, TV and radio broadcasting antennas, radar equipment, and two-way radios.

7. THE SCIENTIFIC CONTROVERSY

Scientists are working to explain how low-level non-ionizing EMFs could have convincing and replicable effects on living systems, as they do not carry enough energy, either to damage biomolecules, or to cause heating effects. The existence of non-thermal effects of low-level, low-frequency EMFs in biological matter remains a theoretical mystery, but an experimental and clinical fact. Therefore, an explanation of the facts happening in the laboratories of experimental scientists, requires a new paradigm for the scientific perception of life processes.

The debate has so far been dominated by physical concepts and arguments. The theoretical "signal-to-noise" dilemma is among the most persistent of the criticisms which have cast doubt on the credibility of reports that weak ELF fields have been shown to affect life processes in biological systems. Exogenous ELF fields reported to induce biological effects have been shown to be orders of magnitude weaker than the endogenous fields associated with "thermal noise" – the randomly fluctuating local fields on the surface of the cell membranes, caused by random thermic movements of charges (ions) in the inter- and intracellular liquids.

In other words, according to this theoretical argument, the induced electrical field of an exogenous ELF should be "drowned" by the thermal noise field inside the tissue. This belief is drawn from the solutions to fundamental mathematical equations from electromagnetic theory, according to which tissue is modeled as an ensemble of simple, smooth, non-interacting insulators surrounded by a conducting medium. These simplified equations result in an induced electrical field which has an order of magnitude equal to the exogenous field.

The simplified theory neglects the electromagnetic detail of the biological cell, which is a complex structure, rich with convoluted, charged surfaces. At the Catholic University of America (CUA) in Washington, D.C., Dr. Joan Farrell has made calculations taking into account a more realistic representation of the electromagnetic properties of the biological cell. The result of this more accurate mathematical model lead to the discovery that exogenous ELF fields induce an electric field in tissue which may become amplified by orders of magnitude relative to the exogenous field. It allows for calculation of the fields close to the cell's surface, where the cell's array of "detectors" or chemoreceptors operate.

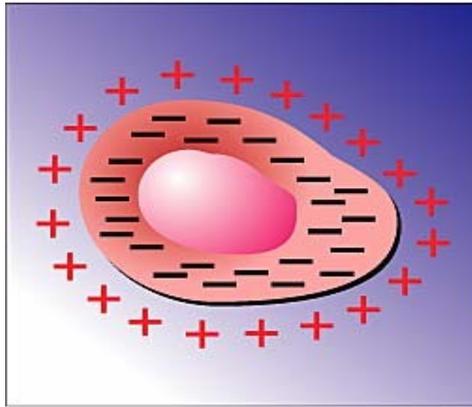


Fig. 12a: A normal resting cell: a cell with a uniform distribution of positive charges surrounding the negatively (-) charged membrane

The empirical explanation of this amplification is that the exogenous field cause a redistribution of charges (ions) around the cell membrane; the negative charges in the cell membrane are fixed, but the external positive charges are relatively free to move and align themselves in the direction of the field, almost like particles of sand piling up around a stone according to the direction of the wind. This creates a dipole around each cell, causing biological tissue to behave like a kind of semiconductor, significantly amplifying the applied signal. This amplification only comes into play when the exogenous field has a low frequency (ELF). At higher frequencies, the charges do not have time to follow the variations in the field, and no amplification takes place.

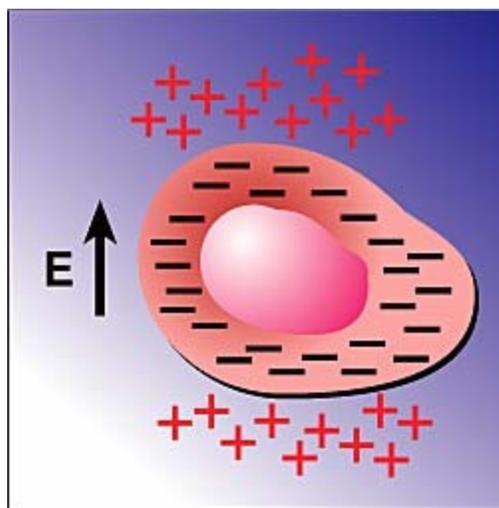


Fig. 12b: A cell influenced by EMFs: a cell with negative charges in the membrane and positive charges concentrating in the direction of the exogenous field

The signal enhancement mechanism offers one framework of understanding how ELF fields - which are lower in energy than any other types of EMF and therefore have represented the greatest puzzle to scientists - may in fact induce biological effects, as seen in numerous laboratory experiments.

There are other frameworks for understanding the phenomenon of ELF field induced biological effects, and one does not necessarily exclude the others. There may be several mechanisms simultaneously in play. At CUA, the team of scientists headed by Professor Litovitz have studied EMF induced effects for more than ten years. In 1993 [ref. 14], professor Litovitz and co-workers proposed that living cells discriminate against thermal noise fields by recognizing them as spatially incoherent, i.e. uncorrelated at different receptor locations on the cell membrane. The team suggested that biological cooperativity - known from other areas of biology (bacterial chemotaxis) and physiology (the functioning of the ear) - is an essential feature of cellular response to EMF; a significant number of receptors at the cell membrane must be simultaneously and coherently activated (coincidence detection) to produce an effect on the functioning of the cell. EMFs must be spatially coherent if they are to affect cell functioning. All external EMFs have the property of being spatially coherent, whereas internal thermal noise fields do not. The team has substantiated their hypothesis with comprehensive scientific studies.

The hypothesis of biological cooperativity enabling sensing of very weak exogenous fields is supported by research done on electric sensing by fish. At sea, dogfish and blue sharks have been observed to execute apparent feeding responses to dipole electric fields designed to mimic prey. Voltage gradients of only 5 nanovolts (one billionth of a volt) per centimeter would elicit the response. Thus, it is definitely possible for beings to sense exogenous fields which are even millions of times smaller than thermal noise fields.

Compared to ELF fields, it is easier to accept that RF and MW fields may cause biological effects, since these fields carry more energy, and electric fields induced in tissue by RF/MW are - without enhancement mechanisms in play - in themselves orders of magnitude higher than the thermal noise fields. Still, however, many scientists are skeptical towards the existence of non-thermal biological effects of low-level RF/MW fields, as they believe that the only effects possible are associated with heating.

Another factor adding to the skepticism towards the existence of biological effects of low-level non-ionizing EMF is the issue of replication. Some laboratories may see one level of effect of an EMF on a specific biological mechanism in a particular line of cells, tissue or animals, while other laboratories may find another level or even no effect. Scientists at the Catholic University of America have studied this phenomenon and found that it may be due largely to differences in the genetics between different strains of cells or animals. Most laboratories usually do not control this confounder when attempting to replicate the results of another laboratory.

In response to the growing body of scientific evidence, the existence of health and biological effects associated with exposures to EMFs is becoming more widely known and accepted. More and more scientists now believe that the low-level non-ionizing EMF induced non-thermal effects are a reality.

For example, on Wednesday, July 24, 1998, a 28-member panel convened by the National Institute of Environmental Health Sciences (NIEHS) decided that extremely low frequency (ELF) electromagnetic fields should be regarded as possible carcinogens.

The final vote of the panel was 19 to 9 in favor of categorizing ELF EMFs, such as those from power lines and electrical appliances, as possible carcinogens. The vote followed one year of study including three major, multi-day symposia and a final 10 day intensive meeting of scientists to review and debate the scientific and medical literature.

In October 1998 at the University of Vienna Workshop on Possible Biological and Health Effects of Radio Frequency (RF/MW) Electromagnetic Fields, (ref. 15) the following resolution was made by the participating scientists (the "Vienna Resolution"):

"The participants agreed that biological effects from low-intensity exposures are scientifically established. However, the current state of scientific consensus is inadequate to derive reliable exposure standards. The existing evidence demands an increase in the research efforts on possible health impact and on adequate exposure and dose assessment."

In conclusion, scientists working in the field of "bioelectromagnetics" are now convinced that man-made EMFs disturb biological processes (induce biological effects). Some of the biological effects seen in the laboratories are similar to biochemical mechanisms believed to be responsible for neurological effects like short term memory loss, whereas others are believed to be involved in the development of serious disorders like cancer, Alzheimer's and Parkinson's.

There is no definitive conclusion whether this may lead to these serious diseases, and research may not be able to provide unequivocal answers until the causes of these diseases have been identified completely. Should we know one day what role low-level non-ionizing EMFs play in cancer, it will only be because we will also know what causes cancer. Until such time, science will have no choice but to continue advancing, studying and rejecting new hypotheses until finally, from many individual findings, a conclusive overall picture of cancer and other diseases emerges.

However, until that time, the NIEHS working group has issued a public health warning. A substantial body of scientific evidence points to a relationship between EMFs and cancer.

8. THE POINT OF INTERACTION: THE CELL MEMBRANE

Man made EMFs differ in one important aspect from natural EMFs: they radiate with steady, regular oscillations or pulses with mainly constant frequencies and amplitudes, whereas natural EMFs are highly irregular with mixed, random frequencies, amplitudes and waveform.

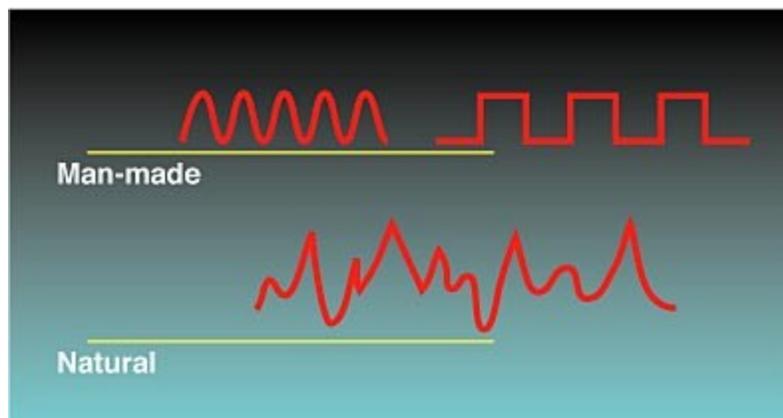


Fig. 13: Man-made versus natural EMFs.

Logical reasoning would suggest that these steady oscillations or pulses may induce effects in living matter exposed to these fields, as indeed recent research has indicated. The impact of ELF fields may be understood in terms of the amplification phenomenon and/or the cooperative sensing associated with simultaneous stimulation of all membrane receptors, which accounts for the fact that electrical fields induced by exogenous ELF fields are apparently not "drowned" by the endogenous thermal noise fields. The impact of RF/MW fields are easier to understand as they, by themselves, induce electrical fields orders of magnitude higher than the endogenous noise fields.

Understanding how EMFs affect life processes requires a new paradigm in the understanding of life itself. Many scientists are still lost in inadequate classic beliefs of mechanistic chemistry which do not recognize how fundamental electromagnetism is to biology and life. Throughout this century, most biologists and doctors have believed only chemical processes were involved in growth and healing.

Our body consists of about 50,000 billion cells, each of which is a living entity in itself, and all of these cells are somehow interconnected, organized and specialized in a finely tuned equilibrium. In reality, scientists understand very little of what is going on even in a single cell, which is an incredibly complex organism where millions of interrelated and carefully balanced biochemical processes are happening every second. These processes all involve electromagnetism in some form. The brain and nervous system are characterized by an incessant activity involving weak electrical currents, which can be read in the electro encephalogram (EEG). Every heart beat is initiated by an electrical stimulus which can be read in the EKG (electro cardiogram). DNA replication and division in each and every cell is in some way controlled by an electromagnetic stimulus.

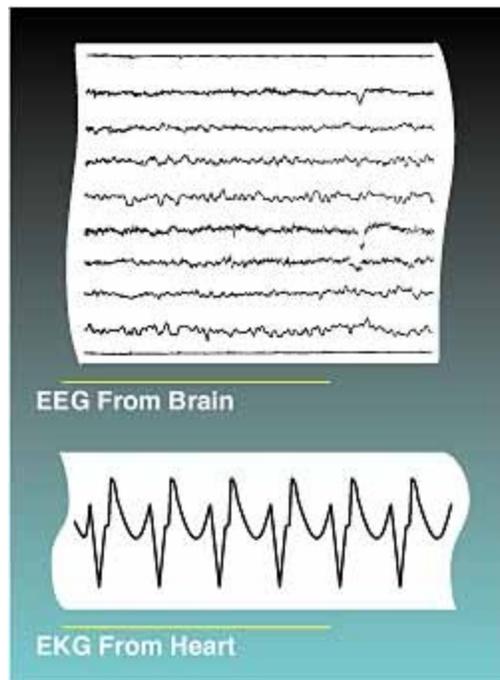


Fig. 14: EEGs from the brain (top). An EKG from the heart. (bottom)

Albert Szent-Györgyi, the discoverer of vitamin C, has written, "We know life only by its symptoms".

We understand virtually nothing about such basic functions as consciousness, pain, sleep, control of cell differentiation, growth and healing. The problem of "when to pull the plug" shows we don't even know how to diagnose death. One thing is certain, however: when a cell dies, its electrical activity immediately ceases.

The research team at the Catholic University of America (CUA) in Washington, DC, headed by Professor Litovitz, has hypothesized and tested that an oscillating EMF needs to be steady for a certain minimum time period (approx. 1 second) for a biological response to occur [ref. 16]. This constancy allows cells to discriminate external fields against thermal noise fields, even though the exogenous field may be orders of magnitude lower than the endogenous noise field. Also, the cell discriminates by spatial coherence, i.e., cooperative sensing by a large number of receptors in the cell membrane. Both temporal and spatial sensing is known from bacterial chemotaxis.

The same medical community largely ignoring that EMFs have any influence on biology and health have for the past couple of decades been using steady pulsed ELF magnetic fields in hospital therapy to accelerate bone growth in fractures that otherwise would not heal, and MW fields to accelerate healing of surficial wounds. The background for this treatment is easily explainable in light of recent laboratory experiments showing that ELF as well as MW frequency EMF accelerate cell growth.

The famous 16th century doctor Paracelsus emphasized that all stimuli are poisons when applied at an improper dose level. When using a mobile phone, hair dryer or electric shaver, we are exposing our brain and nerve cells to a stimulus which – among a variety of induced biological effects – accelerates cell growth, without controlling the dose level. No one can tell the consequences relating to long term repeated, daily dosages of such cell growth accelerating stimuli; but clearly, we are dealing with something which might be potentially hazardous. Laboratory evidence has repeatedly shown that rapidly growing cells like transformed cancer cells are significantly more enhanced in growth rate than normal cells; this is among the factors adding to the conclusion that EMFs are possibly carcinogenic, as expressed by the NIEHS work group in July 1998.

Scientists looking for the mechanism by which EMFs interact with living matter first recognize that living cells are bio-electro-chemical structures which interact with their environment in many ways including physically, chemically, biochemically and electrically. Biological tissue consists of cells in a fixed structure, each cell surrounded by a conducting medium containing charges (ions) more or less free to move around each cell, a setup with extraordinary electrical properties which is ideal for establishing amplification effects with external constant oscillating EMFs.

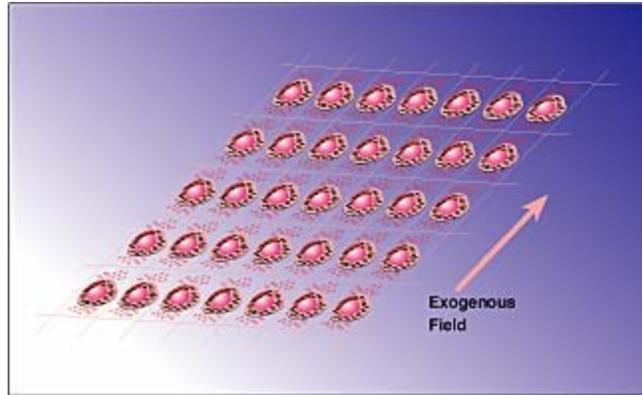


Fig. 15: Once we have many cells communicating in a living tissue, they may act cooperatively to amplify a faint electromagnetic sign

The cell surface is a membrane equipped with thousands of fixed charges and receptors extending into the surrounding medium, sensing the electrical, chemical and physical environment, providing feedback to the cell interior on any changes in this environment. The cell interior is filled with dispersed biological macromolecules with electrical properties, e.g., enzymes, proteins, DNA and RNA, which are responsive to electrical stimuli.

Many scientists believe the cell membrane plays a leading role in the interaction mechanisms between EMF and biological matter. The European Parliament Resolution B3-0280/92, clauses D and E, bases its concern on the matter of EMF health effects, in part, on recognition that the cell membrane is the primary site of cellular interaction of EMF and living tissues:

D. whereas, according to an increasing number of epidemiological and experimental studies, even slight exposure to non-ionizing electromagnetic fields increases the risk of cancer, can be accompanied by nervous disorders and disruption of the circadian rhythm and seems capable of affecting developing organisms,

E. whereas the results of many in vivo and in vitro studies show increasingly clearly the interaction mechanisms underlying such disorders and illnesses, centered mainly in the cell membrane, lead to disruption of melatonin secretions, ornithine decarboxylase activity and T-lymphocyte efficacy, testifying to the probable role of non-ionizing radiation in promoting cancer...

Since electromagnetism is fundamental to all cell types, organs and life processes, it can be expected that man-made EMFs will have a very broad impact on life and may cause many different biological effects and health disorders.

9. THE CHEMICAL LINK: CALCIUM IONS AND ION DISTRIBUTION ACROSS THE MEMBRANE

The universal chemical link between EMFs and life processes is believed by many scientists to be ions, especially calcium ions. External EMFs clearly affect the electrical properties and ion distribution around cells. Virtually all physiological processes in our body involve ions.

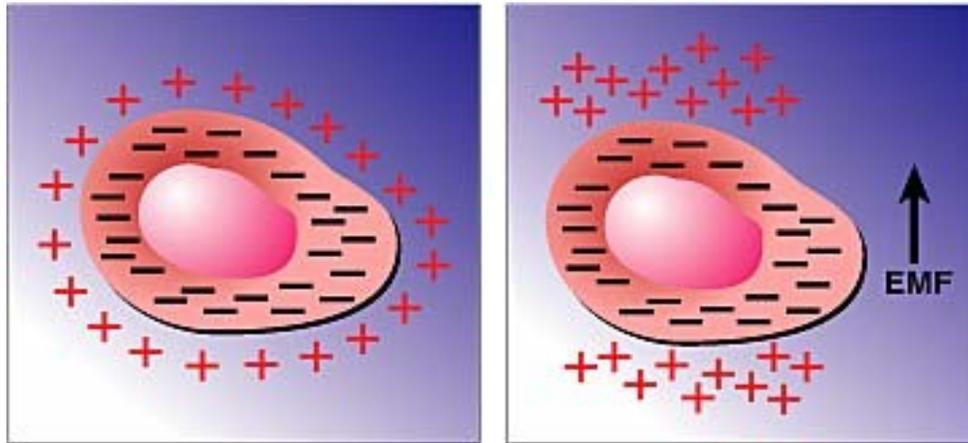


Fig. 16a: A normal resting cell: a cell with a uniform distribution of charges surrounding the negatively (-) charged membrane. (left) Fig. 16b: A cell influenced by EMFs: a cell both with negative charges in the membrane and positive charges concentrating in the direction of the exogenous field. (right)

One of the most experienced researchers in the field, Dr. Ross Adey, in 1988 [ref. 17] presented a three step model involving calcium ions which could explain observed EMF induced biological effects. Key to the model is the activation of intracellular messenger systems (adenylate cyclase and protein kinase) by calcium in a stimulus amplification process across the cell membrane.

Numerous scientific studies have demonstrated the physiological importance of calcium [ref. 13]. Calcium functions as a ubiquitous intracellular messenger. For example, in 1947 it was shown that an intracellular injection of a small amount of calcium causes a skeletal muscle to contract. In recent years it has become clear that calcium acts as an intracellular messenger in a wide variety of cellular responses, including secretion and cell proliferation. In nerve cells, calcium influx has been shown to be involved in the initiation of neurotransmitter secretion; the calcium enters the cells through voltage-gated ion channels that open when the plasma membrane of the nerve terminal is depolarized by an invading action potential. Another function of calcium in all cells is to regulate metabolic processes in conjunction with the calcium-binding protein calmodulin. Many enzymatic processes are regulated by calcium. Calcium has been shown to modify gene transcription.

Thus, induced alteration of intracellular calcium concentrations which disrupt the homeostasis of the cell, has serious consequences for the health and future development of the cell. Calcium ions in partnerships with biomolecules have been shown to control the proliferation of non-tumorigenic cells

in vitro and in vivo. The evidence points to calcium and a biomolecule called AMP being co-generators of the signal committing the cell to DNA synthesis. Calcium influx in a cell stimulates proliferation, whereas calcium efflux does the opposite.

Balcer-Kubiczek (1994) [ref. 18] linked intracellular calcium levels to the future of damaged cells between becoming transformed (cancer) or dying by apoptosis (the healthy situation). Mattana et al. (1997) [ref. 19] described the importance of calcium ions for cell homeostasis which controls a variety of cellular responses determining the health of the cell. Hence, reductions in intracellular calcium have a very important effect.

Calcium ions are involved in the function of gap junctions or protein structures which link adjacent cells and provide a channel for the passing of messenger molecules. The gap junction can open and close to control the flow. The opening and closing is regulated by calcium ion concentration. Thus, calcium plays another key role in maintaining or interrupting the communication mechanisms for maintaining the health of cells because gap junctions are used to sense differences between cells and to initiate corrections in regulatory behavior as necessary.

It is widely accepted that calcium plays a central role in the development of the immune system response. An elevation of calcium ions is a nearly universal feature associated with activation of cells of the immune system. Using T-cell human leukemia cells, Lindstrom et al. (1995) [ref. 20] replicated and extended the research of other scientists and showed, that oscillating low level EMFs produce the same calcium ion reaction as does an antibody.

Numerous scientific studies [ref. 13] have demonstrated that EMFs can alter the membrane ion pumps responsible for pumping calcium, sodium and potassium in and out of the cells. Effects have been shown at low current densities, thousands of times lower than currents induced by MW fields. ELF fields have been shown to have the same effect. Reference is made to a scientific paper from 1992 [ref. 21] mentioning 10 different laboratories which have demonstrated these effects of calcium.

Dr. Cherry of Lincoln University, New Zealand [ref. 13] concludes: There is extremely strong evidence that both ELF and ELF modulated RF/MW radiation causes calcium ion efflux from cells which significantly alters the intracellular calcium concentrations, reducing the efficacy of lymphocytes in the immune system, participating in the alteration of transformation of pineal serotonin to melatonin and altering the damaged cells likelihood of becoming neoplastic (cancerous) or dying by apoptosis.

10. AN IMPORTANT BIOLOGICAL EFFECT: MELATONIN PRODUCTION

Many scientific studies have linked cellular EMF-induced calcium-effects to the extremely important hormone melatonin which is produced in the pea-sized endocrine organ called the pineal gland, located near the centre of the brain.

Dr. Cherry writes [ref. 13]: "The calcium ion mediated responses to neurotransmitters on the membrane of the pineal cells have been discussed by Wilson et al. (1989) in relation to ELF induced melatonin reduction. Thus it is highly probable that pinealocytes exposed to modulated RF/MW will experience an outflow of calcium ions, a reduction of the cAMP signal transduction activity and a reduction in the production of melatonin. This is a highly plausible mechanism to explain why RF/MW can reduce

pineal melatonin production with consequent adverse health effects."

Melatonin is produced at night and released into the blood stream to be dispersed throughout the body. Once in the blood stream, melatonin has access to every cell in the body. It passes through the cell membranes where every nucleus has receptors for it.

Melatonin is believed to have at least six fundamental physiological functions:

- mediating the whole-body 24 hour circadian rhythm;
- regulating sleep, mood and behavior like depression, anger and rage;
- scavenging free radicals (highly reactive cancer promoting agents);
- reduce secretion of tumor-promoting hormones;
- regulating gene expressions;
- protecting and stimulating the immune system.

Dr. Neil Cherry writes [ref. 13]: "Because of its action in removing free radicals, melatonin is probably the most efficient natural cell protection and oncostatic agent in our bodies. Every night, our pineal gland produces large quantities of melatonin which flood almost every cell in our body, cleaning out the free radicals and assisting cell division to take place with undamaged DNA. Since damaged DNA can undergo mutation, it may result in the growth of a tumour. As we age, our nocturnal peak melatonin production falls markedly, making elderly people much more prone to cancer".

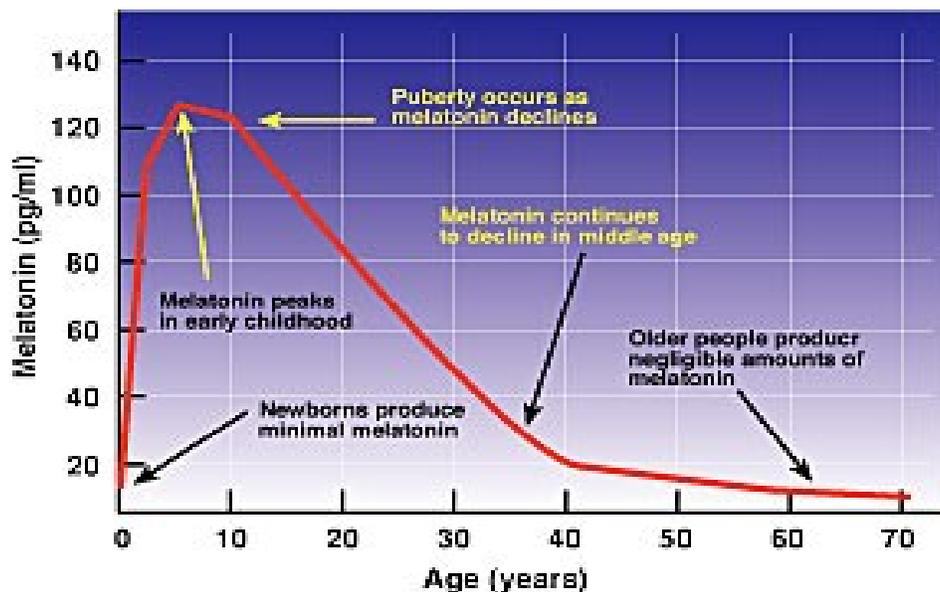


Fig. 17: Peak night time melatonin varies throughout life span. (Reiter & Robinson, 1995)

Numerous studies have shown that free radicals have an important role in the aging processes [ref. 13]. Aging has been ascribed to accumulated oxidative damage to body tissues and involvement of free radicals in neurodegenerative diseases, such as Alzheimer's, Huntington's and Parkinson's has also been suggested.

Melatonin reduction in cells and animals has been found by several laboratories. There is direct evidence of reduction in melatonin secretion in humans exposed to EMF, the effect varying from person to person, and that the timing of the exposures is also a factor. In one of the latest reports on melatonin (1998), Dr. Burch et al. [ref. 22] found reductions in the nocturnal secretion of a urinary melatonin metabolite among electric utility workers.

11. CONSEQUENCE OF LOW MELATONIN: DNA BREAKS AND CHROMOSOME DAMAGE

Dr. Lai and co-workers at University of Washington, Seattle have worked extensively on the induction of DNA damage in rat brain cells and tissue [ref. 12, 12g, 12h]. This research has shown that ELF as well as RF/MW exposures cause a significant increase in the amount of DNA breakage in rat brain cells. This research has been confirmed by other researchers, [ref. 23], [ref. 24], [ref. 10].

Dr. Lai writes: most cells have a considerable ability to repair DNA strand breaks; however, some cells only have a limited ability to handle this, such as brain and nerve cells which therefore could accumulate DNA breaks. Cumulative DNA breaks may affect cell function and may be the cause of slow onset diseases such as cancer. One of the popular hypothesis for cancer development is that DNA damaging agents induce mutations in DNA leading to expression of certain genes and suppression of other genes resulting in uncontrolled cell growth. Thus, damage to cellular DNA or lack of its repair could be an initial event in developing a tumor. However, when too much DNA damage is accumulated over time, the cell will die. Cumulative damage in DNA in cells also has been shown during aging. Particularly, cumulative DNA damage in nerve cells of the brain has been associated with neurodegenerative diseases, such as Alzheimer's, Huntington's and Parkinson's diseases.

Dr. Lai reported that the EMF induced DNA breaks could be blocked by treating the rats with melatonin.

Dr. Cherry [ref. 13] has summarized a number of studies associating EMF exposures with chromosomal damage. The Wireless Technology Research (WTR), an industry support research group, reported that cellular phone radiation can triple the number of chromosomal abnormalities in human blood (Microwave News, March-April 1999). The chairman of WTR, Dr. George Carlo told Microwave News that "WTR has found links between cellular phone use and cancer" [ref. 25].

12. NEUROLOGICAL EFFECTS

One of the most repeated effects of ELF modulated RF/MW is the calcium ion efflux from brain cells. This may lead to altered release and binding of neurohormones and neurotransmitters.

Dr. Adey (1981) [ref. 1] reported "there is unequivocal experimental evidence that fields from ELF to UHF (10 Hz to 450 MHz) interact directly with brain tissue". In 1991, Dr. Adey stated [ref. 26] "RF

fields that are sinusoidally amplitude modulated at ELF frequencies produce a wide range of biological interactions. Induced electric gradients can be substantially higher than those produced by simple ELF electric fields, and at levels of 10-100 mV/cm, are at the same range as intrinsic oscillations generated biologically, such as the electroencephalogram (EEG)".

A recent summary of research relating to neurological effects of EMF exposure reports:

- changes in circadian rhythm (Weber 1974);
- changes in evoked potential induced by MW exposure, decreasing latency and amplitude of reflex responses (Taylor and Ashleman 1975);
- significant and repeatable changes in the behavior of advanced mammals (cats and monkeys) induced by oscillating EMFs [ref. 27];
- changes in the dopamine (neurotransmitter) and opiate systems of the brain induced by EMFs (Frey 1990);
- changes in the functioning of the endogenous opioid system [ref. 12];
- EEG changes in animals have been shown in numerous studies on rabbits, rats, mice, etc;
- EEG and sleep changes in humans exposed to GSM cell phone-like signals at a power density of 0.001 mW/cm² or SAR of 0.001 W/Kg [ref. 28] [ref. 29]; humans react much more quickly than rats and rabbits;
- learning and memory impairment [ref. 62], [ref. 12a-i], [ref. 31];
- stress induction, stress hormone induction and reception: acetylcholine, corticotropin, benzodiazepine [ref. 12a, b, c, d];
- change in brain potentials in humans induced by MW EMFs (Freude 1998).

13. ENZYME ACTIVITIES, CANCER RISK AND FETAL ABNORMALITIES

The research team at the Catholic University of America (CUA) in Washington, D.C., headed by Professor Theodore Litovitz has worked for more than a decade on the effects of EMF on the activity of the important enzyme ornithine decarboxylase (ODC) in different cell lines, human and animal, and in chicken embryos. ODC is involved in DNA replication, i.e., cell growth. Increased ODC activity has for many years been used as a marker for cancer. ODC is very active in fetal development.

The CUA team has consistently found EMF-induced changes in the activity of ODC, and corresponding EMF-induced increase in the rate of fetal abnormalities in developing chicken embryos.

Fig. 18: The red line shows EMF-induced changes in the activity of ODC. (Litovitz et al. 1993)

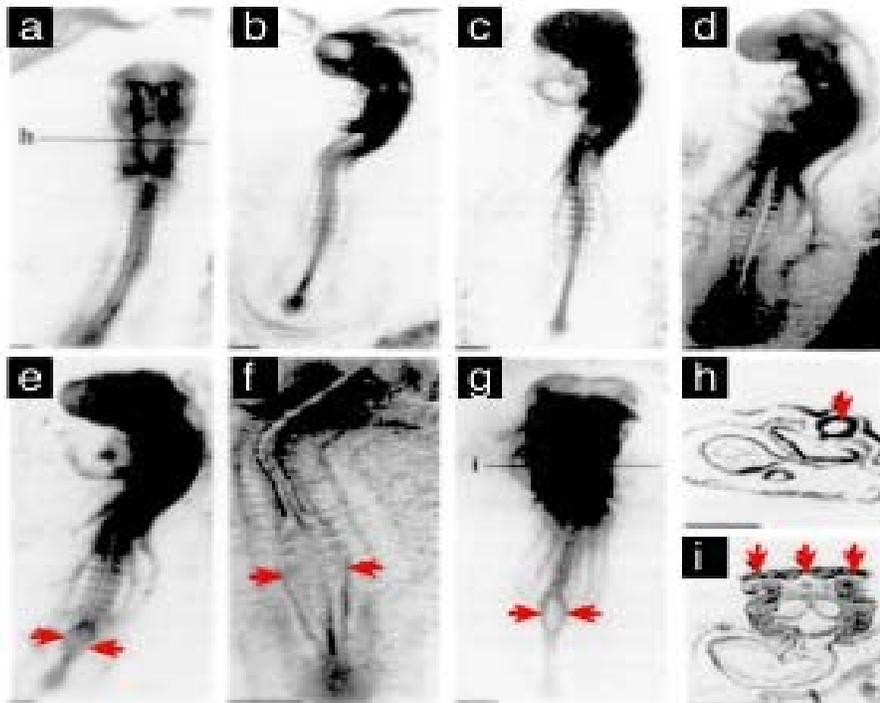
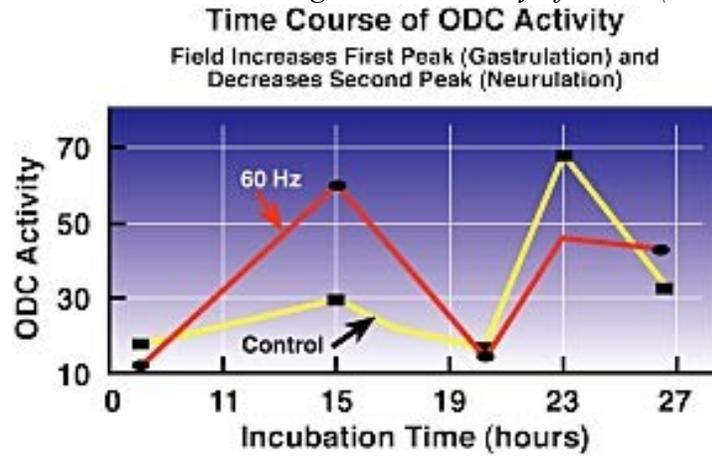


Fig. 19: EMF-induced abnormalities in chicken embryos (Farrell, 1997)

Pictures (a)-(d) show normal, unexposed embryos following a 48 hour incubation. The spinal cord is the "tail" of the embryo, and the neural tube inside this appears completely normal; so does the developing brain. Picture (h) is a transverse section at the level of the hindbrain for embryo (a) as indicated by line (h) in picture (a). This brain is normal.

Pictures (e)-(g) and (i) show neural tube and brain defects induced by electromagnetic fields. In (e)-(g) arrows indicate neural folds of open neural tubes in the spinal cord. This is an abnormality known in

humans as spina bifida. The hindbrain shown in (i) of embryo (g) is abnormal - totally flattened - compared to the normal brain shown in (h).

Dr. Martin of University of Western Ontario, Canada, has found EMF-induced changes in the activity of another important enzyme, nucleotidase (5'-NT), in developing chicken embryos and hatched chickens [ref. 32].

On February 13, 1998 [ref. 33], an international team of collaborating scientists representing five research institutions: Hughes Institute, St. Paul, Minnesota; University of Minnesota, Minneapolis; University of California, Riverside; Yale University, New Haven, Connecticut; and Kansai Medical University, Moriguchi, Japan, published the results of two new studies, funded by NIH, showing that 60 Hz EMFs trigger a cascade of enzyme-driven cell-signaling events that could result in cancer. The EMFs activated a tyrosine kinase enzyme dangling from the inner surface of the cell membrane. The EMFs triggered also a second tyrosine kinase, known as BTK. Studies in people have shown that excessive activation of BTK can lead to leukemia, lymphomas, and other cancers.

14. CELL STRESS AND GENE TRANSCRIPTION CHANGES

In 1987, [ref. 12b] Dr. Henry Lai, University of Washington, Seattle, speculated that biological responses are in effect stress responses, i.e., EMF is a stressor. Dr. Lai and his team carried out a series of experiments to compare the effects of MW EMF on acetylcholine with those of two known stressors: loud noise and body restraint.

The studies showed that the responses are very similar. Two other pieces of information also supported the notion that EMF is a stressor. It turned out that EMF activates the stress hormone corticotropin releasing factor [ref. 12d], and affect benzodiazepine receptors in the brain [ref. 12d]. Benzodiazepine receptors mediate the action of antianxiety drugs, such as valium and librium, and are known to change when an animal is stressed.

Dr. Reba Goodman of Columbia University, New York, has studied altered patterns of biosynthesis induced by EMFs. Dr. Goodman and her team (1989) observed the synthesis of low molecular weight proteins called heat shock or stress proteins following exposure to EMFs. These stress proteins are also formed as a result of other stressors such as heat shock, ionizing radiation, infections, chemical toxins, etc.

In later studies [ref. 35] [ref. 36] Dr. Goodman showed that EMFs alter the expression and transcription of genes responsible for the onset of stress protein production. Dr. Goodman's work has been confirmed later by other scientists (O. Smith 1996).

In 1998 [ref. 37] a team of scientists at the Department of Life Sciences, University of Nottingham, UK, published a study showing that transgenic nematodes, used to monitor toxic contaminants in water and soil, react to MW EMF as a stressor, thus confirming the results of Dr. Goodman.

Dr. Goodman has published other reports of studies showing that EMFs alter the transcription of proto-oncogenes (c-myc and others), which gene factors are believed to be associated with the onset of

cancer

15. EMF EXPOSURE AND CARCINOGENESIS

At the Veterinary High School in Hannover, Germany, (Loscher; Mevissen) it has been shown that EMF exposure has the same effect on tumorigenesis (breast cancer) in rats as the known carcinogen chemical DMBA (dimethylbenzanthrazene). Furthermore, they have shown that EMF exposure has the same activity enhancing effect on the cancer-related enzyme ODC (ornithinedecarboxylase) as DMBA.

From numerous studies, some of which are mentioned in this text, it appears that EMF exposure may affect carcinogenesis in several ways, some of them genotoxic, others non-genotoxic [ref. 38]:

- EMF exposure has the ability to reduce secretion of melatonin from the pineal gland; as melatonin is a powerful free radical scavenger in the whole body, the reduced melatonin output may increase the level of genotoxic free radicals to a level where DNA damage significantly increases; this has been shown in several studies;
- Studies have shown that EMF exposure may interfere with gene repair mechanisms;
- Failures to repair DNA may lead to chromosomal damage; studies have shown that EMF exposure may change calcium levels in cells which determines whether a cell with chromosomal damage will die by apoptosis (programmed death of damaged cells) or survive and maybe become transformed into a cancer cell;
- Studies have shown that EMF exposure enhances the activity of genetic material (proto-oncogenes) which may cause cells to transform to cancer cells;
- Studies have shown that EMF induced intracellular calcium levels may affect intercellular communication mechanisms through gap junctions; this may cause transformed cells to escape being killed by the immune system;
- Studies have shown that EMF exposure may affect the immune system reducing the body's cancer surveillance capability and ability to kill transformed cells;
- Studies have shown that EMF exposure increases the activity of growth enzymes (e.g., ODC) and accelerates cell growth, and more so for growth oriented cells like transformed cells;
- This cascade of events may lead to malignant tumor growth, as illustrated below:

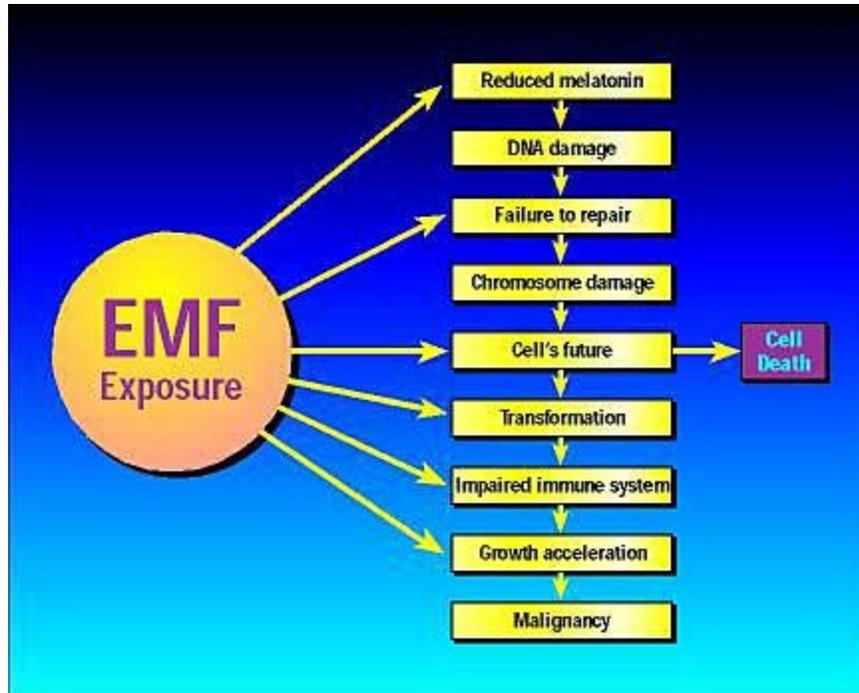


Fig. 20: Effects of EMF exposure on the biological pathway which may lead to cancer

16. LONG TERM IN VIVO (ANIMAL) EFFECTS

Only few long term animal studies are available due to their high costs and extreme difficulty.

Professor C. Susskind and Dr. S. Prausnitz, University of California at Berkeley [ref. 39] carried out the first reported long term study for the US Air Force in 1962. They exposed male Swiss albino mice to microwaves at 0.1 mW/cm² for 4.5 minutes per day, 5 days a week for 59 weeks. They found two adverse effects in the exposed mice compared to the unexposed mice. Testicular degeneration occurred in 40% of the exposed compared to 8% of the unexposed mice, and leukemia occurred in 35% of the exposed mice compared to 10% of the unexposed.

In 1985 Professor Guy [ref. 40] and his team carried out a long term study at the University of Washington, funded by the US Air Force. They exposed 100 rats to pulsed radar-like MW EMF at SAR below 0.4 W/Kg, the human exposure level allowable under the ANSI standard. Guy and his team found 18 malignancies in the exposed rats compared to 5 in the unexposed group. This led the US EPA to classify RF/MW as a possible human carcinogen (group C) in 1985.

A study in Poland (1982) showed similar effects of MW EMF in inducing cancer in mice [ref. 41].

In 1980 a study at Duke University Medical Center gave direct evidence that long term MW EMF exposure caused chronic immuno-suppression.

A study in India (1990) showed behavioral disturbances in rats (lower food and drink intake) and changed blood chemistry, as well as adverse effects on vital organs [ref. 42].

In 1997 [ref. 43] scientists at the Royal Adelaide Hospital, exposed 100 transgenic mice to MW radiation similar to GSM digital mobile phone antenna emissions for 30 minutes twice a day during 18 months. The study was conducted by Dr Repacholi funded by Australian telecommunication giant Telstra. At the end of the test period, the exposed mice had more than double the cancer rate compared to unexposed mice.



Fig. 21: EMF-induced lymphatic cancer in mice with two 30 minute cell phone exposures per day over 18 months

17. EPIDEMIOLOGICAL STUDIES ASSOCIATING EMF EXPOSURE TO DISEASE

More than 100 epidemiological studies have shown an association between residential and occupational EMF exposure and many types of cancer. The association between EMF exposure and childhood cancer is especially strong. This scientific evidence led the 28 member panel convened by the National Institute of Environmental Health Sciences (NIEHS) to conclude on July 24, 1998, that extremely low frequency (ELF) electromagnetic fields should be regarded as possible carcinogens. The final vote of the panel was 19 to 9 in favor of categorizing ELF EMFs, such as those from power lines and electrical appliances, as possible carcinogens. The vote followed a year of exhaustive evaluation of the scientific literature, three multi-day symposia attended by many international scientists, and a final 10 day review and debate of the scientific and medical literature in a closed meeting in Minnesota.

18. SUMMARY OF BIOLOGICAL AND HEALTH EFFECTS INDUCED BY EMF EXPOSURE

In October 1998 at the University of Vienna Workshop on Possible Biological and Health Effects of Radio Frequency Electromagnetic Fields, [ref. 15] the following resolution was adopted by the participating scientists (the "Vienna Resolution"):

"The participants agreed that biological effects from low-intensity exposures are scientifically established. However, the current state of scientific consensus is inadequate to derive reliable exposure standards. The existing evidence demands an increase in the research efforts on possible health impact and on adequate exposure and dose assessment."

In his summary report [ref. 13], Dr. Cherry concludes:

"Scientific studies at the cellular level, whole animal level and involving human populations, show compelling and comprehensive evidence that RF/MW exposure down to very low levels, levels which are a minute fraction of present "safety standards", result in altered brain function, sleep disruption, depression, chronic fatigue, headache, impaired memory and learning, adverse reproductive outcomes including miscarriage, still birth, cot death, prematurity and birth deformities. Many other adverse health effects have been found, predominantly cancer of many organs, especially brain cancer, leukemia, breast cancer and testicular cancer. Studies have also found that RF/MW exposed parents have more children with CNS cancers and other health defects. These effects are consistent with genetic damage caused by RF/MW. Many scientific studies have found chromosome aberrations and DNA damage with RF/MW exposure, the first being published in 1959. Two primary biological mechanisms are linked to these effects, calcium ion efflux and melatonin reduction. With melatonin reduction, there is a rise in serotonin which is associated with awakeness, alertness, anxiety, anger, rage and violence depending on the serotonin level, the person and the circumstances.

Hence, there is strong evidence that ELF and RF/MW is associated with accelerated aging (enhanced cell death and cancer) and moods, depression, suicide, anger, rage and violence, primarily through alteration of cellular calcium ions and the melatonin/serotonin balance."

19. NEW AREAS OF RESEARCH

So far, little attention has been paid to whether EMF exposure might affect the heart. Last year, however, Sastre and his coworkers at the Midwest Research Institute in Kansas City, Missouri, published experimental data showing that 8 hour exposures to intermittent, 60 Hz fields altered heart beat variability in healthy men [ref. 44].

Everyone's heart rate changes slightly from beat to beat, reflecting fine tuning by the nervous system in response to respiration and other factors. Yet, the magnitude of variance can differ dramatically between individuals. Even when two people each have a heart rate averaging 60 beats-per-minute (bpm), the heart rate of one may vary from 59 to 61, while another's swings broadly from 50 to 70 bpm.

Several studies have shown that low heart rate variability correlates with a higher-than-normal risk of

heart attacks and other heart conditions, particularly when the slowing occurs in the component of the heart rate known as the low spectral band. In the February 1998 issue of the scientific paper *Bioelectromagnetics*, Sastre's team reported a slowing in the low spectral band among men exposed to magnetic fields that cycle on and off every 15 seconds for an hour at a time.

When David Savitz, [ref. 45] an epidemiologist at the University of North Carolina at Chapel Hill, learned of the findings, he invited Sastre to help him sift through data on heart disease deaths within a group of 138,903 male electrical utility workers from five US companies over the period 1950-1988. The two researchers and their team now have reported a comparison of these data with men in low-EMF occupations.

It is evident from the data that men in trades exposed to high EMFs – such as line men and power plant operators – were more likely to have died from heart attacks and heart conditions related to abnormal rhythms, or arrhythmias. Moreover, risk of death from these conditions climbed as average EMF exposure increased. Savitz notes that men in the highest risk group tended to have worked in EMFs at least twice as high as those people typically encounter in their homes. Men in the uppermost category had a mortality rate 1.5-3.3 times higher than males in low-EMF occupations.

"These data suggest a possible association between occupational magnetic fields and arrhythmia-related heart disease", the researchers concluded in the January 15, 1999 *American Journal of Epidemiology*. Savitz now plans to follow up with more detailed studies, perhaps simultaneously monitoring heart rate variability and EMFs among electricians at work.

Presently, research is ongoing at the Catholic University of America (CUA) in Washington, D.C. showing that chicken embryo hearts produce stress proteins when exposed to pulsed and sinusoidal EMFs. When repetitively exposed, the chicken embryos hearts starts down-regulating their stress response which is, in effect, a defense mechanism. When down-regulated chicken embryo hearts are exposed to inoxia condition (a simulated heart attack), the chance of surviving that condition becomes substantially reduced.

These results may provide an explanation for the Sastre and Savitz epidemiological findings of elevated heart disease mortality associated with EMF exposures.

On May 20, 1999, Jacobson Resonance Enterprises, Inc., of Boca Raton, Florida, announced via internet-based PRNewswire that preliminary data from studies conducted at the University of Oklahoma Health Sciences Center utilizing the Jacobson Resonator have provided strong evidence that low-level magnetic fields can cause either slowing or speeding of heart rate and associated alterations in conduction from atria to ventricles. For the past several months, Benjamin Scherlag, Professor of Medicine, and William Yamanashi, Professor of Medicine at the V.A. Medical Center, in collaboration with Dr. Jacobson have conducted experiments using pico-tesla (10⁻⁵ mG) electromagnetic fields applied across the chest in anesthetized dogs. The cardiac impulse from atria to ventricles suggested that these low-level fields (intensity and frequency) were affecting autonomic nerves to the heart.

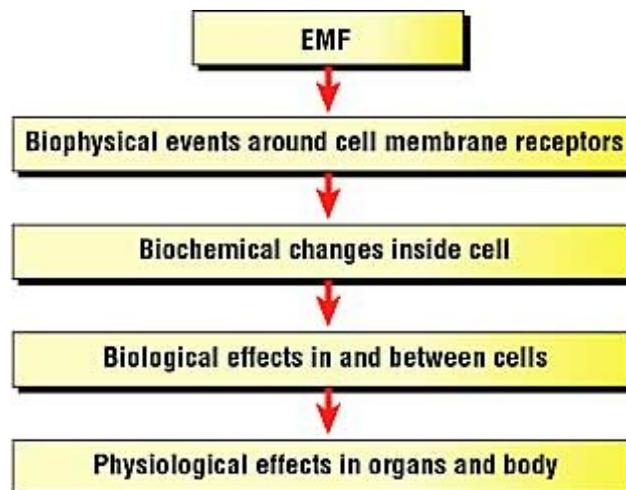
On May 20, 1999 the Associated Press (Washington), published research results from Yale University on treatment of schizophrenia patients with transcranial magnetic stimulation (TMS). The work was presented by Dr. Hoffman, deputy medical director of the Yale Psychiatric Institute, at the annual meeting of the American Psychiatric Association. Schizophrenia patients, whose medication could not

stop the imaginary voices in their heads, gained some relief after researchers repeatedly sent a magnetic field into a small area of their brain for a duration of 16 minutes. The magnetic field pulses make brain cells fire messages to adjoining cells. The magnetic pulses are thought to calm the affected part of the brain if they are given as slowly as once per second, according to Hoffman. He and colleagues targeted an area involved in understanding speech, above and behind the left ear, on the theory that hallucinated voices come from overactivity in that portion of the brain.

20. AN OVERVIEW OF EMF-INDUCED BIOLOGICAL AND PHYSIOLOGICAL EVENTS

Understanding the complex subject of environmental EMF exposure requires combined knowledge from a variety of scientific disciplines, each of which is struggling to thoroughly understand its own scientific discipline:

- an EMF is a complex physical phenomenon in itself, not completely understood by physicists;
- the EMF interacts somehow with the cell's electromagnetic microenvironment, inducing electric fields, establishing cellular membrane-based amplification effects, influencing cell receptors cooperatively, and affecting important membrane ion transport mechanisms and ion distribution balances; these mechanisms are understood only partially by biophysicists;
- changed ion distribution balances, especially relating to calcium, influence complex intracellular and intercellular messenger systems, changing enzyme activities and cell metabolism, endocrine secretion, neurochemical production and gene transcription; these processes are poorly understood by biochemists;
- these biochemical events lead to other biochemical events and physiological changes such as accelerated cell proliferation rate, chromosomal damage, cell stress and immune system impairment; these effects are poorly understood by cell biologists;
- these biological effects may lead to impaired organ function or adverse health conditions such as memory loss and learning difficulties, neuro-degeneration, cancer, etc; these conditions are poorly understood by physicians.



Based on the emerging views of many scientists, Figure 22 and 23 provide a relatively comprehensive overview of biological effects and events which results from EMF exposure. Figure 22 depicts the general mechanisms that account for bioeffects. Figure 23 shows possible disease endpoints resulting from EMF interactions.

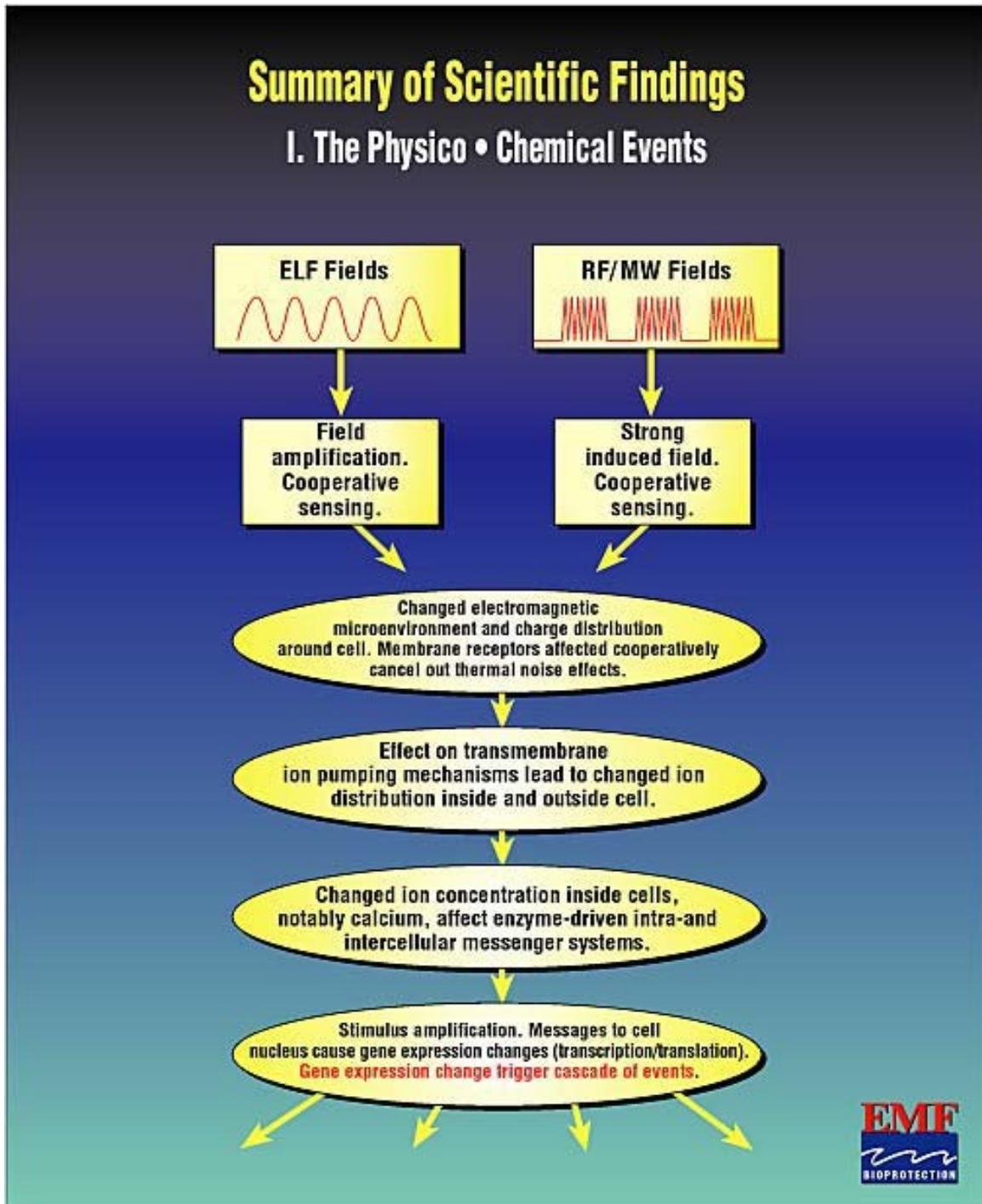


Fig. 22: Summary of scientific findings I

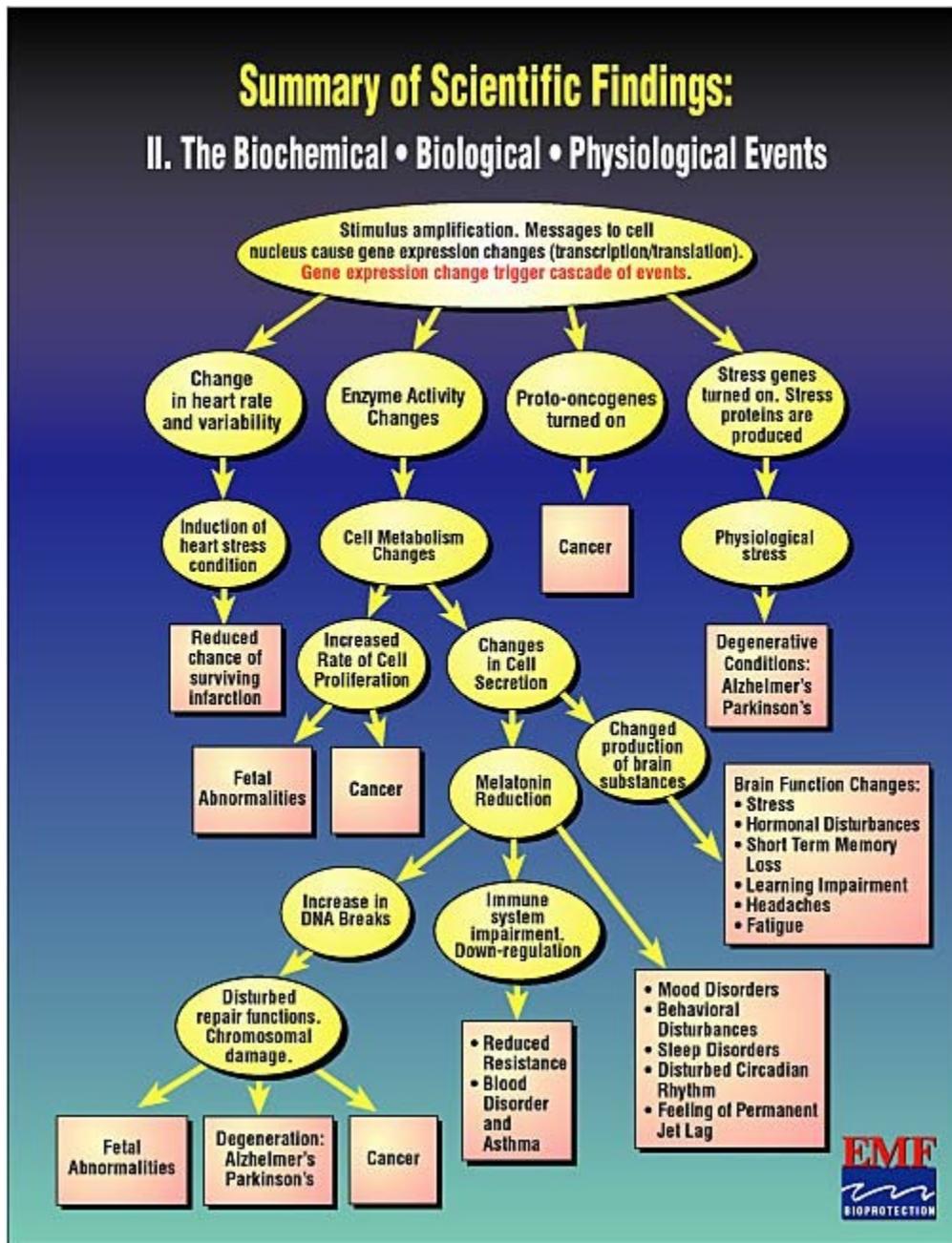


Fig. 23: Summary of scientific findings II

21. COMMENTS ON THE OVERVIEW

The above summary of scientific findings is not exhaustive, and much more scientific research will be needed in the future to expand and refine the picture. No one study can tell the whole story, but taken together many studies can provide a framework of understanding.

Scientists working within their respective limited area of interest and experience have over the past couple of decades found so many different biological effects induced by EMF exposure that the overall picture has become diffuse.

How could these minuscule, low-energy impulses, which moreover are impossible to detect by any of our senses, possibly be causing so many different effects? This is incredible, unless you understand that low-energy electromagnetism is in fact fundamental to all life processes, and that these energies affect some of the most critical factors for proper biological functioning: ions, the electrically charged atoms and atomic groups which are involved in virtually all important biophysical and biochemical processes in cells: enzyme-driven messenger systems and enzyme-driven metabolic processes.

Changes induced in these systems by EMFs are able to trigger a cascade of different effects ranging from gene translation/transcription, enzyme activities, hormonal secretions, neurotransmitter secretions, repair mechanisms, immune system responses, heart functioning, brain functioning, cell proliferation, cell apoptosis (programmed death), cell transformation, tumor suppression, tumor induction, and tumor promotion, among others. Which response particular cells or bodies show will depend on the actual situation in the system: genes, strength of homeostatic balance (health), situation, other stressors, etc. No one knows the exact long term effect in a certain organism until it is too late.

Nobody knows for sure her/his specific genetic heritage, strengths, weaknesses. The same insult may cause different responses in individual bodies. One person may be susceptible to cancer, another to Alzheimer's, a third to Parkinson's, while a fourth person may just get a headache, depression, memory loss or nothing. Large variations have been found in experimental systems as well, e.g., genetic variations in chicken embryos. Some flocks show a high response to EMF exposures and others show no response. Still others show a medium response. This has been the cause of much confusion and skepticism among scientists, but it is actually not hard to understand, considering the fundamental role of EMFs in virtually all life processes.

22. EMF: WHEN IS IT BENEFICIAL, WHEN IS IT ADVERSE?

All stimuli which are capable of affecting biological processes can be either beneficial or adverse, as expressed by the 16th century doctor Paracelsus. It all depends on dose and application. For example, applied once or twice, the use of steroids may be extremely beneficial to the body, whereas chronic, repetitive use is very adverse.

Numerous biological experiments and decades of therapeutical applications confirm that this century-old wisdom applies to EMF exposures as well. In the former Soviet Union (FSU), in particular, controlled EMF exposures have been and still are widely used for the treatment of millions of people for many different adverse conditions. It is used to alleviate stress reactions, stimulate tissue and bone repair and regeneration, protect against ionizing radiation and facilitate recovery in a wide range of diseases.

The research in FSU on adverse effects as well as beneficial use of EMF exposure has been extensively reviewed by scientists at Brooks Air Force Base and the U.S. Army Medical Research Detachment of the Walter Reed Army Institute of Research, San Antonio, Texas, [ref. 22]. According to the authors, publications on MW EMF-related topics in FSU number twice as many as publications in the rest of

the world taken together.

According to the Army and Air Force scientists, EMF therapy in the FSU involves repetitive short local exposures of certain body areas with low intensity EMF. The area(s) to be exposed, the radiation frequency, waveform and modulation, and daily duration of procedures are determined by a physician based on the disease and the condition of the particular patient. The radiation intensity is usually regarded as a less important variable, as long as it does not heat or damage the tissue. For most diseases, the daily exposures vary from 15 to 60 minutes, and the therapy lasts for 8-15 days.

FSU publications on the clinical use of EMF number in the hundreds. Many claim that EMF therapy is more effective than conventional methods such as drug therapy, for a variety of diseases and disorders. One great advantage of EMF therapy is that it is non-invasive. In some cases, EMF has helped patients who had already tried all other known therapies without success and were considered incurable. At the same time, EMF seldom caused any adverse effects or allergies. EMF in combination with drug therapy facilitated favorable effects and/or reduced adverse side effects of drugs. Some authors reported that EMF might be highly effective or not effective at all, contingent on the patient's condition, individual sensitivity to EMF, and parameters of irradiation. This is equivalent to findings of researchers in the West, showing that EMF induced effects vary highly with genetics and other parameters.

Diseases reported to be successfully treated with EMF in the FSU belong to rather diversified groups. The most common applications of EMF are for gastric and duodenal ulcers; cardiovascular diseases, including angina pectoris, hypertension, ischemic heart disease, infarction; respiratory sicknesses, including tuberculosis, sarcoidosis, bronchitis, asthma; and skin diseases, including wounds, trophic ulcers, burns, atopic dermatitis. Isolated studies claimed successful EMF treatment for asthenia, neuralgia, diabetes mellitus, osteochondrosis, acute viral hepatitis, glomerulonephritis, and alcoholism.

It is interesting to note that many of the therapeutical uses of EMF exposures are directly related to reports of potentially adverse biological and health effects of EMF exposures in the West, such as accelerated cell proliferation rate. EMF is also widely used in the West for clinical treatment of bone fractures and tissue wounds.

In the West, the Catholic University of America (CUA) in Washington, D.C. is doing extensive research on EMF exposed chicken embryos. They have found that short exposures of EMF caused the embryos to be able to survive simulated heart attacks (anoxia conditions) far better than unexposed embryos. However, if the embryos were subjected to chronic, repetitive exposures, the results were opposite [ref. 46].

Professor Litovitz, leader of CUA's research team on these issues, has a reasonable explanation to the observed effects. Short exposures of EMF stimulate the living system to produce stress proteins (also called heat shock proteins) which are important factors of the cell's and body's general defense mechanisms. However, repetitive exposures cause the living system to down-regulate the stress response mechanism in order to avoid exhaustion. When the system, in this down-regulated condition, is next exposed to another stressor (e.g., anoxia, infection, ionizing radiation, etc.) which may be a serious threat to its life, it may not have enough stress proteins to fight the adverse stressor. The principle of down-regulation is well-established and an accepted phenomenon in biology and medicine, fundamental to many biological responses [ref. 14, 16, 47, 48].

Recently, other beneficial effects of EMFs have been reported by research teams in the West.

Scientists working at Bristol University and the Bristol Royal Infirmary in the UK, led by Dr. Alan Preece, have reported a faster reaction time in humans subjected to cellular phone microwave exposures [ref. 49]. Dr. Preece stated: "this effect could be a slight warning of the brain leading to increased blood flow, or alternatively a change in protein synthesis (which is caused by a reaction of the body's defense mechanism), leading to the same effect".

A team of scientists from the Pettis VA Medical Center in Loma Linda, California, in 1998 [ref. 10] reported that cell phone radiation in some circumstances decreased DNA damage, in other circumstances the cell phone radiation increased DNA damage. The result was dependent on modulation scheme and exposure intensity.

In summary, a biological effect induced by EMF exposure may lead to an adverse health effect or a beneficial health effect, depending on exposure conditions. Below is pictured the principle in the interaction between EMF and biology, leading either to a beneficial or an adverse health effect.

EMF exposure can be beneficial or adverse depending on exposure conditions

EMF

Physical-chemical interaction
around cell membrane

Biological effect

Adverse effects:

- Down-regulation of stress protein production
- Reduced protection
- Accelerated aging
- Increased DNA damage (increased cancer risk)
- Stimulation of cancer cell growth (promotion)
- Increased heart arrhythmia
- Increased brain function
- Mood and behavior disorders
- Impaired immune system

Beneficial effects:

- Stimulation of stress protein providing cross protection
- Protection against anoxia (heart attacks)
- Decreased DNA damage (decreased cancer risk)
- Inhibition of cancer cell growth
- Stimulation of heart rhythm
- Improved brain function
- Improvement of mental disorders
- Stimulated immune system

Fig. 24: EMF exposure can be beneficial or adverse depending on exposure conditions.

23. A SPECIAL CASE: MOBILE PHONES

Use of wireless communication devices, such as cellular telephones, is increasing dramatically. Presently (May 1999), more than 300 million cellular phones are in use worldwide. For years, annual growth rates in number of subscribers have been 30 – 50 %. No wonder, as these devices provide immeasurable benefits to mankind.

Widespread use of cell phones and other types of handheld wireless communication devices has led to increased concerns about the long term health effects, notably cancer of the brain, degenerative conditions and brain function. With this new technology, large numbers of humans for the first time in history are applying a strong microwave radiation emitter right next to their brains. The issue of health hazards associated with cell phone radiation first came to widespread public attention in 1993, when a Florida man appeared on a popular TV talk show to claim that his wife's brain cancer had been caused by the radiation from her cell phone.

It is scientifically established that the electromagnetic emissions of cell phones are capable of significant biological tissue interactions.

Cell phones emit two types of EMF:

- From the antenna, cell phones emit microwaves (MW) structured according to a modulation scheme which can be analogue (continuous wave with speech-modulated amplitude, being phased out quickly in most countries), or digital; there exist several types of digital schemes, most of them emitting the microwave in pulses per second (pps) such as GSM (217 Hz pps), TDMA (50 Hz pps), Iridium (11 Hz pps), iDEN (22 Hz pps). CDMA is another type of digital system using FM modulation in a band which is narrow compared to the carrier wave.
- From the circuitry in the phone body and the battery, powering the MW emissions from the antenna, digital mobile phones emit ELF fields pulsing or oscillating as a function of the modulation scheme of the MW.

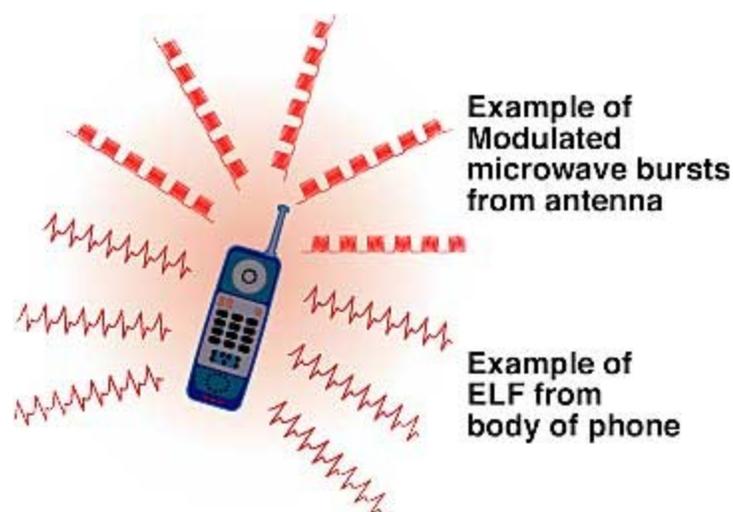


Fig. 25: Digital cell phone emitting microwaves from antenna and ELF pulses from phone body

Experimental evidence of significant biological effects induced by both MW and ELF similar to such fields as emitted from mobile phones has met criteria of scientific consistency and repeatability. Biological effects occur at every level of the organizational hierarchy of living organisms. They include the most basic cellular mechanisms such as ionic movements, through enzymatic responses and metabolism, to regulatory processes in cell growth. Physical and biophysical studies have evaluated sensitivities to ELF and ELF amplitude modulated RF/MW fields, with little or no evidence that observed responses relate directly or indirectly to cell or tissue heating.

The MW output from the antenna of the phones vary somewhat, usually it is within the region of 0.5-1.0 W, giving specific absorption rates (SAR) of up to 0.5 W/Kg. This is well below the official "safety" standards which vary somewhat from one country to another – the US ANSI/IEEE applicable standard is 1.6 W/Kg. However, the problem is that these safety standards are meaningless according to the latest research, showing that the induction of biological effects from EMFs have little to do with energy absorption. Research has shown significant induced effects at energy absorption rates tens of thousands of times below the "safety" limits. Presently, it is totally unclear whether it is at all possible to establish any relevant "safety" limits – what is "safe" to one person may turn out to be totally unsafe to another person, and nobody will know the individual long term health consequences until it is too late.

The ELF output from the body of digital phones usually is around 10-20 mG with peak values up to around 50 mG, well above the 2 mG level believed by many scientists, and the Swedish authorities as well, to be the limit above which the health risks compared to non-exposed conditions become significantly increased.

Laboratory studies have shown that there are actually three factors contributing to the ability of cell phone emissions to induce potentially adverse biological effects:

1. Continuous wave (CW) microwaves have been shown to have the ability to induce biological effects;
2. ELF-modulated microwaves have been shown to induce biological effects even more effectively than CW microwaves;
3. ELF fields have been shown to induce biological effects.

Cell phones using the CDMA digital modulation scheme might have a slight advantage over other digital modulation types, as the modulation uses a kind of "random" frequency modulation. However, scientists working on these issues argue that the frequency variation in CDMA is negligible compared to the frequency of the carrier wave. Therefore, biologic cells will react to CDMA emissions as if it was CW microwave radiation, and biological effects are induced, as recent research has shown.

GSM, TDMA, iDEN and Iridium all use ELF modulation schemes, transmitting the microwave from the antenna in "packages" or "bursts". This digital ELF-modulation of the microwave has been shown in some studies to produce the largest biological effects. Additionally, the current drain on the battery produces ELF-pulses equivalent to the transmission of microwave "packages". This ELF emission is in itself capable of inducing significant biological effects.

In a study not yet published (by May 1999), scientists at Stanford University and Integrated Laboratory Systems (ILS) in Research Triangle Park, North Carolina, have found that cellular phone radiation can triple the number of chromosome abnormalities in human blood cells [ref. 25]. This was disclosed to

the magazine Microwave News (March/April 1999) by Dr. George Carlo, chairman of Wireless Technology Research (WTR), founded and sponsored by the cellular phone industry. Dr. Carlo told Microwave News "WTR has found links between cellular phone use and cancer".

Dr. Ray Tice of ILS, and Drs. Graham Hook and Don McRee of WTR, presented the results at "The 30th Annual Meeting of the Environmental Mutagen Society (EMS)" in Washington on March 29, 1999. The results showed an effect with all four cellular phone technologies tested – analogue, CDMA, TDMA and PCS. The findings were all statistically significant, all but one of them highly so.

In 1999, Swedish cancer specialist Dr. Lennart Hardell looked at brain tumor sufferers and found a connection between phone use and cancer. He found right-handed people had a two-and-a-half times higher risk of a brain tumor in the right hand side of the brain, whereas left-handed people had nearly the same elevated risk of a left-hand side brain tumor [ref. 50].

In 1997 the results of a study funded by the Australian telecommunications company Telstra showed that transgenic mice exposed to GSM cell phone signals had an almost two-and-a-half times higher risk of developing lymphatic cancer than unexposed mice [ref. 43].

In 1997, Dr. Miguel Penafiel et al. [ref. 48] found that TDMA digital cellular phone microwaves produced a significant 40 % increase in the activity of the cancer-related enzyme ODC. Continuous wave microwaves showed a less marked effect, and analogue frequency modulated phone emissions showed no significant effect.

Representatives of the cellular phone industry are still claiming that "their products are safe" or "research indicates no health risk". Claims like these are misleading the general public; the only statement that can be made is the opposite, that "there is no scientific evidence showing that cell phones carry no health risk".

Even though there is not yet scientific consensus as to the long term health consequences of EMF exposures, the body of evidence presented by scientific studies should spur substantial concern, and many scientists aware of this research state that they are cutting conversations short on their cellular phones and advice other users to do likewise.

According to a Swedish study [ref. 51] on 11,000 cell phone users in Sweden and Norway, cell phone users complain of a variety of symptoms from their use of cell phones. According to the scientists, the problems start at just 2 minutes or more on the cell phone per day.

24. WHAT CAN BE DONE ABOUT THE PROBLEM?

There has been a dramatic increase since World War II in the use of systems and devices emitting EMFs; humans are exposed to these fields in the home, in the workplace, and in the external environment. Even though life on earth developed in a sea of weak natural EMFs ranging in frequency from a few cycles per second to the extremely high frequencies of radioactive and cosmic radiation, the intensity of EMFs from man made devices and systems are typically far above the levels of this natural background radiation in our urban environments. More importantly, the man made EMFs are completely different from natural EMFs in terms of their oscillation properties which show a constant

rather than a random pattern of variation.

The rapid development of higher and higher intensities of man made, constantly oscillating EMFs from new technologies is expected to continue and even accelerate, as we adopt an increasing number of systems and devices emitting such fields. This development can not and should not be stopped, as most of these devices are extremely helpful and provide improved quality of life to millions of consumers.

However, with the present scientific knowledge in mind, it is obvious that something must be done to protect consumers against potential hazards associated with the EMF emissions. And users are definitely worried; in a poll conducted in the UK by Mori (May 1999), it was reported that 40 % of regular mobile phone users are afraid of potential health problems on the background of the scientific reports.

Industry associations are eagerly trying to downplay the risks and frequently state that there is no proof of any health risks of EMF exposures. However, the fact is that:

- Man made EMFs evidently induce significant biological effects in human cells, tissues and whole animals. These biological effects are linked to biochemical and physiological events believed to be associated with the development of adverse health conditions; whenever there is evidence of such interactions, there is justified reason for concern;
- A majority of epidemiological studies point to an association between adverse health conditions and EMF exposures; this is another reason justifying public concern.

Added together, these two individual dimensions of "circumstantial evidence" brings a third dimension into the matter of concern. Therefore, the only statement which can be made for certain is:

"There is no scientific evidence that man made EMFs are safe".

The options available to consumers who are concerned about being "guinea pigs" in the large scale experiment set up by the electrical, electronics and telecommunications industries are the following:

- Prudent avoidance of the near field of systems and appliances emitting strong EMFs such as cellular phones and base stations, computers, hair dryers, power line systems, transformer stations, TV transmission towers, photocopying machines, food processors, microwave ovens, sewing machines, electric motors, etc. This is often not practical, and consumers may not be knowledgeable about the proximity of transformer stations, underground power lines, cell phone towers, etc. In many occupations it is not possible to cut down the use of devices like cellular phones and computers. Besides, as research has shown, nobody knows what safe levels of EMF exposures are.
- Use of devices like the ear piece for mobile phones; however, many cell phone users place their handsets in their belts when they use their ear piece, thereby exposing large deposits of blood cells in the hip bone marrow or their genitals to the radiation. Furthermore, even at a distance, the radiation from a mobile phone antenna may induce significant biological effects.
- There are physical shielding devices available in the market, especially for cell phones, and

some of these sell well. The problems associated with shielding are the following:

- It is not practical to shield against ELF fields which penetrate virtually all materials except a special metal alloy (mu metal) which is as expensive as 24 ct gold; thus, a shield for a cell phone would do nothing to the ELF emission from the handset body;
- The shield may take away some of the microwave radiation of the cellular phone antenna; however, the level of the radiation will still be far above the thresholds for induction of biological effects which may to be thousands of times below the level actually emitted from the antenna;
- The shield will in many situations hamper the operation of the phone, depending on the direction to the nearest base station; if the head of the user is in the direction of the nearest base station, the phone will have to increase its output power to reach an alternative base station.
- Shielding devices may appear clumsy and unattractive.
- There are products being offered in the market consisting of little containers filled with "magnetized water", claimed to emit a protective magnetic field which eliminates potential hazards of the radiation. There is no published and peer-reviewed scientific backing for these claims.

25. A SCIENTIFIC SOLUTION TO THE PROBLEM: EMF BIOPROTECTION™

The EMF Bioprotection™ technology is a scientifically developed solution to the EMF problem. The technology is published and peer-reviewed, and its ability to neutralize biological effects induced by EMF-exposures has been tested and confirmed independently by five laboratories in North America and Europe.

The technology was developed in a large, on-going research project at the Catholic University of America (CUA), Department of Physics in Washington, D.C. The research project was initiated in 1986 and funded in its first five years by the U.S. Army Walter Reed Army Institute Department of Microwave Engineering.

The background for the project was a concern of the U.S. Army about the biological effects and potential health consequences to personnel exposed to EMFs. Since World War II, the U.S. Army has been the world's largest user of electrical, electronic, and telecommunication equipment and was the first to recognize effects induced by EMFs on military personnel (radar operators on WW II battleships).

The EMF Bioprotection™ technology is patented in U.S.A. The patent application for the technology is endorsed by the U.S. Army. The U.S. government owns all non-commercial rights to the technology, whereas non-military rights belong to the company EMX Corporation. The company will shortly be introducing products in the marketplace to provide protection for consumers worried about potential health effects of EMF exposures. The EMF Bioprotection™ technology is designed to prevent non-thermal biological effects of EMF exposures. When the biological effects are prevented, there can not

possibly be any health effects associated with non-thermal exposures.

The technology works by blocking the EMF-induced physical-chemical interactions around the cell membrane receptors, probably by preventing cooperative sensing from happening. In this way, the cascade of biochemical events which would result inside the cell as a function of membrane receptors sensing the constant, oscillating EMF, is prevented from being triggered. The EMF Bioprotection% technology re-establishes the situation around the cell as if it was non-exposed. This is illustrated in Figure 26.

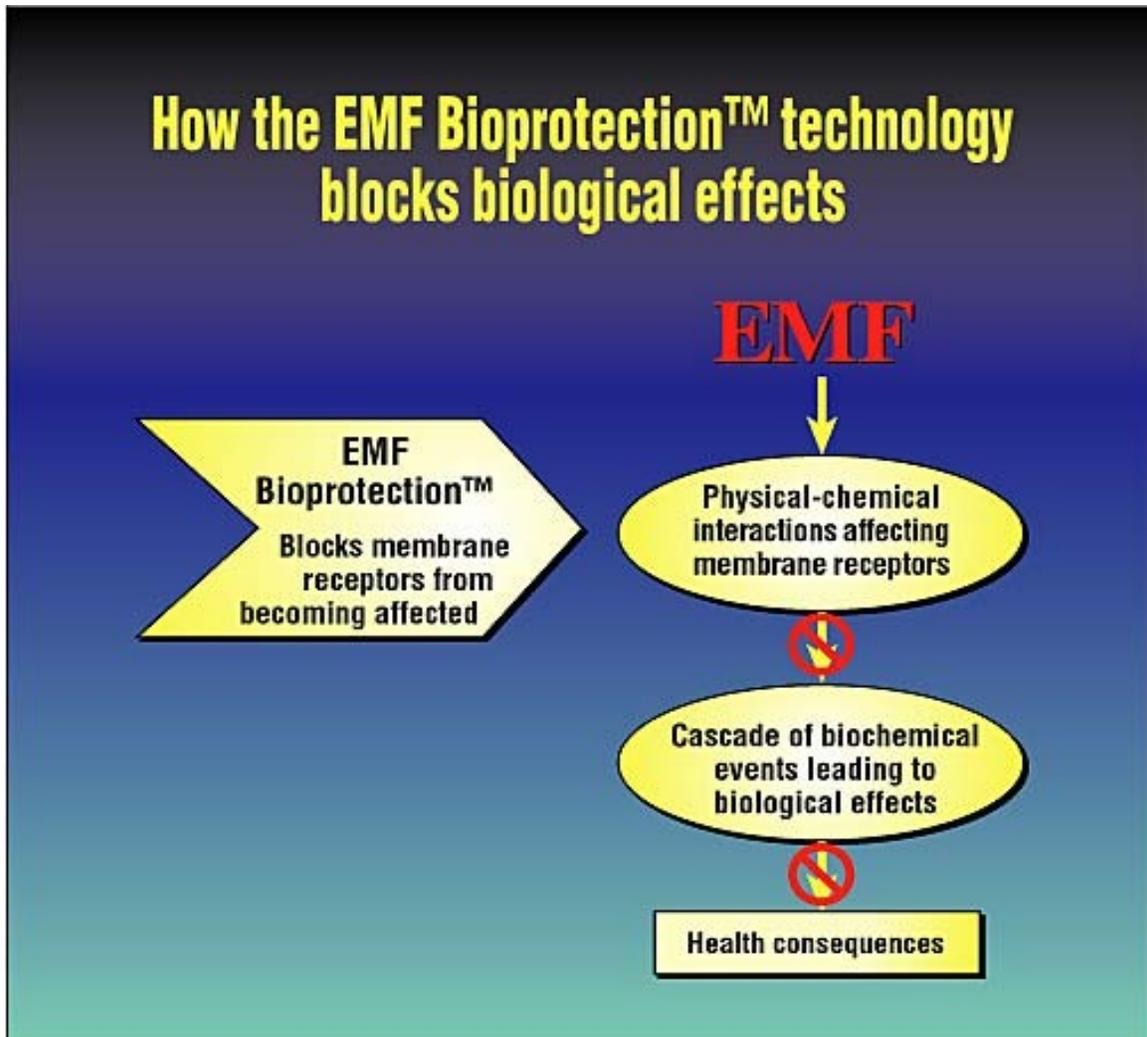


Fig. 26: How the EMF Bioprotection™ technology blocks biological effects

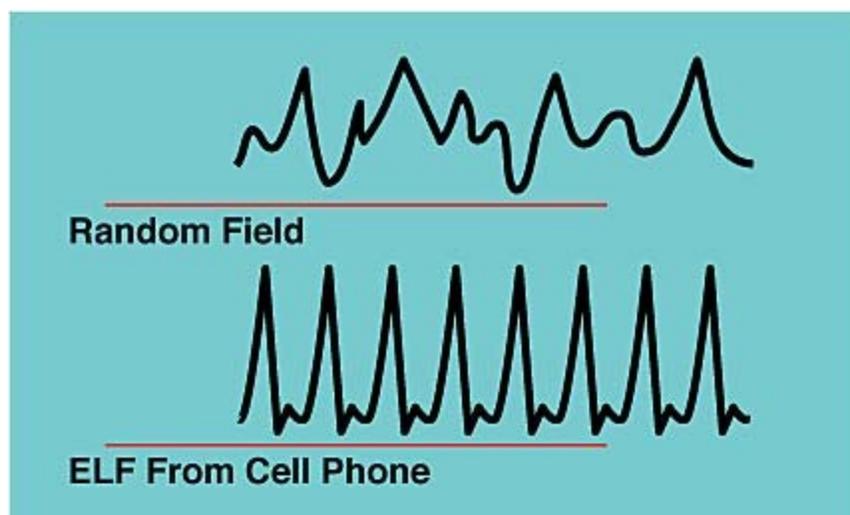


Fig. 27: The time variance of a natural EMF frequency, amplitude and waveform varies at random (top). A "man-made" EMF, emitted from the internal circuitry of a digital mobile telephone. Frequency, amplitude and waveform are constant for a certain time period (bottom).

The EMF Bioprotection™ technology works by simulating nature's random EMFs. The research team at CUA found that the requirement for biological events to be induced by EMF exposure is that the EMF – apart from being spatially coherent like all fields external to the body – is steady for a minimum period of time (constant oscillation) [refs. 52, 53, 54].

The CUA research team found – like other scientists working in this area – that ELF and microwaves induced remarkably similar biological effects. Especially ELF and ELF modulated microwaves are virtually identical in their ability to induce biological effects.

Most important: The scientists found that superimposing a random, "natural"-type ELF field ("noise" field) on a steadily oscillating EMF could mitigate the induced biological effects; and if the noise field was properly engineered, any biological effect tested was completely eliminated.

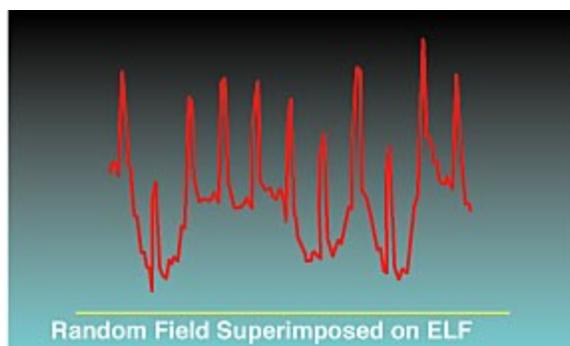


Fig. 28: Noise field superimposed on the constant ELF emitted from the circuitry of digital mobile phone

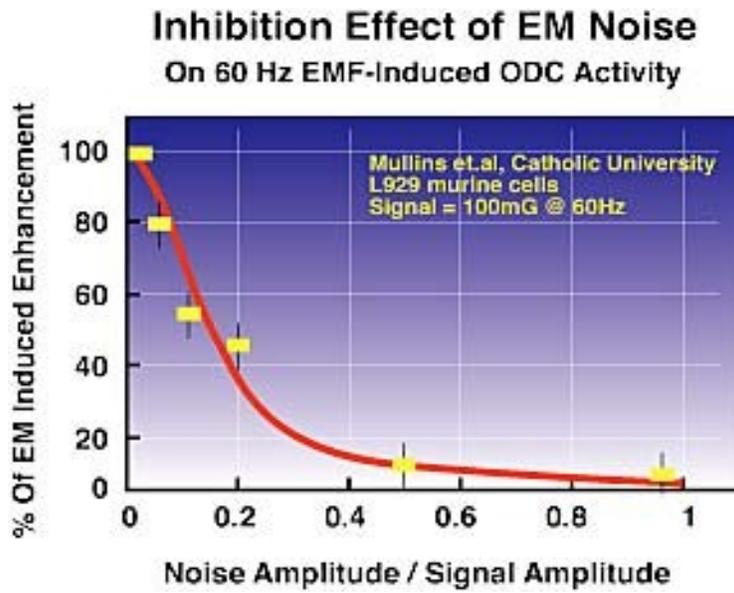


Fig. 29: EM noise inhibits the 60-Hz ELF-induced ODC activity in cells

Among many other studies, the team of scientists in CUA’s laboratories exposed about 3000 chicken embryos to EMFs. They found that:

- Steady, oscillating EMFs increase the rate of neural abnormalities in chicken embryos by a factor of approximately 2.5. (Figure 30)

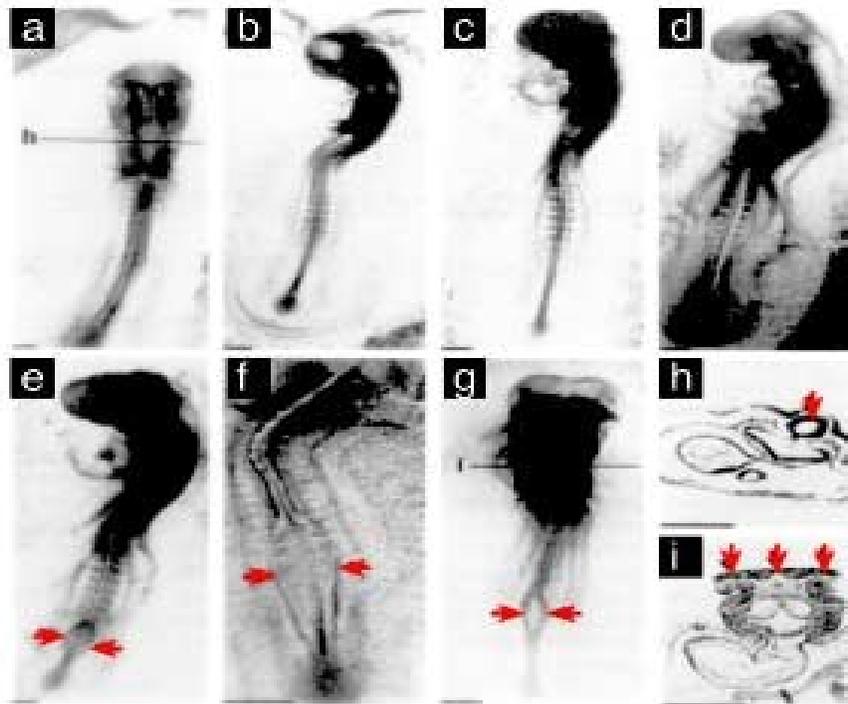


Fig. 30: EMF-induced abnormalities in chicken embryos. (Farrell et al, 1997) Pictures (a)-(d) show normal, unexposed embryos following a 48 hour incubation. The spinal cord is the "tail" of the embryo, and the neural tube inside this appears completely normal; so does the developing brain. Picture (h) is a transverse section at the level of the hindbrain for embryo (a) as indicated by line (h) in picture (a). This brain is normal. Pictures (e)-(g) and (i) show neural tube and brain defects induced by electromagnetic fields. In (e)-(g) arrows indicate neural folds of open neural tubes in the spinal cord. This is an abnormality known in humans as spina bifida. The hindbrain shown in (i) of embryo (g) is abnormal - totally flattened - compared to the normal brain shown in (h)

- There is a biochemical explanation to this. EMFs significantly change the activity of the important growth enzyme ODC (also related to cancer), making the availability of the enzyme inappropriate at critical stages in the development of the embryos. For example, during neurulation (formation of the neural tube) the activity of the enzyme is too little, causing the incomplete closure of the neural tube on the chicken embryos shown above.

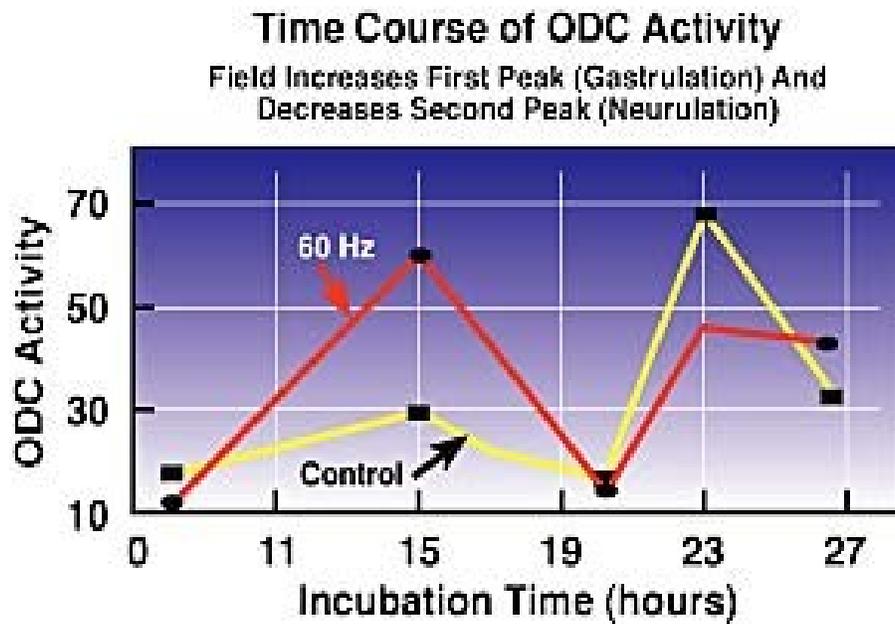


Fig. 31: The red (black circle) line shows EMF-induced changes in the activity of ODC. (Litovitz et al, 1993)

- Superimposing a noise field on the 60 Hz field caused the embryo abnormality ratio as well as the ODC enzyme activity to become normal

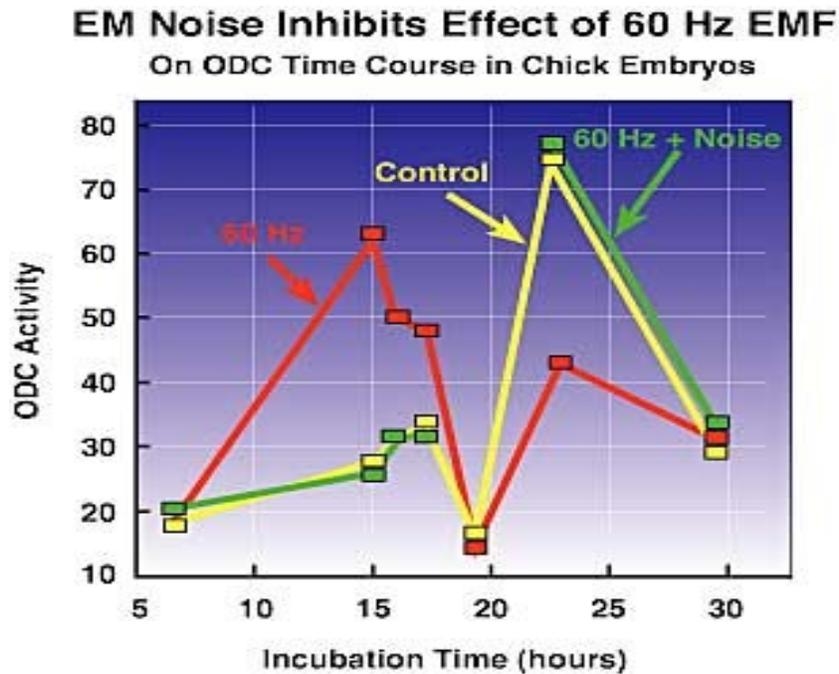


Fig. 32: ODC activity in unexposed, exposed and exposed+noise chick embryos

This series of experiments is just one of many studies performed on different biological systems and

different induced biological effects.

The scientists discovered that a noise ELF-type field could also eliminate the biological effects of a microwave-type field, either continuous wave or ELF modulated microwave.

The explanation of this is not scientifically resolved, but it is an experimental fact. It is believed to be related to another experimental fact mentioned earlier, that ELF and microwave fields by some yet unknown mechanism induce similar biological effects, probably due to:

- Amplification mechanisms in and around the cell membrane;
- Cooperative sensing in the cell membrane receptors.

In popular language, superimposing the noise field re-establishes the normal, unexposed situation around the cell membranes, by inhibition of charge-redistribution around the cell caused by the steady oscillating field, and/or by inhibiting the membrane receptors' sensing of the changed electromagnetic environment, no matter whether this change is caused by microwave radiation or an ELF field.

The graph below (Figure 33) shows the inhibition of a biological effect induced by cell phone microwave radiation (digital TDMA phone), using an ELF noise field. The biological effect is a change in the activity of the important growth enzyme ODC. The stronger the noise field, the better the inhibition of the induced effect. If the noise field is strong enough, it is possible to completely eliminate the induced effect.

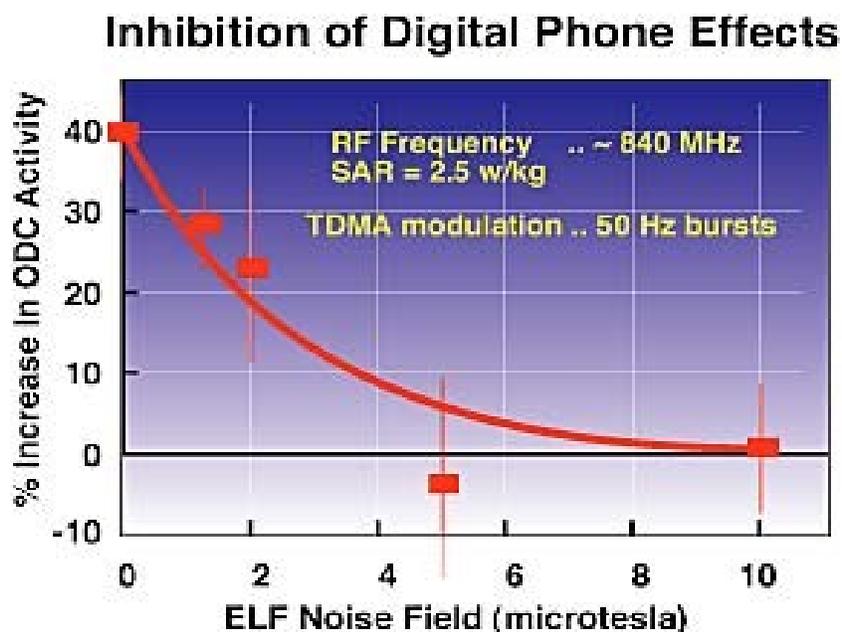


Fig. 33: Inhibition of digital phone effects.

The efficacy of the EMF Bioprotection™ technology in preventing EMFs from causing biological effects has been independently tested at five different laboratories on numerous biological systems and markers. In all tests, EMF-induced biological effects were effectively eliminated, and it has also been reported that the bioprotection noise field does not in itself induce any biological effects.

Laboratories having tested the efficacy of the EMF Bioprotection™ technology:

- 1) Department of Physics, and Department of Biology and Institute for Biomolecular studies, Catholic University of America, Washington, D.C. Att.: Dr. T.A. Litovitz [refs. 52, 53, 54].
- 2) Department of Anatomy, The University of Western Ontario, and Departments of Biochemistry, Victoria Hospital, London, Ontario, Canada. Att.: Dr. A.H. Martin [ref. 55].
- 3) Department of Pathology, College of Physicians and Surgeons, Columbia University, New York. Att.: Dr. R. Goodman [refs. 56, 57, 58].
- 4) Institute of Communication Technology, Aalborg University, Denmark, and Institute of Medical Biochemistry, University of Aarhus, Denmark. Att.: Dr. S. Kwee [ref. 59].
- 5) Bioelectromagnetics Research laboratory, Center for Bioengineering, University of Washington, Seattle. Att.: Dr. Henry Lai.

Re 1). Tests performed at the Catholic University of America (CUA)

A) EMFs change the activity of the important growth enzyme ODC. This significant biological effect, relevant to cancer promotion and teratogenesis (fetal abnormality induction) has been shown in many biological systems. The scientists at CUA found that the EMF Bioprotection™ technology was capable of eliminating EMF-induced (ELF as well as microwave) ODC activity changes in

- Mouse cells [ref. 16, 47,52, 60];
- Chicken embryos [ref. 61];

B) EMFs induce a factor two-and-a-half increase in the rate of neural abnormalities in developing chicken embryos. This can be explained by the induced change in ODC enzyme activity which alters the rate of DNA synthesis and cell proliferation, increasing the risk of something going wrong in a developing embryo or the balance between healthy and transformed cells in a mature organism. The EMF Bioprotection™ technology was tested on the chicken abnormality ratio, and it was totally efficient in reducing the abnormality ratio to the normal level. [ref. 53].

C) Specifically, the research team at CUA tested the ability of the EMF Bioprotection™ technology to eliminate biological effect (ODC activity rate) induced by mobile phone microwave radiation. It was shown that the noise field was totally effective in eliminating the microwave induced biological effect. [ref. 48, 54].

D) The team has worked extensively on the effects of EMFs on the ability of chicken hearts to

survive a simulated heart attack (anoxia). When the chicken hearts were exposed for just 20-30 minutes of EMF exposure, they had consistently higher chances of surviving a simulated heart attack. This is due to the fact that EMF exposures stress the heart, and this is beneficial for short time intervals. However, when they were exposed for an extended period, or repeated short term exposures, they had significantly lower chances of surviving simulated heart attacks. The reason for this is that repetitive or chronic exposures cause a down-regulation in the stress response to the EMF, leaving substantially smaller resources to defend a life-threatening condition like anoxia. This is backed by epidemiological data, showing that electrical utility workers has a significantly higher mortality rate of infarcts. The EMF Bioprotection™ technology relieves the heart from stress, eliminating the biological effect of down-regulation.

These data has not yet been published.

Re. 2). Tests performed by the University of Western Ontario (UWO), Canada

At UWO, the scientists have found that EMF change the activity of a critically important enzyme called 5' nucleotidase which has a multiplicity of functions vital to developing nervous and brain tissue. The tests were performed in developing chicken embryos, and the scientists found that the induced effect persisted even after the field was removed. The scientists tested the efficacy of EMF Bioprotection™ technology on these induced biological effects and found that they were negated. [ref. 55].

Re. 3). Tests performed by Columbia University (CU)

A) EMFs induce an increase in the transcript levels of c-myc, a proto-oncogene found to be associated with the onset of cancer. The test were performed on human leukemia cells. The scientists found that EMF Bioprotection% technology was able to eliminate the gene expression change induced by the EMF exposure. [ref. 56, 57, 58].

B) EMFs alter the expression and transcription of genes responsible for the onset of stress protein production, and an associated alteration of the biosynthesis of these substances – which are produced in response to all stresses like heat shock, radioactive radiation, anoxia, bacterial and viral attacks, toxic chemicals, etc. The scientists at CU showed that the EMF Bioprotection% technology was capable of eliminating the induced production of stress proteins, demonstrating that the noise field prevented the stress condition in the cells, caused by the EMF. The test was performed on human breast cancer cells.

C) EMFs suppress the production of neurotransmitters and other brain and nerve substances, one of these being dopamine. This is believed to influence the function of the brain, and a permanent low level of dopamine is believed to be associated with Parkinson's disease. The scientists at CU have applied the EMF Bioprotection™ technology to the induction of this biological effect and have found that these effects are completely eliminated.

Re. 4). Tests performed at Aalborg and Aarhus Universities (AU) in Denmark

EMFs have been shown to increase cell proliferation rates in cell cultures and primitive animals (nematodes). The scientists at AU showed that application of the EMF Bioprotection%

technology completely eliminates the EMF-induced increase in cell proliferation rates. [ref. 59].

Re. 5). Tests performed at the University of Washington (UW), Seattle

EMFs have been observed by the scientists at UW to cause a change in the function of the brain. This has been confirmed by studies at the UK National Radiological Protection Board (NRPB), the Bristol Royal Infirmary and the British Army. At UW, the scientists demonstrated that the EMF Bioprotection™ technology was capable of eliminating EMF-induced impairment in the learning of rats. The study has not yet been published.

- The test studies of the EMF Bioprotection™ technology are summarized below, organized according to biological effects induced by EMFs and potential health consequences which may result from these biological effects . The research provides ample support for the hypothesis that the superimposed EMF noise field functions by preventing the fundamental sensor mechanisms situated in the receptors of the cell from reacting to the constantly oscillating EMF stimulus. This blocks the triggering effect in the cascade of events leading to significant biological effects and potentially adverse health conditions.

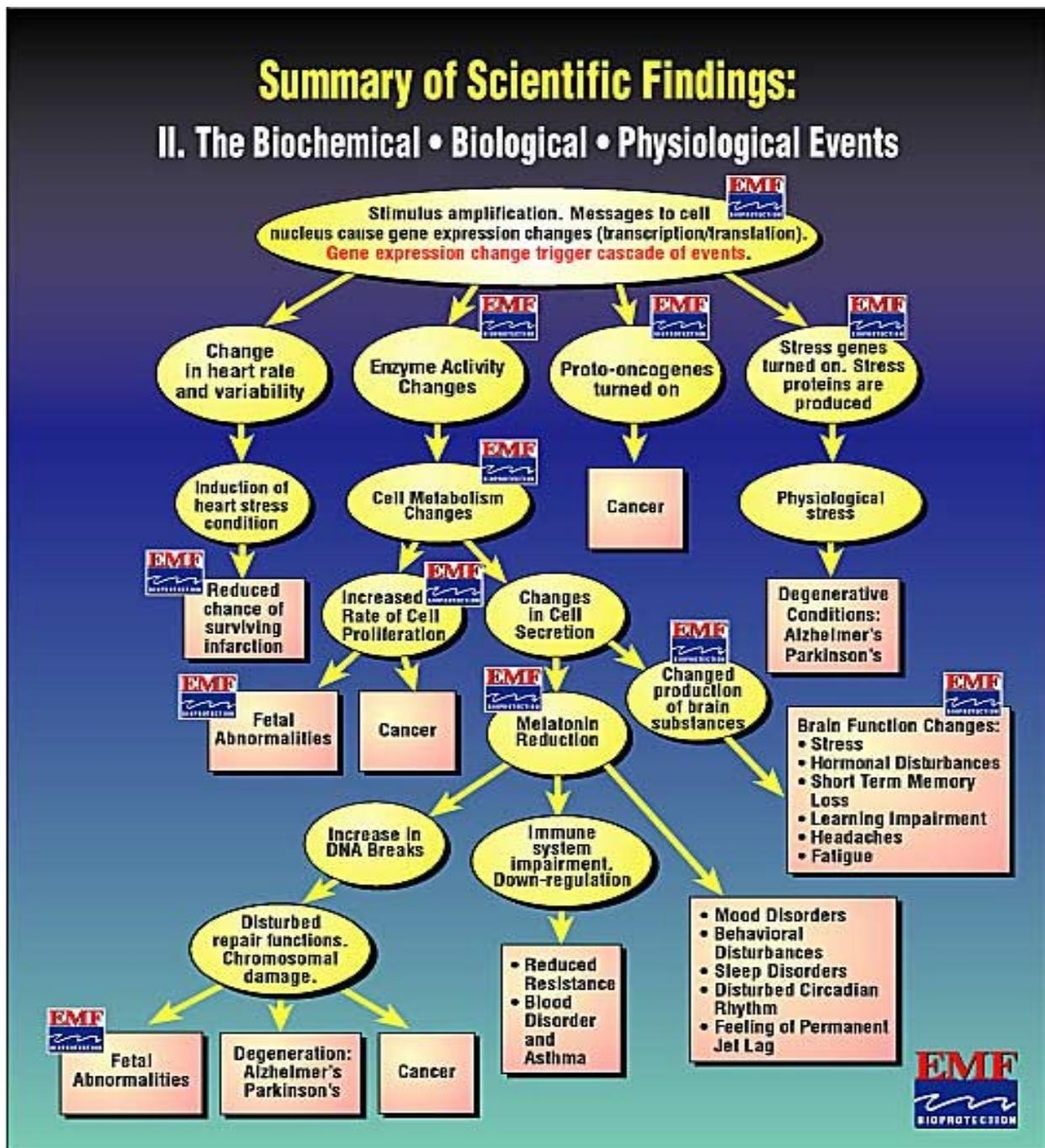


Fig. 34: Tests performed with EMF Bioprotection™ technology reporting that biological effects induced by EMFs are blocked.

As it appears from this overview, the EMF Bioprotection™ technology has proven its ability to eliminate a broad variety of EMF induced biological effects, along any of four critical pathways of biological events:

- Gene expression is the fundamental starting point of all metabolic processes in the cell, if you

fiddle with that, anything can happen. Gene expression changes caused by external factors can be very adverse, triggering unpredictable cascades of undesirable biological events leading to such different conditions as cancer, Alzheimer's, Parkinson's, brain and heart functional impairment, blood disorders, allergies and asthma, mood and behavioral disorders, sleep disturbances, headaches, fatigue, circadian rhythm disorders, etc. It has been demonstrated that the EMF Bioprotection™ technology eliminates EMF-induced gene expression changes related to cancer and biological stress.

- There is epidemiological as well as laboratory evidence that EMFs change the function of the heart and induce stress which may lead to down-regulation of critical defense and repair mechanisms. This has been shown to adversely affect the mortality rate related to infarctions. It has been shown on live chicken embryos that the EMF Bioprotection™ technology eliminates the EMF-induced impairment of heart defense and repair mechanisms.
- There is laboratory evidence that EMFs significantly change the activity of important enzymes related to growth and development of nerve and brain tissue and cancer cells, causing changes in metabolism and cell proliferation which may lead to cancer or fetal abnormalities. The EMF Bioprotection™ technology has been shown to eliminate such effects in cells and chicken embryos. The EMF-induced changes in cell metabolism may lead to changes in the production and secretion of critical endocrine and brain hormones and neurotransmitters, which are vital to the proper functioning of brain, nerves and organs, and important to the body's defense against cancer. EMF Bioprotection™ technology has been shown to eliminate EMF-induced changes in the production of such substances, and to normalize EMF-induced changes in brain function of rats.
- There is laboratory evidence of EMF-induced stress in cells, organs and animals. This is expressed as a change in cell metabolism triggering production of stress proteins, the universal response of a cell exposed to a potentially adverse insult. Stress in short periods is actually beneficial to the organism; however, if the stressful condition persists, such as in the chronic or repetitive exposure to electromagnetic fields, the mechanism of down-regulation comes into play. This may lead to situations where the cells are exhausted, and cannot prepare for further life-threatening stressors such as chemical toxins, bacterial or viral attack, ionizing radiation, anoxia, etc. The consequence of such situations may be excessive cell death, leading to degeneration of tissue in the brain or nerves (Alzheimer's and Parkinson's). The EMF Bioprotection™ technology has been shown to eliminate EMF-induced stress responses.

26. PROVIDING PRODUCTS WITH THE EMF BIOPROTECTION™ TECHNOLOGY

The development and testing of the EMF Bioprotection™ technology has been going on since 1986 by the team of 15 scientists at CUA. The testing will continue, and more laboratories will be involved in this work in addition to the five laboratories already involved.

The development and testing was initiated and funded in the first five years by the U.S. Army. In 1991, a research and development company called EMX Corporation was founded to continue funding of the research, and to develop a technological platform for providing protection to consumers with the EMF

Bioprotection™ technology.

EMX Corporation has offices in London, New York and San Jose, and has developed and tested a microchip-based implementation of the EMF Bioprotection™ technology. This will allow manufacturers and distributors of electric, electronic and telecommunication systems, devices and appliances to offer their customers protection against biological effects induced by the EMFs emitted from their products.

EMX Corporation will work with these companies to help them to integrate EMF Bioprotection™ technology in their products in a practically and cost-efficiently way.

The first product incorporating EMF Bioprotection™ is aimed at the mobile phone market. EMX Corporation has entered into an agreement with a large mobile phone battery manufacturer, incorporating EMF Bioprotection™ in their product line. These products are offered existing users of mobile phones. To obtain protection, users of mobile phones just have to buy a new battery for their phone with the EMF Bioprotection™ technology incorporated.

EMX Corporation will be working together with other companies, providing bioprotection to users of hair dryers, electric hand tools, vacuum cleaners, computers, microwave ovens, etc.

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APPENDIX

EMX Scientific White Paper: Development of the EMX Noise Field Technology

This paper is extracted from <http://www.icswebsite.com/s-whatsnew.htm>

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27.1. HISTORY

The EMX Noise Field Technology (EMX Noise) is based upon research originated by the U.S. Army, Walter Reed Army Institute in 1986, initially performed by the Catholic University of America (CUA) in Washington D.C., and replicated by six other Universities in three different continents from 1993 to 2002.

The background for the initiative was numerous complaints from soldiers operating radar devices about different health effects. Specifically, the Army wanted to test whether the source of these effects might be the EMF fields surrounding the radar system.

The research was initially funded by the U.S. Army with a \$3.9million grant and performed by an interdisciplinary team of 15 physicists, biochemists, biologists and engineers facilitated at the Vitreous State Laboratory of the CUA.

The question addressed under this grant was: Can EMF Fields cause biological effects?

After six years of comprehensive studies the CUA published at August 15th 1991 a scientific paper, titled: " Effect of Coherence time of the applied magnetic field on ODC activity", in the scientific journal: "Biochemical and Biophysical Research Communication".

In this paper CUA introduced the preliminary result that an exposure of mouse cells (L929 murine) to a regular 60Hz electromagnetic field doubled the activity in the cells of the critical enzyme, Ornithine Decarboxylase (ODC), which is involved in DNA and cell reproduction, i.e. the EMF field was shown to cause biological effects.

The 60 Hz EMF field used in these studies is within the so called extremely low frequency field (ELF) range (0 – 1,000 Hertz), but further research done by CUA also showed that the whole spectrum up to visible light, i.e. ELF, Radio frequency (RF) (1,000 Hertz – 0.8 Ghertz) and ELF Microwave , 0.8 Ghertz – 1 Ghertz) cause the same effects and responds equally to the EMX Noise field technology.

These findings were later replicated by the CUA thousands of times on chicken embryos still showing a doubling in the activity of ODC and a similar and possible linked increase in abnormalities in the spinal cord (so called: spina bifida).

The results were scientifically significant enough to convince the scientists at CUA, that regular (constant) 60 Hz EMF fields used in the experiments were "bioeffective". i.e., able to cause biological effects in living cells.

The answer to the question, whether EMF Fields could cause biological effects was therefore: yes.

Later in 1992 the US Army's Walter Reed Institute stated to the U.S. Patent Authorities that the scientific work at the CUA was valid and would have lasting significance.

27.2. THE EMX NOISE FIELD TECHNOLOGY IS BORN

More important still, the scientists at the CUA discovered during their studies that the increase in ODC activity did NOT occur if they made the exposing field vary randomly between 55Hz to 65Hz at intervals of less than one second.

In every single case the tested random field, contrary to the regular field, provoked no cell response at all and appeared to be non-bioeffective.

To document this new experience and to develop the scientific findings into a possible protective device, CUA established a comprehensive research program for the following years.

In one research program, the scientists at CUA exposed a substantial number of chicken embryos and mouse cells to different random fields with exactly the same results. The random fields were without exception not bioeffective and the regular field had no impact on the cells as long as the cell's exposure to the field was less than one second.

In 1993 the CUA scientists published these results in three papers in the scientific journal: "Electricity and Magnetism in Biology and Medicine".

In one of these papers titled: "Superposition of a temporally incoherent magnetic field suppresses the change in ODC activity in developing chick embryos induced by a 60 Hz sinusoidal field", the scientists drew the further logical conclusion, based upon sound physics, that by superimposing a random EMF field on the constant, bioeffective field, the total of the two fields should be random and

therefore not bioeffective.

Their experimental results confirmed this statement; the first step of the development of the EMX Noise Field Technology had now been taken.

Based upon these initial findings several studies, peer reviewed and published by the CUA in scientific journals and sponsored by EMX Corporation, were completed during the following nine years, all showing that by superimposing the random EMX Noise on the bioeffective field the combined field became neutral and not biologically effective.

The scientific findings were afterwards accepted by the US Patent Authorities, which issued five patents in the period from Sept. 1995 to Sept 2002. Patent applications are pending in Europe and Asia.

27.3. EXTERNAL REPLICATION OF THE EMX NOISE FIELD TECHNOLOGY

In the same period, these scientific findings by the CUA were replicated by six other leading Universities in USA, Europe and Asia, in the most comprehensive replication program ever undertaken in the field of bioelectromagnetism:

Columbia University, New York, USA Professor Reba Goodman. Department of Pathology, College of Physicians and Surgeons. Sponsored by the Office of Naval Research, US Department of Energy and NIEHS. *EMF-enhanced gene expression (oncogenes, stress genes, household genes), EMF-induced stress response, EMF-induced suppression of neurotransmitter dopamine.*

University of Washington, USA, Dr. Henry Lai. Bioelectromagnetics Research Laboratory and Professor Baoming Wang. Department of Biomedical Engineering. Tianjin Medical University, China. Sponsored by EMX Corporation. *EMF induced memory loss in rats and DNA strand breaks in rat brain cells.*

University of Western Ontario, Canada, Professor A.H. Martin. Department of Anatomy. Department of Biochemistry, Victoria Hospital. Sponsored by Health and Safety Agency, Ontario, Canada. *EMF induced changes in enzyme nucleotidase levels in chick embryo brain cells.*

University of Aarhus, Denmark. Professor Sianette Kwee, Institute of Medical Biochemistry. Sponsored by Danfoss A/S Denmark. *EMF accelerated cell proliferation rate in human amnion cells.*

University of Aalborg, Denmark. Professor P. Raskmark, Institute of Communication Technology. Sponsored by Danfoss A/S Denmark. *EMF accelerated cell proliferation rate in human amnion cells.*

Zhejiang University, Hangzhou, China. Professor H. Chiang et al., Bioelectromagnetics Laboratory. Sponsored by EMX Corporation. *EMF induced suppression of the gap-junctional intercellular communication and enhancement in SAPK Phosphorylation activity.*

Furthermore, Colorado State University, Burch et Al. 1998, Published in *Scandinavian Journal of Work, Environment and Health* a scientific paper about EMF exposures influence on the level of the important hormone melatonin showing that in utility workers the melatonin reduction due to the occupational exposure to EMF in the environment was dependant on the temporal stability of the field. The more constant the EMF properties, the larger the induced reduction in melatonin levels. A finding confirming the theory behind the EMX Noise Field technology on living human beings.

27.4. IN THE REPLICATION PROGRAMME THE TECHNOLOGY WAS TESTED ON THE FOLLOWING BIOLOGICAL SYSTEM AND SUBSTANCES

Human Lymphoma cells: Catholic University, Washington

Impact of exposure to EMF field: Significant increase in activity of ODC. (Marker for growth and cancer –potential increased cancer risk).

Impact of superimposing the EMX Noise field: No increase in ODC activity.

Human Leukemia cells: Columbia University, New York

Impact of exposure to EMF field: Over-expression of cancer related gene, c-myc proto-oncogenes. (potential increased cancer risk)

Impact of superimposing the EMX Noise field: No EMF response from c-myc proto-oncogenes.

Human breast cancer cells: Columbia University, New York

Impact of exposure to EMF field: Onset of HSP90 stress protein production. (potential increased cancer risk)

Impact of superimposing the EMX Noise field: No increase in HSP90 production.

Human Epithelial amnion cells: Aalborg and Aarhus Universities

Impact of exposure to EMF field: Increased cell proliferation rate. (potential increased cancer risk).

Impact of superimposing the EMX Noise field: No increase in cell proliferation rate.

PC-12 cells: Columbia University, New York

Impact of exposure to EMF field: Decrease in the level of Neurotransmitter Dopamine. (potential increased risk for Parkinson's Disease).

Impact of superimposing the EMX Noise field: No decrease in Dopamine level.

Mouse cells (murine L929 fibroblasts): Catholic University, Washington

Impact of exposure to EMF field: Enhancement of ODC enzyme activity, involving DNA replication (marker for growth and cancer - potential increased cancer risk).

Impact of superimposing the EMX Noise field: No increase in ODC activity.

Zhejiang University, Hangzhou, China:

Impact of exposure to EMF field: Significant inhibition of gap-junction intercellular communication. (Potential cancer promoter).

Impact of superimposing the EMX Noise field: No inhibition of intercellular communication.

Chicken embryos

Chicken embryos: Catholic University, Washington, D.C.

Impact of exposure to EMF field: Two-fold increase in ODC enzyme activity and truncal abnormality ratio. (Spinal cord and brain deformation).

Impact of superimposing the EMX Noise field: No Increase in ODC activity or incidence of truncal abnormality

Catholic University, Washington, D.C.

Impact of exposure to EMF field: Significant decline in HSP70, heat shock protein, and Csytoprotection. (Potential cancer promoter).

Impact of superimposing the EMX Noise field: No increase in HSP70.

University of Western Ontario, Ontario, Canada

Impact of exposure to EMF field: Suppression of activity of Nucleotidase-enzyme related to DNA production. (involved in the development of the central nervous system).

Impact of superimposing the EMX Noise field: No suppression of enzyme activity.

Rat's Brain cells: University of Washington, Washington State

Impact of exposure to EMF field: Significant deficit in learning. Short term memory loss.

Impact of superimposing the EMX Noise field: No learning deficit or memory loss.

University of Washington, Washington State.

Impact of exposure to EMF field: Significant increase in the level of DNA single and double strand breaks. (Potential cancer promoter).

Impact of superimposing the EMX Noise field: No increase in DNA breakage.

Hamster Lung CHL cells: Zhejiang University, Hangzhou, China:

Impact of exposure to EMF field: Significant increase in level of Stress-activated protein kinase SAPK Phosphorylation. (Potential increased cancer risk).

Impact of superimposing the EMX Noise field: No increase in SAPK phosphorylation.

All seventeen studies showed biological effects from exposure to EMF fields and all documented the ability of EMX noise field to neutralize the effects on the tested biological systems and cell substances.

27.5. THE PHYSICAL BASIS FOR THE EMX TECHNOLOGY

The physical ability of an EMF field to establish biological effects ("bioeffects") in living cells and tissues is based on three different elements, the Energy, the Intensity and the Structure. If one of these components actually can cause changes in the cellular system, the field is considered bioeffective.

The fourth dimension, the length of the exposure or the accumulated exposure over time is decisive for whether the biological effects are beneficial, neutral or adverse to the biological system. It is a matter of doses.

Studies have shown, that short term or few times exposure (up to half an hour in a couple of days) to EMF actually can stimulate the defense system of the cells and thereby constitute a beneficial effect, a principle known from hospital magnetotherapy.

On the other hand if the exposure is long term or repetitive (which is mostly the case in the use of electric equipment and cell phones) this effect might change from beneficial via neutral to adverse to the cellular system.

Thus as the three components: energy, intensity and structure are the key to whether biological effects occur or not, the time of the exposure is the decisive factor to whether the effects are adverse or not.

a) Energy: The element of the EMF field, which can promote the biological effect via direct cell damage.

The power of EMF fields carrying high energy (number of photons higher than visible light) can cause biological effects directly by breaking chemical bonds and damaging the cells, in which case the field is called ionizing.

Below visible light the fields carry a lower number of photons and thereby do not contain power enough to damage, in which case the fields are called non-ionizing; (Fields from electric household and office appliances and Cell Phones are such non-ionizing fields).

b) Intensity: The element of the EMF field, which can promote the biological effect via thermal

damage.

EMF fields carrying a high intensity (number of waves) above 10 watts/kg SAR (Standard Absorption rate) can heat up and ultimately damage the cell by directly raising its temperature. This is the case inside a microwave oven dedicated to cooking tissues.

Most countries have set standards for the approved exposure of human beings to 2 watts/kg SAR, significantly below the 10 watts heating threshold. China has recently

lowered the standard to 1 watt/kg SAR, which should bring the exposure out of the potential heating range.

If the fields carry a low intensity below 10 watts/kg SAR and thereby not enough power to heat tissues it is called: non-thermal.

(Fields from electric household and office appliances and Cell Phones are all non-ionizing and non-thermal).

c) Structure: The element of the EMF field, which can promote all other biological effects than direct damage by energy and damage by heating.

EMF fields structured with a constant frequency, amplitude and waveform can cause biological effects even if the SAR intensity is lower than 10watts/kg and even though the intensity is too low to create any significant rise in temperature (probably only a millionth of a degree) in the exposed tissue. These fields are considered nonthermal, and it is the structure of these fields, which makes the field biologically active, without any heating involved. (Fields from electric household and office appliances and Cell Phones are non-ionizing, non-thermal and constant in pattern).

According to the laws of physics and biology, the structure of the EMF fields (frequency, amplitude and waveform) needs to be constant not only in time (intervals) but also in space (covering the exposed cells across the entire surface) in order for the field to act like a (digital information) signal, able to communicate and interact with the cellular system.

One of the important papers demonstrating that a non-ionizing, nonthermal and constant EMF field carrying low energy and low intensity still can create biological effects is: Professor Reba Goodman et al. "Electromagnetic field exposure induces rapid, transitory heat shock factor activation in human cells", 1997.

If the EMF field structure has no regular pattern or signal it is considered noise and not bioeffective; only if the structure is patterned in a constant way is the field able to trigger biological effects in the cell.

Thus the constant signal structure is the trigger of the nonthermal biological effects just as energy is the trigger of direct cell damage and intensity is the trigger of the heating-related effects on the cell.

27.6. THE BIOLOGICAL BASIS FOR THE TECHNOLOGY

As demonstrated, the non-ionizing, non-thermal EMF field carrying a constant signal is capable in transmitting a message into the cellular system of animals and human beings.

This signal is characterized as a warning message informing the cellular system about the EMF exposure, just as if it was exposed to a real threat such as potential damage due to ionizing radioactivity, x-ray, overheating, toxic chemicals, bacterial attacks etc.

Despite the fact that the nonthermal EMF field lacks the energy and intensity to harm the cellular system directly, the response on the biological level to this false alarm is still triggered, which undesirably can exhaust the cell's defense system and makes it vulnerable to real attacks.

However, a condition for triggering the cell's response is that the constancy of the EMF field is at least one second, as it takes that amount of time for the cellular system in humans and animals to respond to the exposures. Where the constancy of the EMF field exceeds one second, the EMF signal is able triggers the sensors in the cell membranes, and thereby transmit the warning message into the cellular system, triggering a cascade of events in the cellular biological system.

Strong evidence for this sequence of events is provided by at least 50 studies showing that EMF exposure triggers the sensors at the cell membrane level. These studies are addressed in a 1996 paper, published by professor W.R. Adey and titled: "A growing scientific consensus on the cell and molecular biology mediating interactions with environmental electromagnetic fields".

Furthermore research supporting the that EMF fields, by triggering the sensors in the cell membrane, actually can cause the activation of messenger enzymes like Tyrosine Kinase, has been published in different scientific papers, where the most important ones are three studies published by Loscher et al. in 1998, Harvey et al. in 1999, and Dibirdik et al in 1998.

As demonstrated the responding sensors transmit the warning message through the messenger enzymes in the cell to the nucleus, which hereafter in self-defense activates a variety of biological effects in the cell metabolism, such as changes in the activities of the genes, hormones, enzymes and proteins, all putting the cell in a stress mode designed to protect the cell against interference from the environment.

The leading studies confirming this are: Lin et al. 1995, 1997, Goodman et al. 1998 and Trosko et al. 2000.

This mechanism, is the natures emergency procedure and should be beneficial or protective, which seems to be the case at shorter exposures.

However, if the exposure is repetitive for a longer accumulating period, generally being the case at EMF exposure, it can establish an almost permanent red alert state, which can involve an exhaustion of the cellular repair system, a condition that in the end can

suppress the production of the some of the most important repair enzymes and stress proteins and thereby down regulate their ability to function.

This down regulation of the cellular repair system is a serious condition, as the cells continually need to maintain efficient repair of their different bio-molecules (among them the DNA molecule) constantly being bombarded and damaged (unfolded) by free radicals and other reactive species.

If the repair enzymes are stressed and thereby unable to repair (fold) the DNA molecules, the ultimate repair tool, the stress proteins, should be activated making the enzymes functional again.

Yet, if the stress protein are exhausted too due to repetitive exposure to the EMF field, this process will not be activated and the molecules will remain non-repaired.

In case of non-repaired DNA molecules, the dysfunctional molecule can either die or transform itself into an abnormal molecule with damaged chromosomes, a so called: micronuclei, in both cases constituting a possible health effects, such as cancer, Alzheimer's and Parkinson's diseases.

If the abnormalities appears in the brain, cancer is most likely to happen in the areas, where the cells have the ability to multiply whereas the areas where the cells cannot reproduce Alzheimer's disease is a possible effect.

Several studies among them two studies done by the Catholic University demonstrate this down regulation as a consequence of repeated EMF exposure: DiCarlo et al., Bioelectromagnetics circulation, 1999, "Myocardial protections conferred by electromagnetic fields" and DiCarlo et al. Bioelectrochemistry, "Electromagnetic field-induced protection of chick embryos against hypoxia exhibits characteristics of temporal sensing".

As shown non-ionizing, nonthermal EMF Fields are not able to damage the cellular system directly due to lack of sufficient energy or intensity, but the self created stress mode (down regulation) creates the only risk involved in the exposure to these powerless EMF field. It is the response to the exposure inside the cell system itself, which causes the biological effects and not the exposure as such.

However, because of the reaction mechanism in the cellular system, no matter the length of the exposure a certain constancy in the pattern of the field is still needed before the exposure of the sensors actually results in an effective message, detectable in a responsive form by the nucleus.

The studies involved and general biological knowledge documents the fact, that it takes a second for the cellular defense system to respond to an exposure from the surrounding environment.

By cutting the exposure of the sensors into fragments of less than a second, the warning system is in consequence interrupted and the exposure is neutralized. The defense system is untouched and no biological effects can possibly occur.

This is exactly what the EMX Noise Field Technology does.

27.7. THE EMX TECHNOLOGY IN A NUTSHELL

The EMX Noise Field is effectively cutting the EMF Field in fragments smaller than a second, which interrupts the membrane sensor's ability to send a responsive warning signal to the nucleus.

By superimposing the EMX Noise Field on the bioeffective EMF field, the sensors detect only a randomized signal that is the sum of the two fields. This process results in the warning system being neutralized, the cell not responding and a consequent absence of biological effects. This is the basic principle of the EMX Technology.

Since no health effects can occur without an initial biological change, the EMX Noise Field Technology effectively eliminates any health effects that might arise from exposure to regular EMF fields.

27.8. THE EMF ISSUE

Due to the level of understanding of the EMF issue the discussion and the scientific efforts should at this point of time focus on the potential link between the recognized biological effects and the possible resulting health effects or rather the risk for health effects tied to the biological effects.

It is the opinion of EMX Corporation, that it is shown beyond reasonable doubt in numerous laboratory studies that biological effects can occur due to exposure to EMF fields and these biological effects may be a risk factor for serious health effects.

Since a biological effect is the first step in the chain which could lead to health effects and thereby an absolutely necessary requirement for a health effect to occur, EMX Corporation has designed the EMX Noise Field Technology to eliminate or block the effects from EMF fields on the biological level in order at the same time to protect against the possible risk for health effects.

If the biological effects are eliminated, the risk of health effects is also eliminated.

27.9. STUDIES SUGGESTING A LINK BETWEEN EMF EXPOSURE AND HEALTH EFFECTS

It is a well known fact that the EMF issue is still surrounded by controversy. Anyway a substantial number of epidemiological studies and scientific publications shows a possible link between EMF exposure and biological and health effects.

More than fifty epidemiological studies:

Although the link between the recognized biological effects and the health effects is not scientifically proven yet, more than fifty important epidemiological studies suggest that EMF exposure is associated with an increased risk of diseases, most commonly Cancer, Alzheimer's and Parkinson's disease.

A considerable number of laboratory studies:

Also a considerable number of significant laboratory studies from universities and laboratories around the world show health effects due to EMF exposure.

The most prominent is the Royal Adelaide Hospital study in Australia, funded by Telstra, showing a doubling of tumors in EMF exposed mice and the paper published in 1966 by D. Jacobson from George Washington University showing chromosomal damage among 34 exposed employees at the US Embassy in Moscow.

Even research done by the Cell Phone Industry Association in US, found a link between EMF exposure and cancer. Dr. George Carlo: *Cell Phones – invisible hazards in the wireless Age*.

Controversy:

However other studies show no effects at all, so the discussion is still ongoing and it is not possible based upon the existing epidemiological and laboratory studies alone to make a clear, unconditional statement about the health issue at this point in time.

But since the majority of epidemiological and laboratory studies suggest a link between EMF exposure and Health effects, the only prudent response to the issue is to be careful and take whatever precaution is available to protect against the potential risk. Otherwise the explanation of the phenomenon and the final proof might be too late.

27.10. FURTHER DOCUMENTATION FOR EMF FIELDS CAUSING BIOLOGICAL EFFECTS

Besides the above listed biological effect tested with the EMX noise field, numerous studies, independent of the EMX research program, demonstrate significant biological effects caused by EMF fields such as:

Chromosomal damage in human blood cells. Maes et al., 1993, Nordenson et al., 1994 and 1996.

Chromosomal damage (micronuclei) in human cells. Dr. George Carlo, 2000, Maes et al., 1993, Garaj-Vhrovac et al., 1992.

Increased DNA strand breaks in animal and human cells. Dr. Lai et al., 1995, 1996, and 1997. Philips et al. 1998.

Changes in Gene expression in human cells. Professor Reba Goodman et al. 1995, 1997 and 1998. Tsurita et al., 1999. Harvey et al., 1999.

Change in Cell differentiation in human blood cells. Trosko et al., 2000.

Change in Melatonin metabolism in electric utility workers. Burch et al., 1998.

Change in cellular repair mechanism. DiCarlo et al., Lin et al., 1997. Professor Goodmann et al., 1998. Tsurita et al., 1999.

These studies, along with those mentioned above, provide compelling evidence that biological effects can occur due to exposure to EMF fields.

27.11. PUBLIC STATEMENTS ABOUT POSSIBLE BIOLOGICAL AND HEALTH EFFECTS

Based upon the existing epidemiological and laboratory studies the following public statements have been made to guide the users of electric equipment.

The Vienna Resolution: In 1968, at a scientific conference on biological and health effects of EMF exposure from cellular phones at the University of Vienna, the following resolution was adopted: "The participants agreed that biological effects from low-intensity exposures are scientifically established."

Sweden's National Board of Industrial and Technical Development: (Date?) "We will proceed on the assumption that there is a connection between exposure to lower frequency magnetic fields and cancer, in particular, childhood cancer."

European Parliament Resolution 1992: "...according to an increasing number of epidemiological and experimental studies, even slight exposure to non-ionizing electromagnetic fields increases the risk of cancer..."

U.S. National Institute of Environmental Health Sciences (NIEHS), 1997: The vast majority of the members of the advisory panel voted for the following conclusion: "Extremely low frequency electromagnetic fields should be regarded as possible carcinogens."

Wireless Technology Research (an independent group funded by the cell phone industry), Dr. George Carlo, former chairman: "WTR has found links between cellular phone use and cancer."

Department of the Army, Walter Reed Institute of Research, Colonel Edward C. Elson, 1992:

"As a major user of radio frequency and extremely low frequency energy in the field, the Army is closely following the epidemiological studies on health and the laboratory investigations, especially that of The Catholic University of America group, as the evidence accumulates, the Army will consider application of the Litovitz technique of ameliorating possible adverse effects of electromagnetic energy. I and others monitoring the research are persuaded that the phenomena described are valid and that the work will have lasting significance."

27.11. SPECIFICS ABOUT THE CELLULAR PHONE

The cell phone emits two EMF fields, one from the antenna related to the transmission, which is a microwave (continuous from Analog and CDMA phones and ELF-modulated from GSM and TDMA phones) and one from the two circuits inside the handset, which is an ELF field. Both type of fields can as verified above be neutralized by the EMX Noise Field Technology.

27.12. CONCLUSION

It is demonstrated in the majority of published scientific studies, that nonthermal EMF fields in the ELF, RF and microwave frequency area can cause biological effects, which can be, but not necessarily are, harmful to the exposed human or animal cellular system.

The biological effects recognized in the research program around the EMX Noise Field Technology are all first steps in a possible adverse development in the cellular system involved.

Some of the effects are acknowledged promoters of cancer, Parkinson's and Alzheimer's diseases.

However it is not proven at this stage, that the first step actually results in a disease further down the line and it is still to be found whether the self defense system ultimately manages to stop the development before the changes in the cellular system trigger the disease.

It will probably take another decade before the final answer can be given to the link between EMF exposure and diseases, but at that point it might be too late.

For a prudent participant in this area, however, the fact that EMF Fields can cause fundamental biological effects should lead to a consideration of whatever precautions are available and the EMX Noise field Technology is the only scientifically documented precaution related to the EMF issue.

