International Institute for Bau-biologie® & Ecology

IBE 204.9

IBE 204.9 Cellphones: Unhealthy at any Speed

BRINGING TOGETHER TECHNOLOGY AND DESIGN METHODS TO PROVIDE THE INFORMATION NEEDED TO CREATE HEALTHY HOMES AND WORKPLACES

Cell Phones: Unhealthy at Any Speed™ – IBE 204.9

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Lesson 1 – Cell Phones and Health

Research conclusions and opinions about the effects of exposure to such pollution vary depending on who funded the study. Independent studies conclude that exposure to Information Carrying Radio Waves (*ICRW)* pollution also called digital communications pollution is more detrimental to living organisms than exposure to *Analog* (non-digital) signals from older wireless systems such as AM and FM radio, citizens band radio, microwave telephone links.

It is important to note that digital wireless radiation is emitted by a host of electronic devices NOT JUST CELL PHONES. These devices include the new smart meter now being installed by utilities, wireless Internet connections, cordless phones, some wireless games, TV digital media receivers and bluetooth devices.

The ICRW exposures of concern now are: 1) direct exposure from use of a cell phone or a cordless phone due to high power density and heating effects (eye and brain health) and 2) indirect exposure to low energy density, ambient cell antenna radiation and the ambient radiation of all other digital wireless products (akin to second hand smoke). This radiation, now pervasive, is like a fine mesh blanket surround all urban centers and interstate highway corridors, and, of course, the inside of most homes.

The latest information on what happens (detailed further on in the lessons) indicates that cell vibratory receptor proteins sense, but do not recognize ICRW and interpret them as a threat. Sensing occurs within milliseconds of exposure, interpretation as a threat in seconds and in about 30 seconds the response is cell membrane compression. Compression interferes with or stops transport of nutrition in and waste out of cells. A cascade effect follows, impairing intercellular communication and, hence, organ function. This effect is reversible so long as the affected cell is still alive. However, long-term exposure causes cell death due to the build-up of injurious free radicals in the cells. When a cell dies and is past 50% of its life expectancy, the new daughter cell has a permanently compressed membrane. It takes 18 months for this defective cell to be replaced with a 'good' cell assuming freedom from the ICRW radiations. (Lecture by Dr. George Carlo, MD, PhD, IBE Conference, Nashville, 2008).

The *German Environmental Physician Initiative* in a letter of July 2008 states that "Even a radiation dose of 1000 to 5000 $\mu W/m^2$ breaks the blood-brain barrier, which causes the entry of water, dissolving metabolism waste products, environmental toxins and blood proteins (especially albumins) into the central nervous system. The fatal consequences are: miniature edemas occur in the brain, multiple selective swellings in non-renewable brain cells are irretrievably squeezed to death. They occur as dark neurons in a microscopic picture. Those dark neurons are proven to be the possible starting point of very serious neurodegenerative diseases like multiple sclerosis, Parkinson's disease, Alzheimer's disease, senile dementia and so on." Full text at:

http://books.google.com/books?id=SolvQ5XRFxwC&pg=PT381&lpg=PT381&dq=german+environmental+physician+initiative+on+wireless+lan&source=bl&ots=V9w7Tg1zZF&sig=Aitd0I_WwVDVRtzakYbNRKLGAIg&hl=en&sa=X&ei=TXxaT5LrBoWGiQL6oeHQCw&sqi=2&ved=0CB4Q6AEwAA#v=onepage&q=german%20environmental%20physician%20initiative%20on%20wireless%20lan&f=false

The American Academy of Environmental Medicine released a letter on Jan 25, 2012 to the Public Utilities Commission of California speaking to wireless radiation. The most important passage is this: "Chronic exposure to wireless radio frequency radiation is a preventable environmental hazard that is sufficiently well documented to warrant immediate preventative public health action." Full Text at: http://aaemonline.org/images/CaliforniaPublicUtilitiesCommission.pdf

Specialist MDs working with people exhibiting motor neuron disease (like Alzheimer's) are now convinced that digital pollution accelerates brain deterioration by destruction of brain synapses. Work with autistic children indicates that cell membrane transport impairment compromises the ability to remove cellular toxins hindering the ability to reverse the symptoms of Autism.

Lesson 2 – Government Protection, Cell Network Growth

While it is understandable that corporations will not have your best interests in mind if you or your health comes in the way of profits, the absence of government oversight is not so easily dismissed. You might be thinking “surely there is government regulation protecting us.” If the hazards of cell phones were actually established, surely the government would step in and take care of the problem, wouldn't it?

Unfortunately, this is not the case. More and more over the past few decades, government regulatory agencies have become financially entangled with the businesses they are supposedly overseeing. Some agencies, like the FDA and FCC are, in fact, partially funded by the very businesses they are in charge of regulating. The conflicts of interest are rampant and are written about so often in the popular press that most consumers have become immune to the implications - this breach of public trust by the regulatory authorities has a direct impact on your well-being. It is highly unlikely that regulators are going to shut down their funding source.

Changing the Trend

It took twenty years after modern cell phones hit the market before a billion of them were in use, in 2004. But after that, it only took eighteen months to reach the second billion. Nine months later, three billion were in use, and only six months after that there were four billion cell phones.

The world is already showing the early signs of an epidemic of brain cancer - an epidemic that is expected by some scientists to grow to 500,000 cases in 2010 and over one million cases in the U.S. alone in 2015. Those who avoid the tragedy of brain cancer may find themselves battling other health problems both major and minor, such as headaches and dizziness, Alzheimer's disease, autism and even impotence. But this is a future that is preventable and you can help by protecting yourself, and your family. If enough people demand change, and act to make change, then change will happen. It is the only way it ever does.

Lesson 3 – Scientific Research

Radiation devices

The cell phone industry once claimed there were thousands of studies showing safety. Well, to be completely fair, there were "thousands of studies", but they were about microwave ovens. So, some in the cell phone industry tried to claim that since microwave ovens had been extensively safety tested, cell phones must be safe too. Microwave ovens and cell phones use radiation in similar, although not identical, frequency ranges. However, oven radiation is not digitized or modulated as is cell phone radiation. And of course, the microwave oven is not held next to your head. Additionally, it is also carefully shielded to prevent the oven from broadcasting their obviously dangerous form of electromagnetic radiation. Perhaps this was not the best comparison to make in terms of a safety claim for a cell phone.

In 1993, only a grand total of eight studies had ever looked at electromagnetic radiation in the range of frequencies and power used by cell phones. Most of these eight studies were not even live animal research - they were performed on cells in petri dishes or test tubes. And all of them had serious design flaws that rendered their conclusions, whether they showed possible dangers or not, highly questionable.

The media began to cry foul on the lack of studies on the health effects. Congressional hearings were held on the issue, and it became rapidly obvious that there was no pre-market testing, no studies relating to the safety of cellular phones, no FDA or EPA oversight, and millions of people using devices whose possible hazards were completely unknown.

At that point the Wireless Trade Association (WTA, an industry trade association for cell phone carriers) and the Cellular Telephone Industry Association (CTIA) came up with an idea that they hoped would diminish the media firestorm. They proposed that the cell phone industry itself spend 15 to 25 million dollars

conducting a massive research project investigating cell phone safety. The FDA and the industry agreed. The Wireless Technology Research group was formed.

This group of researchers was head by Dr. George Carlo. The result of all their work contradicted industry claims of safety. Brain cancer was three times more prevalent in heavy cell phone users. Non-malignant tumors of the auditory nerve and chromosome damage were more probable.

Meanwhile, a few other researchers had begun to find potentially troubling results. Dr. Henry Lai and Dr. N. P. Singh, during a series of experiments meant to test the biological effects of power-line exposure, had found that radiation in the cell phone range could cause DNA damage in human blood cells.[1] This was the first real scientific evidence that cell phones might be dangerous indeed. But the test they were using to determine genetic damage was at the time very new and experimental, and its reliability unknown, so their study did not raise immediate alarm.

In Sweden, Dr. Leif Salford was looking at the effects of microwaves on brain function. His findings seemed to show that the blood-brain barrier, which protects the brain from being penetrated by harmful chemicals, could break down when exposed to cellular phone-like radiation.[2] This was a potentially serious problem as it could provide a pathway for dangerous chemicals to damage brain tissue, which could have effects ranging from brain damage to cancer. But again, Dr. Salford was using new techniques of unknown reliability, and could only track the radiation exposure of the rats he was testing in very broad and imprecise ways.

Research confirming Cell Phone Dangers

In the late 1990s, a number of troubling studies about cell phones began to be released. The first came in 1997, when an Australian researcher named Dr. Michael Repacholi published the first scientific evidence that cell phones could cause cancer.[3] He reported that long-term exposure to the type of radiation that comes from digital cell phones caused an increase in the occurrence of lymphoma in mice. Mice that were exposed to radiation were almost two and a half times more likely to develop lymphoma than mice that were not so exposed. While extremely worrisome, many scientists still questioned whether the results seen in mice would also apply to humans.

In early 1998, Dr. Kjell Hansson Mild, a Swedish scientist, reported that as people increased their use of cell phones, they also experienced a corresponding increase in headaches and fatigue.[4] Dr. Mild began the research when government employees in Stockholm reported an unusual number of headaches when they switched to using digital cell phones. The study looked at more than 15,000 people, and showed as much as a 600 percent increase in dizziness, headaches, and discomfort as cell phone usage increased from two minutes or less each day to an hour or more each day. Leakage in the blood brain barrier was cited as a possible mechanism causing the symptoms.

First, a study using their new exposure system produced an alarming finding - cell phone radiation did indeed cause genetic changes in human blood cells.[5] Dr. Ray Tice and Dr. Graham Hook, of the Integrated Laboratory Systems in North Carolina, had conducted a study for Carlo's group intended to further investigate the early DNA damage findings of Dr. Lai and Dr. Singh. Tice and Hook were looking for evi-

[1] H. Lai and N. P. Singh, "Acute exposure to a 60 Hz magnetic field increases DNA strand breaks in rat brain cells," Bioelectromagnetics 18 (2) (1997): 156-165.
[2] L. G. Salford, A. E. Brun, K. Sturesson, J. L. Eberhardt, L. and B. R. Persson, "Permeability of the blood-brain barrier induced by 915 MHz electromagnetic radiation, continuous wave and modulated at 8, 16, 50, and 200 Hz," Microscopy Research and Technique 27 (6) (1994): 535-542.
[3] M. Repacholi, "Low-level exposure to radiofrequency electromagnetic fields: health effects and research needs,"Bioelectromagnetics 19 (1) (1998): 1-19.
[4] M. Sandström, J. Wilen, G. Oftedal, and K. Mild, "Mobile phone use and subjective symptoms: Comparison of symptoms experienced by users of analogue and digital mobile phones," Occupational Medicine (London) 51 (1) (2001): 25-35.
[5] R. R. Tice, G. G. Hook, M. Donner, D. I. McRee, and A. W. Guy, "Genotoxicity of radiofrequency signals: Investigation of DNA damage and micronuclei induction in cultured human blood cells," Bioelectromagnetics 23 (2) (2002): 113-126.

dence of damaged DNA in the form of fragments of chromosomes that had broken off and formed membranes around themselves. The relationship between cancer and these fragments, called micronuclei, are so strong that doctors around the world use them to test to see if patients are likely to develop cancer.

Their preliminary results showed a nearly three hundred percent increase in the incidence of genetic damage when human blood cells were exposed to radiation in the cellular frequency band.

Tice and Hook immediately re-did the study with tighter controls, to see if the preliminary results were still apparent. The genetic damage still showed up. The results were confirmed.

And still more research …

Soon after, results began coming in from epidemiological studies that others in the group had been conducting. One showed a significant increase in cell phone users' risk of rare brain tumors at the brain's outer edge, on whichever side the cell phone was held most often.[6] Cell phone users were almost two and a half times more likely to develop these neuro-epithelial tumors.

Another epidemiological study looked at acoustic neuromas, a rare noncancerous tumor affecting the nerve that controls hearing. The research showed a 60 percent greater chance of acoustic neuromas for people who had used cell phones for six years or more. The longer they used a cell phone, the greater their risk.[7]

A third study, looking at more than 285,000 cell phone users, found a higher rate of brain cancer deaths among handheld mobile phone users, who hold the antenna next to their heads, than among car phone users, where the antenna is further away.[8] This study looked at all causes of death, and additionally found that there was an increase in deaths as result of motor vehicle accidents among users of both handheld phones and car phones - the rate of fatal traffic accidents was two and a half times greater for those who used their cell phones more than three minutes each day, when compared to those who used it for less than one minute each day.

Lesson 4 – EMR Basics

EMR Radiation Climate

Cell phones, like radios, operate by using radio waves, which are a form of electromagnetic radiation. But what is electromagnetic radiation? What exactly are radio waves? An understanding of the very powerful forces used by cell phones is crucial if you want know how and why they are affecting your body and health.

Various types of electromagnetic radiation (EMR) sustain life on earth. In nature, the quantity and quality of the many different electromagnetic energies surrounding us and flowing through us, follow a very distinct pattern. It all starts with the sun. Though the sun gives off energy throughout the entire electromagnetic spectrum, the protective layers of the earth's atmosphere are very selective about which "light" to let in and which "light" to keep out.

Underneath these atmospheric covers, the earth itself also gives off various types of electromagnetic energies. Wrapped in the fold of its own magnetic field, the earth keeps a more or less steady beat essential to the rhythm of life.

In the course of evolution, all living organisms have adapted themselves to this unique radiation climate prevalent on planet earth. This natural balance is being threatened now because over the last 100 years

[6] G. Carlo and R. Jenrow, "Scientific Progress - Wireless Phones and Brain Cancer: Current State of the Science," Medscape General Medicine 2 (2) (2000).
[7] Ibid.
[8] Ibid.

humans have been very busy adding their own versions of electromagnetic energies without giving due considerations to the biological implications.

Biological effects

In science, the damaging (toxic) effects of high-energy or so-called ionizing radiation such as radiation in the form of X-rays, gamma rays and particle radiation as well as ultraviolet radiation (UV) are rather well understood, even at very low dosages. However, non-ionizing types of electromagnetic radiation such as radar radiation, radio frequency radiation (RF), laser rays as well as extremely low frequency (ELF) from power radiation and static electric and magnetic fields can also have detrimental biological effects at amazingly low exposure levels.

This holds especially true for situations where low exposure levels are combined with long periods of exposure, that is, chronic exposure. Though this mechanism is very poorly understood, highly industrialized countries keep producing more and more emitters of non-ionizing radiation (e.g. cellular phones, cordless phones, children's games, digital TV, home electronics, smart meters). This new kind of pollution is referred to as "electromagnetic radiation (EMR)" or "electromagnetic pollution (smog)".

Our daily dosage of electromagnetic radiation continues increase - due to natural as well as human-made sources. Natural sources include, for example, increasing amounts of UV radiation because the protective ozone layer in the stratosphere continues to be depleted. We also expose ourselves to more high-energy radiation or radioactivity from natural (e.g. high-altitude air travel) as well as human-made sources (medical X-ray exams). And in our everyday living environment, we expand our usage of wireless communication (microwaves), entertainment (radio waves), electricity (power frequency), synthetic materials (static electricity) and magnetized metals (static magnetism). Since modern humans spend most of their time indoors or in cars, away from the natural background radiation, they find themselves more often cut off from this life-sustaining stream of natural electromagnetic information.

In exchange, we surround ourselves with many more electronic gadgets that put out radio frequency energies as well as alternating and static electric and magnetic fields. These forms of energy rarely occur in nature. This unnatural radiation climate leads on the one hand to natural radiation deficiency and on the other hand to unnatural radiation stress. In Building Biology, we are concerned with electromagnetic radiation (EMR) under-exposure from natural sources: EMR over-exposure, particularly from human-made sources, and EMR exposures foreign to our natural settings.

Generally speaking, potential risks can be detected and assessed. In most cases the exposure level can be drastically reduced or even eliminated with comparatively little effort, and without having to sacrifice the luxury and convenience of electricity.

Basics of EMR

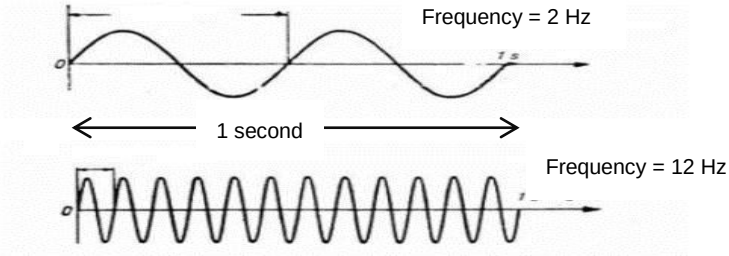
In order to understand how electromagnetic energy works and which affects the various types of radiation can have, it is necessary to familiarize yourself with such basic terminology. Therefore, we highly recommend, if you are not already fluent in this terminology, to refresh or study the basic terms in a suitable physics or basic electricity textbook. Or you can take two courses offered on the IBE web site, IBE 206.2 Electrical Home Wiring and IBE 204.3 Electromagnetics. It is far beyond the scope of this course unit to discuss the physical properties in depth.

Electromagnetic Spectrum

All matter produces electromagnetic radiation. It is given off in many different forms, which all share one fundamental property: the electric charge. The various manifestations of electromagnetic radiation differ only in frequency and wavelength.

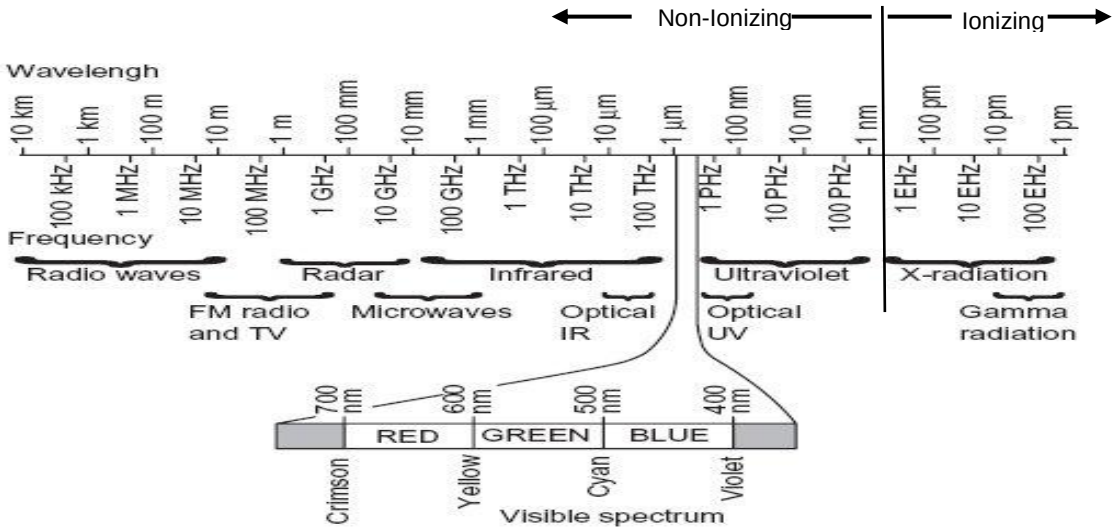
Electromagnetic radiation can either be seen as a continuous wave or as discrete particles, photons of energy beams traveling through space with the speed of light.

- Alternating wave - A magnitude crest followed by a trough, and then crests again and so on
- Frequency - the number of cycles, from one crest to the next crest, per time, usually expressed in Hertz (Hz). For example, a frequency of 60Hz means 60 cycles per second.
- Wavelength - distance from crest to crest of an alternating wave.



- EMF stands for *electromagnetic field*; it is the combination of electric and magnetic fields. These fields have active emissions that are referred to as *electromagnetic radiation (EMR)*

Electromagnetic Spectrum



Electromagnetic radiation can either be seen as a continuous wave or as discrete "particles" of energy, traveling through space with the speed of light. Electromagnetic energy acts like waves or particles (photons) depending on its frequency of vibration.

The Electromagnetic Spectrum provides a visual overview of the types of sources and some of the issues based on the frequency of vibration. The pictures show the types of sources that produce each of the types going from slow vibration at the left to high vibration on the right. The basic rule applies: the higher the frequency, the higher its energy and the shorter its wavelength. When the frequency of a given radiation becomes so high that the released energy is sufficient to form ions in matter it is passing through, we speak of ionizing radiation. All other forms of electromagnetic radiation not capable of creating such ionization processes are classified as non-ionizing radiation. Visible light belongs to the latter group and starting with ultraviolet radiation marks the borderline between those two sections along the broad electromagnetic spectrum.

Based on the place of action where the electric charges are generated and interact with the surrounding environment, the electromagnetic spectrum can be divided into four major sections. (See image: EM Spectrum) First, at low frequencies (up to 10,000,000,000Hz = 10GHz) electric charges typically are found as freely moving electrons in, for example, wires and antennas or as free moving electrons or

ions in space. They give rise to wave and beam phenomena related to power frequency fields, radio waves and microwaves. Second, at higher frequencies (up to 100,000,000,000,000Hz = 100THz) electric charges are mainly associated with the rotations and vibrations of molecules in the infrared region. Third, in the optical region visible light is given off when electrons in the atomic shell make a transition from a higher energy state to a lower one. Fourth, the most energetic (ionizing) radiation including x-rays, gamma rays and cosmic rays is generated when charges inside certain atomic nuclei are being transformed.

Lesson 5 – Radio Frequency

Radio frequency (RF) radiation starts at a frequency of about 30 thousand cycles per second (30 kHz) in the AM radio wave region and reaches up to the microwave region, ending at about 300 MHz. Radio frequency radiation is given off purposely by transmitters, but also inadvertently by electronic equipment and electrical wiring. The various frequency bands can be divided into two sections: radio waves (longwave radio, AM radio, shortwave radio, FM radio, and TV stations) as well as microwaves (radar, cellular phone communication and microwave ovens). The unit of electromagnetic waves is either given as field strength or power density.

At higher frequencies, these so-called electromagnetic waves (RF) are not bound to electrons in electrical conductors as for instance electromagnetic fields of power lines, but are free to travel wirelessly through the air. The unit of power density is watt per square meter (W/m^2) equals 1000 milliwatts per square centimeter (mW/cm^2) equals 1 million microwatts per square centimeter ($\mu W/cm^2$) equals 1 billion nanowatts per square centimeter (nW/cm^2).

Sources of RF

Common sources are thought of primarily as communication systems, but there are also microwave ovens, and many industrial applications, such as sealing of plastic. Microwave ovens are designed to have seals to keep the microwaves in; however, this assumes that the seals stay in perfect condition as they age and that nothing is accidentally between the seal and the door. And this ignores the leakage through the viewing screen in the door of the oven. There are also unintentional sources, such as light dimmers, that put out radio frequency as a side effect of its operation. Poorly maintained or faulty power distribution lines have bad connections that spark or arc creating a broad range of RF.

Radio frequency transmitters can be modulated in many different ways. For a rough orientation they can be classified into three major categories:

- Frequency Modulation (FM), e.g. FM radio or walky-talkies,
- Amplitude Modulation (AM), e.g. AM radio including short wave, medium wave and long wave stations, and
- Pulse Modulation (PM), e.g. cellular phone technologies, cordless phone systems, point-to-point microwave systems, radar.

A table of the government assigned spectrum bands within the RF portion of the electromagnetic spectrum is on the following page. You will note that as the frequency goes up the wave length goes down. The higher frequencies have very small wave lengths, hence, the name microwave.