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Mobile phone radiation and biology

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Abstract

Many people have a hard time fathoming that something that they cannot see, touch, smell, taste or hear can harm them so much. However, we are constantly immersed in a sea of Electromagnetic Radiation (EMR) and it can affect life markedly. The rapid growth rate of mobile phones, phone masts and wireless communication systems, alongside various reports of possible adverse effects on living things, has caused increased concern around the world over the potential effect of electromagnetic pollution on health and the environment. "There have been many instances of harmful effects of electromagnetic fields from such seemingly innocuous devices as mobile phones, computers, power lines and domestic wiring. They include an increased risk of cancer, loss of fertility & unpleasant physiological symptoms.....". At present, the technology is being increasingly used with almost no effective precautionary advice to the public and urgent guidance is needed in order to alert the public and especially our children about the inherent dangers of over exposure to electromagnetic radiation**.** EMR need to be identified measured and remediated to significantly reduce its sources in our environment.

Keywords: Electromagnetic Radiation; Electromagnetic pollution; Mobile phone; Health and environment.

Introduction

Radiation is energy that travels and spreads out as it goes. When all of the possible forms of radiation are classified and arranged according to wavelength or frequency, the result is the Electromagnetic Spectrum. The electromagnetic spectrum includes types of radiation that range from extremely low energy, long wavelength, and low frequency energy like Radio energy to extremely high energy, short wavelength, high frequency energy types such as x-ray and Gamma Ray radiation (Fig.1).

Radio Frequencies (RF), Electromagnetic Fields (EMF) and X-rays are all produced by electromagnetic sources, and are part of the electromagnetic spectrum. The difference between them is the frequency of their source. All electromagnetic energy falls somewhere on the electromagnetic spectrum, ranging from extremely low frequency (ELF) radiation to microwaves, x-rays and gamma rays (Fig.1). The electromagnetic (EM) spectrum is just a name that scientists give a bunch of types of radiation when they want to talk about them as a group (Jim, 2009).

It is a proven fact that at extremely high frequencies, like that of x-rays, the electromagnetic waves have enough force to damage ionic and covalent bonds and damage DNA and other human tissue. This is known as ionizing radiation. Since X-rays have the power to damage the genetic material of cells, they can lead to cancer and birth defects—which is why you wear a lead vest during x-rays to protect the surrounding areas from unnecessary damage. At lower frequencies, such as the microwave range used by mobile phones and base stations, the energy emitted is too low to damage chemical bonds (non-ionizing radiation). This is the primary argument used by those who believe that cell phone radiation is completely harmless and choose to live in ignorant bliss. Although extremely low frequencies (ELF's emitted from appliances and power lines) and extremely high frequencies (ultraviolet and gamma rays) are known to be carcinogenic, the scientific community is extremely hesitant to attach any kind of danger to the in-between frequencies where cell phones operate (Mercola, 2008).

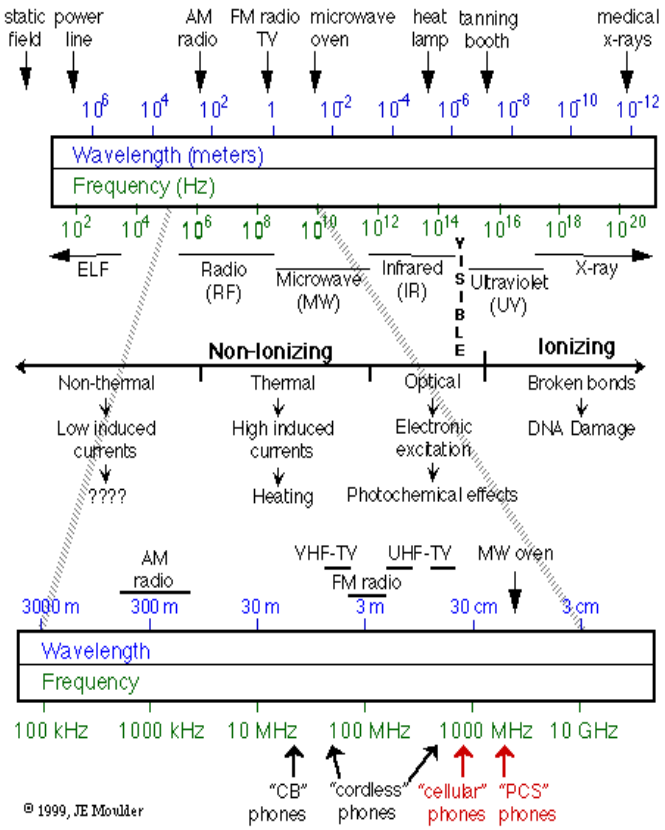

Fig. 1. Electromagnetic Radiation spectrum

All modern electronics emit electromagnetic radiation. Radio waves, microwaves, visible light, and x rays are all examples. Electromagnetic waves are produced by the motion of electrically charged particles. These waves are also called "electromagnetic radiation" because they radiate from the electrically charged particles. They travel through empty space as well as through air and other media.

The internal circuits of personal computers generate EM fields. In addition, cathode ray tube (CRT) eg. TV displays generate EM energy over a wide band of frequencies. As do mobile phones. To prove this simply place a radio receiver of any kind and use it at the same time as you use your personal computer, or mobile phone and you will probably hear RF noise in the receiver that originates in the computer or from the phone.

EMI (electromagnetic interference) is the disruption caused by an electromagnetic field. This is why mobile phones are not allowed to be used in hospitals, aeroplanes or petrol stations. The EM radiation emitted from them can interfere with sensitive equipment and poses a danger to safety. EMI was traditionally used to describe how one EM field emitted from one electronic device effects the operation of another electronic device; EMI can now also be used to help explain the ways in which EM radiation affects living things (EM Radiation Research Trust). However, just HOW are electromagnetic fields and information-carrying radio waves capable of causing damage in human body?

Life has become busier for most without a doubt. This has lead to the invention of many “modern conveniences” to save precious time and to make life easier. However, in this process we have at times created issues that are severely affecting health without realizing it. Moreover, we are constantly immersed in a sea of Electromagnetic Radiation and it can affect life markedly. These areas need to be identified, measured and remediated to significantly reduce sources of EMR in our environment.

Electromagnetic fields are found in a vast array of applications such as:

- Power lines
- Computers and wireless mousses
- Mobile phones and their masts
- Cordless phones
- Wireless internet
- Bluetooth
- Electric blankets
- Baby monitors
- Electric alarm clock
- Electrical Appliances like TV

The transmitter in mobile phones operates on about 0.75 watt (or much less, if you're close to a base station) to 1 watt of power, with 2 W at peak usage. This electric current running through the transmitter circuit also creates an electromagnetic field around it. As the electric current moves back and forth, the fields continue to build and collapse, forming electromagnetic radiation. Thus, cell phone radiation is generated in the transmitter, and is emitted through the antenna in the form of radio waves. In the case of cell phones, the frequencies

of these radio waves fall in the low microwave range. Most experts base their cell phone safety recommendations on the basic sinusoidal wave, also known as a "carrier signal." However, what they fail to recognize is that the danger does not come just from the carrier wave but also from a modulated signal that actually carries the data or your voice, which operates at a different frequency than the carrier signal (Mercola, 2008).

Making matters worse, modern Digital Service and PCS cell phones—as opposed to analog cell phones—have two additional low frequency magnetic fields associated with them.

Time division multiple access" (TDMA), is one of the systems currently used to increase the number of people who can communicate simultaneously with a base station. The process of TDMA results in a continuous low frequency pulsing at 8 to 34 Hz. Some phones also have the energy-saving discontinuous transmission mode (DTX), which emits yet a third, even lower frequency that pulses at 2 Hz when the user is listening and not speaking. Since extremely low frequency radiation (ELF) has been shown to cause cancer—like leukemia—these additional ELF's raise new questions. Many warn that our current technology is in fact far more dangerous in this respect than previous analog models.

Mobile phone Radiation and Human Biology

Electrical waves pass straight through our bodies and an electric current is generated within. This is how an aerial works – waves come in and electricity is generated. The electricity generated in our bodies, like all electric currents, goes to ground (if able) and, like all electric currents, takes the path of least resistance. Unfortunately, the path of least resistance is through our bodies. To travel through our bodies the waves use the 10% of our pathways that carry 90% of our traffic, rather like freeways in peak hour. This 90% of our traffic consists of:

• Hormones which help regulate the functions of the body

• Antibodies which help fight disease

• Neurotransmitters which carry messages around the body

Thus 90% of our bodily functions can be severely affected by these harmful electrical currents. Although cell phone radiation is of low intensity, it is the oscillatory similarity between this pulsed microwave radiation and certain electrochemical activities within the body that raises serious concerns, according to the study *Physics and biology of mobile telephony*, published in *The Lancet*. The body is essentially a very sensitive electromagnetic instrument, controlled by highly complex and orderly oscillatory electrical processes. Each one of these electro-biological processes vibrate at a specific frequency—some of which happen to be close to those used in modern GSM cell phone technology. The pulsating, low-intensity microwaves from mobile phones can exert subtle, non-thermal influences on the human biology simply because microwaves are *waves*. As such, they have properties other than just intensity (which is the only part regulated by safety guidelines). Therefore, much in the same way as a radio can receive interference; the oscillatory aspect of the incoming radiation can interfere with your biological processes.

Highly organized electrical processes at the cellular level are especially vulnerable to interference from cell phone radiation, because their frequency happens to fall within the microwave range. Many of these biological activities are influenced by metabolism, meaning that the effect of the radiation will be different from one person to another. The effect could also depend on the type of cell phone used, as different cell phones emit radiation at different frequencies. Ultra-low intensity microwaves can affect processes as fundamental as cell division, and the TDMA frequencies of 8-34 Hz, and the DTX pulse frequency at 2 Hz, correspond to the frequencies of alpha and delta brain waves (Mercola, 2008). Therefore, the body has a two-fold sensitivity to cellular phone signals: The microwave radiation itself, plus the lower frequency oscillations of the TDMA and DTX signals.

In addition to that, there's also the packet rate of newer 3G phones, which is 250 Hz. One good example of how someone may be vulnerable to the non-thermal electromagnetic influence is the ability of a flashing light (at about 15 Hz) to induce seizures in people with photosensitive epilepsy. It's not the energy absorption itself that causes the seizure. Rather it's because the brain recognizes the information being transmitted via the pulsating light, since it is delivered at a frequency the brain uses (Mercola, 2008).

In fact, the cells in human body are loaded with receptors that specifically respond to these signals. So when you are exposed to these information carrying radio waves, the receptors are stimulated. Once that happens the delicate micro-tubular connections between the cells become impaired.. Once they start to fail, the cells "lock up" and retain far more heavy metals and free radicals, which can wreak havoc in the body.

In 2004, a Swedish physicist named Bo Sernelius, stumbled across a surprising finding that suggests non-thermal mobile phone radiation can cause a massive increase in the forces that living cells exert on each other. He discovered that electromagnetic forces might act on cells by affecting the attractive forces between them, without thermal heating (Mercola, 2007). Water molecules have poles of positive and negative electrical charge that create attractive forces between cells, known as van der Waals forces. Van der Waals forces are much weaker than chemical bonds. And, whereas chemical bonds need high frequency ionizing radiation in order to break, van der Waals forces are disrupted by much smaller thermal fluctuations. These intermolecular forces may be weak, but without them, life as we know it would be impossible. Sernelius found that the water molecules inside cells will try to align their positive and negative poles with the alternating field produced by cell phone radiation.

They all end up pointing in the same direction, and this strengthens the van der Waals forces. In the fields of 850 MHz (around the frequency used by mobile phones), the van der Waals forces leap - from a billionth-billionth of a Newton, to micro Newton strength - a massive jump of around 11 orders of magnitude. Although it's still only theoretical, this may be the missing link when trying to explain tissue damage from non-ionizing, non-thermal radiation. Stronger attractive forces between cells can also make them clump together, and cause blood vessels to contract (Mercola, 2008). All in all, I believe the evidence is clear that EMF's can indeed harm your health, and that you would be best served to do whatever you can to limit your exposure to as many sources as possible (Mercola, 2007).

One of the main concerns associated with cell phone use is that the phone is pressed to the head. Since electromagnetic radiation shoots out—at the speed of light-in all directions, this radiation can penetrate into the brain. And, as Dr. Mercola discussed in the article, Cancer Institute Warns of Cell Phone Risks, electromagnetic radiation can penetrate *almost straight through* the entire brain of a 5-year old child (Mercola, 2008).

The effect of these microwaves can be explained using the analogy of putting a frog in water. If you put a frog in boiling water, it will jump out. However, if you put a frog in cold water and gradually heat the water, you can cook the frog because the frog's body will adjust to the slight changes in temperature and it will not notice it is being cooked (Karen & Helen 2008). Using wireless broadband, Bluetooth, cordless phones, mobile phones & blackberry devices all use the microwave spectrum of radiation energy to work. This means that when we use them they are slowly cooking us as they heat up our cells without us being able to sense it until the symptoms start to appear.

In 1971 the US Government stated "Unless adequate monitoring and control based on fundamental understanding of biological effects are instituted in the near future, in the decades ahead, man may enter an era of energy pollution of the environment comparable to the chemical pollution of today (Karen & Helen 2008). The electromagnetic hazard was identified in 1971 – to what extents are you exposed today? As we cannot see, touch, smell, taste or hear this radiation the only way to

measure the levels are with a number of specific instruments designed for various types of radiation.

Mobile Radiation Stunts Crop Growth

Mobile phones may have become ubiquitous in rural areas and popular among farmers. But electromagnetic radiation emanating from them may be stunting the growth of agricultural crops and plants, preliminary research has revealed. Studies carried out at Panjab University, Chandigarh, suggest that electromagnetic field (EMF) radiation from cell phones could choke seeds, and affect germination and early growth. This is said to be the first such study on the impact of EMF radiation on seeds. Though different groups of scientists have been studying the effect of mobile radiation on human beings, there has been no conclusive outcome yet. But Panjab University scientists have found definite clues on the ill-effects of electromagnetic radiation on crops and plants. The results were surprising - they indicated that the radiation emitted from the cell phones inhibited germination and early growth of the pulse. The germination of the seeds exposed to two and four hours of cell phone radiation reduced by 18 and 30 per cent respectively, compared to seeds that were not exposed to any radiation. (EM Radiation Research Trust).

The Birds, the Bees and Electromagnetic Pollution

This is another article written by Andrew Goldsworthy, covering the understood mechanisms by which animals use the Earth's magnetic field for navigation, and how man made electromagnetic radiation may cause a number of potentially severe problems. "Animals use their cryptochrome pigments for both magnetic and solar navigation. They also control the activity of the immune system. Weak electromagnetic fields can affect all of these functions with disastrous consequences." (EM Radiation Research Trust).

Research and Findings

The 2004 REFLEX report also summarizes multiple projects from a dozen different research groups, on the genotoxic potential of radio frequency radiation. Agents that can damage cell DNA are called genotoxins, and are presumed to have carcinogenic potential. The REFLEX report received a lot of attention because of the genotoxicity reported, including: Intermittent, but not continuous, Extremely Low Frequency ELF-EMF exposure damages DNA in human cells. DNA damage is dependent on the frequency, but higher frequency does not necessarily correlate with more damage. The frequencies causing DNA damage were ranked, from high to low damage, as follows: 50 Hz, 16 2/3 Hz, 3 Hz, 300 Hz, 550 Hz and 30 Hz. DNA strand breaks after ELF-EMF exposure and it is dependent on the person's age, with older individuals showing a higher rate of DNA damage. DNA damage through ELF-EMF radiation is cell type specific. For example, human melanocytes (deep layer epidermal cells that synthesize melanin) reacted, whereas skeletal muscle cells did not. ELF-EMF radiation generated several types of chromosomal abnormalities in human cells.

The radiation of wireless communication indeed has effects on the central nervous system, influences the functioning of the brain and causes damage to DNA. That is confirmed by 25 experts who studied the relevant scientific literature of 2000 to 2004. The investigation was done by the working group 'Mensch Umwelt Technik' (MUT) of the Jülich research institute in Jülich, Germany. The results were presented to the public on May 9th, 2005. The experts guess that the effects on the central nervous system cannot cause health problems, though this opinion has no scientific base. The influence on the brain results in shortened or prolonged reactions time and less or more mistakes, depending on the parameters of the radiation. The experts think the damage to DNA is not a problem, since it would not lead to cell damage (EM Radiation Research Trust).

This investigation was ordered and paid by T-Mobile, a provider of mobile communications. The experts only studied scientific reports and did not pay attention to the many experiences of people suffering from health effects of modern radiofrequency radiation. The complaints of these

people however fit in perfectly with the effects on the central nervous system, increased neuronal activity and influence on the functioning of the brain. The damage to DNA moreover fits in well with the results of epidemiologic investigations, finding an increased risk of cancer in the neighborhood of antenna towers. The experts however state that the results of epidemiologic investigations are not conclusive and more research is needed. In the meantime they advise to keep mobile calls short and not to use a mobile phone in a moving car without outside antenna nor at a far distance from the antenna tower.

Risk Groups

Young and healthy people are not at risk, say the experts. However, the radiation of mobile communication systems (probably combined with other factors) could be harmful to other groups, like children, elderly or sick people, babies and pregnant women. Probably the pulse-modulated radiation has most effect on the central nervous system and brain. The working mechanism is non-thermal and not yet understood. Pulse-modulation is used by e.g. GSM, UMTS, DECT, WLAN, WIFI, TETRA and many other wireless systems. The experts say headaches and problems with concentration and remembrance could be related to the radiation of mobile phone systems, but according to the literature, other complaints probably are not. Having studied the scientific literature, they doubt if electro-hypersensitivity (EHS) exists, but they emphasize that the absence of evidence is not evidence of absence.

No Consensus

The experts studied the permeability of the 'blood brain barrier', the risk of cancer, the damage to DNA, the effects on the brain and central nervous system and the disturbance of well-being. About the permeability of the 'blood brain barrier' there is no consensus. The experts think the 'blood brain barrier' could fail under stress or thermal conditions, but without relevance to health. There is no consensus about the damage to DNA. However, the experts think this cannot be relevant biologically and to health, since the literature does not mention cell damage as a consequence. Laboratory tests with animals do not show an increase of cancer. Nevertheless the experts say there could be an increased risk of cancer in humans in the long term. They advise to be on the safe side and keep mobile phone calls short (EM Radiation Research Trust).

Conclusion and Recommendation

Long-lasting adverse effect on important cells of our immune system can have strong relationship with health risk from mobile telephony. *In vitro* studies indicate that the duration of exposure can be more important for non-thermal effects than intensity and therefore, effects of microwaves from base stations on primary human cells should be studied.

Remember, the damage from cell phone exposure will take many years to surface, and there are rarely any initial symptoms, just like smoking and lung cancer. At this point, you cannot completely avoid wireless radiation from all sources, such as WI-FI, since they are so pervasive. Getting rid of your cell phone altogether can help protect you. But even if you don't want to take that step, you can still minimize your exposure and reduce your risks by following these common sense guidelines.

1. Remove any plugged in devices in and around sleeping areas; including electric blankets, waterbeds, extension cords and clock radios.
2. Check where your meter box is and don't sit or sleep near here.
3. Do not have wireless emitting devices in the home. Yes, this means wireless internet too! These bring in and emit microwaves radiation which can pass through brick walls, so there is no escape for the body. If you must have them, turn them off when not in use (Karen & Helen, 2008).
4. Do not site your buildings near or under a power lines.
5. Children should never use cell phones: barring a life-threatening emergency, children should not

use a cell phone, or a wireless device of any type. Children are far more vulnerable to cell phone radiation than adults for a number of reasons are; first, their thinner skull bones allow for greater penetration of radiation. The radiation can enter all the way into the midbrain, where tumors are more deadly. In addition, children's cells reproduce more quickly, so they are more susceptible to aggressive cell growth. Their immune systems are also not as well developed as adults. Lastly, children face a far greater lifetime exposure.

6. Reduce your cell phone use: turn your cell phone off more often. Reserve it for emergencies or important matters.
7. Use a landline at home and at work: although more and more people are switching to using cell phones as their exclusive phone contact, it is a dangerous trend and you can choose to opt out of the madness.
8. Reduce or eliminate your use of other wireless devices: you would be wise to cut down your use of these devices. Just as with cell phones, it is important to ask yourself whether or not you really need to use them every single time. It's important to realize that portable phones are also highly problematic. Recent research has linked portable house phones to an increased heart rate in people who are electromagnetically sensitive.
9. Use your cell phone only where reception is good: the weaker the reception, the more the power your phone must use to transmit. And the more power it uses, the more radiation it emits, and the deeper the dangerous radio waves penetrate into your body. Ideally, you should only use your phone with full bars and good reception.
10. Turn your cell phone off when not in use: as long as your cell phone is on, it emits radiation intermittently, even when you are not actually making a call.
11. Keep your cell phone away from your body when it is on: the most dangerous place to be, in terms of radiation exposure, is within about six inches of the emitting antenna. You do not want any part of your body within that area. It is worth nothing that your cell phone manual will actually tell you the minimum safety range of operation for your phone, even when not in use. For example, the iphone states the phone must be at least 5/8 inch away from your body or ear for "safe operation." Almost all of them state that the cell phone "should NOT be worn or carried on the body."
12. Use safer headset technology: wired headset will certainly allow you to keep the cell phone farther away from your body. However, if a wired headset is not well shielded—and most of them are not—the wire itself acts as an antenna attracting ambient radiation and transmitting radiation, not only directly to your brain, but also all along your torso. The best kind of headset to use is a combination shielded wire and air-tube headset. These operate like a stethoscope, transmitting the information to your head as an actual sound wave; although there are wires that still must be shielded, there is no wire that goes all the way up to your head.
13. Use a shielded case: there are some shielded cases on the market, but you could also purchase a certain kind of EMF-shielding fabric. Making a pouch from this fabric to put inside your regular case can help shield up to 99.9 percent of the radiation emitted if you cover the entire phone and antenna. If you wrap most of the phone but leave the antenna out, you would still achieve a significant reduction in radiation, but it would not be nearly as effective as wrapping up the entire phone. This is a particular useful solution to significantly reduce unnecessary radiation exposure if you simply must carry the phone on your body (Mercola, 2009).

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