

Impact of Electromagnetic Radiations (EMR) on Human Health

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ABSTRACT

Various scientific studies have raised concerns about the impact of electromagnetic radiations on individual health and other living organism. These ionizing / non-ionizing radiations interact through electromagnetic field. Such radiation sources are commonly found in the home and everywhere in society in the form of electrical devices, power appliances and communication devices. These slowly but steadily exposure energies our blood cells, gifting a long term implication on human genetics. Various finding indicate considerable potential for injury to cell or molecules as a result of such radiation exposure. But still, there are many views against such harm. This work try to establish a scientific proof of harm in this regards. To correlate a link between electromagnetic radiation and human health, effect of such EMR exposure is mathematically studied on water molecules. Our skin and body fluids including water molecules remains exposed to such low energy radiation, but for long duration. The calculation shows that there is an finite probability for effecting to the energy of Blood Cells. These slowly but steadily exposure energies our blood cells, gifting a long term implication on Human genetics.

1. Introduction

The greedy goal of development cannot be attained without use of electronic items. All electronic items behavior depends on quantity and associated properties of charged particle. Any electronic item having time varying charge and currents radiates electromagnetic waves. Radiation is a form of "separated" or "radiates" energy away from the source of energy. An electromagnetic radiations (EMR) is traditionally connected with charged particles being accelerated (direction, velocity) by forces acting on them. Because electrons have a low mass and may be quickly accelerated by a variety of methods, they are responsible for the majority of EMR emissions. Electrical materials and devices form 'electric fields' around them when power is generated, transmitted, or utilized. Both electric and magnetic field components are indicated by the Maxwell equations. These electric and magnetic fields have a constant strength ratio which is in phase. This close relationship results in field's maxima / nodes location at the same places in space. This results in a continuous flow of radiated energy that extends far away from the source. In the electromagnetic field of a charged particle, information travels at the speed of light. As a result, electrostatics electric and magnetic field expressions added a time factor to electrostatics expression which is known as retarded time, opposite to advanced time factor. EMR is the result of these extra terms. According to the de-Broglie relation, EMR is in the quantum range, so it can act as a wave or particle depending on the circumstances. Radiation impact on interacting particles is described by its energy E. A wide range of frequencies are used in EMR, ranging from high to low frequency, detailed of such ionizing / non-ionizing radiation is described in Fig. 1. These include ionizing gamma-rays, ultraviolet and X-ray radiation to low-frequency non-ionizing radiations such as microwaves and radio waves [7,9].

The human being exposure to radiation is not new and man-made but the human beings are constantly exposed to low intensity level natural background radiation such as

Sunlight - a mixture of visible light, ultraviolet light and infrared light. Earth surfaces radioactive materials radiation and natural human body radioactivity also affect us. Not only this, but also we are constantly under exposure of outer space cosmic rays radiation coming through the earth's atmosphere.

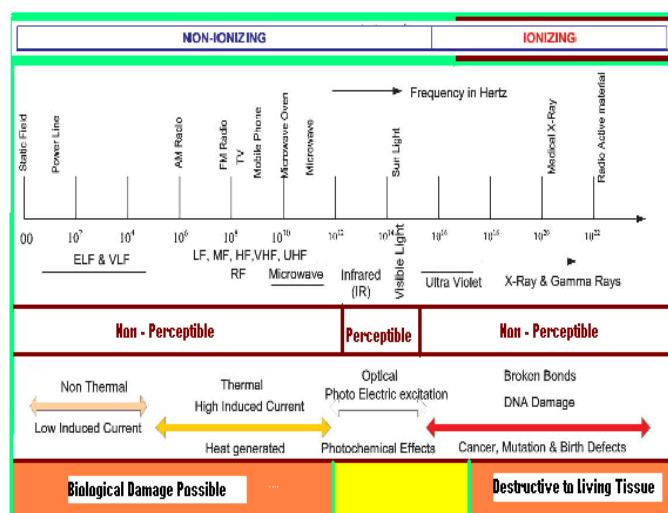


Fig 1: List of EMR Radiations [1,10,11,12]

There is also a long list of manmade sources of radiation, such as mobile phones, televisions, microwaves, etc. In this article we restrict ourselves to radiation sources produced due to communication devices. Despite their proximity to living beings, communication devices have become a necessity for most civilized living beings. Globally, the use of mobile phones and other mobile communication devices has increased dramatically and the majority of devices are operating between frequency ranges from 900 MHz to 1800

MHz. Water molecules and some organic molecules can be excited by this radiation range.

Thermal and non-thermal effects have also been associated with this frequency range. In living organisms, the majority of physiologic functions are electrochemical in nature. As a result, cell function can be affected by electro dynamical disturbances which results changes in electrical, chemical processes within the cell's structure. Heating may be the main cause of possible damage to cells and tissues

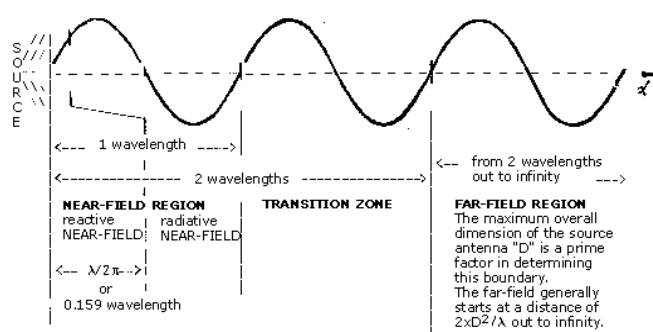
In this article we have studied the impact of these manmade radiation such as mobile radiations on the physiology of living being. This is studies through changes in electrical properties of cell fluid on radiation exposure. The volume of such radiation are increasing day by day due to increases in communication products such as mobiles, computer etc. These technology advances and demand for wireless networks have increases safety concerns.

2. Propagation of Radiation and Antenna

The passage of alternating current through conducting objects like wire, set of conductor such as antenna, results in propagation of electromagnetic radiation at the same frequency as AC current. As the charges move back and forth, an electrical dipole moment can be identified. It is set in motion by oscillations at a certain frequency, which cause electric and magnetic fields to fluctuate. Such oscillation and accelerated motion of charges particles are occur at quantum level. So wave packets are associated with them and resulting in electromagnetic radiation. The electric dipole moment oscillates in time when a charged particle is stationary. A transition state with an electric dipole moment may result from the superposition of such states. Radioactive quantum state transitions are caused by this oscillating dipole moment. In the transition from one stationary state to another, an atom releases photons.

Furthermore, because of their extensive penetration, these radiations necessitate the use of antennas. As a result, we can communicate over long distances in an energy efficient manner []. While the extremely strong electric and magnetic induction fields fade away with distance, the much weaker electromagnetic radiation field persists until it is cancelled.

Fig 2: Near and Far Field Region



Through the transmission of energy, the radiation field allows humans to communicate. This energy has the potential to have a negative impact on pathway objects. In this EMR, the near-field is directly produced by charges and current. Unlike charges and currents, electric and magnetic

fields are affected by changes in the other type of field. When charged particles are far enough away from each other to be absorbed by electromagnetic fields, their behavior is no longer affected. As a result, these two types of behavior are sometimes called "near-field" or "far-field"[7, 8].

Electromagnetic radiation from an antenna is shown in figure 2. Antennas are placed at different distances from each other and as a result, their radiated energy crosses an imaginary spherical surface at the same rate. Emissions from transmitters include the far-field electromagnetic field around them. Near the transmitter is a "near-field" that contributes to an ever-changing field, but does not qualify as electromagnetic radiation. It is easy to understand why our antennas have all three fields, and why we can communicate so well over long distances with low power levels. Whilst electric and magnetic induction fields diminish rapidly with distance, the initially much weaker electromagnetic radiation field persists until it is cancelled out by something else (see below). Electric or magnetic induction fields do not allow us to communicate. Antenna-induced E-M fields decay linearly with distance (INVERSE SQUARE) and lose density only as the radius of a fictitious sphere is increased. Antenna energy is constant no matter how far it is away. Antenna radiation, while weak near the antenna, travels through space indefinitely (unless cancelled) [3,9].

EMR carries energy away from the source and have different energy carrying behavior in near-field, transition and far-field region. Momentum and angular momentum are also carried by the electromagnetic field. Material with which it interacts may acquire any or all of these properties. Interactions of EM radiation with matter are characterized by qualitative changes in its behavior with its frequency variations. Radiation having frequencies in the range of radio and microwave interact with matters is broad. The will affect large number of atoms and results in charge production in large quantity, but scattered.

As long as the current is large enough, the EMR can be absorbed or regenerated. In a microwave oven, for example, the microwaves are absorbed by water or other molecules with an electric dipole moment, and the radio waves are emitted from the microwave oven. It either produces electricity and heat, or both. As atoms vibrate at the ends of chemical bonds, single molecules have dipoles, which change as the atoms vibrate. Many other substances absorb the infrared radiation, which causes them to warm up as the vibrations dissipate into heat. Substances in bulk radiate infrared spontaneously.

3. Biological impact of Radiation

Various invisible and imperceptible radiations are constantly strike on humans or other living organisms. Some of these like X-rays and ultraviolet energy, are ionizing radiation (IR) because the energy of the radiation is sufficient to cause certain effects at the atomic level. Most of these frequencies cannot be detected without specialized equipment, so people are generally unaware of their exposure to these energies. Such radiation exposure study are depends on four interrelated factors such as radiation intensity, exposure time, actual absorbed dose and radiation dose equivalent. Table 1 gives reported

biological response on exposure to various radiation level [1,12].

Table 1: Biological Response to High Doses of Radiation

Radiation Level	Effect
5 rad	No short-term noticeable effects
5 - 50 rad	Slight changes in blood observed
50 - 150 rad	Significant changes Blood Components, Few symptoms like fatigue, nausea, vomiting, etc. observed
150 -1,100 rad	It is possible to die from severe blood changes
> 1100 rad	Higher probability of death

Ionizing and Non-ionizing radiation affects nearly everyone in our society to varying degrees. By altering the atomic makeup of cell structures, disrupting chemical bonds, and causing the creation of free radicals, certain types of radiation can cause damage to human cells. Subatomically, human cells are governed by electron mobility. We shouldn't be surprised if EM radiation produces powerful electrical fields that interfere with the human body's electrical system, including brain function and cardiac activity (for example). "Ionizing radiation" (high frequency energy) can potentially damage human cells and cause DNA damage or mutation, according to various health studies.

Most molecules are not permanently or irreversibly affected by visible light, but recent studies have shown that some NIR frequencies may have the potential to cause biological damage. Radiation at extremely low frequencies as well as radio & microwave frequencies has been the subject of many studies. Power lines and some electrical equipment produce and emit low-frequency radiation, while wireless communication and cellular phones, as well as some electrical materials, produce and emit radio- and microwave-frequency emissions.

Some results based on radiation-matter interaction are [1,4,5,6,9,12] :

1. Radiation exposure will affect cells productivity and chromosomes may not be replicated properly. Direct radiation exposure of cell, could make cell to die or undergo a mutation. This is because the DNA molecule information transmission has got some modification.
2. In the presence of radiation, water can be broken down into (H) and (OH) fragments. A further recombination or interaction can form compounds such as hydrogen peroxide from this fragmentation. Cellular structures are destroyed by this compound.
3. As a result of their constant regeneration, lymphocytes and the cells that produce blood are highly sensitive. This is due to the fact that blood forming cells are most sensitive to radiation.
4. An EMF-exposed pineal gland could be negatively affected by melatonin metabolism. So free radical metabolism, blood pressure control, immune system functioning, etc. are all affected as they are regulated melatonin.
5. EMFs also affect the nervous system. Small doses of radiation have been shown to cause nervous overexcitement, changes in normal reflex responses and disturbances in the electrical currents in the brain.

6. EMR exposure has been linked to adverse pregnancy outcomes such as miscarriages, stillbirths, preterm deliveries, altered gender ratio and congenital anomalies. As a result of paternal EMF exposure, offspring may be born with congenital defects.
7. Electromagnetic radio frequency radiations are emitted from mobile phone antennas and can cause thermal effects. When mobile phone antennae are placed in close proximity to the user's ear canals, large amounts of EMF energy can be deposited in the ear canals. Thermal effects or heating can occur when EMF energy is deposited in the biological tissue.
8. At very low doses, the central nervous system is affected and there are chemo-functional changes in the brain, according to available evidence. Reflex action changes can be observed. EMF exposure is associated with higher rates of depression and suicide.
9. Exposure to certain frequencies of electromagnetic radiation (EMR) at high levels may cause cancer. Children with leukemia have also been linked to high EMR exposure in studies. Blood pressure changes and lymphoma have also been linked with EMR exposures. Dermal abnormalities can be caused by EMR.

A photon's interaction with atoms and molecules depends on its energy. If a molecule is doubly bonded, a photon with enough energy of about 3 electron volts or more can cause a chemical rearrangement. This is known as photo ionization. For wavelengths smaller than 124 nm, the required energy is always greater than 10 electron volts (eV) . A more realistic cutoff is around 33 eV, which is the energy required to ionize water, according to various studies.

Ultraviolet radiation at all wavelengths can damage DNA and cause cancer. It can also cause skin burns that are far worse than simple heating effects (sunburn). Consequently, EMR with frequencies in the visible light range and above can cause molecular damage far out of proportion to any temperature-changing effects (e.g., heating). Due to quantum effects, high-frequency electromagnetic radiation (EMR) exhibits these properties, which cause permanent tissue damage at the molecular level [11].

In summary, learning and memory problems like Alzheimer's disease, insomnia, headaches, chronic fatigue are some of the major health problems associated with radiation. Some minor health problems include headaches, burning sensations on the face, an increase in blood pressure and an increase in heart rate. A growing body of research suggests that exposure to certain EMR frequencies may affect physiological processes, with long-term consequences, according to a recent study.

4. Radiation impacts on Water Molecules

The most mobiles and other communication devices radiated their radiation mostly in surrounding area. The range vary with frequency and have a wide range for frequencies 900-1800 MHz The energy of these radiation will be having lower and upper limit which is $E_{\text{Lower limit}}$ & $E_{\text{Upper limit}}$. This spectrum energy is nearly 6×10^{-25} Joule having power of 6×10^{-28} kJ per unit time. The lower power generated by these radiation depends on exposure time with range is given by $P=6 \times 10^{-28}$ kJ per unit time .

Also we know that the even a little change in the information of protein can affect the DNA coding leading to the mutation of animals and planets as well. These mutation causing DNA has the information of Water, RBC's and other structures with them. So, any change may alter the coming generation. The recognition of the time interval for possible mutation is the pivotal aim of our paper. For this, we need to calculate the power needed to deform the red blood corpuscle, or to change the structure of protein, etc. Basically we need to see the minimum energy required to mutate our body structure.

The electric dipole moment of a water molecule 6.2×10^{-30} C.m. in its vapor state. The amount of work required to rotate this molecule by 180° degrees, starting from its current position, for which $\theta=0^\circ$, is now available to calculate. By means of external torque, work done by an external agent is compensated by the change in a molecule's potential energy because of orientation.

$$\begin{aligned} W_{\text{Rotate}} &= U_{180} - U_0 \\ &= (-pE \cos 180^\circ) - (-pE \cos 0^\circ) \\ &= 1.24 \times 10^{-29} \text{ J} \\ &= E_{\text{rotate}} \end{aligned}$$

i.e. energy required to rotate a mole of water molecule-
 $E_{\text{Water}} = 1.24 \times 10^{-32} \text{ kJ/molecule}$

Now the time taken by the radiation to rotate the water molecule is $T_{\text{Water}} = 2.06 \times 10^{-5} \text{ Sec}$

Or, **number of H₂O molecule rotated in a Day = $2.06 \times 8.64 \times 10^4 \times 10^{-5} = 1.78 \text{ molecules/Day}$**

Further, the amount of energy needed to deform or bend a single RBC molecule is of the order of curvature elastic modulus of RBC's [1] is nearly equal to $10^{-22} \text{ kJ/molecule}$. So, the time taken to deform RBC's is-

$$T_{\text{RBC's}} = 1.67 \times 10^5 \text{ Sec}$$

i.e. number of RBC molecule deform in a day

$$= T_{\text{RBC's}} \times 86,400 = 1.44 \text{ Molecules/Day}$$

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Our body remain in radiation exposure for longer time, so this considerably increases to lend a mind-mending effect on human anatomy.

Again average deformation energy of protein is 35 kcal/mole or 146.4 kJ/mole or 24.31×10^{-23} per molecule. Time taken to deform the protein is-

$$T_{\text{Protein}} = 4.05 \times 10^5 \text{ Sec}$$

Now, Number of nucleotides being deformed in a day $\approx 3.5 \text{ Molecules/Days}$. This calculation clearly shows that the energy of non-ionized radiations being used in TV and mobile towers is of the range nearly $(6-12) \times 10^{-25} \text{ Joule}$. This energy is sufficient enough to rotate some of the water molecules, RBC's and normally affect the nucleotides of proteins in our body. Though our reckonings suggested that a few number of molecules are being deformed or affected per day. But as the exposure is for longer time, the power i.e. Energy/time will considerably increase creating nuisance in the genes, especially in the genes of embryos. These changes affects the mobility and viscosity of blood and thus vitamins and mineral flow in our body tending to change our DNA information in a considerably longer but steadier period.

5. Conclusion

All natural, man-made, small or large doses of radiation will have some biological effects. Such biological impacts are due to electro dynamical disturbances. This occurs at atomic level i.e. atoms that form the cells. Most common among them is water with its polarity. This polar property provides a much higher probability of interaction with radiations. It is found that such persistent radiation interaction causes dissociation of water molecules. Hydrogen (H) and hydroxyls (OH) to be released from the water molecules (H₂O). The combination with other molecules or ions, form a new compounds that can cause the cell to be destroyed. Cellular reproduction and chromosome replication are affected by such radiations. The destroying of cell ultimately affects our life-sustaining system.