



– A REVIEW

# MOBILE CELL AND CELL TOWER RADIATIONS : A MASS KILLING

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## ABSTRACT

Mobile cell and cell towers radiations pose serious problem for sustainability of a sound human life. These mobile cells and cell towers emits electromagnetic radiations (EMR) which is harmful to human health. Up to June 2009, there were more than 4.3 billion mobile users worldwide. In India, nearly 270 million customers use cell phones and there are over three lakh towers, which emit electromagnetic radiations. These EMR can harm blood cell, may trigger Alzheimer's Brain tumors', cancers and miscarriage in pregnant woman. The most dangerous area is of concern is the radiations emitted by the fixed infrastructure used in mobile telephony, such as base station and their antennas. Experts consulted by France consider, it is mandatiory that main antemma axis not to be directly in fornt of a living place at a distance shorter than 100 meters. It is immediate need of WHO experts to make recommendations for precautionary measures to minimize exposure of their citizens and protect our self form these radiations.

**Key words:** Cell towers, Mobile cell, Hazardous radiation, Ill effect, Precautions.

## INTRODUCTION

Sometimes ago, after a proposal to install cell towers at Sir J. J. Hospital, the institution's dean consulted its radiology, pharmacology and neurology experts to find out the possible ill effects of such an installaion. The hospital was told that the international commission on non-ionizing radiations protection and the telecommunication engineering centre, a technical wing of the department of telecommunication did not recommend setting up such towers on school or hospital campuses.

A measurement of electromagnetic radiation done by Mumbai with the help of Delhi based company of magnetic radiation levels emitted by cell towers in the city showed

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alarming levels of radiations. High EMR levels are known to cause brain damage and heart problems, apart from raising other health issues.

It is found that in most of the cities, two or more than two towers are in series i.e. the distance between two towers is just 10 to 25 meters away from each other. In such cases (Area), density of electromagnetic radiations is much more than permissible limits prescribed by the WHO. People who are living near mobile towers 400-500 meters should get their houses tested for radiation and use anti-radiation devices to prevent diseases. On 9 Jan 2008, in New Delhi, the Government proposed to make it compulsory for mobile phone manufacturers to specify the radiations levels (SAR) emitted by mobiles and mobile towers, as has been hailed by experts.

Karmajyot Seva Trust President V. B. Gupta said that the trust had filed a PIL I in supreme court in August 2005 for control of radiations and norms for putting up mobile towers setup. With the united efforts of several NGO's, the court has ordered the Government to look into the matter. Gupta claimed that in India, nearly 270 million customers use cell phones and there are over three lakh towers, which emit electromagnetic radiation and application of ICNIPP norms be a boon to people. All electronic appliances emit harmful radiation and strict norm should be applied to see that radiations remain within permissible limits.

The cellular operator association of India (COAI) has opposed the Government proposal to make it mandatory for mobile phone manufacturers to specify radiation levels of mobile phones and monitor levels of mobile towers.

The effect of mobile phone radiation has on human health is the subject of recent interest and study, as a result of the enormous increase in mobile phone usage throughout the world (as of June 2009, there were more than 4.3 billion users worldwide<sup>1</sup>). Mobile phones use electromagnetic radiation in the microwave range and researchers believe that this may be either harmful to human health, still a large body of research exists, both epidemiological and experimental, in non-human animals and in humans. Other digital wireless systems such as data communication networks produce similar radiations. The scientific and medical communities, has stated in the past that cancer is unlikely to be caused by cellular phones or their base stations and that reviews have found no convincing evidence for other health effect. Some scientists theorize that reviews have found no convincing evidence for other health effects. Some scientists theorize effect. Some labs evaluate the phone's effects on tissue at varying doses, called the specific absorption rate (SAR). Mobile phones harm blood cells. It may trigger Alzheimer's brain tumors and cancers. Mobile tower radiations can cause miscarriage in pregnant women and trouble in pacemakers or even insomnia. The

WHO expects to make recommendations about precautionary measures to minimize exposure to their citizens.

### **Effects of radiations**

Many scientific studies have investigated possible health effects of mobile phone radiations. These studies are occasionally reviewed by some scientific committees to assess overall risks. A recent assessment was published in 2007 by the European commission scientific committee on emerging and newly identified health risks (SCENIHR)<sup>2</sup>. It concludes that the three lines of evidence, viz. animal, *in vitro*, and epidemiological studies, indicate that “exposure to RF fields is unlikely to lead to an increase in cancer in humans.”

### **Radiation absorption**

A device SAR (measured in Watts per kilogram, w/kg) is a reliable measure of its ability to cause cell damage and is a way of measuring the quantity of radiofrequency (RF) (energy) that is absorbed by the body.

Calculated specific absorbed radiation (SAR) distribution in an anatomical model of head next to a 125 mW dipole antenna. Peak SAR is 9.5 w/kg averaged over a 1 mg cube. Lower is the SAR, it is better for you.

Part of the radio waves emitted by a mobile telephone handset are absorbed by the human head. The radio waves emitted by a GSM handset can have a peak power of 2 Watts, and a US analogue phone had a maximum transmit power of 3.6 Watts. Other digital mobile technologies, such as CDMA 2000 and DAMPS, use lower output power, typically below 1 Watt, UVA. The maximum power output from a mobile phone is regulated by the mobile phone standard, it is following and by the regulatory agencies in each country. In most systems, the cell phone and the base station check reception quality and signal strength and the power level is increased or decreased automatically, within a certain span, to accommodate for different situations such as inside or outside of buildings and vehicles. The rate at which radiation is absorbed by the human body is measured by the specific absorption rate (SAR), and its maximum levels for modern handsets have been set by governmental regulating agencies in many countries. In the USA, the federal communications commission (FCC) has set a SAR limit of 1.6 W/kg average over a volume of 1 g of tissue, for the head. In Europe, the limit is 2 W/kg, average over a volume of 10 g of tissue. SAR values are heavily dependent on the size of the averaging volume. Without information about the averaging volume used, comparisons between different measurements cannot be made. Thus, the European 10 g ratings should be compared among themselves, and the American 1 g ratings should only be compared among themselves.

**Thermal effect**

Thermal effect of microwave radiation is dielectric heating, in which any dielectric material (such as living tissue) is heated by rotations of polar molecules induced by the electromagnetic field. In the case of a person using a cell phone, most of the heating effect will occur at the surface of the head, causing its temperature to increase by a fraction of a degree. In the case of cell phone, SAR is highest at the “Hot Spot”, where the cell phone is held to the user’s ear. The US federal communication commission (FCC) has imposed a maximum SAR limit of 1.6 W/kg. If currently marketed cell phone based on the scientific evidence public. In this case, the level of temperature increase is an order of magnitude less than that obtained during the exposure of the head to direct sunlight. The brain’s blood circulation is capable of disposing of excess heat by increasing local blood flow. However, the cornea of the eye does not have this temperature regulation mechanism and exposure of 2-3 hours duration has been reported to produce cataracts in rabbits’ eyes at SAR values from 100-140 W/kg, which produced lenticular temperatures of 41°C. There were no cataracts detected in the eyes of monkeys exposed under similar conditions.<sup>3</sup>

**Non-thermal effects**

The communications protocols used by mobile phones often result in low-frequency pulsing of the carrier signal.

Some researchers have argued that so-called “non-thermal effects” could be reinterpreted as a normal cellular response to an increase in temperature. The german biophysicist Roland Glaser<sup>4</sup> has argued that there are several thermo receptor molecules in cells, and that they activate a cascade of second and third messenger systems, gene expression mechanisms and production of heat shock proteins in order to defend the cell against metabolic cell stress caused by heat. The increase in temperature that cause these changes are too small to be detected by studies such as Reflex, which base their whole argument on the apparent stability of thermal equilibrium in their cell cultures.

**Blood-brain barrier effects**

Swedish researchers from Lund University (Salford, Brun, Perrson, Eberhardt, and Malmgren) have studied the effects of microwave on the rat brain. They found a leakage of albumin into the brain via a permeated blood-brain barrier<sup>5</sup>. Other groups have not confirmed these findings in cell or animal studies.

**Cancer**

In 2006, a large Danish study about the connection between mobile phone use and

cancer incidence was published. In order to investigate the risk of cancer for the mobile phone user, a cooperative project between 13 countries has been launched call interphone<sup>6</sup>. The idea is that cancers need time to develop so only studies over 10 years are of interest<sup>7</sup>.

The following studies of long time exposure have been published.

- A Danish study (2004) that took place over 10 years found no evidence to support a link. However, this study has been criticized for collecting data from subscriptions and not necessarily from actual users. It is known that some subscribers do not use the phones themselves but provide them for family members to use. That this happens, is supported by the observation that only 61% of a small sample of the subscribers reported use of mobile phones when responding to a questionnaire.
- A Swedish study (2005) draws the conclusion that “the data do not support the hypothesis that mobile phone use is related to an increased risk of glioma or meningioma”<sup>8</sup>.
- A British study (2005) draws the conclusion that “The study suggests that there is no substantial risk of acoustic neuroma in the first decade after starting mobile phone use. However, an increase in risk after longer term use or after a longer lag period could not be ruled out”<sup>9</sup>.
- A German study (2006) states “In conclusion, no overall increased risk of glioma or meningioma was observed among these cellular phone users; however, for long-term cellular phone users, results need to be confirmed before firm conclusions can be drawn”<sup>10</sup>.
- A joint study conducted in northern Europe draws the conclusion that “Although our results overall do not indicate an increased risk of glioma in relation to mobile phone use, the possible risk in the most heavily exposed part of the brain with long-term use needs to be explored further before firm conclusions can be drawn”<sup>11</sup>.

In 2007, Dr. Lennart Hardell, from Orebro University in Sweden, reviewed published epidemiological papers (2 cohort studies and 16 case-control studies) and found that –

- Cell phone users had an increased risk of malignant gliomas.
- Link between cell phone use and a higher rate of acoustic neuromas.

- Tumors are more likely to occur on the side of the head that the cell handset is used (Fig. 1 & 2).
- One hour of cell phone use per day significantly increases tumor risk after ten years or more.



**Fig. 1**



**Fig. 2**

In a February 2008 update on the status of the interphone study, IARC stated that the long term findings could either be causal or artifactual, related to differential recall between cases and controls.

A publication titled “Public health implications of wireless technologies” cites that Lennart Hardell found that age is a significant factor. The report repeated the finding that the use of cell phones before age 20 increased risk of brain tumors by 5.2, compared to 1.4 for all ages.<sup>12</sup> A review by Hardell and Carlberg<sup>13</sup> concluded that current mobile phones are not safe for long-term exposure.

The lack of a trend change in incidence from 1998 to 2003 suggests that the induction period relating mobile phone use to brain tumors exceeds 5-10 years; the increased risk in this population is too small to be observed, the increased risk is restricted to subgroups of brain tumors or mobile phone users, or there is no increased risk.

### **Electromagnetic hypersensitivity**

Some users of mobile handsets have reported feeling several unspecific symptoms during and after its use, ranging from burning and tingling sensations in the skin of the head and extremities, fatigue, sleep disturbances, dizziness, loss of mental attention, reaction times and memory retentiveness, headaches, malaise, tachycardia (heart palpitation), to disturbances of the digestive system. Reports have noted that all of these symptoms can also

be attributed to stress and that current research cannot separate the symptoms from placebo effects<sup>14</sup>.

### **Genotoxic effects**

A large recent meta-study of 101 scientific publications on genotoxicity of RF electromagnetic fields shows that 49 report a genotoxic effect and 42 do not<sup>15</sup>. Research published in 2004 by a team at the University of Athens had a reduction in reproductive capacity in fruit flies exposed to 6 minutes of 900 MHz pulsed radiation for five days<sup>16</sup>. Subsequent research, again conducted on fruit flies, was published in 2007, with the same exposure pattern but conducted at both 900 MHz and 1800 MHz, and had similar changes in reproductive capacity with no significant difference between the two frequencies<sup>17</sup>. Australian research conducted in 2009 by subjecting *in vitro* sample of human spermatozoa to radio-frequency radiation at 1.8 GHz and specific absorption rates (SAR) of 0.4 to 27.5 W/kg showed a correlation between increasing SAR and decreased motility and vitality in sperm.

In 1995, in the journal Bioelectromagnetics, Lai and Singh reported damaged DNA after two hours of microwave radiation at levels deemed safe according to government standard<sup>18</sup>. Later, in December 2004, a pan-European study named reflex (risk evaluation of potential environmental hazards from low energy electromagnetic field (EMF) exposure using sensitive *in vitro* methods), involving 12 collaborating laboratories in several countries showed some compelling evidence of DNA damage of cells in *in vitro* cultures, when exposed between 0.3 to 2 Watts/kg, whole sample average.

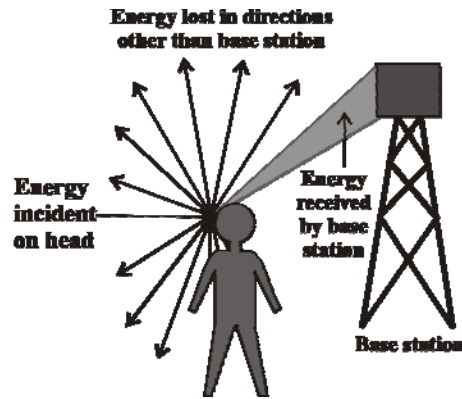
### **Sleep and EEG effects**

Sleep, EEG and working CBF have been studied in relation to RF exposure for a decade now, and the majority of papers published to date have found some form of effect. While a Finnish study failed to find any effect on sleep or other cognitive function from pulsed RF exposure<sup>19</sup>. German research from 2006 found that statistically significant EEG changes could be consistently found, but only in a relatively low proportion of study participants (12-30%).<sup>20</sup>

### **Radiation emitted from the base stations and health hazards**

The area of concern is the radiation emitted by the fixed infrastructure used in mobile telephone, such as base stations and their antennas, which provide the link to and from mobile phones (Fig. 3 & 4). This is because, in contrast to mobile handsets, it is emitted continuously and is more powerful at close quarters. On the other hand, field intensities drop rapidly with distance away from the base of the antenna because of the

attenuation of power with the square of distance. Base station emissions must comply with safety guidelines. Several surveys have found increases of symptoms depending upon proximity to electromagnetic sources such as mobile phone base stations.



**Fig. 3**



**Fig. 4**

A 2002 survey study by Santini et al. in France found a variety of self-reported symptoms for people who reported that they were living within 300 meters (984 ft) of GSM cell towers in rural areas, or within 100 m (328 ft) of base stations in urban areas. Fatigue, headache, sleep disruption and loss of memory were among the symptoms reported. Similar results have been obtained with GSM cell towers in Spain, Egypt, Poland and Austria. No major studies have been reported in which health effects did not occur on actual populations living near mobile base stations. However, there are significant challenges in conducting studies of populations near base stations, especially in assessment of individual exposure. A study conducted at the University of Essex and another in Switzerland concluded that mobile phone masts were unlikely to be causing these short term effects in a group of volunteers who complained of such symptoms. The Essex study has been criticized as being skewed due to drop-outs of test subjects, although these criticisms were answered by the authors.

As technology progresses and data demands have increased on the mobile network, towns and cities have seen the number of towers increase sharply, including 3G towers which work with larger bandwidths. Many measurements and experiments have shown that transmitter power levels are relatively low-in modern 2G antennas, in the range of 20 to 100 W, with the 3G towers causing less radiation than the already present 2G network. An average radiation power output of 3 W is used.

Experts consulted by France consider, it is mandatory that main antenna axis not to be directly in front of a living place at a distance shorter than 100 meters. This



recommendation was modified in 2003 to say that antennas located within a 100 metre radius of primary schools or childcare facilities should be better integrated into the cityscape.

### **Occupational health hazards**

Telecommunication workers who spend time at a short distance from the active equipment, for the purposes of testing, maintenance, installation, etcetera, may be at risk of much greater exposure than the general population. Many times base stations are not turned off during maintenance, but the power being sent through to the antennas is cut off, so that the workers do not have to work near live antennas.

A variety of studies over the past 50 years have been done on workers exposed to high RF radiation levels; studies including radar laboratory workers, military radar workers, electrical workers and amateur radio operators. Most of these found no increase in cancer rates over the general population or a control group. Many positive results could have been attributed to other work environment conditions and many negative results of reduced cancer rates also occurred.

### **Safety standards and licensing**

In order to protect the population living around base stations and users of mobile handsets, governments and regulatory bodies adopt safety standards, which translate to limits on exposure levels below a certain value. There are many proposed national and international standards, but that of the international commission for non-ionizing radiation protection (ICNIRP) is the most respected one, and has been adopted so far by more than 80 countries. For radio stations, ICNIRP proposes two safety levels : one for occupational exposure, another one for the general population. Currently, there are efforts underway to harmonize the different standards in existence.

Radio base licensing procedures have been established in the majority of urban spaces regulated either at municipal/county, provincial/state or national level. Mobile telephone service providers are, in many regions, required to obtain construction licenses, provides certification of antenna emission levels and assure compliance to ICNIRP standards and/or to other environmental legislation.

Many government bodies also require that competing telecommunication companies try to achieve sharing of towers so as to decrease environmental and cosmetic impact. This issue is an influential factor of rejection of installation of new antennas and towers in communities.

The safety standards in the U.S. are set by the federal communications commission

(FCC). The FCC has based its standards primarily on those standards established by the institute of electrical and electronics engineers (IEEE), specifically subcommittee 4 of the “International Committee on electromagnetic safety”.

### **Evolution of safety standards**

The following is a brief summary of the wireless safety standards, which have become stricter over time.

- **1966:** The ANSI C95.1 standard adopted the standard of  $10 \text{ mW/cm}^2$  ( $10,000 \text{ }\mu\text{W/cm}^2$ ) based on thermal effects.
- **1982:** The IEEE recommended further lowering this limit to  $1 \text{ mW/cm}^2$  ( $1,000 \text{ W/cm}^2$  or  $10 \text{ }\mu\text{W/m}^2$ ) for certain frequencies in 1982, which became a standard ten years later in 1992.
- **1986:** The national council on radiation protection and measurements (NCRP) recommended the exposure limit of  $580 \text{ }\mu\text{W/cm}^2$ .
- **1992:** The ANS/IEEE C95.1-1992 standard based on thermal effects used the  $1 \text{ mW/cm}^2$  ( $1,000 \text{ }\mu\text{W/cm}^2$ ) safety limit. The United States Environmental Protection Agency called this revised standard “seriously flawed”, partly for failing to consider non-thermal effects, and called for the FCC to adopt the 1986 NCRP standard, which was five times stricter.
- **1996:** The FCC updated to the standard of  $580 \text{ }\mu\text{W/cm}^2$  over any 30 minute period for the 869 MHz, while still using  $1 \text{ mW/cm}^2$  ( $1,000 \text{ }\mu\text{W/cm}^2$ ) for PCS frequencies (1850-1990 MHz).
- **1998:** The ICNIRP standard uses the limit of  $450 \text{ }\mu\text{W/cm}^2$  at 900 MHz, and  $950 \text{ }\mu\text{W/cm}^2$  at 1900 MHz. The limit is frequency dependent.

### **In the courts**

In the USA, a small number of personal injury law suits have been filed by individuals against cell phone manufactures, such as Motorola, NEC, Siemens and Nokia, on the basis of allegations of causation of brain cancer and death. In US federal court, expert testimony relating to science must be first evaluated by a judge, in a Daubert hearing, to be relevant and valid before it is admissible as evidence. In one case against Motorola, the plaintiffs alleged that the use of wireless handheld telephones could cause brain cancer, and that the use of Motorola phones caused one plaintiff’s cancer. The judge ruled that no

sufficiently reliable and relevant scientific evidence in support of either general or specific causation was proffered by the plaintiffs; accepted a motion to exclude the testimony of the plaintiffs' experts; and denied a motion to exclude the testimony of the defendants' experts.

## **Precaution**

### **Precautionary principle**

In 200, the world health organization (WHO) recommended that the precautionary principle could be voluntarily adopted in this case. It follows the recommendations of the European community for environmental risks. According to the WHO, the "precautionary principle" is "a risk management policy applied in circumstances with a high degree of scientific uncertainty, reflecting the need to take action for a potentially serious risk without awaiting the results of scientific research". Other less stringent recommended approaches are prudent avoidance principle and ALARA (As low as reasonably achievable). Although all of these are problematic in application, due to the widespread use and economic importance of wireless telecommunication systems in modern civilization, there is an increased popularity of such measures in the general public, though also evidence that such approaches may increase concern. They involve recommendations such as the minimization of cell phone usage, the limitation of use by at risk population (such as children), the adoption of cell phones and microcells with ALARA levels of radiation, the wider use of hands-free and earphone technologies such as Bluetooth headsets, the adoption of maximal standards of exposure, RF field intensity and distance of base stations antennas from human habitations, and so forth.

### **Precautionary measures and health advisories**

Some national radiation advisory authorities, including those of Austria<sup>6</sup>, France, Germany and Sweden have recommended measures to minimize exposure to their citizens. Examples of the recommendations are –

- Use hands-free to decrease the radiation to the head.
- Keep the mobile phone away from the body.
- Do not use telephone in a car without an external antenna.

The use of "hand-free" was not recommended by the British Consumers' Association in a statement in November 2000 as they believed that exposure was increased. However, measurements for the (then) UK department of trade and industry and others for the French l'Agemce framcaose de security sanitaire environment showed substantial

reductions. In 2005 Professor Lawrie Challis and others said clipping a ferrite bead onto hands-free kits stops the radio waves traveling up the wire and into the head. People who are living near mobile tower should get their houses tested for radiation and use anti-radiation devices to prevent diseases. SAR shield-cell phone radiation shield reduce the danger by 89%. Never keep mobile phone near your heart (left pocket), never allow children below 10 years and pregnant women to use mobile phones.

Do not use it in a confined space such as an elevator, basement, underground station, caravan, etc. In these situations, the strength of the signal both sending and receiving is much greater; thus, the radiation is much more intense. Do not use the phone while you are in a moving vehicle, including the train, bus, etc. since its antenna will be constantly scanning for contact using the maximum signal strength, and the radiation from both incoming and outgoing signal will be intensified. Do not keep a mobile phone beside the bed at night switched on, because even when on standby, it is in contact with the nearest phone mast and emits radiation at regular intervals. Switch off the phone in the vicinity of chemical plants, petrol pumps and other locations containing explosive objects. Switch off the phone, when boarding an aeroplane and do not switch the phone on during the flight.

### **REFERENCES**

1. H. Ronald, Cancer Risk from Mobile Cell, *International Herald Tribune*, 7, 24 (2008).
2. European Commission Scientific Committee on Emerging and Newly Identified Health Risks, Conclusion on Mobile Phones and Radio Frequency Field, **12**, 08 (2008).
3. International Commission on Non-Ionizing Radiation Protection (April 1998), Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic and Electromagnetic Fields, *Health Physics*, **74**, 495-205 (2010).
4. Glaser and Roland, Are Thermoreceptores Responsible for Non-Thermal Wissenschaft (2008).
5. L. G. Salford and E. B. Arne, Nerve Cell Damage in Mammalian Brain after Exposure to Microwaves from GSM Mobile Phones, *Environmental Health Perspective*, **111**, 881-883 (2008).
6. Mc Laceylin Centre for Population Health Risk Assessment, Research Programme : Interphone Study (2010).
7. International Agency for Research on Cancer, The Interphone Study (2008).
8. Lonn, A. Si Aglbom and P. Hall, Long Term Mobile Phone Use and Brain Tumor Risk, *American J. Epidemiology*, **161(6)**, 526-535 (2008).

9. M. J. Schomaker and A. J. Swerdlow, Mobile Phone Use and Risk of Acoustic Neuroma : Result of Interphone Case-Control Study in Five North European Countries, *British J. Cancer*, **93(7)**, 842-848 (2008).
10. J. Schuz, E. Bohler and G. Berg, Cellular Phones, Cordless Phones and the Risks of Glioma and Meningioma, *American J. Cancer*, **120(8)**, 1769-1775 (2007).
11. A. S. Lahkola, A. Auvinen and J. Raitanen, Mobile Phone Use and Risk of Glioma in 5 North European Countries, *International J. Cancer*, **120(8)**, 1769-1775 (2007).
12. C. Sage and D. Carpenter, Public Health Implication of Wireless Technologies, *Pathophysiology*, **16(2)**, 233-246 (2009).
13. L. Hardell and M. Carlberg, Epidemiological Evidence for an Association between Use of Wireless Phones and Tumor Diseases, *Pathophysiology*, **16(2)**, 113-122 (2009).
14. Radiofrequency Electromagnetic Field Exposure and Non-Specific Symptoms of ill Health, Roosli, *Environmental Research*, Available online, 21 March (2008).
15. H. W. Ruediger, Genotoxic Effect of Radiofrequency Electromagnetic Field, *Pathophysiology*, **16(2)**, 89 (2009).
16. D. J. Panagopoulos and L. H. Margaritis, Effect of GSM 900 MHz Mobile Phone Radiation on the Reproductive Capacity of *Drosophila Melanogaster*, *Electromagnetic Biology and Medicine*, **23(1)**, 29-43 (2004).
17. D. J. Panagopoulos and E. D. Chavdoala, Comparison of Bioactivity between GSM 900 MHz and DCS 1800 MHz Mobile Telephony Radiation, *Electromagnetic Biology and Medicine*, **26(1)**, 33-44 (2007).
18. Vajaya Laxmi et al., Genetic Damage in Mammalian Somatic Cell Exposed to Radiofrequency Radiation, **169(5)**, 561-574 (2008).
19. C. Harala and F. Takio, Pulsed and Continuous Wave Mobile Phone Exposure over Left Versus Right Hemisphere : Effect on Human Cognitive Function, *Bioelectromagnetics*, **28(4)**, 289-295 (2007).
20. M. Bachmann, J. Lass and J. Kalda, Integration of Difference in EEG Analysis Reveals Change in Human EEG Caused by Microwave, *Conf. Proc. IEEE Eng. Med. Biol. Soc.*, (2006).

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