

As part of my research looking at microwave radio frequencies and whether that have the propensity to cause biological harm I have been collecting and evaluating studies over the last 4 years. I have purposely listed only positive studies (those that show biological effects) to demonstrate that not all “swans are white” as some scientists and industry representatives would have us believe. The evidence provided below demonstrates the current view held by many people that RF emissions below basic restrictions set by RF Standards and International Guidelines are safe is in fact refutable and falsifiable. Most of the studies listed below have set exposures that are within ICNIRP and therefore Australia’s RF basic restrictions. A summary of the effects and possible health implications is provided at the end of the document.

Studies (~2012 – to present day)

800MHz – 2100Mhz Microwave Radiation Studies (typically mobile phone frequencies)

- 1. Effect of 900 MHz Electromagnetic Radiation on the Induction of ROS in Human Peripheral Blood Mononuclear Cells.** The study investigated the effect of 900 MHz GSM on the induction of oxidative stress and the level of intracellular reactive oxygen species (ROS) in human mononuclear cells, monocytes and lymphocytes as defence system cells. The results obtained in this study clearly showed the oxidative stress induction capability of RF electromagnetic field in the portion of PBMCs mostly in monocytes, like the case of exposure to micro organisms, although the advantages or disadvantages of this effect should be evaluated. (1 Sep 2015) <http://www.ncbi.nlm.nih.gov/pubmed/26396966?dopt=Abstract> [OS]
- 2. Maternal exposure to a continuous 900-MHz electromagnetic field provokes neuronal loss and pathological changes in cerebellum of 32-day-old female rat offspring.** Large numbers of people are unknowingly exposed to electromagnetic fields (EMF) from wireless devices. Evidence exists for altered cerebellar development in association with prenatal exposure to EMF. However, insufficient information is still available regarding the effects of exposure to 900 megahertz (MHz) EMF during the prenatal period on subsequent postnatal cerebellar development. Pregnant rats were divided into control, sham and EMF groups. Pregnant EMF group (PEMFG) rats were exposed to 900MHz EMF for 1h inside an EMF cage during days 13-21 of pregnancy. Pregnant sham group (PSG) rats were also placed inside the EMF cage during days 13-21 of pregnancy for 1h, but were not exposed to any EMF. No procedure was performed on the pregnant control group (PCG) rats. The cerebellums of the newborn female rats were extracted on postnatal day 32. Total Purkinje cell numbers calculated using stereological analysis were significantly lower in EMFG compared to CG ($p < 0.05$) and SG ($p < 0.05$). Additionally, some pathological changes such as pyknotic neurons with dark cytoplasm were observed in EMFG sections under light microscopy. In conclusion, our study results show that prenatal exposure to EMF affects the development of Purkinje cells in the female rat cerebellum and that the consequences of this pathological effect persist after the postnatal period. (20 Sep 2015) <http://www.ncbi.nlm.nih.gov/pubmed/26391347?dopt=Abstract> [BD, CI]
- 3. 8-oxoG DNA Glycosylase-1 Inhibition Sensitizes Neuro-2a Cells to Oxidative DNA Base Damage Induced by 900 MHz Radiofrequency Electromagnetic Radiation.** The purpose of this study was to explore the in vitro putative genotoxicity during exposure of Neuro-2a cells to radiofrequency electromagnetic fields (RF-EMFs) with or without silencing of 8-oxoG DNA glycosylase-1 (OGG1). Exposure to 900 MHz RF-EMFs with insufficient energy could induce oxidative DNA base damage in Neuro-2a cells. These increases were concomitant with similar increases in the generation of reactive oxygen species (ROS). Without OGG1 siRNA, 2 W/kg RF-EMFs induced oxidative DNA base damage in Neuro-2a cells. Interestingly, with OGG1 siRNA, RF-EMFs could cause DNA base damage in Neuro-2a cells as low as 1 W/kg. However, neither DNA strand breakage nor altered cell viability was observed. (25 Sep 2015) <http://www.ncbi.nlm.nih.gov/pubmed/26401913?dopt=Abstract> [DD, OS]
- 4. The Screening of Genes Sensitive to Long-Term, Low-Level Microwave Exposure and Bioinformatic Analysis of Potential Correlations to Learning and Memory.** Mice were exposed to whole body 2100 MHz microwaves with specific absorption rates (SARs) of 0.45 W/kg, 1.8 W/kg, and 3.6 W/kg for 1 hour daily for 8 weeks. The gene chip results demonstrated that 41 genes (0.45 W/kg group), 29 genes (1.8 W/kg group), and 219 genes (3.6 W/kg group) were differentially expressed. GO analysis revealed that these differentially expressed genes were primarily involved in metabolic processes, cellular metabolic processes, regulation of biological processes, macromolecular metabolic processes, biosynthetic processes, cellular protein metabolic processes, transport, developmental processes, cellular component organization, etc. KEGG pathway analysis showed that these genes are mainly involved in pathways related to ribosome, Alzheimer's disease, Parkinson's disease, long-term

potentiation, Huntington's disease, and Neurotrophin signalling. Long-term, low-level microwave exposure may inhibit learning and memory by affecting protein and energy metabolic processes and signalling pathways relating to neurological functions or diseases. (Aug 2015)
<http://www.ncbi.nlm.nih.gov/pubmed/26383594?dopt=Abstract> [BI, BM, EA, GE]

5. **Impact of mobile phone radiation on the quality and DNA methylation of human sperm in vitro.** to investigate the influences of mobile phone radiation on the quality and DNA methylation of human sperm in vitro. Compared with the control, the radiation group showed significantly decreased progressive sperm motility ($[36.64 \pm 16.93]$ vs $[27.56 \pm 16.92]\%$, $P < 0.01$) and sperm viability ($[63.72 \pm 16.35]$ vs $[54.31 \pm 17.35]\%$, $P < 0.01$) and increased sperm head defects ($[69.92 \pm 4.46]$ vs $[71.17 \pm 4.89]\%$, $P < 0.05$), but no significant differences in sperm acrosomal reaction ($[66.20 \pm 6.75]$ vs $[64.50 \pm 3.47]\%$, $P > 0.05$). The early apoptosis rate of sperm cells was remarkably higher in the radiation group ($[6.89 \pm 9.84]\%$) than in the control ($[4.44 \pm 5.89]\%$) ($P < 0.05$). Mobile phone radiation reduces the progressive motility and viability of human sperm and increases sperm head defects and early apoptosis of sperm cells. (21 Jun 15) <http://www.ncbi.nlm.nih.gov/pubmed/26242041?dopt=Abstract> [AP, SE]
6. **Electromagnetic radiation at 900 MHz induces sperm apoptosis through bcl-2, bax and caspase-3 signaling pathways in rats.** Twenty four rats were exposed to 900 MHz electromagnetic radiation with a special absorption rate of 0.66 ± 0.01 W/kg for 2 h/d. After 50d, the sperm count, morphology, apoptosis, reactive oxygen species (ROS), and total antioxidant capacity (TAC), representing the sum of enzymatic and nonenzymatic antioxidants, were investigated. RF-EMR increases the ROS level and decreases TAC in rat sperm. Excessive oxidative stress alters the expression levels of apoptosis-related genes and triggers sperm apoptosis through bcl-2, bax, cytochrome c and caspase-3 signaling pathways.(4 Aug 2015) <http://www.ncbi.nlm.nih.gov/pubmed/26239320?dopt=Abstract> [AP, EA, OS]
7. **Deleterious impacts of a 900MHz electromagnetic field on hippocampal pyramidal neurons of 8-week-old Sprague Dawley male rats.** The numbers of pyramidal neurons in the cornu ammonis of the Sprague Dawley male rat (8-weeks old, weighing 180-250g) hippocampus following exposure to a 900MHz (MHz) electromagnetic field (EMF) were examined. The EMF-EG rats were exposed to 900MHz EMF (1h/day for 30 days) in an EMF jar. Histopathological observation showed abundant cells with abnormal, black or dark blue cytoplasm and shrunken morphology among the normal pyramidal neurons. In conclusion, our results suggest that pyramidal neuron loss and histopathological changes in the cornu ammonis of 8-week-old male rats may be due to 900MHz EMF exposure. (31 Jul 15) <http://www.ncbi.nlm.nih.gov/pubmed/26239913?dopt=Abstract> [CI]
8. **Effect of GSTM1 and GSTT1 Polymorphisms on Genetic Damage in Humans Populations Exposed to Radiation From Mobile Towers.** The objective of our study was to evaluate the genetic damage caused by radiation from mobile towers and to find an association between genetic polymorphism of GSTM1 and GSTT1 genes and DNA damage. In our study, 116 persons exposed to radiation from mobile towers and 106 were control subjects. DNA damage in peripheral blood lymphocytes was determined using alkaline comet assay in terms of tail moment (TM) value and micronucleus assay in buccal cells (BMN). There was a significant increase in BMN frequency and TM value in exposed subjects (3.65 ± 2.44 and 6.63 ± 2.32) compared with control subjects (1.23 ± 0.97 and 0.26 ± 0.27). (5 Aug 2015)
<http://www.ncbi.nlm.nih.gov/pubmed/26238667?dopt=Abstract> [DD]
9. **Effects of Wi-Fi (2.45 GHz) Exposure on Apoptosis, Sperm Parameters and Testicular Histomorphometry in Rats: A Time Course Study.** This study aimed to investigate the major cause of male infertility during short- and long-term exposure of Wi-Fi radiation. Both 1-hour and 7-hour groups showed a decrease in sperm parameters in a time dependent pattern. In parallel, the number of apoptosis-positive cells and caspase-3 activity increased in the seminiferous tubules of exposed rats. The seminal vesicle weight reduced significantly in both 1-hour or 7-hour groups in comparison to the control group. We concluded that there should be a major concern regarding the time dependent exposure of whole-body to the higher frequencies of Wi-Fi networks existing in the vicinity of our living places. (11 Jul 15) <http://www.ncbi.nlm.nih.gov/pubmed/26199911?dopt=Abstract> [AP, EA, SE]
10. **Does the brain detect 3G mobile phone radiation peaks? An explorative in-depth analysis of an experimental study.** This study aimed to investigate whether third generation mobile phone radiation peaks result in event related potentials. Using multilevel regression analyses the placement*exposure interaction effect was significant for the frontal and central cortical regions, indicating that only in the mobile phone exposure with ear-placement an enlarged cortical reactivity was found. Post-hoc analyses based on visual inspection of the ERPs showed a second significantly increased area between 500-1000 ms post-stimulus for almost every EEG location measured. It was concluded that, when a dialing mobile phone is placed on the ear, its radiation, although unconsciously, is electrically detected by the brain. The question of whether or not this cortical reactivity results in a negative health outcome has to

be answered in future longitudinal experiments. (11 May 2015)
<http://www.ncbi.nlm.nih.gov/pubmed/25962168?dopt=Abstract> [EG]

- 11. Effect of Mobile Phone Radiation on Cardiovascular Development of Chick Embryo.** The biological effects on cardiovascular development of chicken embryos were examined after radiation exposure using mobile phone (900 MHz; specific absorption rate 1.07 W/kg) intermittently 3 h per day during incubation. The results showed the rate of embryonic mortality and cardiac deformity increased significantly in exposed group ($P < 0.05$). No histological pathological changes were observed on Day 5-7 (D5-D7) of incubation. A higher distribution of lipid droplets was unexpectedly present in myocardial tissue from the exposure groups on D10-D13. Soon afterwards, myofibril disruption, atrioventricular valve focal necrosis, mitochondria vacuolization and atrial natriuretic peptide (ANP) decrease appeared on D15-D21 of incubation. Comet assay data showed the haemocyte mean tail in the exposed group was significantly larger than that of the control ($P < 0.01$). The arterial vascular wall of exposed group was thicker ($P < 0.05$) than that of the control on D13, which was reversed to normal in later stages. Our findings suggest that long-term exposure of MPR may induce myocardium pathological changes, DNA damage and increased mortality; however, there was little effect on vascular development. (14 Jul 15) <http://www.ncbi.nlm.nih.gov/pubmed/26171674?dopt=Abstract> [CI, DD]
- 12. Possible cause for altered spatial cognition of prepubescent rats exposed to chronic radiofrequency electromagnetic radiation.** The effects of chronic and repeated radiofrequency electromagnetic radiation (RFEMR) exposure on spatial cognition and hippocampal architecture were investigated in prepubescent rats. Progressive learning abilities were found to be decreased in RF-EMR exposed rats. Memory retention test performed 24 h after the last training revealed minor spatial memory deficit in RF-EMR exposed group. However, RF-EMR exposed rats exhibited poor spatial memory retention when tested 48 h after the final trial. RF-EMR exposure influenced dendritic arborization pattern of both apical and basal dendritic trees in RF-EMR exposed rats. Structural changes found in the hippocampus of RF-EMR exposed rats could be one of the possible reasons for altered cognition. (3 Jun 15) <http://www.ncbi.nlm.nih.gov/pubmed/26033310?dopt=Abstract> [BM, CI, MR]
- 13. In vitro effect of cell phone radiation on motility, DNA fragmentation and clusterin gene expression in human sperm.** Use of cellular phones emitting radiofrequency electromagnetic field (RF-EMF) has been increased exponentially and become a part of everyday life. This study aimed to investigate the effects of in vitro RF-EMF exposure emitted from cellular phones on sperm motility index, sperm DNA fragmentation and seminal clusterin (CLU) gene expression. There was a significant decrease in sperm motility, sperm linear velocity, sperm linearity index, and sperm acrosin activity, whereas there was a significant increase in sperm DNA fragmentation percent, CLU gene expression and CLU protein levels in the exposed semen samples to RF-EMF compared with non-exposed samples in OAT>AT>A>N groups, respectively ($p < 0.05$). (21 Apr 2015)
<http://www.ncbi.nlm.nih.gov/pubmed/25918601?dopt=Abstract> [DD, EA, GE, SE]
- 14. Can prenatal exposure to a 900 MHz electromagnetic field affect the morphology of the spleen and thymus, and alter biomarkers of oxidative damage in 21-day-old male rats?** We investigated the effects of a 900 Megahertz (MHz) electromagnetic field (EMF), applied during the prenatal period, on the spleen and thymus of 21-day-old male rat pups. Compared to the control group, thymus tissue malondialdehyde levels were significantly higher in the group exposed to EMF, while glutathione levels were significantly decreased. Increased malondialdehyde and glutathione levels were observed in splenic tissue of rats exposed to EMF, while a significant decrease occurred in superoxide dismutase values compared to controls. Transmission electron microscopy showed pathological changes in cell morphology in the thymic and splenic tissues of newborn rats exposed to EMF. (19 May 2015)
<http://www.ncbi.nlm.nih.gov/pubmed/25985826?dopt=Abstract> [BI, CI, EA]
- 15. EFFECTS OF CHRONIC EXPOSURE TO 2G AND 3G CELL PHONE RADIATION ON MICE TESTIS – A RANDOMIZED CONTROLLED TRIAL.** Following chronic exposure of 2G and 3G cell phone radiation in mice, there was significant reduction of animal weight at first, second and fourth month. The mean testis weight and volume of 2G and 3G radiation exposed mice were significantly reduced in the first three months. The comparison between 2G and 3G exposed groups, showed no significant changes in mean body weight, mean testis weight and mean testis volume. Chronic exposure to ultra-high frequency radiation emitted from 2G and 3G cell phone could cause microscopic changes in the seminiferous epithelium, reduction of serum testosterone level, reduction in the number of Sertoli cells and Leydig cells. (Feb 2015)
<http://www.scopemed.org/fulltextpdf.php?mno=181637> [BI, CI, EA]
- 16. Effects of chronic exposure to electromagnetic waves on the auditory system.** The rats were divided into two groups of six rats. The study group was exposed to the electromagnetic waves over a

period of 30 days. The control group was not given any exposure to the electromagnetic fields. After the completion of the electromagnetic wave application, the auditory brainstem responses of both groups were recorded under anesthesia. The degeneration of cochlear nuclei was graded by two different histologists, both of whom were blinded to group information. The histopathologic and immunohistochemical analysis showed neuronal degeneration signs, such as increased vacuolization in the cochlear nucleus, pyknotic cell appearance, and edema in the group exposed to the electromagnetic fields compared to the control group. (2 Apr 2015)

<http://www.ncbi.nlm.nih.gov/pubmed/25836770?dopt=Abstract> (AD, BD, CI)

- 17. Effect of Low-Intensity Microwave Radiation on Monoamine Neurotransmitters and Their Key Regulating Enzymes in Rat Brain.** The aim of the study was to demonstrate the effect of low-intensity microwave radiation on levels of monoamine neurotransmitters and gene expression of their key regulating enzymes in brain of Fischer rats. Animals were exposed to 900 MHz and 1800 MHz microwave radiation for 30 days (2 h/day, 5 days/week) with respective specific absorption rates as 5.953×10^{-4} and 5.835×10^{-4} W/kg. Results showed significant reduction in levels of DA, NE, E and 5-HT in hippocampus of microwave-exposed animals in comparison with sham-exposed (control) animals. In addition, significant downregulation in mRNA expression of TH, TPH1 and TPH2 was also observed in microwave-exposed animals ($p < 0.05$). (12 Feb 2015)

<http://www.ncbi.nlm.nih.gov/pubmed/25672490> [BI, GE]
- 18. Investigation of the effects of distance from sources on apoptosis, oxidative stress and cytosolic calcium accumulation via TRPV1 channels induced by mobile phones and Wi-Fi in breast cancer cells.** In all exposure groups (2-4), the cytosolic Ca^{2+} concentration was significantly increased in samples with a distance of 0-5 cm to the field source compared to the control group. Cell viability was significantly reduced in group 2 (900 MHz) and 4 (2450 MHz) at distances of 0-5 cm and in group 3 (1800 MHz) at distances of 0-25 cm compared to the control group. The generation of reactive oxygen species was significantly increased in all exposure groups in samples with a distance of 0-5 cm to the field source in comparison to the control group. Apoptosis was significantly increased in groups 2 and 3 at distances of 0-10 cm and in group 4 at 0-5 cm compared to the control group. The enzyme activities of caspase-3 and -9 were significantly increased in all exposure groups in samples with a distance of 0-5 cm to the field source when compared to the control group.

<http://www.ncbi.nlm.nih.gov/pubmed/25703814?dopt=Abstract> (19 Feb 2015) [AP, CA, EA, OS]
- 19. Cognitive Impairment and Neurogenotoxic Effects in Rats Exposed to Low-Intensity Microwave Radiation.** Experiments were performed on male Fischer rats exposed to MWR for 180 days at 3 different frequencies, namely, 900, 1800 MHz, and 2450 MHz. All the rats were tested for cognitive function at the end of the exposure period and were subsequently sacrificed to collect brain. Level of HSP70 was estimated by enzyme-linked immunotarget assay and DNA damage was assessed using alkaline comet assay in all the groups. The results showed declined cognitive function, elevated HSP70 level, and DNA damage in the brain of microwave-exposed animals. The results indicated that, chronic low-intensity microwave exposure in the frequency range of 900 to 2450 MHz may cause hazardous effects on the brain. <http://www.ncbi.nlm.nih.gov/pubmed/25749756?dopt=Abstract> (5 March 2015) [BM, CS, DD, EA, MR, OS]
- 20. Exposure to a 900 MHz electromagnetic field for one hour a day over 30 days does change the histopathology and biochemistry of the rat testis.** EMF group rats exhibited vacuoles in seminiferous tubules basal membrane and edema in the intertubular space. Seminiferous tubule diameters and germinal epithelium thickness were both smaller, and apoptotic index was higher, in the EMF group than in the other groups. Malondialdehyde, superoxide dismutase, catalase and glutathione values in the EMF group decreased significantly compared to those of the control group. The results show that exposure to 900-MHz EMF causes alterations in adult rat testicular morphology and biochemistry. <http://www.ncbi.nlm.nih.gov/pubmed/25786704?dopt=Abstract> (19 March 2015) [BI, CI, EA]
- 21. Cognitive Impairment and Neurogenotoxic Effects in Rats Exposed to Low-Intensity Microwave Radiation.** The present study aimed to investigate the effects of chronic low-intensity microwave exposure on cognitive function, heat shock protein 70 (HSP70), and DNA damage in rat brain. The results showed declined cognitive function, elevated HSP70 level, and DNA damage in the brain of microwave-exposed animals. The results indicated that, chronic low-intensity microwave exposure in the frequency range of 900 to 2450 MHz may cause hazardous effects on the brain.

<http://www.ncbi.nlm.nih.gov/pubmed/25749756?dopt=Abstract> (5 March 2015) [BM, DD, EA]
- 22. Effect of Short-term 900 MHz low level electromagnetic radiation exposure on blood serotonin and glutamate levels.** Ten male Wistar Albino rats were anesthetized 30 min before the Long term

exposure to low level electromagnetic radiation (LLER) exposure, 0.5 ml blood was taken from the tail vein of rats in order to determine control values. It was found that a single 45 min of LLER exposure increased the blood 5-HT level significantly, but did not change the glutamate level of rats. Increased 5-HT level may lead to a retarded learning and a deficit in spatial memory
<http://www.ncbi.nlm.nih.gov/pubmed/25665475?dopt=Abstract> (2015) [BD, BI, EA,MR]

- 23. Melatonin exerts certain antioxidant effects in the liver of rats exposed to microwaves, by diminishing the intensity of lipid peroxidation.** Exposure to microwaves caused an increase in malondialdehyde after 40 (p < 0.01), protein carbonyl content after 20 (p < 0.05), catalase (p < 0.05) and xantine oxidase activity (p < 0.05) after 40 days. Increase in deoxyribonuclease I activity was observed after 60 days (p < 0.05), while deoxyribonuclease II activity was unaffected. Melatonin treatment led to malondialdehyde decrease after 40 days (p < 0.05), but surprisingly had no effect on other analyzed parameters. The lipid peroxidation was significantly increased in group 3 (exposure to microwaves) (2015) <http://www.ncbi.nlm.nih.gov/pubmed/25665474?dopt=Abstract> [EA, OS]
- 24. Investigation of the effects of distance from sources on apoptosis, oxidative stress and cytosolic calcium accumulation via TRPV1 channels induced by mobile phones and Wi-Fi in breast cancer cells.** TRPV1 is a Ca²⁺ permeable channel and gated by noxious heat, oxidative stress and capsaicin (CAP). Some reports have indicated that non-ionized electromagnetic radiation (EMR)-induces heat and oxidative stress effects. human breast cancer cell lines were divided into A, B, C and D groups as control, 900, 1800 and 2450MHz groups, respectively. Cells in Group A were used as control and were kept in cell culture conditions without EMR exposure. Wi-Fi and mobile phone EMR placed within 10cm of the cells induced excessive oxidative responses and apoptosis via TRPV1-induced cytosolic Ca²⁺ accumulation in the cancer cells. The cytosolic ROS production, Ca²⁺ concentrations, apoptosis, caspase-3 and caspase-9 values were higher in groups B, C and D than in A group at 0cm, 1cm and 5cm distances although cell viability (MTT) values were increased by the distances. (19 Feb 2015) <http://www.ncbi.nlm.nih.gov/pubmed/25703814?dopt=Abstract> [AP, BI, CA OS]
- 25. Tumor promotion by exposure to radiofrequency electromagnetic fields below exposure limits for humans.** Previously published results from a pilot study with carcinogen-treated mice, however, suggested tumor-promoting effects of RF-EMF (Tillmann et al., 2010). We have performed a replication study using higher numbers of animals per group and including two additional exposure levels (0 (sham), 0.04, 0.4 and 2 W/kg SAR). We could confirm and extend the originally reported findings. Numbers of tumors of the lungs and livers in exposed animals were significantly higher than in sham-exposed controls. In addition, lymphomas were also found to be significantly elevated by exposure. A clear dose-response effect is absent. We hypothesize that these tumor-promoting effects may be caused by metabolic changes due to exposure. Since many of the tumor-promoting effects in our study were seen at low to moderate exposure levels (0.04 and 0.4 W/kg SAR), thus well below exposure limits for the users of mobile phones (Feb 2015) <http://www.sciencedirect.com/science/article/pii/S0006291X15003988> [TP]
- 26. Exposure to 900 MHz electromagnetic fields activates the mcp-1/ERK pathway and causes blood-brain barrier damage and cognitive impairment in rats.** This study demonstrated blood-brain barrier and cognitive changes in rats exposed to 900MHz electromagnetic field (EMF) and aims to elucidate the potential molecular pathway underlying these changes. We found that the frequency of crossing platforms and the percentage of time spent in the target quadrant were lower in rats exposed to EMF for 28 days than in rats exposed to EMF for 14 days and unexposed rats. Moreover, 28 days of EMF exposure induced cellular edema and neuronal cell organelle degeneration in the rat. In addition, damaged BBB permeability, which resulted in albumin and HO-1 extravasation were observed in the hippocampus and cortex. Thus, for the first time, we found that EMF exposure for 28 days induced the expression of mcp-1, resulting in ERK dephosphorylation. Taken together, these results demonstrated that exposure to 900MHz EMF radiation for 28 days can significantly impair spatial memory and damage BBB permeability in rat by activating the mcp-1/ERK pathway.
<http://www.ncbi.nlm.nih.gov/pubmed/25598203?dopt=Abstract> (15 Jan 2015) [BB, BD, GE, CI, MR]
- 27. Circadian Rhythmicity of Antioxidant Markers in Rats Exposed to 1.8 GHz Radiofrequency Fields.** The potential health risks of exposure to Radiofrequency Fields (RF) emitted by mobile phones are currently of considerable public interest, such as the adverse effects on the circadian rhythmicities of biological systems. Circadian rhythms in the synthesis of Mel and antioxidant enzymes, GSH-Px and SOD, were shifted in RF-exposed rats compared to sham-exposed animals: the Mel, GSH-Px and SOD levels were significantly decreased when RF exposure was given at 23 and 3 h GMT. The overall results indicate that there may be adverse effects of RF exposure on antioxidant function, in terms of both the daily antioxidative levels, as well as the circadian rhythmicity.
<http://www.ncbi.nlm.nih.gov/pubmed/25685954?dopt=Abstract> (12 Feb 2015) [BI, CR, OS]

- 28. Comparison of the Genotoxic Effects Induced by 50 Hz Extremely Low-Frequency Electromagnetic Fields and 1800 MHz Radiofrequency Electromagnetic Fields in GC-2 Cells**
Extremely low-frequency electromagnetic fields (ELF-EMF) and radiofrequency electromagnetic fields (RF-EMF) have been considered to be possibly carcinogenic to humans. Our results suggest that both ELF-EMF and RF-EMF under the same experimental conditions may produce genotoxicity at relative high intensities, but they create different patterns of DNA damage. Therefore, the potential mechanisms underlying the genotoxicity of different frequency electromagnetic fields may be different. <http://www.ncbi.nlm.nih.gov/pubmed/25688995?dopt=Abstract> (17 Feb 2015) [DD]
- 29. The effect of exposure of rats during prenatal period to radiation spreading from mobile phones on renal development.** A control group and an EMF-exposed group. The study group was exposed to 900-MHz of EMF during the first 20 days of pregnancy, while the control group was unexposed to EMF. Mild congestion and tubular defects, and dilatation of Bowman's capsule were observed in the kidney tissues of rats in the exposed group. Apoptosis was evaluated using anti-caspase-3; stronger positive staining was observed in the renal tubular cells in the study group than those of the control group. Although there was a significant difference between the study and control groups in terms of K(+) level ($p < 0.05$) <http://www.ncbi.nlm.nih.gov/pubmed/25691088?dopt=Abstract> (Mar 2015) [AP, CI]
- 30. Radiofrequency signal affects alpha band in resting electroencephalogram.** Results: Compared with sham session, the exposure session showed a statistically significant ($p < 0.0001$) decrease of the alpha band spectral power during closed eyes condition. This effect persisted in the post-exposure session ($p < 0.0001$). No significant changes were detected in electrode impedance, salivary cortisol and caffeine in the sham session when compared to the exposure one. Conclusions: These results suggest that GSM-EMFs of a mobile phone affect alpha band within spectral power of resting human EEG. <http://www.ncbi.nlm.nih.gov/pubmed/25695646?dopt=Abstract> (18 Feb 2015)
- 31. Long term and excessive use of 900 MHz radiofrequency radiation alter microRNA expression in brain.** Rats in the exposure group were exposed to 900 MHz RF radiation for 3 h per day (7 days a week) for 12 months (one year). Results: Results revealed that long-term exposure of 900 MHz RF radiation only decreased rno-miR107 (adjP* = 0.045) value where the whole body (rms) SAR value was 0.0369 W/kg. However, our results indicated that other microRNA evaluated in this study was not altered by 900 MHz RF radiation. Conclusion: 900 MHz RF radiation can alter some of the miRNA, which, in turn, may lead to adverse effects. <http://www.ncbi.nlm.nih.gov/pubmed/25529971?dopt=Abstract> (27 Jan 2015) [GE]
- 32. Effects of Cellular Phone- and Wi-Fi-Induced Electromagnetic Radiation on Oxidative Stress and Molecular Pathways in Brain.** This paper reviews the effects of Wi-Fi (2.45 GHz) EMR exposure on the central nervous system in humans and experimental animals. Electromagnetic radiation may induce some degenerative effects in the brain by increasing oxidative stress and DNA breakage plus interference with the blood-brain barrier permeability. There are also recent reports on the role of Wi-Fi and mobile phone frequencies on Ca²⁺ influx through Ca²⁺ channels. The EMR increases ROS production in the neurons through the activation of oxidant system including NADPH oxidase activity and nitric oxide production. These effects are accompanied by a decrease in brain tissue of enzymatic antioxidants such as superoxide dismutase, catalase, and glutathione peroxidase together with a fall in the levels of nonenzymatic antioxidants such as glutathione and vitamin C. Cell phone- and Wi-Fi-induced EMR appears to induce degenerative effects through increase of oxidative stress and decrease of antioxidants in the brain that affect neuronal physiological functions. (May 2014) http://link.springer.com/referenceworkentry/10.1007/978-3-642-30018-9_210 [BB, BD, BI, DD, OS]
- 33. Protective role of sesame oil against mobile base station-induced oxidative stress.** The effects of exposure of rats to a 900 MHz electromagnetic field on blood parameters and the possible protective role of sesame oil (antioxidant) against oxidative stress should be investigated. Exposure of rats to a 900 MHz electromagnetic field might influence blood parameters and induce oxidative stress and that sesame oil as an antioxidant might attenuate these effects. (2014) <http://www.emf-portal.de/viewer.php?l=e&aid=23921> [Bi, EA, OS]
- 34. Radiofrequency electromagnetic field exposure effects on antioxidant enzymes and liver function tests.** Rats exposed to microwaves (2.45 GHz) or to the radiofrequency field of a mobile phone (900 MHz) showed significantly decreased enzyme activities of the glutathione peroxidase and the superoxide dismutase when compared to the control, while the enzyme activity of the catalase and the lipid peroxidation were significantly increased. Additionally, all liver values in the serum of exposed rats (microwave or mobile phone) were significantly increased in comparison to the control group. The authors conclude that exposure to microwaves (2.45 GHz) or to the radiofrequency field of a mobile phone (900 MHz) could lead to oxidative stress in the liver and to increased liver values in rats. <http://www.indianjournals.com/ijor.aspx?target=ijor:lsijls&type=home> [EA, OS]

- 35. The effect of 2100 MHz radiofrequency radiation of a 3G mobile phone on the parotid gland of rats.** The parotid gland of rats showed numerous histopathological changes after exposure to 2100 MHz radiofrequency radiation, both in the short and relatively long terms. Increased exposure duration led to an increase in the histopathological changes.
<http://www.ncbi.nlm.nih.gov/pubmed/25456509?dopt=Abstract> [CI]
- 36. Liver antioxidant stores protect the brain from electromagnetic radiation (900 and 1800 MHz)-induced oxidative stress in rats during pregnancy and the development of offspring.** Brain and liver glutathione peroxidase activities, as well as liver vitamin A and β -carotene concentrations decreased in the EMR groups, although brain iron, vitamin A, and β -carotene concentrations increased in the EMR groups. In the 6th week, selenium concentrations in the brain decreased in the EMR groups. There were no statistically significant differences in glutathione, vitamin E, chromium, copper, magnesium, manganese, and zinc concentrations between the three groups. Conclusion: EMR-induced oxidative stress in the brain and liver was reduced during the development of offspring. Mobile phone-induced EMR could be considered as a cause of oxidative brain and liver injury in growing rats.
<http://www.ncbi.nlm.nih.gov/pubmed/24580725?dopt=Abstract> [BI, EA, OS]
- 37. Long term and excessive use of 900 MHz radiofrequency radiation alter microRNA expression in brain.** Results revealed that long term exposure of 900 MHz RF radiation only decreased rno-miR107 (adjP*= 0,045) value where the whole body (rms) SAR value was 0.0369 W/kg. However, our results indicated that other micro RNAs evaluated in this study was not altered by 900 MHz RF radiation. Conclusion: 900 MHz RF radiation can alter some of the miRNAs, which, in turn, may lead to adverse effects. <http://www.ncbi.nlm.nih.gov/pubmed/25529971?dopt=Abstract> [EA, GE]
- 38. Effect of electromagnetic irradiation produced by 3G mobile phone on male rat reproductive system in a simulated scenario.** Significant decrease in sperm count, increase in the lipid peroxidation damage in sperm cells, reduction in seminiferous tubules and testicular weight and DNA damage were observed following exposure to EMF in male albino rats. The results suggest that mobile phone exposure adversely affects male fertility. <http://www.ncbi.nlm.nih.gov/pubmed/25241589> [OS, DD, SE]
- 39. Immunohistochemical localization of brain-derived neurotrophic factor and glial cell line-derived neurotrophic factor in the superior olivary complex of mice after radiofrequency exposure.** Protein expression of the brain-derived neurotrophic factor and glial-derived neurotrophic factor was significantly reduced in all examined brain areas in the exposure group compared to the sham exposure group. The authors conclude that exposure of mice to an 835 MHz electromagnetic field could have an effect on the protein expression of the brain-derived neurotrophic factor and glial-derived neurotrophic factor in the central auditory system, which in turn might affect its function. (3 Apr 2014)
<http://www.ncbi.nlm.nih.gov/pubmed/24548626?dopt=Abstract> [EA]
- 40. Evaluation of oxidant stress and antioxidant defense in discrete brain regions of rats exposed to 900 MHz radiation.** Altered behavioural performances were found in RF-EMR-exposed rats. Additionally, elevated TBARS level was found with all brain regions studied. RF-EMR exposure significantly decreased TA in the amygdala and cerebellum but its level was not significantly changed in other brain regions. GST activity was significantly decreased in the hippocampus but, its activity was unaltered in other brain regions studied. RF-EMR exposure for a month induced oxidative stress in rat brain, but its magnitude was different in different regions studied.
<http://www.ncbi.nlm.nih.gov/pubmed/25174055?dopt=Abstract> [OS, BM, EA]
- 41. The effects of prenatal exposure to a 900-MHz electromagnetic field on the 21-day-old male rat heart.** Malondialdehyde, superoxide dismutase and catalase values were significantly higher in the experimental group rats, while glutathione values were lower. Light microscopy revealed irregularities in heart muscle fibers and apoptotic changes in the experimental group. Electron microscopy revealed crista loss and swelling in the mitochondria, degeneration in myofibrils and structural impairments in Z bands. Our study results suggest that exposure to EMF in the prenatal period causes oxidative stress and histopathological changes in male rat pup heart tissue.
<http://www.ncbi.nlm.nih.gov/pubmed/25166431?dopt=Abstract> [BI, OS, EA, AP, CI, EM]
- 42. Pathological effects of prenatal exposure to a 900 MHz electromagnetic field on the 21-day-old male rat kidney.** Light microscopy revealed some degenerative changes in the tubule epithelium, small cystic formations in the primitive tubules and large cysts in the cortico-medullary or medullary regions in the experimental group. Electron microscopy revealed a loss of peritubular capillaries and atypical parietal layer epithelial cells in the experimental group. Biochemical analysis showed significantly increased MDA levels in the experimental group and decreased SOD and CAT levels. EMF applied during the prenatal period can caused pathological changes in kidney tissue in 21-day-old male rats owing to oxidative stress and decreased antioxidant enzyme levels.
<http://www.ncbi.nlm.nih.gov/pubmed/25158858?dopt=Abstract> [BI, OS, EA, CI]

- 43. The effect of prenatal exposure to 900-megahertz electromagnetic field on the, 21-old-day rat testicle.** NEMFG rats exhibited irregularities in seminiferous tubule basal membrane and epithelium, immature germ cells in the lumen, and a decreased diameter in seminiferous tubules and thickness of epithelium. Apoptotic index, lipid peroxidation and DNA oxidation were higher in NEMFG rats than in NCG. 21-day-old rat testicles exposed to 900-MHz EMF in the prenatal term may be adversely affected, and this effect persists after birth.
<http://www.ncbi.nlm.nih.gov/pubmed/24095929?dopt=Abstract> [BI, OS, DD, CI]
- 44. Analysis of rat testicular proteome following 30-days exposure to 900 MHz electromagnetic field radiation.** Heat shock proteins, superoxide dismutase, peroxiredoxin-1 and other proteins related to misfolding of proteins and/or stress were identified. These results demonstrate significant effects of radio-frequency modulated electromagnetic fields (RF-EMF) exposure on proteome, particularly in protein species in the rodent testis, and suggest that a 30 d exposure to EMF radiation induces non-thermal stress in testicular tissue. <http://www.ncbi.nlm.nih.gov/pubmed/25146694?dopt=Abstract> [BI, OS, EA]
- 45. Effects of microwaves (950 MHz mobile phone) on morphometric and apoptotic changes of rabbit epididymis.** This study showed that the microwaves with the frequency of 950 MHz can have negative impacts on morphometric and apoptotic changes of rabbit epididymis.
<http://www.ncbi.nlm.nih.gov/pubmed/25060044?dopt=Abstract> [CI, AP]
- 46. Selenium Reduces Mobile Phone (900 MHz)-Induced Oxidative Stress, Mitochondrial Function, and Apoptosis in Breast Cancer Cells** Exposure to mobile phone-induced electromagnetic radiation (EMR) may affect biological systems by increasing free oxygen radicals, apoptosis, and mitochondrial depolarization levels although selenium may modulate the values in cancer.
<http://www.ncbi.nlm.nih.gov/pubmed/24965080?dopt=Abstract> [BI, OS, AP, EM]
- 47. Effects of mobile phone radiation (900 MHz radiofrequency) on structure and functions of rat brain.** Discussion: Thus our findings indicate extensive neurodegeneration on exposure to radio waves. Increased production of reactive oxygen species due to exhaustion of enzymatic and non-enzymatic antioxidants and increased lipid peroxidation are indicating extensive neurodegeneration in selective areas of CA1, CA3, DG, and cerebral cortex. This extensive neuronal damage results in alterations in behavior related to memory and learning.
<http://www.ncbi.nlm.nih.gov/pubmed/24861496?dopt=Abstract> (Dec 2014) [BD, BI, OS, CI, BM, MR]
- 48. Biochemical Modifications and Neuronal Damage in Brain of Young and Adult Rats After Long-Term Exposure to Mobile Phone Radiations.** Bax/Bcl-2 ratio, caspase-3 activity, and tumor necrosis factor-alpha level were enhanced, whereas no DNA fragmentation was detected. The relative brain weight of young rats was greatly affected, and histopathological examination reinforced the neuronal damage. The study highlights the detrimental effects of mobile phone radiations on brain during young and adult ages. The interaction of these radiations with brain is via dissipating its antioxidant status and/or triggering apoptotic cell death. <http://www.ncbi.nlm.nih.gov/pubmed/24801773?dopt=Abstract> [BI, OS, EA, AP]
- 49. Cell oxidation-reduction imbalance after modulated radiofrequency radiation.** Test with 1800Mhz RF exposure. In exposed samples, ROS level significantly ($p < 0.05$) increased after 10 min of exposure. Decrease in ROS level was observed after 30-min treatment indicating antioxidant defence mechanism activation. In conclusion, under the given laboratory conditions, modulated RF radiation might cause impairment in cell oxidation-reduction equilibrium within the growing cells.
<http://www.ncbi.nlm.nih.gov/pubmed/25119294?dopt=Abstract> [BI, OS]
- 50. The influence of direct mobile phone radiation on sperm quality.** The number of spermatozoa with progressive movement in the group, influenced by electromagnetic radiation, is statistically lower than the number of spermatozoa with progressive movement in the group under no effect. The number of non-progressive movement spermatozoa was significantly higher in the group, which was influenced by cell phone radiation. The DNA fragmentation was also significantly higher in this group. A correlation exists between mobile phone radiation exposure, DNA-fragmentation level and decreased sperm motility. <http://www.ncbi.nlm.nih.gov/pubmed/24982785> [DD, SE]
- 51. The effect of radiofrequency radiation generated by a Global System for Mobile Communications source on cochlear development in a rat model.** Results: Distortion product otoacoustic emission tests revealed no significant difference among the groups, but electron microscopic evaluation revealed significant differences among the groups with regard to the number of normal, apoptotic and necrotic cells. Conclusion: The findings indicated cellular structural damage in the cochlea caused by radiofrequency radiation exposure during cochlear development in the rat model.
<http://www.ncbi.nlm.nih.gov/pubmed/24784924?dopt=Abstract> [AP, CI]

52. **Effect of exposure and withdrawal of 900-MHz-electromagnetic waves on brain, kidney and liver oxidative stress and some biochemical parameters in male rats.** In conclusion, electromagnetic field emitting from mobile phone might produce impairments in some biochemical changes and oxidative stress in brain, liver and renal tissue of albino rats. These alterations were corrected by withdrawal. <http://www.ncbi.nlm.nih.gov/pubmed/24712749?dopt=Abstract> [BI, OS]
53. **Oxidative changes and apoptosis induced by 1800-MHz electromagnetic radiation in NIH/3T3 cells.** Results indicate that an 1800-MHz EMR enhances ROS formation and promotes apoptosis in NIH/3T3 cells <http://www.ncbi.nlm.nih.gov/pubmed/24665905?dopt=Abstract> [BI, OS, DD, AP]
54. **Maternal mobile phone exposure alters intrinsic electrophysiological properties of CA1 pyramidal neurons in rat offspring.** Exposure to mobile phones adversely affects the cognitive performance of both female and male offspring rats <http://www.ncbi.nlm.nih.gov/pubmed/24604340?dopt=Abstract> [BM, MR]
55. **Spatial learning, monoamines and oxidative stress in rats exposed to 900MHz electromagnetic field in combination with iron overload.** No significant differences regarding learning and memory were observed in the Morris water maze and eight-arm radial maze between the groups. However, exposed rats from group 1 (electromagnetic field) and group 2 (electromagnetic field + iron) showed significantly impaired results in the object exploration test in comparison to the sham exposed rats. <http://www.ncbi.nlm.nih.gov/pubmed/24144546?dopt=Abstract> (1 Jan 2014) [BI, OS, BM]
56. **Study of Oxidative Stress in Human Lens Epithelial Cells Exposed to 1.8 GHz Radiofrequency Fields** - In all exposed cell cultures, the level of reactive oxygen species and the lipid peroxidation were significantly increased compared to the corresponding sham exposed cell cultures, while the cell viability, the gene expression and the protein expression were significantly decreased. <http://www.ncbi.nlm.nih.gov/pubmed/23991100?dopt=Abstract> [BI, OS, GE]
57. **Mobile phone radiation induces mode-dependent DNA damage in a mouse spermatocyte-derived cell line: a protective role of melatonin.** The levels of DNA damage were significantly increased following exposure to MPR in the listen, dialed and dialing modes. <http://www.ncbi.nlm.nih.gov/pubmed/23952262?dopt=Abstract> [DD]
58. **Circadian alterations of reproductive functional markers in male rats exposed to 1800 MHz radiofrequency field.** Via these measurements, we confirmed the existence of circadian rhythms in sham-exposed animals. However, rats exposed to RF exhibited a disruption of circadian rhythms, decreased testosterone levels, lower daily sperm production and sperm motility, down-regulated activity of γ -GT and ACP, as well as altered mRNA expression of cytochrome P450 and StAR. All of these observations were more pronounced when rats were exposed to RF at ZT0. Thus, our findings indicate potential adverse effects of RF exposure on male reproductive functional markers, in terms of both the daily overall levels as well as the circadian rhythmicity. <http://www.ncbi.nlm.nih.gov/pubmed/24117058?dopt=Abstract> [CR, SE, GE, EA]
59. **Investigation of the Effects of 2.1 GHz Microwave Radiation on Mitochondrial Membrane Potential ($\Delta\Psi$ m), Apoptotic Activity and Cell Viability in Human Breast Fibroblast Cells.** The results of this study showed that 2.1 GHz W-CDMA modulated MW radiation-induced apoptotic cell death via the mitochondrial pathway. <http://www.ncbi.nlm.nih.gov/pubmed/23723005?dopt=Abstract> [AP, ME]
60. **Evaluation of the cytogenotoxic damage in immature and mature rats exposed to 900 MHz radio frequency electromagnetic fields.** The exposure of RF-EMF leads to cytotoxic and genotoxic damage in immature and mature rats. More sensitive studies are required to elucidate the possible carcinogenic risk of EMF exposure in humans, especially children. <http://www.ncbi.nlm.nih.gov/pubmed/23718180?dopt=Abstract> [DD, AP, CI]
61. **Effect of low level microwave radiation exposure on cognitive function and oxidative stress in rats.** The study aimed to evaluate the effects of 900 MHz MW radiation exposure on cognitive function and oxidative stress in blood of Fischer rats. Results showed significant impairment in cognitive function and increase in oxidative stress, as evidenced by the increase in levels of MDA (a marker of lipid peroxidation) and protein carbonyl (a marker of protein oxidation) and unaltered GSH content in blood. Thus, the study demonstrated that low level MW radiation had significant effect on cognitive function and was also capable of leading to oxidative stress. <http://www.ncbi.nlm.nih.gov/pubmed/23720885?dopt=Abstract> [BI, OS, BM]
62. **Effects of intensive cell phone (philips genic 900) use on the rat kidney tissue.** Considering the damage in rat kidney tissue caused by EMR-emitting cell phones, high-risk individuals should take protective measures. <http://www.ncbi.nlm.nih.gov/pubmed/23801472?dopt=Abstract> [CI]

63. **Effect of 950 MHz UHF Electromagnetic radiation on biomarkers of oxidative damage, metabolism of UFA and antioxidants in the liver of young rats of different ages.** For rats of 30 days, no OS, but it is genotoxic to the livers of ER to total body irradiation. <http://www.ncbi.nlm.nih.gov/pubmed/23789976?dopt=Abstract> [DD]
64. **Detection of Low Level Microwave Radiation Induced Deoxyribonucleic Acid Damage Vis-à-vis Genotoxicity in Brain of Fischer Rats.** Experiments were performed on male Fischer rats exposed to microwave radiation for 30 days at three different frequencies: 900, 1800 and 2450 MHz. We concluded that low SAR microwave radiation exposure at these frequencies may induce DNA strand breaks in brain tissue. <http://www.ncbi.nlm.nih.gov/pubmed/23833433?dopt=Abstract> [DD]
65. **Stimulation of the brain with radiofrequency electromagnetic field pulses affects sleep-dependent performance improvement negatively.** Pulse-modulated radiofrequency electromagnetic fields (RF EMF, carrier frequency 900 MHz) are capable to modulate these electroencephalographic (EEG) characteristics of sleep. The changes in the time course of SWA during the exposure night may reflect an interaction of RF EMF with the renormalization of cortical excitability during sleep, with a negative impact on sleep-dependent performance improvement. <http://www.ncbi.nlm.nih.gov/pubmed/23482083?dopt=Abstract> [SP]
66. **The exposure of adult rats to EMR may cause disturbances in monoamine neurotransmitters and this may underlie many of the adverse effects reported after EMR including memory, learning, and stress.** Adult rats were exposed daily to EMR (frequency 1800 MHz). The exposure of adult rats to EMR may cause disturbances in monoamine neurotransmitters and this may underlie many of the adverse effects reported after EMR including memory, learning, and stress. <http://www.ncbi.nlm.nih.gov/pubmed/23852905?dopt=Abstract> (Jul 2013) [BI, BM, MR]
67. **Exposure to 1800MHz Radiofrequency Electromagnetic Radiation Induces Oxidative DNA Base Damage in a Mouse Spermatoocyte-Derived Cell Line.** The authors conclude that exposure to radiofrequency electromagnetic fields causes a DNA damage in male germ cells via oxidative stress. <http://www.emf-portal.de/viewer.php?l=e&aid=21674> [OS, DD]
68. **Effect of 900 MHz radiofrequency radiation on oxidative stress in rat brain and serum.** Our results suggest that there is a significant increase in brain lipid and protein oxidation after electromagnetic radiation (EMR) exposure and that garlic has a protective effect against this oxidative stress. <http://www.ncbi.nlm.nih.gov/pubmed/23301880?dopt=Abstract> [BI, OS, EA]
69. **Effect of 3G Cell Phone Exposure with Computer Controlled 2-D Stepper Motor on Non-thermal Activation of the hsp27/p38MAPK Stress Pathway in Rat Brain.** Result shows that microwave radiation emitted from 3G mobile phone significantly induced DNA strand breaks in brain. <http://www.ncbi.nlm.nih.gov/pubmed/23949848?dopt=Abstract> [OS, DD, EM, EA, AP]
70. **Effect Of Microwave Radiation On The Retina Of Mice Embryos.** Exposure to a frequency of 950 MHz and exposure to a frequency of 1800 MHz. The mean body length and body weight were significantly decreased when compared to the control group, cells of the retinal tissue lost their normal arrangement and became aggregated in the inner and outer layer of the retina. <http://www.emf-portal.de/viewer.php?l=e&aid=23338> [ME, CI]
71. **Effect of 900MHz electromagnetic fields emitted from cellular phones on fracture healing: an experimental study on rats.** Results of this study demonstrate that EMF at 900 MHz of frequency emitted from cellular phones has a significantly negative effect on bone fracture healing in a rat tibia model. <http://www.ncbi.nlm.nih.gov/pubmed/23999516?dopt=Abstract> [RH]
72. **The toxic effects of mobile phone radiofrequency (940 MHz) on the structure of calf thymus DNA.** Collectively, these experiments indicate that exposure to an electromagnetic radiofrequency field can alter the structure of DNA irreversibly. <http://www.ncbi.nlm.nih.gov/pubmed/23164448?dopt=Abstract> [DD]
73. **Overproduction of free radical species in embryonal cells exposed to low intensity radiofrequency radiation.** The exposure resulted in a significant persistent overproduction of superoxide and nitrogen oxide in embryo cells during all period of analyses. Exposure of developing quail embryos to extremely low intensity RF-EMR of GSM 900 MHz during at least one hundred and fifty-eight hours leads to a significant overproduction of free radicals/reactive oxygen species and oxidative damage of DNA in embryo cells. <http://www.ncbi.nlm.nih.gov/pubmed/24084462?dopt=Abstract> [BI, OS, DD]
74. **The protective effect of autophagy on mouse spermatoocyte derived cells exposure to 1800MHz radiofrequency electromagnetic radiation.** Intracellular ROS levels significantly increased in a dose- and time-dependent manner after cells were exposed to RF. <http://www.ncbi.nlm.nih.gov/pubmed/24813634?dopt=Abstract> [BI, OS]

- 75. Male reproductive health under threat: Short term exposure to radiofrequency radiations emitted by common mobile jammers.** The motility of sperm samples exposed to jammer RF radiation for 2 or 4 h were significantly lower than those of sham-exposed samples. <http://www.ncbi.nlm.nih.gov/pubmed/24082653?dopt=Abstract> [SE]
- 76. The effects of mobile phones on apoptosis in cerebral tissue: an experimental study on rats.** In the study group of 10 rats; mobile phones that spread EMW at a frequency between 1900-2100 MHz. Our results showed that the electro-magnetic waves emitted by the mobile phones may have effect on apoptosis. <http://www.ncbi.nlm.nih.gov/pubmed/24763879?dopt=Abstract> [AP, GE]
- 77. Effect of mobile phone use on salivary concentrations of protein, amylase, lipase, immunoglobulin A, lysozyme, lactoferrin, peroxidase and C-reactive protein of the parotid gland.** Salivary flow rate and parotid gland salivary concentrations of protein were significantly higher on the right side compared to the left in those that predominantly held mobile phones on the right side. In addition, there was a decrease in concentrations of amylase, lipase, lysozyme, lactoferrin and peroxidase. <http://www.ncbi.nlm.nih.gov/pubmed/24739140?dopt=Abstract> [BI, EA]
- 78. DNA damage but not linked cellular dysfunction.** Cell Type-Dependent Induction of DNA Damage by 1800 MHz Radiofrequency Electromagnetic Fields Does Not Result in Significant Cellular Dysfunctions. <http://www.ncbi.nlm.nih.gov/pubmed/23355902?dopt=Abstract> [OS, DD]
- 79. GSM 900 MHz cellular phone radiation can either stimulate or depress early embryogenesis in Japanese quails depending on the duration of exposure.** An exposure for 158 hours significantly decreased the number of differentiated somites and resulted in a significant increase of DNA strand breaks compared to the control group. The authors conclude that mobile phone-exposure can stimulate or depress the embryogenesis of Japanese quails and that this effect could depend on the exposure duration. <http://www.emf-portal.de/viewer.php?l=e&aid=22134> [DD]
- 80. Transient and cumulative memory impairments induced by GSM 1.8 GHz cell phone signal in a mouse model.** One-way analysis of variance revealed statistically significant impairments of both types of memory gradually accumulating, with more pronounced effects on the spatial memory. The impairments persisted even 2 weeks after interruption of the 8 weeks daily exposure, whereas the memory of mice as detected by both tasks showed a full recovery approximately 1 month later. <http://www.ncbi.nlm.nih.gov/pubmed/23320614?dopt=Abstract> [MR]
- 81. Effect of electromagnetic irradiation produced by 3G mobile phone on male rat reproductive system in a simulated scenario.** Testicular function is particularly susceptible to the radiation emitted by EMFs. Significant decrease in sperm count, increase in the lipid peroxidation damage in sperm cells, reduction in seminiferous tubules and testicular weight and DNA damage were observed following exposure to EMF in male albino rats. The results suggest that mobile phone exposure adversely affects male fertility. <http://www.ncbi.nlm.nih.gov/pubmed/25241589?dopt=Abstract> [SE, DD]
- 82. Differential Pro-Inflammatory Responses of Astrocytes and Microglia Involve STAT3 Activation in Response to 1800 MHz Radiofrequency Fields.** RF exposure induced differential pro-inflammatory responses in astrocytes and microglia, characterized by different expression and release profiles of IL-1 β , TNF- α , IL-6, PGE2, nitric oxide (NO), inducible nitric oxide synthase (iNOS) and cyclooxygenase 2 (COX2). Results demonstrated that RF exposure differentially induced pro-inflammatory responses in microglia and astrocytes <http://www.ncbi.nlm.nih.gov/pubmed/25275372?dopt=Abstract> [BI, IN, EA]
- 83. Exposure to 1800 MHz radiofrequency radiation impairs neurite outgrowth of embryonic neural stem cells.** Neurite outgrowth of eNSC differentiated neurons was inhibited after 4 W/kg RF-EMF exposure for 3 days. Additionally, the mRNA and protein expression of the proneural genes Ngn1 and NeuroD, which are crucial for neurite outgrowth, were decreased after RF-EMF exposure. The expression of their inhibitor Hes1 was upregulated by RF-EMF exposure. These results together suggested that 1800 MHz RF-EMF exposure impairs neurite outgrowth of eNSCs. <http://www.ncbi.nlm.nih.gov/pubmed/24869783> [GE]
- 84. Non-thermal continuous and modulated electromagnetic radiation fields effects on sleep EEG of rats.** Two types of radiation fields were used; 900 MHz unmodulated wave and 900 MHz modulated at 8 and 16 Hz waves. Animals has exposed to radiation fields for 1 month (1 h/day). EEG power spectral analyses of exposed and control animals during slow wave sleep (SWS) and rapid eye movement sleep (REM sleep) revealed that the REM sleep is more susceptible to modulated radiofrequency radiation fields (RFR) than the SWS. The latency of REM sleep increased due to radiation exposure indicating a change in the ultradian rhythm of normal sleep cycles. The cumulative and irreversible effect of radiation exposure was proposed and the interaction of the extremely low

frequency radiation with the similar EEG frequencies was suggested. (March 2013)
<http://www.ncbi.nlm.nih.gov/pubmed/25685416> [CR, SP]

WiFi (2.4Ghz - 2450Ghz) Exposure Studies

- 85. 2.45 GHz Microwave Radiation Impairs Learning and Spatial Memory via Oxidative/Nitrosative Stress Induced p53 Dependent/Independent Hippocampal Apoptosis: Molecular Basis and Underlying Mechanism.** A close association between microwave (MW) radiation exposure and neurobehavioral disorders has been postulated but the direct effects of MW radiation on central nervous system still remains contradictory. Twelve-weeks old mice were exposed to 2.45 GHz MW radiation (continuous-wave (CW) with overall average Power density of 0.0248 mW/cm² and overall average whole body SAR value of 0.0146 W/Kg) for 2h/day over a period of 15, 30 and 60 days). Spatial learning and memory was monitored by Morris Water Maze. We observed that, short-term as well as long-term 2.45 GHz MW radiation exposure increases the oxidative/nitrosative stress leading to enhanced apoptosis in hippocampal subfield neuronal and non-neuronal cells. Present findings also suggest that learning and spatial memory deficit which increases with the increased duration of MW exposure (15<30<60 days) is correlated with a decrease in hippocampal subfield neuronal arborization and dendritic spines. These findings led us to conclude that exposure to continuous-wave MW radiation leads to oxidative/nitrosative stress induced p53 dependent/independent activation of hippocampal neuronal and non-neuronal apoptosis associated with spatial memory loss. (22 Sep 2015)
<http://www.ncbi.nlm.nih.gov/pubmed/26396154?dopt=Abstract> [AP, BM, OS]
- 86. Effect of long-term exposure of 2.4 GHz radiofrequency radiation emitted from Wi-Fi equipment on testes functions.** The aim of this study was to investigate long-term effects of radiofrequency radiation (RFR) emitted from a Wireless Fidelity (Wi-Fi) system on testes. The study was carried out on 16 Wistar Albino adult male rats by dividing them into two groups such as sham (n: 8) and exposure (n: 8). Rats in the exposure group were exposed to 2.4 GHz RFR radiation for 24 h/d during 12 months (1 year). The results were evaluated by using Johnsen's score. Head defects increased in the exposure group (p < 0.05) while weight of the epididymis and seminal vesicles, seminiferous tubules diameter and tunica albuginea thickness were decreased in the exposure group (p < 0.01, p < 0.001, p < 0.0001). However, other alterations of other parameters were not found significant (p > 0.05). In conclusion, we observed that long-term exposure of 2.4 GHz RF emitted from Wi-Fi (2420 µW/kg, 1 g average) affects some of the reproductive parameters of male rats. (Mar 2015)
<http://www.ncbi.nlm.nih.gov/pubmed/24460421?dopt=Abstract> [CI, SE]
- 87. Effects of acute exposure to WIFI signals (2.45 GHz) on heart variability and blood pressure in Albinos rabbit.** Electrocardiogram and arterial pressure measurements were studied under acute exposures to WIFI (2.45 GHz) during one hour in adult male rabbits. Antennas of WIFI were placed at 25 cm at the right side near the heart. Acute exposure of rabbits to WIFI increased heart frequency (+22%) and arterial blood pressure (+14%). Moreover, analysis of ECG revealed that WIFI induced a combined increase of PR and QT intervals. By contrast, the same exposure failed to alter maximum amplitude and P waves. After intravenously injection of dopamine (0.50 ml/kg) and epinephrine (0.50 ml/kg) under acute exposure to RF we found that, WIFI alter catecholamines (dopamine, epinephrine) action on heart variability and blood pressure compared to control. These results suggest for the first time, as far as we know, that exposure to WIFI affect heart rhythm, blood pressure, and catecholamines efficacy on cardiovascular system; indicating that radiofrequency can act directly and/or indirectly on cardiovascular system. (2 SEP 2015)
<http://www.sciencedirect.com/science/article/pii/S1382668915300594> [EG, HRV]
- 88. Impact of 2.45 GHz microwave radiation on the testicular inflammatory pathway biomarkers in young rats: The role of gallic acid.** The aim of this study was to investigate electromagnetic radiation (EMR) transmitted by wireless devices (2.45 GHz), which may cause physiopathological or ultrastructural changes, in the testes of rats. Forty-eight rats were equally divided into four groups, which were named: Sham, EMR only (EMR, 3 h day⁻¹ for 30 days), EMR + GA (30 mg/kg/daily), and GA (30 mg/kg/daily) groups. Malondialdehyde (MDA) and total oxidant status (TOS) levels increased (p = 0.001 for both) in EMR only group. Total antioxidant status (TAS) activities decreased in EMR only group. Testosterone and vascular endothelial growth factor (VEGF) levels decreased in EMR only group, but this was not statistically significant. Prostaglandin E2 (PGE2) and calcitonin gene related peptide (CGRP) staining increased in tubules of the testes in EMR only group (p < 0.001 for both). In EMR only group, most of the tubules contained less spermatozoa, and the spermatozoon counts decreased in tubules of the testes. Long term EMR exposure resulted in testicular physiopathology via oxidative damage and inflammation. (13 Aug 2015) [CI, EA, GE, IN, OS, SE]
- 89. EMF radiation at 2450 MHz triggers changes in the morphology and expression of heat shock proteins and glucocorticoid receptors in rat thymus.** The thymus tissue presented several

morphological changes, including increased distribution of blood vessels along with the appearance of red blood cells and hemorrhagic reticuloepithelial cells. Levels of Hsp90 decreased in the thymus when animals were exposed to the highest power level (12 W), but only one group did not show recovery after 24 h. Hsp70 presented no significant modifications in any of the groups. The glucocorticoid receptors presented greater immunomarking on the thymic cortex in exposed animals. (15 Apr 2015) <http://www.ncbi.nlm.nih.gov/pubmed/25731700?dopt=Abstract> [CI, EA]

- 90. EFFECTS OF 2.4 GHz RADIOFREQUENCY RADIATION EMITTED FROM WI-FI EQUIPMENT ON microRNA EXPRESSION IN BRAIN TISSUE.** The results revealed that long term exposure of 2.4 GHz Wi-Fi radiation can alter expression of some of the miRNAs such as miR-106b-5p (adjP* = 0,010) and miR-107 (adjP* = 0,005). We observed that mir 107 expression is 3.3 times and miR-106b-5p expression is 3.65 times lower in the exposure group than in the control group. Long term exposure of 2.4 GHz RF may lead to adverse effects such as neurodegenerative diseases originated from the alteration of some miRNAs expression. <http://www.ncbi.nlm.nih.gov/pubmed/25775055?dopt=Abstract> (16 March 2015) [BD, GE]
- 91. Structural and ultrastructural study of rat liver influenced by electromagnetic radiation.** The aim of this study was to examine the effects of EMR on Wistar rat liver. Mature rats were exposed to electromagnetic field of frequency 2.45 GHz and mean power density of 2.8 mW/cm(2) for 3 h/d for 3 wk. Samples of the liver were obtained 3 h after the last irradiation and processed histologically for light and transmission electron microscopy. Data demonstrated the presence of moderate hyperemia, dilatation of liver sinusoids, and small inflammatory foci in the center of liver lobules. Occasionally necrotizing hepatocytes were observed. Our observations demonstrate that EMR exposure produced adverse effects on rat liver. (2015) <http://www.ncbi.nlm.nih.gov/pubmed/25734762?dopt=Abstract> [CI, IN]
- 92. Experimental analysis of HSP 90 and 70 in-vivo changes induced in the thyroid by exposure to microwave electromagnetic fields.** Fifty-four rats were individually exposed for 30 min to 2.45 GHz radiation in a Gigahertz Transverse Electromagnetic (GTEM) cell at different levels of non-thermal SAR. Ninety minutes after radiation, HSP-90 and HSP-70 had decreased significantly (p<0.01) after applying a SAR of 0.046±1.10 or 0.104±5.10-3W/kg. Twenty-four hours after radiation, HSP-90 had partially recovered and HSP-70 had recovered completely. There are few indications of lesions in the glandular structure and signs of apoptosis were negative in all radiated animals. The results suggest that acute sub-thermal radiation at 2.45 GHz may alter levels of cellular stress in rat thyroid gland without initially altering their anti-apoptotic capacity.(2012) http://www.researchgate.net/publication/261226695_Experimental_analysis_of_HSP_90_and_70_in-vivo_changes_induced_in_the_thyroid_by_exposure_to_microwave_electromagnetic_fields [BI, CI, EA]
- 93. Exposure to non-ionizing radiation provokes changes in rat thyroid morphology and expression of HSP-90.** Morphological changes in the thyroid tissue may indicate a glandular response to acute or repeated stress from radiation in the hypothalamic-pituitary-thyroid axis. Further research is needed to determine if the effect of this physical agent over time may cause disease in the human thyroid gland. <http://www.ncbi.nlm.nih.gov/pubmed/25649190?dopt=Abstract> [CI, CS, GE]
- 94. Radiofrequency electromagnetic field exposure effects on antioxidant enzymes and liver function tests.** The aim of this study was to investigate the effect of mobile phone and microwave (MW; 2.45 GHz) radiation on the oxidative status of liver. Result shows that exposure to mobile phone and MW radiations decrease the level of GPx and SOD in exposed group as compared to sham exposed group. While CAT level was found to be increased in exposed group as compared to sham exposed. Meanwhile, elevated level of MDA and changes in liver function parameters were also observed in mobile phone and MW-exposed groups by comparing to control ones. The study concludes that the chronic exposure to these radiations adversely affect the liver functioning and may be an indication of possible tumour promotion due to significant (P<0.05) changes occur in antioxidative enzymes. [BI, EA, OS, TP]
- 95. Increased DNA oxidation (8-OHdG) and protein oxidation (AOPP) by Low level electromagnetic field (2.45 GHz) in rat brain and protective effect of garlic.** Conclusions: It may be concluded that low level EMF at 2.45 GHz MWR increases the DNA damage in both brain tissues and plasma of the rats whereas it increases protein oxidation only in plasma. It may also be argued that the use of garlic decreases these effects. <http://www.ncbi.nlm.nih.gov/pubmed/24844368> [BI, OS, DD]
- 96. Structural and ultrastructural study of rat testes influenced by electromagnetic radiation.** Pulsed electromagnetic field at frequency of 2.45 GHz and mean power density 2.8 mW/cm(2) by 3-h daily applications for 3 wk. Except for relatively unchanged Sertoli cells, some locations of basal compartment of seminiferous epithelium contained shrivelled Sertoli cells with dark cytoplasm. These areas showed degenerative features including necrotizing and shrivelled spermatogonia surrounded by

empty irregular spaces, and undulating basement membrane. The intertubular spaces were enlarged but interstitial Leydig cells did not show any marked morphological changes. Evidence demonstrates the adverse effects of EMR on testicular parenchyma in rats.

<http://www.ncbi.nlm.nih.gov/pubmed/24839928?dopt=Abstract> [CI]

- 97. Electromagnetic radiation (Wi-Fi) and epilepsy induce calcium entry and apoptosis through activation of TRPV1 channel in hippocampus and dorsal root ganglion of rats.** In results of whole cell patch-clamp experiments, treatment of DRG with Ca²⁺ channel antagonists [thapsigargin, verapamil + diltiazem, 2-APB, MK-801] indicated that Wi-Fi exposure induced Ca²⁺ influx via the TRPV1 channels. In conclusion, epilepsy and Wi-Fi in our experimental model is involved in Ca²⁺ influx and oxidative stress-induced hippocampal and DRG death through activation of TRPV1 channels, and negative modulation of this channel activity by CPZ pretreatment may account for the neuroprotective activity against oxidative stress.
<http://www.ncbi.nlm.nih.gov/pubmed/24792079?dopt=Abstract> [BI, OS, AP, CA]
- 98. Effects of olive leave extract on metabolic disorders and oxidative stress induced by 2.45 GHz WIFI signals.** Our investigations suggested that RF exposure induced a diabetes-like status through alteration of oxidative response. Olive leaves extract was able to correct glucose metabolism disorder by minimizing oxidative stress induced by RF in rat tissues.
<http://www.sciencedirect.com/science/article/pii/S1382668913001609> [OS, GM]
- 99. The effects of long-term exposure to a 2450 MHz electromagnetic field on growth and pubertal development in female Wistar rats.** Exposure to 2450 MHz EMF, particularly in the prenatal period, resulted in postnatal growth restriction and delayed puberty in female Wistar rats. Increased TOS and OSI values in the brain and ovary tissues can be interpreted as a sign of chronic stress induced by EMF. (Mar 2015) <http://www.ncbi.nlm.nih.gov/pubmed/24460416?dopt=Abstract> [BI, OS]
- 100. Wi-Fi (2.45 GHz)- and Mobile Phone (900 and 1800 MHz)-Induced Risks on Oxidative Stress and Elements in Kidney and Testis of Rats During Pregnancy and the Development of Offspring.** In conclusion, Wi-Fi- and mobile phone-induced EMR caused oxidative damage by increasing the extent of lipid peroxidation and the iron level, while decreasing total antioxidant status, copper, and GSH values. Wi-Fi- and mobile phone-induced EMR may cause precocious puberty and oxidative kidney and testis injury in growing rats. <http://www.ncbi.nlm.nih.gov/pubmed/24101576?dopt=Abstract> [BI, OS, CI]
- 101. Replication of heart rate variability provocation study with 2.4-GHz cordless phone confirms original findings.** Of the 39 participants who claimed to experience some electrical hypersensitivity, 36% claimed they also reacted to a cordless phone and experienced heart symptoms and, of these, 64% were classified as having some degree of electrohypersensitivity (EHS) based on their HRV response. Novel findings include documentation of a delayed response to radiation.
<http://informahealthcare.com/doi/abs/10.3109/15368378.2013.776437> [HR]
- 102. Use of laptop computers connected to internet through Wi-Fi decreases human sperm motility and increases sperm DNA fragmentation.** Ex vivo exposure of human spermatozoa to a wireless internet-connected laptop decreased motility and induced DNA fragmentation by a nonthermal effect. We speculate that keeping a laptop connected wirelessly to the internet on the lap near the testes may result in decreased male fertility. <http://www.ncbi.nlm.nih.gov/pubmed/22112647> [DD, SE]

Epidemiological/Case Studies (Mobile Phone, Radar, etc.)

- 103. A Challenging Issue in the Etiology of Speech Problems: The Effect of Maternal Exposure to Electromagnetic Fields on Speech Problems in the Offspring.** The purpose of this study was to investigate whether the maternal exposure to different sources of electromagnetic fields affect on the rate and severity of speech problems in their offspring. We found a significant association between either the call time (P=0.002) or history of mobile phone use (months used) and speech problems in the offspring (P=0.003). However, other exposures had no effect on the occurrence of speech problems. Although a major limitation in our study is the relatively small sample size, this study indicates that the maternal exposure to common sources of electromagnetic fields such as mobile phones can affect the occurrence of speech problems in the offspring. (1 Sep 2015)
<http://www.ncbi.nlm.nih.gov/pubmed/26396971?dopt=Abstract> [BD, SI]
- 104. Association between mobile phone use and self-reported well-being in children: a questionnaire-based cross-sectional study in Chongqing, China.** The potential health effects of children's exposure to MP have been the subject of widespread public concern. The aim of our study is to investigate the associations between MP use and well-being in children. Among the 793 children invited to participate,

781 returned the questionnaires. In total, 746 (94.1%) valid questionnaires were received. Fatigue was significantly associated with the years of MP usage (OR 1.85; 95% CI 1.07 to 3.22) and the daily duration of MP calls (OR 2.98; 95% CI 1.46 to 6.12). Headache was significantly associated with the daily duration of MP calls (OR 2.85; 95% CI 1.23 to 6.57). However, after adjusting for confounders only, the association between fatigue and MP usage remained statistically significant. There was no significant association between MP use and other physical symptoms in children. (11 May 2015) <http://www.ncbi.nlm.nih.gov/pubmed/25967996?dopt=Abstract> [FA, HA]

- 105. Habits of cell phone usage and sperm quality - does it warrant attention?** Male infertility constitutes 30-40% of all infertility cases. Some studies have shown a continuous decline in semen quality since the beginning of the 20th century. One postulated contributing factor is radio frequency electromagnetic radiation emitted from cell phones. This study investigates an association between characteristics of cell phone usage and semen quality. Our findings suggest that certain aspects of cell phone usage may bear adverse effects on sperm concentration. Investigation using large-scale studies is thus needed. (18 Jun 2015) <http://www.ncbi.nlm.nih.gov/pubmed/26206279?dopt=Abstract> [SE]
- 106. Use of mobile phone during pregnancy and the risk of spontaneous abortion.** All data pertaining to mobile phone use such as average calling time per day, the location of the mobile phones when not in use, use of phones for other applications, SAR and the average of the calculated effective SAR, except the use of hands-free devices were different between the case group and the control group. A significant association between the calculated effective SAR and the risk of spontaneous abortions was observed (OR 1.11; CI 1.07-1.16). The results suggest that use of mobile phones could be related to the early spontaneous abortions. (21 Apr 2015) <http://www.ncbi.nlm.nih.gov/pubmed/25937931?dopt=Abstract> [MC]
- 107. Association between mobile phone use and self-reported well-being in children: a questionnaire-based cross-sectional study in Chongqing, China.** 746 (94.1%) valid questionnaires were received. Fatigue was significantly associated with the years of MP usage (OR 1.85; 95% CI 1.07 to 3.22) and the daily duration of MP calls (OR 2.98; 95% CI 1.46 to 6.12). Headache was significantly associated with the daily duration of MP calls (OR 2.85; 95% CI 1.23 to 6.57). However, after adjusting for confounders only, the association between fatigue and MP usage remained statistically significant. There was no significant association between MP use and other physical symptoms in children. (11 May 2015) <http://www.ncbi.nlm.nih.gov/pubmed/25967996?dopt=Abstract> [FA, HA]
- 108. The semen quality of the mobile phone users.** To evaluate the conventional and some of the main biofunctional sperm parameters in healthy men according to the different use of the mobile phone. All the enrolled subjects in this study were divided into four groups according to their active cell phone use: group A= no use (no.=10 subjects); group B= <2 h/day (no.=16); group C= 2-4 h/day (no.=17); and group D= >4 h/day (no.=20). Among the subjects of the group D (>4 h/day), a further evaluation was made between the "trousers users"(no.=12) and "shirt users"(no.=8), None of the conventional sperm parameters examined were significantly altered. However, the group D and the trousers users showed a higher percentage of sperm DNA fragmentation compared to other groups. (26 Dec 2013) <http://www.ncbi.nlm.nih.gov/pubmed/23722985?dopt=Abstract> [DD]
- 109. Mobile phone radiation causes brain tumors and should be classified as a probable human carcinogen (2A).** The CERENAT finding of increased risk of glioma is consistent with studies that evaluated use of mobile phones for a decade or longer and corroborate those that have shown a risk of meningioma from mobile phone use. In CERENAT, exposure to RF-EMF from digitally enhanced cordless telephones (DECTs), used by over half the population of France during the period of this study, was not evaluated. If exposures to DECT phones could have been taken into account, the risks of glioma from mobile phone use in CERENAT are likely to be higher than published. We conclude that radiofrequency fields should be classified as a Group 2A probable human carcinogen under the criteria used by the International Agency for Research on Cancer (Lyon, France). Additional data should be gathered on exposures to mobile and cordless phones, other WTDs, mobile phone base stations and Wi-Fi routers to evaluate their impact on public health. (25 Feb 2015) <http://www.ncbi.nlm.nih.gov/pubmed/25738972?dopt=Abstract> [BT]
- 110. Mobile usage and sleep patterns among medical students.** Sleep disturbance, latency and day dysfunction was more in cases especially females. A significant association of hours of usage and sleep indices were observed in both genders (males $r = 0.25$; $p = 0.04$, females $r = 0.31$; $p = 0.009$). Evening usage of mobile phone in cases showed a statistically significant negative association (-0.606 ; $p = 0.042$) with Sleep quality (higher PSQI means sleep deprivation). Students using mobile for > 2 hours/day may cause sleep deprivation and day sleepiness affecting cognitive and learning abilities of medical students. <http://www.ncbi.nlm.nih.gov/pubmed/25464686?dopt=Abstract> [SP]
- 111. The influence of direct mobile phone radiation on sperm quality.** Results the number of spermatozoa with progressive movement in the group, influenced by electromagnetic radiation, is

statistically lower than the number of spermatozoa with progressive movement in the group under no effect of the mobile phone. The number of non-progressive movement spermatozoa was significantly higher in the group, which was influenced by cell phone radiation. The DNA fragmentation was also significantly higher in this group. Conclusion: A correlation exists between mobile phone radiation exposure, DNA-fragmentation level and decreased sperm motility.

<http://www.ncbi.nlm.nih.gov/pubmed/24982785?dopt=Abstract> [OS, SE, DD]

112. Mobile phone use and health symptoms in children. MP use was associated with a significantly increased adjusted odds ratio (AOR) for headaches and migraine and Children who regularly used MPs were also considered to have a health status worse than it was 1 year ago.

<http://www.ncbi.nlm.nih.gov/pubmed/25115529?dopt=Abstract> [HA, SI]

113. Mobile phone use and brain tumours in the CERENAT case-control study. The positive association was statistically significant in the heaviest users when considering life-long cumulative duration (≥ 896 h, OR 2.89; CI 1.41-5.93 for gliomas; OR 2.57; CI 1.02-6.44 for meningiomas) and number of calls for gliomas ($\geq 18,360$ calls, OR 2.10, CI 1.03-4.31). Among heavy mobile phone users (≥ 896 h) increased risks were observed for gliomas (OR 2.89, CI 1.41-5.93), temporal tumors (OR 3.94, CI 0.81-19.08), occupational use (OR 3.27, CI 1.45-7.35) and urban mobile phone use (OR 8.20, CI) <http://www.ncbi.nlm.nih.gov/pubmed/24816517?dopt=Abstract> [BT]

114. Lifestyle Risk Factors Associated with Threatened Miscarriage: A Case-Control Study. An association of threatened miscarriage with computer usage (>4 hours/day: OR 6.03, CI 2.82-12.88), mobile phone use (>1 hour/day: OR 2.94, CI 1.32-6.53) <http://omicsgroup.org/journals/lifestyle-risk-factors-associated-with-threatened-miscarriage-a-casecontrol-study-jfiv.1000123.pdf> [MC]

115. Association between mobile phone use and semen quality: a systemic review and meta-analysis.

Evidence from current studies suggests potential harmful effects of mobile phone use on semen parameters. <http://www.ncbi.nlm.nih.gov/pubmed/24700791?dopt=Abstract> [SE]

116. Association between vestibular schwannomas and mobile phone use. Tumors may coincide with the more frequently used ear of mobile phones and tumor volume that showed strong correlation with amount of mobile phone use, thus there is a possibility that mobile phone use may affect tumor growth. <http://www.ncbi.nlm.nih.gov/pubmed/23975478?dopt=Abstract> [BT, TP]

117. Subjective symptoms related to GSM radiation from mobile phone base stations: a cross-sectional study. We observed that the incidence of most of the symptoms was related to exposure levels-independently of the demographic variables and some possible risk factors. Concerns about adverse effects from exposure, despite being strongly related with sleep disturbances, do not influence the direct association between exposure and sleep.

<http://www.ncbi.nlm.nih.gov/pubmed/24381254?dopt=Abstract> [IS, BM, IR]

118. The relationship between adolescents' well-being and their wireless phone use: a cross-sectional study. Using a wired cellphone headset was associated with tinnitus (adjusted OR 1.8, CI 1.0-3.3), while wireless headsets were associated with headache (adjusted OR 2.2, CI 1.1-4.5), feeling down/depressed (adjusted OR 2.0, CI 1.1-3.8), and waking in the night (adjusted OR 2.4, CI 1.2-4.8). Several cordless phone frequencies bands were related to tinnitus, feeling down/depressed and sleepiness at school, while the last of these was also related to modulation.

<http://www.ncbi.nlm.nih.gov/pubmed/24148357?dopt=Abstract> [TN, HA, IS]

119. Multifocal Breast Cancer in Young Women with Prolonged Contact between Their Breasts and Their Cellular Phones. All patients regularly carried their smartphones directly against their breasts in their brassieres for up to 10 hours a day, for several years, and developed tumors in areas of their breasts immediately underlying the phones. All patients had no family history of breast cancer, tested negative for BRCA1 and BRCA2, and had no other known breast cancer risks.

<http://www.ncbi.nlm.nih.gov/pubmed/24151509?dopt=Abstract> [BC]

120. Health effects of living near mobile phone base transceiver station (BTS) antennae: a report from Isfahan, Iran. The results showed that most of the symptoms such as nausea, headache, dizziness, irritability, discomfort, nervousness, depression, sleep disturbance, memory loss and lowering of libido were statistically significant in the inhabitants living near the BTS antenna (<300 m distances) compared to those living far from the BTS antenna (>300 m).

<http://www.ncbi.nlm.nih.gov/pubmed/23781985?dopt=Abstract> [HA, IS, BM, MR]

121. Changes in brain glioma incidence and laterality correlates with use of mobile phones--a nationwide population based study in Israel. We found a statistically significant decrease in LGG's over 30-years period that correlates with introducing of mobile phones technology and a shift in laterality towards left-sided tumors, the latter occurred in both low and high-grade gliomas.

<http://www.ncbi.nlm.nih.gov/pubmed/23317269> [BT]

- 122. Use of mobile and cordless phones and survival of patients with glioma.** Decreased survival of glioma cases with long-term and high cumulative use of wireless phones was found. A survival disadvantage for astrocytoma grade IV, but a survival benefit for astrocytoma grade I-II was observed which could be due to exposure-related tumour symptoms leading to earlier diagnosis and surgery in that patient group. <http://www.ncbi.nlm.nih.gov/pubmed/23095687?dopt=Abstract> [BT]
- 123. Pooled analysis of case-control studies on acoustic neuroma diagnosed 1997-2003 and 2007-2009 and use of mobile and cordless phones.** OR increased per 100 h cumulative use and per year of latency for mobile phones and cordless phones, though the increase was not statistically significant for cordless phones. The percentage tumour volume increased per year of latency and per 100 h of cumulative use, statistically significant for analogue phones. This study confirmed previous results demonstrating an association between mobile and cordless phone use and acoustic neuroma. <http://www.ncbi.nlm.nih.gov/pubmed/23877578?dopt=Abstract> [BT]
- 124. Long-term exposure to microwave radiation provokes cancer growth: evidences from radars and mobile communication systems.** Model studies in rodents unveiled a significant increase in carcinogenesis after 17-24 months of MW exposure both in tumor-prone and intact animals. To that, such metabolic changes, as overproduction of reactive oxygen species, 8-hydroxi-2-deoxyguanosine formation, or ornithine decarboxylase activation under exposure to low intensity MW confirm a stress impact of this factor on living cells. <http://www.ncbi.nlm.nih.gov/pubmed/21716201> [TP, OS]
- 125. Lifestyle and semen quality: role of modifiable risk factors -** using a cell phone more than 10 years decreased the percentage of motile sperm cells ($p = 0.02$). <http://www.ncbi.nlm.nih.gov/pubmed/24074254?dopt=Abstract> [SE]
- 126. Effect of mobile telephones on sperm quality: A systematic review and meta-analysis** Mobile phone exposure was associated with reduced sperm motility and viability. <http://www.sciencedirect.com/science/article/pii/S0160412014001354> [SE]
- 127. The semen quality of the mobile phone users.** Results suggest that the sperm DNA fragmentation could represent the only parameter significantly altered in the subjects who use the mobile phone for more than 4 h/day and in particular for those who use the device in the pocket of the trousers. <http://www.ncbi.nlm.nih.gov/pubmed/23722985?dopt=Abstract> [SE, DD]
- 128. Connection between Cell Phone use, p53 Gene Expression in Different Zones of Glioblastoma Multiforme and Survival Prognoses.** Forty-one out of 63 patients (65%) with the highest level of cell phone use (≥ 3 hours/day) had higher mutant type p53 expression in the peripheral zone of the glioblastoma; the difference was statistically significant ($P=0.034$). Results from the present study on the use of mobile phones for ≥ 3 hours a day show a consistent pattern of increased risk for the mutant type of p53 gene expression in the peripheral zone of the glioblastoma, and that this increase was significantly correlated with shorter overall survival time. <http://www.ncbi.nlm.nih.gov/pubmed/25276320?dopt=Abstract> [GE, TP, BT]
- 129. Decreased Survival of Glioma Patients with Astrocytoma Grade IV (Glioblastoma Multiforme) Associated with Long-Term Use of Mobile and Cordless Phones.** Use of wireless phones in the >20 years latency group (time since first use) yielded an increased hazard ratio (HR) = 1.7, 95% confidence interval (CI) = 1.2-2.3 for glioma. For astrocytoma grade IV (glioblastoma multiforme; $n = 926$) mobile phone use yielded HR = 2.0, 95% CI = 1.4-2.9 and cordless phone use HR = 3.4, 95% CI = 1.04-11 in the same latency category. The hazard ratio for astrocytoma grade IV increased statistically significant per year of latency for wireless phones, HR = 1.020, 95% CI = 1.007-1.033, but not per 100 h cumulative use, HR = 1.002, 95% CI = 0.999-1.005 www.ncbi.nlm.nih.gov/pubmed/25325361?dopt=Abstract [BT]
- 130. Associations between specific technologies and adolescent sleep quantity, sleep quality, and parasomnias.** Frequent weekday technology use at bedtime was associated with significant adverse effects on multiple sleep parameters. <http://www.ncbi.nlm.nih.gov/pubmed/24394730?dopt=Abstract> [SP]

Novel Studies using RF or review of RF research

- 131. The implications of non-linear biological oscillations on human electrophysiology for electrohypersensitivity (EHS) and multiple chemical sensitivity (MCS).** Pulsed electromagnetic fields (PEMF) and radiofrequency radiation (RFR) can have the devastating biological effects of disrupting homeostasis and desynchronizing normal biological rhythms that maintain health. Non-linear, weak field biological oscillations govern body electrophysiology, organize cell and tissue

functions and maintain organ systems. Artificial bioelectrical interference can give false information (disruptive signaling) sufficient to affect critical pacemaker cells (of the heart, gut and brain) and desynchronize functions of these important cells that orchestrate function and maintain health. Chronic physiological stress undermines homeostasis whether it is chemically induced or electromagnetically induced (or both exposures are simultaneous contributors). This can eventually break down adaptive biological responses critical to health maintenance; and resilience can be compromised. (12 Sep 2015) <http://www.ncbi.nlm.nih.gov/pubmed/26368042> [BB, BI, CR, OS]

- 132. Microwave frequency electromagnetic fields (EMFs) produce widespread neuropsychiatric effects including depression.** Soviet and Western literature shows that much of the impact of non-thermal microwave exposures in experimental animals occurs in the brain and peripheral nervous system, such that nervous system histology and function show diverse and substantial changes. These may be generated through roles of VGCC activation, producing excessive neurotransmitter/ neuroendocrine release as well as oxidative/nitrosative stress and other responses. (20 Aug 2015) <http://www.ncbi.nlm.nih.gov/pubmed/26300312?dopt=Abstract> [BD, BI, EG, FA, HA, OS]
- 133. Noninvasive radiofrequency treatment effect on mitochondria in pancreatic cancer cells.** RF fields treatment changed the morphology of mitochondria in cancer cells, altered polarization of the mitochondrial membrane, substantially impaired mitochondrial respiration, and increased reactive oxygen species production, indicating RF-induced stress on the mitochondria. This suggests that RF-induced stress can damage mitochondria and induce elimination of damaged organelles via autophagy. <http://www.ncbi.nlm.nih.gov/pubmed/24986120?dopt=Abstract> [OS, EM, CI]
- 134. Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects.** Pathophysiological responses to EMFs may be as a result of nitric oxide-peroxynitrite-oxidative stress path-way of action. A single such well-documented example, EMF induction of DNA single-strand breaks in cells, as measured by alkaline comet assays, is reviewed here. Such single-strand breaks are known to be produced through the action of this pathway. Data on the mechanism of EMF induction of such breaks are limited; what data are available support this proposed mechanism. Other Ca²⁺ mediated regulatory changes, independent of nitric oxide, may also have roles. This article reviews, then, a substantially supported set of targets, VGCCs, whose stimulation produces non-thermal EMF responses by humans/higher animals with downstream effects involving Ca²⁺ /calmodulin-dependent nitric oxide increases, which may explain therapeutic and pathophysiological effects. <http://onlinelibrary.wiley.com/doi/10.1111/jcmm.12088/pdf> [BI, OS, DD, CA, EA]
- 135. MicroRNAs: Novel Mechanism Involved in the Pathogenesis of Microwave Exposure on Rats' Hippocampus.** Studies from our group and others showed that microwave-induced structural and functional injury of hippocampus, accompanied with alteration of gene and protein expression. <http://www.ncbi.nlm.nih.gov/pubmed/24748327?dopt=Abstract> [GE, EA, CI]

Other Microwave Frequencies or Microwave Frequency not specified

- 136. Microwave-Induced Structural and Functional Injury of Hippocampal and PC12 Cells Is Accompanied by Abnormal Changes in the NMDAR-PSD95-CaMKII Pathway.** Recent studies have highlighted the important role of the postsynaptic NMDAR-PSD95-CaMKII pathway for synaptic transmission and related neuronal injury. Here, we tested changes in the components of this pathway upon microwave-induced neuronal structure and function impairments. Ultrastructural and functional changes were induced in hippocampal neurons of rats and in PC12 cells exposed to microwave radiation. We detected abnormal protein and mRNA expression, as well as posttranslational modifications in the NMDAR-PSD95-CaMKII pathway and its associated components, such as synapsin I, following microwave radiation exposure of rats and PC12 cells. Thus, microwave radiation may induce neuronal injury via changes in the molecular organization of postsynaptic density and modulation of the biochemical cascade that potentiates synaptic transmission. (25 August 2015) <http://www.ncbi.nlm.nih.gov/pubmed/26337368?dopt=Abstract> [CI, GE]
- 137. Alterations of cognitive function and 5-HT system in rats after long term microwave exposure** We demonstrated that chronic exposure to microwave (2.856GHz, with the average power density of 5, 10, 20 and 30mW/cm²) could induce dose-dependent deficit of spatial learning and memory in rats accompanied with inhibition of brain electrical activity, the degeneration of hippocampus neurons, and the disturbance of neurotransmitters, among which the increase of 5-HT occurred as the main long-term change that the decrease of its metabolism partly contributed to. Besides, the variations of 5-HT_{1A}R and 5-HT_{2C}R expressions were also indicated. The results suggested that in the long-term

way, chronic microwave exposure could induce cognitive deficit and 5-HT system may be involved in it. <http://www.ncbi.nlm.nih.gov/pubmed/25542888?dopt=Abstract> (1 Mar 2015) [BD, BI, CI, GE, MR]

138. Effects of Pulsed 2.856 GHz Microwave Exposure on BM-MSCs Isolated from C57BL/6 Mice.

We detected no significant effects on the differentiation ability of these cells in vitro, with the exception of reduction in mRNA expression levels of osteopontin (OPN) and osteocalcin (OCN). These findings suggest that microwave treatment at a SAR of 4 W/kg has undefined adverse effects on BM-MSCs. However, the reduced-expression of proteins related to osteogenic differentiation suggests that microwave can influence at the mRNA expression genetic level.

<http://www.ncbi.nlm.nih.gov/pubmed/25658708?dopt=Abstract> [BI, EA, GE]

139. Neural Cell Apoptosis Induced by Microwave Exposure Through Mitochondria-dependent Caspase-3 Pathway.

Wistar rats were exposed to 2.856 GHz for 5 min and 15 min. The results showed chromatin condensation and apoptotic body formation in neural cells 6h after microwave exposure. Moreover, the mitochondria membrane potential decreased, DNA fragmentation increased, leading to an increase in the apoptotic cell percentage.

<http://www.ncbi.nlm.nih.gov/pubmed/24688304?dopt=Abstract> [EM, DD, AP]

140. Impairment of long-term potentiation induction is essential for the disruption of spatial memory after microwave exposure.

Wistar rats were exposed to a 2.856 GHz pulsed microwave field. This study suggested that impairment of LTP induction and the damages of hippocampal structure, especially changes of synapses, might contribute to cognitive impairment after microwave exposure.

<http://www.ncbi.nlm.nih.gov/pubmed/23786183?dopt=Abstract> [MR, CI]

141. Spatial memory and learning performance and its relationship to protein synthesis of Swiss albino mice exposed to 10 GHz microwaves.

It can be concluded from the current study that exposure to microwave radiation caused decrements in the ability of mice to learn the special memory task, this may be due to simultaneous decrease in protein levels in the brain of mice.

<http://www.ncbi.nlm.nih.gov/pubmed/23952535?dopt=Abstract> [BI, EA, MR]

142. Reduction of Phosphorylated Synapsin I (Ser-553) Leads to Spatial Memory Impairment by Attenuating GABA Release after Microwave Exposure in Wistar Rats.

Both microwave exposure and p-Syn I silencing reduced GABA release and maximal reduction was found for the combination of the two, indicating a synergetic effect.

<http://www.ncbi.nlm.nih.gov/pubmed/24743689?dopt=Abstract> [GE, EA, MR]

143. Microwave radiation induces injury to GC-2spd cells

Microwave radiation at 10 and 30 mW/cm² may cause injury to GC-2spd cells, which is manifested by decreased content of intracellular cAMP, reduced activity of cell proliferation, and increased rate of cell apoptosis

<http://www.ncbi.nlm.nih.gov/pubmed/24738454?dopt=Abstract> [AP, BI, EA, CI]

144. Adverse health effects of occupational exposure to radiofrequency radiation in airport surveillance radar operators.

Altogether these results indicate that occupational exposure to radar microwave radiations may be linked to some adverse health effects.

<http://www.ncbi.nlm.nih.gov/pubmed/24082641?dopt=Abstract> [HA, MR]

145. A new problem in inflammatory bladder diseases: Use of mobile phones

Conclusion: Intensive use of mobile phones has negative impact on bladder tissue as well as the other organs. Keeping a minimum level of mobile phone use makes it easy to be kept under control of diseases in which inflammation is an etiologic factor.

<http://www.ncbi.nlm.nih.gov/pubmed/25251956?dopt=Abstract> [IN]

146. Prevalence of fatigue reported by physiotherapists operating diathermy equipment for microwave.

The results demonstrate a significant and independent association between occupational exposure of physical therapists to radiation of microwave diathermy and prevalence of fatigue.

<http://www.ncbi.nlm.nih.gov/pubmed/25272253?dopt=Abstract> [FA]

147. Alteration of glycine receptor immunoreactivity in the auditory brainstem of mice following three months of exposure to radiofrequency radiation at SAR 4.0 W/kg.

Auditory brainstem response (ABR) analysis also revealed a significant threshold elevation of in the exposed (E4) group, which may be associated with auditory dysfunction. The present study suggests that the auditory brainstem region is susceptible to chronic exposure to RF radiation, which may affect the function of the central auditory system.

<http://www.ncbi.nlm.nih.gov/pubmed/24866721> [AD]

Microwave effect on Blood Brain Barrier (Specific frequency not specified)

- 148. Activation of VEGF/Flk-1-ERK Pathway Induced Blood-Brain Barrier Injury After Microwave Exposure.** Our results showed that microwave radiation caused intercellular tight junctions to broaden and fracture with decreased TEER values and increased HRP permeability. After microwave exposure, activation of the VEGF/Flk-1-ERK pathway and Tyr phosphorylation of occludin were observed, along with down-regulated expression and interaction of occludin with zonula occludens-1 (ZO-1). <http://www.ncbi.nlm.nih.gov/pubmed/25195697?dopt=Abstract> [BB, BI, EA]
- 149. Altered expression of matrix metalloproteinases and tight junction proteins in rats following PEMF-induced BBB permeability change.** Compared with the sham group, PEMF exposure led to increased permeability of the BBB to EB, which was prolonged after exposure. BBB permeability became progressively more severe, and recovered at 6 h. <http://www.ncbi.nlm.nih.gov/pubmed/22998827?dopt=Abstract> [BB]

RF Oxidative Stress (no specific details on frequencies used)

- 150. Low intensity radiofrequency radiation: a new oxidant for living cells** Notwithstanding the non-ionizing nature of RFR, profound mutagenic effects and features of significant oxidative stress in living cells under low intensity RFR exposure were detected using various biological models [18,19]. <http://www.scopemed.org/fulltextpdf.php?mno=154583> [OS, DD, BT]
- 151. Confirmation of hydroxyl radicals (\bullet OH) generated in the presence of TiO₂ supported on AC under microwave irradiation.** The results showed that the (\bullet)OH could be generated under MW combined with loaded TiO₂/AC. Also, anatase TiO₂/AC can generate more (\bullet)OH radicals than rutile TiO₂/AC under MW irradiation. <http://www.ncbi.nlm.nih.gov/pubmed/24960308?dopt=Abstract> [BI, OS, EA]
- 152. Changes in mitochondrial functioning with electromagnetic radiation of ultra-high frequency as revealed by electron paramagnetic resonance methods.** (i) Abnormalities in the mitochondrial ETC of liver and aorta cells are more pronounced for animals radiated in a pulsed mode; (ii) the alterations in the functioning of the mitochondrial ETC cause increase of superoxide radicals generation rate in all samples, formation of cellular hypoxia, and intensification of the oxide-initiated metabolic changes; and (iii) electron paramagnetic resonance methods could be used to track the qualitative and quantitative changes in the mitochondrial ETC caused by the UHF EMR. <http://www.ncbi.nlm.nih.gov/pubmed/24597749?dopt=Abstract> [BI, OS, EM, CI]
- 153. Spin Biochemistry Modulates Reactive Oxygen Species (ROS) Production by Radio Frequency Magnetic Fields.** This study demonstrates the interplay between O₂^{•-} and H₂O₂ production when influenced by RF magnetic fields and underscores the subtle effects of low-frequency magnetic fields on oxidative metabolism, ROS signaling, and cellular growth. <http://www.ncbi.nlm.nih.gov/pubmed/24681944?dopt=Abstract> [BI, OS]

ELF added to show common symptoms of EMR exposure appear to occur across a large range of the non-ionising spectrum.

The Potential Bioeffects of Extremely Low Frequency Electromagnetic Fields on Melatonin Levels & Related Oxidative Stress in Electric Utility Workers Exposed to 132 kV Substation.

The plasma melatonin level was significantly decreased in high exposed workers (group 11) when compared to the low and medium exposed groups (groups 9 and 10). The lipid peroxidation and nitric oxide levels were significantly increased in all exposed subjects (group 2) in comparison to the control group (group 1). The enzyme activities of antioxidative enzymes of exposed workers (group 2) were significantly lowered when compared to the control group (group 1).

<http://www.scirp.org/journal/jemaa/>

Relationship between exposure to extremely low-frequency electromagnetic fields and breast cancer risk: a meta-analysis. Sixteen research outcome was ORDL = 1.10, 95% CI = (1.01, 1.20), the OR(MH) of the non-menopause status group was 1.25, 95% CI = (1.05, 1.49), the OR(MH) of the menopause status group was OR(MH) = 1.04, 95% CI = (0.93, 1.18). The authors found that ELF-EMFs may be increase the risk of human breast cancer. The women's exposure to ELF-EMFs may be the risk factor of breast cancer when they are non-menopausal.

<http://www.ncbi.nlm.nih.gov/pubmed/24984538?dopt=Abstract>

Severe Cognitive Dysfunction and Occupational Extremely Low Frequency Magnetic Field Exposure among Elderly Mexican Americans. The results of this study indicate that working in an occupation with high or M/H MF exposure may increase the risk of severe cognitive dysfunction. Smoking and older age may increase the deleterious effect of MF exposure.
<http://www.ncbi.nlm.nih.gov/pubmed/24839595?dopt=Abstract>

Exposure to extremely low frequency electromagnetic fields alters the calcium dynamics of cultured entorhinal cortex neurons. Findings indicate that ELF-EMF exposure specifically influences the intracellular calcium dynamics of cultured EC neurons via a calcium channel-independent mechanism. <http://www.ncbi.nlm.nih.gov/pubmed/25462671?dopt=Abstract>

Dirty electricity, chronic stress, neurotransmitters and disease. Dirty electricity, also called electrical pollution, is high-frequency voltage transients riding along the 50 or 60 Hz electricity provided by the electric utilities. It is generated by arcing, by sparking and by any device that interrupts current flow, especially switching power supplies. It has been associated with cancer, diabetes and attention deficit hyperactivity disorder in humans.
<http://www.ncbi.nlm.nih.gov/pubmed/23323864?dopt=Abstract>

Changes in gene and protein expression in magnetic field-treated human glioma cells. The results of gene expression analysis showed a significant up-regulation of five and down-regulation of 25 genes in cells exposed to the magnetic field compared to sham exposure. Protein expression analysis indicated that the expression rates of ten identified proteins were significantly altered. Three of these showed an increase and seven a decrease in their expression rate, following the exposure compared to sham exposure. However, no obvious relationship between the affected genes and proteins could be found. <http://www.ncbi.nlm.nih.gov/pubmed/20021071?dopt=Abstract>

The Influence of 50 Hz Magnetic Field on Liver Function. All investigated liver values showed significant increases in groups 4 and 5 compared to sham exposure (group 1). For alanine aminotransferase and aspartate aminotransferase, significant higher values could already be measured in group 3 (0.6 mT). Liver lipid peroxidation was significantly increased in groups 3, 4 and 5, while the glutathione levels were significantly decreased in these groups compared to sham exposure, indicating oxidative stress. <http://www.rjb.ro/articles/205/mibra.pdf>

Occupational electromagnetic field exposures associated with sleep quality: a cross-sectional study. The findings showed that daily occupational EMF exposure was positively associated with poor sleep quality. It implies EMF exposure may damage human sleep quality rather than sleep duration.
<http://www.ncbi.nlm.nih.gov/pubmed/25340654?dopt=Abstract>

Extremely low-frequency magnetic fields can impair spermatogenesis recovery after reversible testicular damage induced by heat. Magnetic field exposure during the spermatogenesis recovery induced changes in testis components volume, cell ultrastructure and histomorphometrical parameters. Control animals had a re-established and active spermatogenesis at 60 d after heat shock, while animals exposed to magnetic field still showed extensive testicular degeneration. Magnetic field exposure did not change the plasma testosterone. In conclusion, extremely low-frequency magnetic field may be harmful to fertility recovery in males affected by reversible testicular damage.
<http://www.ncbi.nlm.nih.gov/pubmed/23781997?dopt=Abstract>

Effect of long-term pulsed electromagnetic field exposure on hepatic and immunologic functions of rats

The content of all immunoglobulins in the serum decreased gradually with increasing intensity of the magnetic field exposure, with all exposure groups (groups 1-3) showing significantly reduced values compared to the sham exposure group. Likewise, the enzyme activities of alanine aminotransferase and aspartate aminotransferase in the serum increased gradually with increasing intensity of the magnetic field exposure, with all exposure groups showing significantly higher values than the sham exposure group.

Oxidative stress was increased in serum, liver and spleen with increasing intensity of the magnetic field, with groups 2 (10 mT) and 3 (20 mT) showing a significant increased lipid peroxidation and significant decreased superoxide dismutase and glutathione peroxidase enzyme activities compared to the sham exposure group.

The authors conclude that chronic exposure of rats to a 50 Hz magnetic field might have detrimental

effects on the liver and immunologic parameters and could induce oxidative stress in serum, liver and spleen.

<http://www.ncbi.nlm.nih.gov/pubmed/25910613?dopt=Abstract>

Summary

153 RF Studies referenced. The following observations and effects were noted:

[AD] (2)	=	Auditory dysfunction
[AP] (20)	=	Apoptosis (Cell Death)
[BB] (5)	=	Blood Brain Barrier Permeability Changes
[BC] (1)	=	Breast Cancer
[BD] (10)	=	Brain Developmental Issues/Changes/Neurological degeneration
[BI] (48)	=	Biochemical changes
[BM] (13)	=	Behavioural Modification/Cognitive Function Impairment
[BT] (9)	=	Brain Tumours
[CA] (4)	=	Calcium Influx/Efflux
[CI] (35)	=	Cell Irregularities/Cell Damage/Morphological changes
[CR] (4)	=	Circadian Rhythm Disruption
[CS] (3)	=	Cellular Stress
[DD] (30)	=	DNA Damage/Mutagenic/Genotoxic
[EA] (39)	=	Altered Enzyme Activity/Protein Damage/Altered Protein Levels
[EG] (3)	=	EEG changes
[EM] (6)	=	Effects Mitochondria
[FA] (4)	=	Fatigue
[GE] (19)	=	Altered Gene Expression
[GM] (1)	=	Altered Glucose Metabolism
[HA] (7)	=	Headaches
[HRV] (2)	=	Heart Rate Variability
[IN] (4)	=	Inflammation
[IS] (4)	=	Insomnia
[MC] (2)	=	Miscarriage/Spontaneous Abortion (pregnancy)
[MR] (15)	=	Memory Retention/Impairment issues
[OS] (50)	=	Oxidative Stress/ROS/Super Oxides, Free Radicals, Lipid Peroxidation
[RH] (1)	=	Impaired/Reduced Healing
[SE] (17)	=	Sperm Effects/Sperm Damage - Viability/Motility issues
[SI] (1)	=	Speech impairment
[SP] (4)	=	Sleep Performance Issues
[TN] (1)	=	Tinnitus
[TP] (5)	=	Tumour Promoter

Biological effect implications on health

There are many studies, implicating oxidative stress and free radical breakdown products in generating pathophysiological effects in the presence of EMR exposure. Reactive Oxygen Species (ROS) are directly involved in oxidative damage of cellular macromolecules, such as lipids, proteins, and nucleic acids in cells. When one looks at the effect a free radical (a reactive oxygen species that is a product of oxidative stress) has on a cell, it demonstrates very similar biological effect characteristics as ionising radiation has on DNA and other cellular components.

It is true that some of the biological effects are indeterminate as to whether they will lead to long term health problems. Altered gene and protein expression as well as biochemical changes can occur naturally as a result of cells dealing with any number of environmental changes. Without doing long term studies it is not always possible to know what the effect may translate to in many cases. However, in one study it was found that 900Mhz RF results in down regulation of miR-107, this has serious implications because miR107 regulates tumour invasion and metastasis. Down regulation of miR-107 will give cancers more opportunities to develop. Also Alzheimer's features too i.e. Expression of miR-107 decreases early in Alzheimer's disease and may accelerate disease progression through regulation of beta-site amyloid precursor protein-cleaving enzyme 1 (Wang et al., 2008).

Although apoptosis occurs naturally as cells become damaged or have functional problems, the incidence of apoptosis also correlates with the level of accumulated injury (Higami Y et al. 2000). Increased Apoptosis may also be a contributor to premature aging.

Behavioural modification and cognitive functional impairments are often described as temporary in nature when exposures are of short duration but there is uncertainty what will happen if exposures are chronic and long term or when an exposure is on a child's brain which is developing. There is a real possibility that chronic exposure could lead to the early onset of dementia/Alzheimer's disease (also see inflammation) which at this stage is irreversible. It is also of interest to note that Dementia incidences have increased dramatically and it is occurring at younger and younger ages (being seen in people who are in their forties).

Other effects like insomnia, headaches and tinnitus are noted in a number of studies, particularly those that survey populations living near Mobile Phone base stations. These effects could be considered as nuisance effects however "Annoyance or discomfort may not be pathological per se but, if substantiated, can affect the physical and mental wellbeing of a person and the resultant effect should be considered as a potential health hazard." (ICNIRP 2002 statement). It is well known in the medical community that insomnia (lack of good sleep), if persistent, may lead to a host of cascading health problems that can lead to a premature death.

DNA damage is something that is very concerning especially in sperm as this can lead to congenital defects in later generations. DNA damage if in the right combinations can lead to uncontrolled cell growth leading to cancer especially if the cell does not experience controlled apoptosis (programmed cell suicide).

Brain cancer and breast cancer are most definitely health problems that are invariably fatal often resulting in dramatically shortened lives. Although the evidence for classifying RF as a carcinogen is "limited" at this time it has recently been backed up with a replicated study on rats (Lerchl A. et. al. 2015 and Tillman T. et. el. 2010) demonstrating that RF acts as a tumour promoter. It is very likely that other cancers (i.e. Thyroid, Saliva gland etc.) are also linked to exposure but no one is actually investigating.

Inflammation also has serious negative health effects if persistent. Chronic inflammation can destroy brain cells, can induce auto immune reactions that lead to the development of allergies, damage intestinal lining, cause eczema, stroke, arthritis, cardiovascular disease, artery damage etc.

A number of studies indicated renal damage as a result of RF exposure. Renal damage can lead to Kidney failure and a premature death.

Some studies showed an increase serotonin levels for short term exposures and decreases in long term exposures. Serotonin can affect mood and social behaviour, appetite and digestion, sleep, memory and sexual desire and function. If sustained excessive serotonin can accumulate resulting in serotonin syndrome which has been linked sleep problems (insomnia), nausea, dizziness, agitation, headaches,

memory issues and mood changes. Very similar symptoms are also experienced when people have lower than normal serotonin levels. Many of these symptoms described in both scenarios can also be associated with symptoms experienced by those who suffer from Electromagnetic Hypersensitivity.

One only has to look at the rising incidence of mental health issues, depression, headaches, insomnia, nerve pain, arthritis and allergies over the last 10 -15 years, which is also reflected in the increased number of prescriptions to deal with these disorders, to understand that many of these problems can be associated with the rise in manmade EMF's.

We are all affected and it can take many years before many pathophysiological symptoms begin to manifest making it very difficult to isolate the original cause.