

Biological control systems, DNA changes and effects on cells and the blood

Many leading EMF-bio-effects scientists believe living systems use EMF to convey information needed for survival. This includes the replication of DNA, the function of the immune system, relaying of messages to the brain and communication. As long ago as 1982, the late Professor Adey, one of the foremost researchers into the biological mechanisms underlying EMF interaction with human cells, said *"It is now well established that intrinsic electromagnetic fields play a key role in a broad range of tissue functions, including embryonic morphogenesis, wound healing, and information transmission in the nervous system. These same processes may be profoundly influenced by electromagnetic fields induced by an external force."*

An interesting study by Rossi ([2011](#)) showed how cells in one petri dish affected cell proliferation rate and morphology of the cells in another petri dish even when separated, an example of the bystander effect. A black filter prevented transmission of electromagnetic radiation between 2 other petri dishes and no changes were observed. The study authors assumed that there was some form of intercellular electromagnetic communication causing the changes in the affected cells.

A study by Belyaev ([2009](#)) concluded that the strongest microwave effects were always observed in stem cells and they reacted to more frequencies than do differentiated cells.

The Austrian Insurance company AUVA report in 2009 verified that EMFs from mobile phones damage the brain and nervous system, immune system, and induced changes in protein synthesis which led to increased rates of DNA breakage, starting at 0.1 W/kg, 20 times lower than the UK safety guidelines (AUVA report: *Nonthermal effects confirmed; exposure limits challenged; precaution demanded*. August 22 2009 from <http://www.diagnose-funk.org>).

Biological control systems

Mobile phones are known to heat body tissue (the temperature of ears during a call can increase by over 0.5°C). Many people complain of heating of the ear, head or neck as one of the side effects of phone use. An analogue phone caused an increase in temperature of 4.5°C and a 2G phone 2.3°C in the user's cheek after 6 minutes use in one study (Anderson & Rowley [2007](#)). The authors suggested that RF radiation was responsible for only a part of the heating effect, the rest was due to heat conduction from the batteries (Tahvanainen [2007](#)). One of the functions of blood is to help keep brain tissue cool. Mobile phone use heats the head, including the blood, so that it cannot manage to keep the brain as cool as it should be.

A study in Australia showed that the thyroid, pancreas, ovaries, testes and hormonal balance were affected, as measured by blood tests, after using a mobile phone for 10 minutes on two consecutive days. The tests showed that the endocrine system of volunteers was severely impacted by using the mobile phone for just 10 minutes. While all volunteers showed hormonal changes, most showed stress to the pancreas, some to the ovaries or testes, some showed inflammation and a few showed thyroid impacts. Two studies by Söderqvist ([2009](#), [2009](#)) have shown changes in transthyretin after mobile phone exposure, a potential breach of the blood-cerebrospinal fluid barrier. Those whose thyroids were most affected showed greatest stress to the phone exposure, with one subject totally exhausted and unable to move for some time after each exposure. According to Jennie Burke, Director of Australian Biologics, the profound impacts

on the endocrine system that she detected are likely to be due to hormonal changes in the hypothalamus or the pituitary gland.

Noor ([2011](#)) found changes in excitatory and inhibitory amino acids in rat brains after RF exposure. The authors believe that these alterations may underlie the adverse effects of using mobile phones.

Heat shock protein

Biologist and geneticist Dr David de Pomerai, at Nottingham University, showed exposure to radiation from mobile phones for an hour could double the heat shock protein (HSP) in cells ([2000](#)). Even half an hour after exposure, cells behaved *as if* they were heated by 3°C, although there was no actual rise in temperature. Dr de Pomerai said in the journal *Nature*, "*If that reaction is left unchecked it would 'gum up' the cell with protein and it would become lethal to that cell.*" Velizarov ([1999](#)), Harvey & French ([2000](#)) and Chauhan ([2007](#)) found similar cellular changes at temperatures below heating levels. Dr French says "*if you turn on the heat shock protein response all the time, that can cause the cells to become cancerous. It is also an inducer of metastasis, or cancer spread.*" Professor Gordon McVie, director of the Cancer Research Campaign, said "*If the cells were exposed to heat shock over a long time it might exhaust the repair process. This may produce mutations and that is where you get problems. It takes more than one mutation to cause cancer, but it is very much a slippery slope.*" De Pomerai later found no effect (Dawe [2008](#)), neither did Sanchez ([2007](#)) find heat shock protein changes in rat skin as a result of GSM signals.

Markova ([2005](#)) found effects on human lymphocytes, similar to heat shock. It was dependent on carrier frequency.

In an experiment on flies, Dr Reba Goodman of Colombia University found that 2 hours mobile phone exposure for 10 days caused HSP to triple and there was a 33% increase in a rare form of brain tumour. She found some evidence that genes vital to growth changed, with the potential to become cancer-causing agents (Blank [1997](#)).

Barrie Trower, a UK expert on Electrical Sensitivity (ES), says that a rise of just 0.6°C can cause heat shock proteins to take various measures to start protecting cells from microwave induced heat. If they leave one vital task to start defending cells against internal hotspots, we may not have the resources to protect our immune system, or to repair pre-cancerous cells.

Lee's study ([2005](#)) found that 221 genes altered their expression after a 2 hour exposure to RF, and 759 after a 6 hour exposure. There was no significant increase in the expression of heat shock genes, showing that the mechanism of change was a non-thermal one.

Belyaev's study ([2009](#)) showed that cellular effects as a result of exposure to UMTS (3G) signals persisted for up to 72 hours, longer than the stress response following heat shock. The team believe that 3G signals may have more of a biological effect because of the spread spectrum nature of the signal. DNA repair characteristics were different in the group of hypersensitive subjects compared with controls.

Dr Gerard Hyland, Warwick University, believes that the microwave radiation from mobile phones can interfere with the body's own electromagnetic field. Mobile phone systems emit pulses of radiation mainly at a rate of 217 times a second, but also with 4 and 2 Hz frequency components. Partsvania's study ([2008](#)), showed that exposing mollusc neurons to these low frequency fields dehabituated them to intracellular stimuli, thus altering the neuron's normal function.

Epilepsy

In a review in the **Lancet**, Dr Hyland ([2000](#)) explained the perils of mobile phone technology: "A good example of human vulnerability to a non-thermal, electromagnetic influence is the ability of a light flashing at about 15Hz to induce seizures in people with photosensitive epilepsy. It is not so much the amount of energy absorbed from the light that provokes the seizure, but rather the information transmitted to the brain by the (coherent) regularity of its flashing, at a frequency that the brain "recognises" because it matches, or is close to a frequency utilised by the brain itself."

In October 1999 he reported that epileptic seizures had gone up in schools as a result of youngsters using mobiles. He also suspects that the increase in adolescent female Chronic Fatigue Syndrome (CFS) in Australian schools may be related to the extensive use of mobile phones amongst this age group.

Migraines

The incidence of reported migraines has increased by 70% in the last 10 years though the reason is unknown. It is anticipated that only about 1 in 3 migraines are reported to GPs, people just cope in the majority of cases. There are generally speaking five different sorts of 'migraines' only two of which have the severe headaches usually considered to be the primary symptom of migraines. It is believed that 'resonance' migraines are caused as a result of pulsed fields on the brain stem. Transcranial magnetic stimulation was found to induce migraines in people predisposed to visually triggered headaches (Aurora [1999](#)).

DNA

Dr Jerry Phillips' experiments in 1998 found significant DNA breakages in human white blood cells with pulsed signals at SARs as low as 0.0026 W/kg at frequencies of 800-900 MHz. Schwarz ([2008](#)) and Diem ([2005](#)) concluded that UMTS exposure may cause genetic alterations in some human cells at levels considerably below the safety standard. These findings show that DNA damage is not dependent on thermal effects. The data in Diem's paper has been challenged by Lerchl ([2010](#)).

Panagopoulos ([2007](#)) found cell death and DNA fragmentation in the early stages of fruit fly adulthood as a result of a few minutes a day exposure to mobile phone radiation. Mancinelli ([2004](#)) found that microwave radiation at 1.95 MHz represented a potential risk for protein "misfolding", suggesting that RF could have biochemical and biological effects on cells. Studies by Zeng ([2006](#)) and Zhao ([2006](#)) suggested that protein expression changes induced by RF radiation may affect many biological processes to do with signal transduction, and DNA damage and repair. Scientists in the AUVA report proposed that it was vibrations within the oxygen-hydrogen bonds responsible for stabilising three dimensional protein structures which cause a weakening of these bonds.

Chromosomal damage in rat foetal tissue as a result of exposure to a non-thermal emission from a mobile phone was also revealed in work done by Ferreira ([2006](#)). Belyaev ([2006](#)) found that microwaves did not directly induce DNA breaks, but did affect the *expression* of genes. Nikolova ([2005](#)) found double strand DNA breaks after short exposure to RF (6 hours), but not longer exposure (48 hours), whereas Zhang ([2008](#)) found gene expression was more obvious with intermittent rather than continuous exposure, and 24 hour exposure had a greater effect than 6 hour exposure (Zhang [2006](#)). Franzellitti ([2010](#)) found that RF signals could affect DNA integrity, but that recovery was possible.

A review of research done by Russian & Ukrainian scientists "*Influence of High-frequency Electromagnetic Radiation at Non-thermal Intensities on the Human Body*" edited by Kositsky, Nizhelska & Ponezha (2001), suggests that as a result of the 'soup' of sources of radiation, standing waves may arise, the frequency of which may coincide with resonance frequencies of living cells, organs or systems of a living being. Exposure to low-energy electromagnetic radiation from high level communications installations may change genetic structures, leading to genomic instability.

Exposing leukaemia cells to RF EMFs for 48 hours caused them to multiply aggressively, overriding the signals that trigger cell death. It seems that the DNA changes either switch off tumour-suppressor genes or switch on oncogenes, the genes that encourage cells to grow.

In 1999, the REFLEX project (QLK4-CT-1999-01574 / REFLEX / Final Report) of 12 research groups in 7 European countries working from 2000 to 2004 found that radiation from mobile phones breaks DNA in human brain cells (confirming Lai & Singh's work in the 1990s), They suggested that "increased formation and activity of free radicals" could be responsible for the damage. There are some questions about some of the research protocols, including the fact that the SARs were high, and the effects of long-term exposure were not addressed. The results of this aggregation of work, known as the REFLEX project, were exclusively obtained in *in vitro* studies and the authors officially concluded that any health risk to people from RF EMF exposure below the presently valid safety limits could not be assessed using these techniques. One can only ask why they then bothered to do the tests?

Despite this rider, the leader of the study, Franz Adlkofer of Verum Foundation advised against using mobile phones when fixed line phones are available, and also recommended using a headset with a mobile phone whenever possible.

As a result of recent research Professor Adlkofer said in a lecture in October 2007 to a forum of scientists in Gelsenkirchen in Germany, that DNA strand breaks in conjunction with the formation of micronuclei does not allow any further doubting of the genotoxic effect of UMTS (3G) signals. "*The DNA strand breaks occur at only 1/40th of the guideline limits. Hence, UMTS signals are almost ten times as active as GSM signals.*" His lecture was entitled "Mobile phone radiation damages the genetic material and raises the risk of cancer". Prof Adlkofer called the mobile radiation and the political justifications for it an "*uncontrolled and unplanned field experiment*" on humans.

A study in [2006](#) from Nylund & Leszczynski found changes in RNA in two cell variants after exposure to 900 MHz radiation, though in a later study they found very little change at 1800 MHz (Nylund [2010](#)). In the first study, the changes were different in the two cell groups, and the authors concluded that "*small genetic differences can influence the cell response to radiowaves*". Huang ([2008](#)) also found small effects on both genetic expression and regulation. A review of studies by Verschaeve ([2009](#)) concluded that a majority showed that RF-exposed individuals have increased frequencies of genetic damage, but due to the shortcomings of some of the papers, further large scale research should be undertaken.

Interaction with other environmental exposures and indirect effects

Höytö ([2008a](#), [2008b](#)), found that changes occurred in astrocytes (cells in the brain and spinal cord supporting the blood-brain barrier) but not fibroblasts (cells forming connective tissue which plays a critical role in wound healing) after exposure to mobile phone-type signals in cells which had been sensitized by chemical stress, but not in those which had *not* been so sensitized. Li (1999) did not find effects on fibroblast cells, either. This finding may shed some light on the

difficulties of study replication and the complexities involved in reactions to environmental stressors.

Mathur (2008) also found that chronic intermittent exposure to radiofrequency fields had a number of statistically significant effects on the way rats responded to pain-inducing stimuli. The conclusion was that exposure to EMFs in itself may be insufficient to cause adverse health effects, but it may cause responses to other environmental stimuli to become more severe.

Sometimes it may be that RF radiation can act as a promoter of damage caused by known carcinogens. Manti [2008] found that SARs of 2 W/kg enhanced the effect of X-ray-induced chromosomal damage, though Zhijian (2009) found no such effect. When we are surrounded by proliferating sources of all environmental pollutants it is unclear what synergies may be happening to cause cellular changes.

Dr Andrew Goldsworthy, an honorary lecturer in biology at Imperial College, London, reminds us that exposure to mobile phone radiation allows molecules to cross the barrier protecting the surfaces of the nasal cavity. With the general increase in electromagnetic exposure, we would expect to see a greater penetration of allergens as well as other toxic chemicals. The number of GP diagnoses of allergic rhinitis, which includes allergies to pollen, animal fur and dust mite, rose by a third between 2001 and 2005. Symptoms include a persistently runny nose, sneezing, itching and sore eyes and can last all year round. If you suffer from these symptoms and use a phone, you might want to consider using a shield, such as the [BlocSock](#), or using an airtube [hands-free](#) kit.

Franzellitti (2008) found strong but inconsistent effects in a gene transcript in human trophoblasts (cells providing nutrients to the embryo and which develop into the placenta) from GSM radiofrequency exposure. The authors believed that the effects may not be direct effects, but may be secondary effects caused by more subtle alterations not detected at the protein level.

Cellular Mechanisms

Andrew Goldsworthy believes that microwave signals from phones weaken cell membranes, which then leak (also Cammaerts 2011). Enzymes can then get into the cell and start digesting it. This causes the fragmentation of DNA, which can cause a loss of fertility and genetic damage to future generations. For more information on Dr Goldsworthy's theories, see <http://tinyurl.com>

Friedman (2007) showed how mobile phone signals could create free radicals, which could then be involved in the development of cancer, leukaemia, arteriosclerosis, arthritis, Alzheimer's, Parkinson's, MND, etc. Ammari (2008) showed that high levels of 900 MHz radiation could induce changes in brain cells similar to those associated with some degenerative disorders. Beason (2002) found changes in more than half of bird's brain cells after exposure to 900 MHz signals. 76% of these increased activity and the rest decreased activity.

Karinen (2008) found protein expression changes in people's skin after RF exposure. Gerner (2010) found that an 8 hour exposure to an 1800 MHz RF electromagnetic fields caused a significant increase in protein synthesis in metabolically active cells, but not in inactive ones. Neither did they find the effect with a short term exposure. They suggested that these differential effects may explain some of the conflicting results of previous studies. The slower frequencies of digital signals will interact with protein receptors on the cell membrane and cause vibrations which can close down the cell membrane. Nutrient flow is impaired and waste products cannot make it out of the cell. It also disrupts inter-cellular communication so that cell clusters no longer work together effectively. With the increase in waste products free radicals are generated along with messenger RNA which passes on this 'learned response' to daughter cells so that these new cells respond to microwaves in the same way (Anslow 2007 The Ecologist).

Cell demodulation of digital signals is a process in which the body collects the signal and turns it into electric currents which are carried by ions in the tissues and blood vessels. When the currents contact the cell membrane it tries to vibrate in time with the current. The cell then demodulates the signal so that the low frequency component is extracted and appears across the membrane where it can do the most damage; positively and negatively charged ions are driven in the opposite of their natural direction, the cell membrane destabilises and causes leakage of the cell membrane (Goldsworthy 2009).

One consequence of the leakage is to make the sensory cells of electrosensitive individuals give a whole range of false sensations. People suffering from ES have significantly higher natural rates of membrane leakage as measured by their skin conductance. Since their leakage rates are already high, even small amounts of electromagnetic radiation that would not affect non-sensitive individuals can trigger their symptoms.

Irmak (2002), Yurekli (2006) and Lee (2008) found that animals exposed to the level of radiation some people may experience from a mobile phone, suffered oxidative stress, a form of tissue damage, caused by excessive free radicals. Oxidative stress is suspected of being a cause of neurodegenerative diseases such as motor neurone disease. Oral (2006) found that oxidative stress produced by 900MHz phone radiation produced endometrial damage.

Orendáčová (2010) found different changes in neurogenesis as a result of RF radiation depending on the age of the rats in the experiment, which may indicate different windows of effect.

Rağbetli (2010) found mobile phone exposure decreased the number of Purkinje cells in the cerebellum. These are involved in the control of motor movement.

The World Health Organisation fact sheet 183 says that exposure to low-levels of RF fields, too low to produce heating, has been reported to alter the electrical activity of the brain in cats and rabbits by changing calcium ion mobility. This finding was supported by Maskey (2010) in experiments on rats. This effect has also been reported in isolated tissues and cells.

Other studies have suggested that RF fields change the proliferation rate of cells, alter enzyme activity (Barteri 2005), affect the genes in the DNA of cells (Kim 2008), or provoke oxidative stress that promotes reactive oxygen species (ROS) production. Dr Howard Fisher exposed samples of brain cells to a mobile phone signal for 60 minutes and found a greater than 10% decrease in cell growth, though Sekijima (2010) and Dogan (2011) found no changes.

In a study by Volkow (2011) 50 minutes of mobile phone radiation significantly raised the brain's level of glucose. Increased glucose levels are associated with inflammation, which may indicate that cells are being damaged in ways that could raise the risk of brain tumours.

However, the World Health Organisation (WHO) does not believe that these effects are well established, nor are their implications for human health sufficiently well understood for them to provide a basis for restricting human exposure. Whilst there is this uncertainty, we would have thought a precautionary response (limiting exposure) would be appropriate.

Blood changes

The relationship between the presence of micronuclei and cancer is so strong that doctors from around the world use tests for micronuclei to identify patients likely to develop cancer. Such tests were used extensively after the Chernobyl nuclear accident.

Tice (2002) found serious human blood cell changes following exposure to four different types of cell phone signals. The nuclei of many red blood cells had been split into little bits ("micronuclei")

- direct evidence of genetic damage to the cells. This was a well controlled, peer reviewed, and repeated set of experiments that showed a two- to eight-fold increase in micronuclei in the blood that was exposed to cell phone type microwave radiation for 24 hours. D'Ambrosio (2002) also found micronuclei after microwave exposure that was phase modulated.

Stopczyk (2002) found that after only one minute of exposure to cell phone radiation, anti-oxidant levels in the blood had dropped significantly. This clearly has implications for many illnesses.

Papers by Mashevich (2003) and Belyaev (2005), report that exposure of human peripheral blood lymphocytes to electromagnetic fields associated with cellular phones leads to chromosomal instability. The radiation has a genotoxic effect, elicited via a non-thermal pathway, but can include the same stress response as heat shock. The chromosome change that may be induced is a phenomenon known to increase the risk for cancer. RF levels at half the permitted SAR elicited behavioural signs of microwave-induced thermal stress (Hirata 2010).

As early as 1927, Ernst Muth first discovered that red blood cells exposed to radio frequency waves at levels far less powerful than permitted today line up in chains resembling strings of pearls. In 2002, Bo Sernelius, a physicist at Linkoping University in Sweden, calculated what effect EMFs created by different frequencies would have on van der Waals forces, the attractive forces between cells. According to Sernelius' figures, in fields of 850 MHz, the attractive forces appear to leap to micronewton strength. That is a huge jump of around 11 orders of magnitude, and completely unexpected, says Sernelius. If the effect could be confirmed experimentally, it could form the basis of an explanation for tissue damage: stronger attractive forces might make them clump together, for example, or cause blood vessels to contract. Two students of the gymnasium high school in Spaichingen in Germany in 2005 got their fellow pupils to use a mobile phone for 20 seconds and tested the red blood cells. The cells lumped together in 'rolls of coins' immediately after. Ten minutes later the effect could still be seen. For German-speaking readers, see: <http://www.szon.de/lokales/spaichingen/stadt/200503070146.html>. Cells which clump together take up less oxygen and also raise the risk of thrombosis. The micro blood clots are due to the increase of thromboxane in blood as reported by Omura & Losco (1993).

The European Research Institute for Electronic Components in Bucharest has found that the radiation emitted by mobile phones causes red blood cells to leak haemoglobin which is important for transporting oxygen within the body. A build up of haemoglobin can cause heart and kidney problems. Mousavy (2009) found that mobile phone radiation decreased oxygen uptake and changed haemoglobin structure.

Aalto (2006) and Huber (2005) found changes in regional blood flow after exposure to a mobile phone signal, and Oktem (2005) found oxidative damage in the kidneys after exposure to 900MHz radiation.

Kumar (2010) found no effect on the hematopoietic system on in vitro bone marrow cells from a continuous wave 900 MHz source. Maybe the effect on bone marrow cells, rather than cells in a living system is different.