The research

Ruediger's review (2009) of 101 publications looking at the health effects of radiofrequency electromagnetic fields (RF-EMF) concluded that “there is ample evidence that RF-EMF can alter the genetic material of exposed cells in vivo and in vitro and in more than one way. This genotoxic action may be mediated by microthermal effects in cellular structures, formation of free radicals, or an interaction with DNA-repair mechanisms.” Garaj-Vrhovac (2009) found evidence of basal and oxidative DNA damage after long-term exposure to microwave radiation. Ruediger also said the studies showed that RF-EMF enhanced the genotoxic action of other chemical or physical agents.

However, Röösli (2010) in a review of 17 articles concluded that there was insufficient data to draw firm conclusions about health effects from long-term low-level RF exposure.

Dr Dariusz Leszczynski from STUK, the Finnish governmental authority for the nuclear industry, reported after the 5th International Seminar in China in April 2009, the Chinese concern over ICNIRP and WHO evaluation of RF research. The negative studies seem accepted without scrutiny, whereas the positive studies are examined in every detail, even though the negative studies might include erroneous results or interpretations. Only the positive studies have to be replicated before they can be accepted as valid, but not the negative ones.

Essex University consistently reports negative findings as a result of exposure to masts (Eltiti 2007, 2009, Wallace 2010, 2011). We have heard that people with electrical sensitivity refuse to take part because of their subsequent health reactions to the exposure. There are insufficient people taking part for the results to achieve statistical significance.

Various hypotheses have been put forward about how radiofrequency exposure may create the effects reported. Among these are that the radiation reduces melatonin levels and increases nitric oxide (NO) levels. A study by Yariktas (2005) found that melatonin prevented the build-up of NO in the nasal and sinus mucosa after rats were exposed to 900 MHz radiation. These changes in melatonin and nitric oxide levels may reduce the amount of cancer fighting cells in our bodies, promote sleeping disorders, increase cholesterol levels leading to greater risk of atherosclerosis and coronary heart disease, and increase blood pressure giving greater risk of blood clots and strokes. Maskey (2010) showed calcium ion changes which could affect neuronal connectivity and integration.

Lee (2009) found no observable adverse effects on mouse foetuses after maternal exposure to CDMA and WCDMA during pregnancy.

A paper by Matronchik & Belyaev (2008) suggested that it is the interaction of environmental exposures that may have biological effects, that non thermal effects of microwaves are dependent on carrier frequency and also static magnetic field in the area of exposure. This could help to explain inconsistencies in study results.

Autism

Robert Kane (2004) has suggested a possible link between the increased incidence of autism and foetal or neo-natal exposures to RF radiation.
Blood changes

RF radiation at 900 MHz affected the speed and direction of movement of neutrophils (Aly 2008), which may be significant in that neutrophils have an important role in killing pathogens in the body.

Blood pressure

One person who reacts to RF radiation checked his blood pressure readings; first thing 120/70, and then surrounded by electrosmog at work 189/106, 160/104 and 158/103. These readings, of course, could have changed for other reasons, but as this effect has been widely reported, we would like to see further detailed investigations carried out.

High blood pressure increases the risk of developing dementia, being 6 times more likely in people with high blood pressure in their 40s and 50s; the exact mechanism is unclear, but it has been suggested that high blood pressure can starve the brain of bloodflow and the oxygen it carries. The NHS has been under increasing pressure to provide care facilities for people with early onset dementia. If the increase in ambient RF exposure is responsible for changes in blood pressure, this could be one explanation. Melatonin supplementation may help, as it has been shown to reduce the damage caused by changes in bloodflow.

Cancer

Cancer has not been the most reported health effect from environmental microwave sources. One of the reasons for this is likely to be the length of time between exposure to an environmental pollutant and the time that a cancer takes to be diagnosed. This often takes longer than the length of time many populations have been exposed to environmental microwave radiation. There are likely to be some differences in genetic susceptibility that make epidemiological research more difficult (Czyz 2004).

However, two studies found that people living near a mobile phone mast were 3 times (Eger 2004) or over 4 times (Wolf & Wolf 2004) more likely to develop cancer than those living in an area away from the mast, and Eger found that people became ill much earlier. Wolf & Wolf reported that women were more than 10 times more likely to develop cancer. No particular type of cancer was identified as being more likely to develop. Geographical areas covered by several transmitters show higher incidences of melanoma than areas covered by one transmitter (Hallberg & Johansson 2009).

Firefighters have been reported as having an increased risk of dying from cancer, including leukaemia, multiple myeloma, non-Hodgkin's lymphoma, male breast cancer, malignant melanoma, and cancers of the brain, stomach, colon, rectum, prostate, urinary bladder, testes and thyroid (Milham 2009). This list strongly overlaps the list of cancers at increased risk in workers exposed to EMFs and RF radiation. Although exposure to carcinogens in combustion products could be a contributory factor, respiratory system cancers and diseases are usually not increased in firefighters as they are in workers exposed to known inhaled carcinogens. Firefighters have increased exposure to RF radiation in the course of their work, from the mobile two-way radio communications devices which they routinely use while fighting fires, and at times from fire station and fire vehicle radio transmitters.

Thirteen children attending La Asunción secondary school in Gijón, Spain, mapped the beams of radiation emitted by the 92 base stations in their city (reported in La Nueva España 20.06.05).
They then pinpointed all of the houses of people who had developed cancer during the previous 5 years. They found that:

a) Cancer rates were abnormal in the locality of base stations (the area was exposed to higher levels of radiation)

b) The cancer rates were highest where 2 or more beams crossed

In November 2009, Malagahoy reported that among the 350 inhabitants of Pérez Los Cortijos, near Vélez-Málaga, in Spain, there have been 43 cases of cancer resulting in 35 deaths, which are blamed on the phone mast in the village.

Roland Stabenow, the head of cancer registry in Berlin, informed the residents of Steinbach-Hallenberg that there was a 7 fold increase in breast cancer amongst people in their area living near the cellular antennas.

It is believed that microwaves may interfere with the body’s bio-electro-chemical signalling systems, affecting the mechanisms whereby cells become cancerous, and the mechanisms which repair pre-cancerous damage. This may explain why no particular cancer is associated with microwave exposure; the immune system’s ability to repair cancer damage is compromised, no matter in which area of the body the cancer first appears. Buttiglione (2007) found changes in human neuroblastoma cells after being exposed to 900 MHz radiation, though Billaudel (2009) didn’t.

The study by Hallberg & Johansson (2009) proposed another interesting confounder. Breast cancer more frequently occurs in the left breast among both men and women and melanoma is found more on the left side. They suggest that a high prevalence of breast cancer and melanoma on the left side of the body may be a logical consequence of sleeping in beds having mattresses containing wave-reflecting metal springs. People tend to sleep for longer periods on their right side, apparently to avoid disturbance by the heart beat. This puts the left side further away from the field-attenuating influence of the metal springs in the mattress; thus the left side will spend more time exposed to stronger combined fields from incident and reflected radiation. They thought that it may explain why body parts farthest away from the mattress have higher melanoma rates than the sun-exposed face area.

A new pilot study by Tillmann (2008 page 10) found tumour-promoting effects in mice following chronic exposure to UMTS signals. The levels used were very high, but it does demonstrate RF effects on living systems.

Central Nervous System

Juutilainen reviewed possible biological effects of RF and concluded that there may be specific effects from amplitude-modulated RF fields on the human central nervous system (2011).

DNA

Nikolova (2005) found transient DNA double-strand DNA breakages after 6 hours exposure to RF. A longer (48 hour) exposure did not have this effect.

Eyes

High-power microwave radiation can cause cataracts due to thermal mechanisms (Zaret 1975, 1977a, 1977b).
Low-power radiation has been associated with lens transparency, alteration in cell proliferation and apoptosis, inhibition of gap junctional intercellular communication, genetic instability and stress responses in lens epithelial cells (Yu & Yao 2010).

**Headaches**

Riddervold (2008) found headaches, but not cognitive changes reported by people exposed to RF from mobile phone base stations.

**Hearing**

GSM like radiofrequency radiation affected hearing function in rabbits (Budak 2009).

An occupational study by Oktay (2004) found hearing loss as a result of RF exposure.

**Effects on heart pacemakers**

The following sources of RF have been reported by pacemaker wearers to have the effects noted.

- **Car bluetooth** ~ Had to be returned when it interfered with the pacemaker and made the wearer unwell.
- **IPOD** ~ In most cases when the IPOD was held within 50 mm of the pacemaker for 5-10 seconds, it interfered with its functioning. One instance of interference still at 450 mm, and in another, the pacemaker stopped working altogether. Study by the Cardiovascular Institute at Michigan State University.
- **Microwave oven** ~ At 3 feet from the oven, the wearer experienced a small vibration that felt like a slight 'buzzing' in the centre of their chest, coinciding with the time of operation of the oven.
- **Security scanner** ~ The 'wand' part of a security scanner can stop pacemakers; one wearer felt dizzy when exposed, but the feeling passed off.
- **TV wireless headphone** ~ Caused one wearer to pass out at once.
- **Wii games** ~ Pulse rate went down to 54, though the pacemaker usually keeps it at 60. General 'interference'.
- **Wireless router for broadband internet connection with laptop** ~ Pacemaker went 'crazy' even at 1.5 feet away, from the little 'radar switch'; the router had to be switched off after 5 minutes.

**Neurological changes**

Gerd Oberfeld and his colleagues in the Public health Dept in Salzburg measured brain wave changes in volunteers exposed to 1 V/m pulsed radiation from a GSM base station 80 metres away. The changes in relative strength of alpha 1, alpha 2 and beta brain waves were documented from EEG measurements. It was suggested that these findings verified the prediction by Gerard Hyland (2000) that the pulsing pattern of GSM phone systems would resonate with the lower frequency human brainwaves.

Significant EEG changes implying that brain functioning had been affected by low-frequency microwaves was found in a study by Vorobyov (2010).

Low frequency RF was found to change EEG, depending on frequency (Hinrikus 2008).
Kolodynski & Kolodynska (1996) found that school children living near a Radio Location Station in Latvia had memory and attention problems, their reaction time was slower and their motor functions were poor.

When Hocking & Westerman (2003) searched 11 original articles investigating neurological effects, they found that threshold studies found neurological abnormalities, though only a small proportion of exposed people develop the symptoms.

**Reproductive problems**

Two studies looking at occupational exposure to RF in the Norwegian navy (Møllerløkken 2008, Baste 2008) showed an increased risk of infertility in men exposed to radiofrequency fields; the higher the exposure, the greater the risk for infertility. Where children were born to exposed men, there were a greater number of girls born than boys.

A Chinese study (Xu 2009) showed toxic changes to female rats' reproductive organs with exposure to RF radiation. However, the frequency (30 MHz) used experimentally is likely to be military radar and uncommonly encountered, and at signal levels where an individual, to be exposed, would have to be working nearby, or in the main beam.

A study by Lishko (2010) showed that human sperm move to the egg in an electrically created pathway. This may well be affected by external EMFs, which could explain some of the research findings. Mice have much larger sperm (relatively speaking) than humans, so they may not be affected as much. This could be significant when many of the laboratory studies are carried out in mice.

The following graph shows an increase in risk of miscarriage for pregnant physiotherapists who have increased exposure to microwaves, as a result of their occupation. The microwave levels are not particularly high and are similar to those which will be found in many places near mobile phone base stations and in homes and workplaces with DECT phones and wireless LAN systems.

![Figure 41: Microwave exposure associated miscarriage for pregnant physiotherapists, Ouellet-Hellstrom and Stewart (1993).](image)

Liu (2007) found that the use of a microwave oven or a mobile phone were risk factors for early spontaneous abortion.

**Effects on sleep**

Sleep problems affect around 10 to 12 per cent of the adult population, according to Professor Colin Espie, director of the University of Glasgow Sleep Research Laboratory. By his definition, a chronic insomniac is someone who spends at least 30 minutes trying to get to sleep or is awake
for at least 30 minutes during the night, at least three times a week for three months. This is similar to what is reported by people who live near RF transmitters. Sleep recharges the brain, repairing important neuronal connections and helping it organise data. Sleep also gives the cardiovascular system a break and helps damaged cells mend themselves. So any effect on sleep quality may express itself in many different symptoms according to individual susceptibility.

Humans use cryptochrome in our biological clocks. Cryptochrome is affected by RF (Ritz 2004), and this interaction may be responsible for the poor sleep patterns often reported in people living near mobile phone masts. They suffer fatigue during the day and interrupted sleep at night.

The Schwarzenburg radio transmitter in Switzerland was shut down in 1998, and Altpeter and his colleagues did a ‘before and after’ study (2006) on sleep quality and melatonin excretion (a measure of melatonin availability) in nearby residents. They found an improvement in sleep quality and melatonin excretion after the mast ceased broadcasting, depending on the previous level of RF exposure, but only in poor sleepers. They accepted that there may have been a psychosomatic element in their result.

Studies have linked disturbed sleep patterns to heart disease and diabetes, and found that a twentysomething deprived of sleep for 36 hours will have the mental capacity of a 60-year-old.

The RAC says that sleepy drivers were to blame for 20,000 crashes last year. Sleep deprivation results in a reduced ability to make sense of what is seen. There can be severe drops in visual processing and attention. In between there may be periods of apparently normal brain functioning which can lead to a false sense of competency and security (Chee 2008). This clearly could have serious consequences if people were suffering sleep problems and engaged in work that needed a clear focus of concentration.

A study by Clark (2007) showed that there may be a sensitive subgroup of women who react to RF transmissions with a reduction in melatonin levels, especially post menopause. As this is such a potent hormone with respect to our health, this deserves further investigation.

Other biological changes

De Pomerai’s team (2003) found that exposure to microwave radiation enhanced the aggregation of bovine serum albumin, in a similar way to heating, and that the effect could be inhibited in a similar way to the way heat-shock responses caused by temperature increases were inhibited.

Orendáčová (2009) found that 2.45 GHz radiation induced age- and dose-dependent changes in proliferating cell numbers in the nervous system of newborn rats, at levels similar to those that will be found in classrooms where there is WiFi. Del Vecchio (2009a) found reduced neurite growth and maturation after exposure to 900 MHz radiation. The team suggested that it was only under certain conditions that the exposure acted as a co-stressor for neurodegenerative oxidative damage (2009b). Yurekli (2006) also found oxidative stress biomarkers in rats exposed to GSM far field signals such as those found near base stations. This suggests an interactive environmental component that makes experimental studies harder to replicate.

Electromagnetic ‘noise’ was found to have a protective effect on lens cells damage induced by microwave radiation (Yao 2008).

It is accepted that electromagnetic fields affect the behaviour of calcium in living cells. The textbook symptoms of too little calcium, such as fatigue, muscle cramps, irregular heart rhythm and gut problems are very similar to those reported by people who say they are affected by microwave radiation. As long ago as 1975, Bawin reported that RF could remove structurally
important calcium ions from cell membranes at levels far too low to generate significant heat. This makes them leak. The most serious effect is on the membranes of the lysosomes. When these leak, they can release their enzymes and do serious damage to the rest of the cell, including to its DNA. One effect of DNA damage is the disruption of cell division in the bone marrow, which affects the production of healthy white blood cells and can lead to a reduced immunity to disease.

Pulses carried by microwaves are particularly dangerous. This is because their very short wavelength allows the transmission of pulses with extremely rapid rise and fall times, and it is the rate of change of the fields (rather than their total energy) that does most of the biological damage; it catapults vital calcium ions away from cell membranes, which in turn makes them leak. This leakage can explain the great majority of the observed adverse health effects of prolonged exposure to electromagnetic radiation.

Augner (2010) found various biomarkers of stress in the saliva of study participants exposed to base station signals at low levels. The authors felt that these would be indicative of some of the symptoms ascribed to RF-EMF exposure from the masts.

Hyland suggested (2008) that it is the similarities between the characteristics of external microwave fields and the natural cellular qualities that cause the interactions between the two, interfering with the cell’s optimum functioning. The incoming microwaves “undermine the efficacy of processes that would otherwise afford natural protection against the development of pathology”. The microwaves can create ill-health effects by altering the protective effects of cellular behaviour. Interestingly, using microwaves in carefully considered therapeutic ways can enable aberrant behaviour of cells to be ‘normalised’ thus improving health. For more information on this, see our article “EMFs and their healing potential”.

Physicists at UC Berkeley (Jensen 2007) have produced the world’s smallest radio out of a single carbon nanotube that is 10,000 times thinner than a human hair. It serves as an antenna, tuner, amplifier and demodulator. The nanotube absorbs the radio transmission and physically vibrates in response, like a tuning fork or the tiny hairlike structures inside the human ear. The multi-walled cylinders were better at picking up AM and FM transmissions and the single walled nanotubes were best for receiving the frequencies used in cell phones. It is interesting that the mechanism is by physical vibration of the nanotube in response to RF fields. This may give more pointers as to the bio-detection capability of the body, even at a cellular level and also may well invoke a bio-response. Pavicic (2008) found that 935MHz radiation affected microtubule proteins, which the authors believed could obstruct cell growth.

**The need for precaution with respect to schoolchildren**

Many of the symptoms reported by people living near mobile phone base stations, that is, concentration, learning and memory problems, behavioural changes, irritability and aggression are particularly undesirable to be found occurring in school pupils. There has been a dramatic increase in the use of wireless local area network (wLAN) systems and interactive whiteboards in schoolrooms. Enclosed environments (particularly where there are microwave-reflective structures such as reinforced concrete, metal joists, steel furniture etc.) will add to the overall exposure of children to microwave radiation. The study by Kolodynski & Kolodynska, referred to above, found RF levels in the homes similar to those that children in classes with wLANs will be exposed to.

The ICNIRP guidelines (which determine the permitted exposure to RF by the general public), are relevant only to heating effects. However, the bulk of the damage is due to direct electrical effects on the stability of cell membranes and can occur at levels orders of magnitude lower. It is generally accepted that about 3% of the population (about one child per class) will develop some
form of electromagnetic hypersensitivity (EHS) and a larger number will show behavioural
problems, experience learning difficulties and risk permanent genetic damage.

A study reported by Powerwatch in 2000 (Section 4, study I), showed that in a comparison of 2
schools in the North East of England, one with a mast for almost 3 years, and one without, the
one with reported more children complaining of nausea, tiredness, memory loss, skin problems,
anxiety, and poor concentration.

A study by Lai (1989) found that 45 minutes of exposure to pulsed microwaves affected choline
uptake in the rat. Choline is a chemical precursor or "building block" needed to produce the
neurotransmitter acetylcholine, and research suggests that memory, intelligence and mood are
mediated at least in part by acetylcholine metabolism in the brain.

Since 1997, there has been a four-fold rise in children diagnosed with hyperactivity and Attention
Deficit Hyperactivity Disorder (ADHD) - indeed the National Institute for Clinical Excellence
now estimates that as many as 5% of children have this problem. It is possible that microwave
exposure plays a role in this rise.

A councillor in London reported that he had been into homes where the children were “screaming
monsters”. After he suggested to the parents that they switch off the wireless network for two
days, “the kids were transformed”. 

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www.powerwatch.org.uk or www.emfields.org