

**Modern Day Electromagnetic
Frequencies and Effects on
Human Health**

Andrew Goldsworthy 2008

Our exposure to electromagnetic radiation has increased many thousand-fold in recent years

- The main sources are mobile phones, cordless phones, Wi-Fi, microwave ovens, power lines, energy-saving lamps and domestic wiring.
- There has been a simultaneous increase in the incidence of electrosensitivity, allergies, cancer and a loss of fertility.
- **Is there a link; if so what is it?**

The Link

- There is a link and it was discovered over thirty years ago!
- A simple phenomenon that affects membrane permeability can explain all of these biological effects.
- More information and references at <http://tinyurl.com/5ru6e6> and <http://tinyurl.com/59a6b9>

There could be a causal relationship

- Effects of non-ionising electromagnetic radiation occur in many organisms and at levels too low to generate significant heat.
- They occur in animals, plants and even unicells such as yeast and diatoms.
- So effects must occur at the cellular level.
- We can explain almost all of them as being due to leaking cell membranes.

Effects on Animals and Humans

- Our bodies act as antennas that absorb the radiation and convert it into alternating eddy currents.
- These generate alternating voltages across cell membranes which remove structurally important calcium ions.
- Electromagnetic calcium loss was first shown in brain slices by Bawin *et al.* in 1975.

Amplitude, Frequency and Waveform Matter

- Electromagnetic calcium release only occurs within certain “*amplitude windows*”.
- Low frequencies work best.
- 16 Hz is particularly effective.
- Pulses work better than sine waves.
- Radio frequencies have little effect unless amplitude modulated at a low frequency.

What is the Mechanism?

- Positive ions bind naturally to negative cell membranes.
- Alternating voltages try to drive the ions on and off the membranes
- Some of them are “shaken loose”.
- Divalent ions such as calcium and magnesium (which have two charges) are preferentially dislodged.

Amplitude and Frequency

- The voltage must be high enough to remove divalent calcium ions but not monovalent ions such as potassium.
- When the field reverses, the calcium tries to return, but if the frequency is low, its place may have been taken by other ions.
- Potassium is the most likely ion to do this because of its relative abundance.

Why is 16Hz Special?

- It is the ion cyclotron resonance frequency for potassium in the Earth's magnetic field.
- It absorbs electromagnetic energy at this frequency, which makes it more likely to replace calcium.
- Radiation at this frequency should enhance calcium loss and all that stems from it.

Effects that Peak or Trough at around 16Hz

- **Growth in yeast** (Mehedintu & Berg 1997).
- **Growth in higher plants** (Smith et al. 1993).
- **Locomotion in diatoms** (McLeod *et al.* 1987).
- **Neurophysiological symptoms** provoked in some people by **TETRA handsets** (pulsed at 17.6Hz).

Why pulses are more effective than sine waves

- The rapid rise and fall times of pulses catapult calcium ions quickly from the cell membrane and allow relatively more time for them to be replaced by other ions before the field reverses.
- Pulsed radiation is usually more effective than sine waves in triggering many biological effects, which also suggests that calcium release may be the underlying cause.

Amplitude Modulated Radio Waves

- Unmodulated radio waves have little effect
- But they give biological effects if amplitude modulated at a low frequency; i.e. when the signal strength rises and falls in time with the low frequency.
- Pulsed radio waves also do this.
- **Mobile phone signals are pulsed**

Calcium Loss Makes Membranes Leak

- Positive ions strengthen cell membranes by cross-linking the negative phospholipids.
- Divalent ions do this better than monovalent ions.
- Replacing calcium with potassium weakens cell membranes and makes them more inclined to leak.

Membrane Leakage Can Explain Virtually All the Biological Effects of Electromagnetic Radiation

- These include
- **Electrosensitivity**
- Effects on **brain function (including autism)**
- **DNA damage**
- **Loss of fertility**
- **Miscarriages**
- **Cancer**
- **Genetic damage to future generations**

Electrosensitivity

- About 3 percent of the population are electrosensitive; also known as electromagnetic hypersensitivity (EHS).
- EHS sufferers have more permeable skins (Elititi et al. 2007), which suggests their cell membranes are already more leaky and therefore more easily damaged by the radiation.
- Symptoms include skin rashes, various paresthesias, dizziness, tinnitus, partial loss of vision, headaches and fatigue.

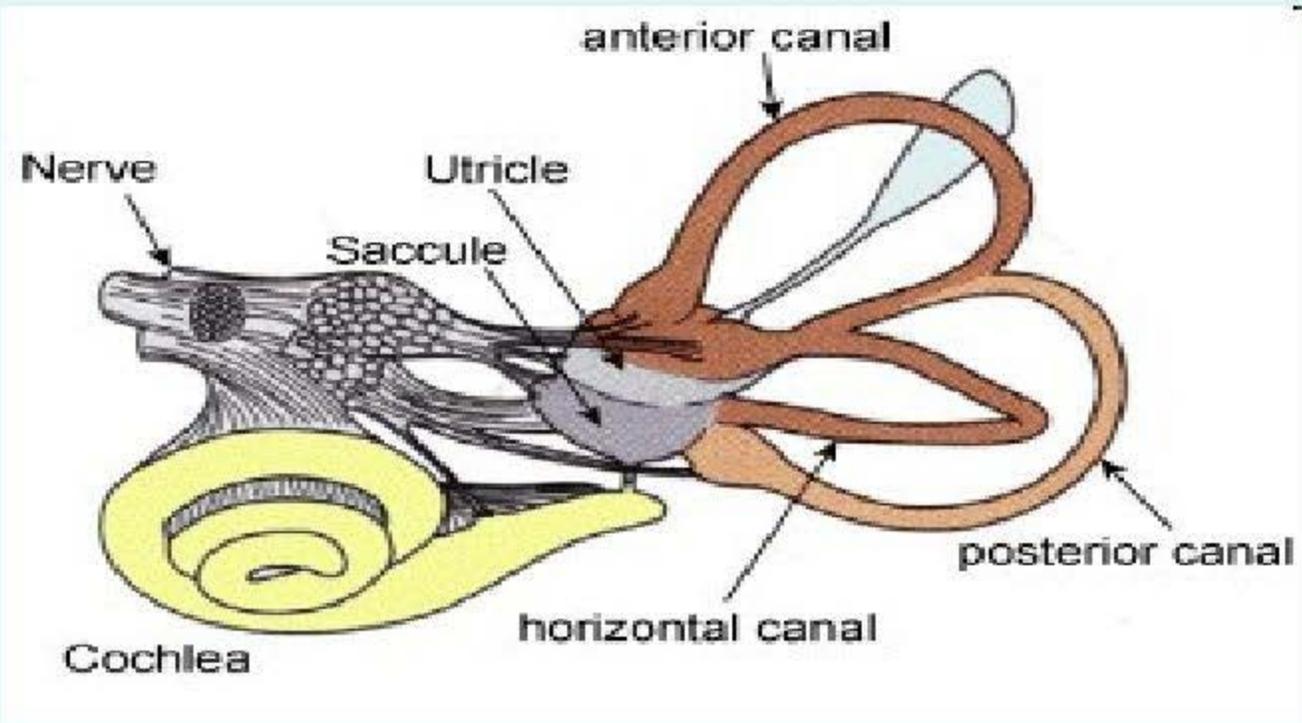
They can all be explained by membrane leakage

- **Inflammation** and other skin disorders can result from damage to the cell membranes of the skin (which is the most exposed part of the body).
- The release of cell contents sets up an inflammatory response

Paresthesias

- Mechanoreceptors, thermoreceptors and nociceptors all work in the same way.
- When they are stimulated, their membrane potentials become reduced, which triggers nerve impulses that are sent to the brain.
- Electromagnetically induced membrane leakage has the same effect and send out signals that give false sensations.

The Inner Ear



Inner Ear Hair Cells

- These have apical hairs that sense motion, which reduces their membrane potentials and trigger nerve impulses.
- In the cochlea they detect sound and false stimulation gives us tinnitus.
- In the semicircular canals and vestibule they sense motion and gravity.
- False stimulation results in dizziness, nausea and symptoms of motion sickness.

The Eye Is Different

- The rods and cones are unusual in that they respond to light by increasing their membrane potential.
- Here, membrane leakage has the opposite effect to make the transmission of nerve impulses less likely.
- This results in a partial loss of vision rather than hallucinations.

Effects on the Heart

- The generation and transmission of electrical signals from cell to cell in the heart muscle is essential to maintain its rhythm.
- Membrane leakage will disrupt the flow of ions responsible for this, which results in cardiac arrhythmia.

Effects on Neurons

- The controlled entry of free calcium ions through membranes into the cytosol is a prerequisite for neurotransmitter release.
- Leaky membranes let in too much and increase the background concentration.
- This speeds the chemical transmission of action potentials but also generates spurious ones.
- Beason and Semm (2002) found a 3.5-fold increase in neuron firing in birds exposed to GSM signals
- The expected effect is brain hyperactivity.

Hyperactivity

- Hyperactivity speeds reaction times in simple tasks but spurious action potentials give rise to confused thought.
- This could be responsible for difficulties in getting to sleep after using a mobile phone, ADHD, and the high accident rate when driving using one.
- Hyperactivity in early childhood may also cause autism since it may prevent the normal pruning of interneuron connections that “hard-wire” those concerned with social interactions.

DNA Damage

- There have been many reports dating back to 1995 of mobile phone radiation damaging DNA.
- The most comprehensive is the “Reflex Study” sponsored by the EC.
- **Because the DNA molecule is very stable, it is unlikely that there is a direct effect.**
- The most likely explanation is that it is due to a radiation-induced leakage of DNase through the damaged membranes of lysosomes.

Consequences of DNA damage

- Increased risk of **cancer**
- Reduced **fertility**
- Embryo **malformation and miscarriage**
- **Mutations** in future generations

25

Allergies

- Mobile phone radiation allows protein molecules through the blood-brain barrier, where the cells are connected by tight junctions in which the gaps between them are sealed.
- There are similar “**tight junction**” barriers protecting all of our body surfaces.
- Chu et al. (2001) found that low Ca or adding EGTA increased the permeability of respiratory epithelia to ions and even virus particles.
- A similar increase in the permeability any of these barriers would allow the more rapid entry of allergens, carcinogens and toxic chemicals.

Consequences of barrier breakdown

- Increased incidence of many allergies and multiple chemical sensitivities.
- An increased permeability of the gut lining has also been linked to Crohn's disease, celiac disease, multiple sclerosis, irritable bowel syndrome and type-1 diabetes (Arrietta et al 2006).

Defence Mechanisms

- Several defence mechanisms are known to be triggered by the radiation; e.g. -
- Ornithine decarboxylase **protects DNA**
- Heat-shock proteins **protect enzymes**
- **Growth and repair** mechanisms are stimulated.
- There may be more, but they all take their toll by using resources and are likely to result in fatigue and reduced immunity to disease and cancer.

The Good And The Bad

- Low doses of non-ionising radiation have been shown to promote bone healing.
- They also promote the growth of plants.
- Higher doses are toxic.
- This is called **radiation hormesis** and is probably due to the stimulation of repair.
- **Just like strychnine; a little is a tonic, a lot is not.**

Useful URLs

Information on electrosensitivity

www.es-uk.info/

How to screen against EM radiation

www.powerwatch.org.uk

The Orchid Low Radiation Cordless Phone
(base station switches off between calls)

www.lowradiation.co.uk