

Mobile phone lab

abridged version of <http://news.bbc.co.uk/1/hi/health/4113989.stm> (21.12.04):

Mobile phones 'alter human DNA'

Radio waves from mobile phones do harm body cells and damage DNA, a laboratory study has shown.

But the European Union-funded Reflex research did not prove such changes were a risk to human health.

The scientists behind the study, which has not been published in a journal, said more work was needed to see the actual effect of the phones on health.



But the UK National Radiological Protection Board said people should not be worried by the study's findings.

The mobile industry says there is no proof phones harm health

A spokesman said the study had not shown the biological changes led to disease.

He added that even research looking at the effects of radiowaves on cells and DNA did not consistently find evidence of damage.

Around 1.5 billion people around the world use mobile phones.

There is an ongoing debate over their safety, with fears over potential dangers linked to mobile phone masts and the handsets themselves.

But the UK government-commissioned Stewart report in 2000 concluded there was no evidence of harm associated with using mobile phones.

However, the report did recommend a precautionary approach and said children should only use mobile phones in emergencies.

The mobile phone industry maintains there is no scientific evidence of harmful effects from electromagnetic radiation.

'Precautions'

The four-year Reflex study, co-ordinated by the German research group Verum, studied the effects of radiation on animal and human cells in a laboratory.

They found that, after being exposed to electromagnetic fields, the cells showed a significant increase in DNA damage which could not always be repaired by the cell.

Damage was also seen in the next generation of cells. Mutated cells are seen as a possible cause of cancer.

The study, which has not been published in a journal, also reported other harmful effects on cells.

The radiation used in the study was at Specific Absorption Rate (SAR) levels of between 0.3 and 2 watts per kilogram.

The SAR is the rate at which the body absorbs emissions from the phone handset.

Most phones emit radio signals at SAR levels of between 0.5 and 1 W/kg.

Mobile phones cannot be sold to unless they fall within the SAR of 2 watts per kg.

[...]

Consider ways to reduce your exposure to mobile phone radiation. Wherever possible, quantify the amount of reduction achieved with the help of experiments. Graphically display your results and consider the effects of measurement errors. Write an editorial in the role of a physicist in response to the BBC article.

Additional information:

Mobile phone radiation is electromagnetic radiation, just like visible light. The only difference between visible light and mobile phone radiation is the wavelength of the radiation: while visible light has wavelengths between 400 and 800 nm, mobile phone radiation has frequencies of 900 and 1800 MHz, corresponding to wavelengths of ~ 33 cm and ~ 16 cm.

When mobile phone radiation passes an aerial (or the antenna in the mobile phone), some of the radiation's energy is absorbed and causes electrons in the aerial to oscillate back and forth with the frequency of the radiation. This creates an alternating current with this very high frequency in the aerial. The length of the aerial should ideally be $\frac{1}{4}$ of the wavelength of the incoming radiation. The alternating current in the aerial is then rectified using a so-called Schottky-diode detector. Schottky diodes have very fast switching times compared with other types of diodes, and are thus ideal for high-frequency applications. The DC output of the Schottky diode detector can then be measured with an oscilloscope as a voltage.

The Schottky diode detectors, without the aerial, have been calibrated with a signal generator, meaning the output voltage as a function of input power into the detector is known (see below). As this calibration was done without the aerial, the mobile phone power determined with this setup is not the absolute power, but only the relative power, i.e., power multiplied by a constant C which is fixed and identical for all measurements, but unknown. The constant C incorporates the unknown efficiency of the aerial. The amount of radiation absorbed by the aerial depends on the angle of the emitter to the aerial. This is the so-called radiation pattern of an aerial. Therefore, it is important to keep this angle constant during measurements.

Calibration data: P is power in mW, V is voltage in Volts

S/N 11066: $P=7.352 \cdot V^2 - 0.066 \cdot V + 0.056$ (etc, one calibration curve for each diode)

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Additional information: In groups of 3 to 4, students were given the BBC article, the problem text and the equipment at the start of the session. They were also given the additional information on mobile phone radiation and Schottky diode detectors. The setup consisted of an aerial and a groundplate, the aerial connected to a Schottky diode detector and an oscilloscope.

Equipment per group:

- flipchart
- tape measure
- large protractor (photocopied and laminated), small protractor
- clamp stands
- oscilloscope
- grounding points with wristband
- aerial on ground plate
- lab jack
- SMA/BNC adapter
- BNC cable
- Schottky diode detector (from Castle Microwave, EZR0140A3)
- polar millimetre paper
- sheets of wood, plexiglas, aluminium, styrofoam, etc.

Marking Scheme:

Quality of group work (demonstrator, peer and self-assessment): 25%

Lab report: 75%