Exposure to microwaves from mobile communication, DNA repair and cancer risk

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Electromagnetic spectrum

The wavy line at the right illustrates the concept that the higher the frequency, the more rapidly the field varies. The fields do not vary at 0 Hz (direct current) and vary trillions of times per second near the top of the spectrum.

Microwaves from mobile phones
800 MHz - 3 GHz (800 million Hz – 3 billion Hz)
Microwave (MW) exposure safety standards

- Current safety standards are most often based on thermal effects of microwaves in short-term exposures, 2 W/kg ICNIRP (International Commission for Non-Ionizing Radiation Protection)

- Safety standards very significantly, up to 1000 times, between countries

- Why?
Many groups over the world described various non-thermal biological responses to microwaves (MW) including cancer-related effects.  

68% of available experimental studies report non-thermal biological effects of microwaves (Huss et al., 2007)
The impact of non-thermal mobile phone radiation depends on the nature of the waves and conditions of exposure.

- Frequency
- Modulation
- Polarization
- Coherence time
- Dose and duration
- Intermittence
- Electromagnetic environment
Non-thermal microwave exposure of human differentiated and stem cells in different frequency channels

The test-mobile phone is programmed to select a GSM/UMTS frequency channel, and 0.25 W output power.

Distribution of specific absorption rate (FDTD-METHOD)
Molecular markers (γ-H2AX, 53BP1) of DNA double-strand breaks (DSB), which are used to visualize and quantify double strand breaks (DSB) by confocal laser microscopy and immunofluorescence

<table>
<thead>
<tr>
<th>γ-H2AX</th>
<th>53BP1</th>
<th>MERGED</th>
<th>MERGED+DNA</th>
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VH-10 cells, 12 h following irradiation with 3 Gy

Microwaves completely blocked DNA repair foci in stem cells with multiple DNA damage.
Human stem cells were more sensitive to microwave exposure than differentiated human cells and more responsive to GSM frequency channels.
Contrary to differentiated cells, human mesenchymal stem cells did not adapt to effects of MW during chronic exposure.

Exposure during 2 weeks, 1 hour daily.
Results with **stem cells** may be especially important because different cancer types (tumors and leukemia) originate from stem cells by well-known genetic and recently suggested epigenetic mechanisms.

*Nat Rev gene.* 7: 21–33 doi:10.1038/nri1748
In dependence on frequency channel, non-thermal microwaves from mobile phones inhibited DNA repair 53BP1/γ-H2AX foci in human cells. These effects indicate severe stress response and disruption of the balance between cellular repair systems and DNA damage.

Importantly, human stem cells were most sensitive to microwaves and did not adapt to chronic exposure, providing mechanistic link to the epidemiologic data on increased brain cancer risk in heavy users of mobile phones.
Key References from Cancer Research Institute, Slovak Academy of Sciences