

Biological effects in experimental systems

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Why do experimental studies?

- Experimental studies are explanatory and can provide insights into mechanisms
- Experimental studies can be predictive and be used for screening purposes
- Experimental studies can be performed with in vivo or in vitro models, or with patients or healthy volunteers

"Thermal" and "non-thermal" effects of RF radiation

- Radiofrequency waves can cause tissue heating, so-called **thermal effects**.
 - Heating $>1^{\circ}\text{C}$ activates physiological processes, which can influence activity of the nervous system, influence fertility, fetal development, cause cataracts
- **Non-thermal effects** are thus biological effects that are noted at effect levels where heating is not supposed to occur
- Are such effects existing?
- Explanation?

Current issues related to mobile telephony

- Tumour development
 - in vivo tumour studies
 - in vitro studies on:
 - cell proliferation
 - cell cycle
 - cell death
 - DNA structure and integrity
 - cellular signal transduction
- Nervous system functions
 - behavioural studies
 - electrophysiology
 - blood-brain-barrier integrity
 - neurochemical end-points
- Inflammation and immunological functions
- Reproduction and development
- General responses to RF radiation
 - gene expression (transcriptome and proteome)
 - stress responses
 - radical homeostasis

What is the outcome of experimental studies on RF radiation related to mobile telephony?

- A large number of experimental studies have been performed
- The majority of studies show no effect of RF at non-thermal levels
- Several studies that initially have shown/indicated effects have not been possible to replicate or reproduce, even by the same investigators
- Exposure set-ups, dosimetry issues, and experimental designs are sometimes inadequately described, incorrect or flawed

Certain experimental findings indicate effects and need careful follow-up

- Blood-brain-barrier permeability increases in rats exposed to RF at very low levels (Salford group; not possible to replicate)
- Increased breast tumour development in DMBA treated rats (part of PERFORM-A project)
- Induction of gliosis in rats (de Seze group)

Certain experimental findings indicate effects and need careful follow-up (Cont.)

- Genotoxic effects in certain rat and human cells (Ruediger group, part of REFLEX project, not possible to replicate; also some others)
- MAPK-pathway activation via radicals (Seeger group)
- Protein expression in endothelial cells and human skin biopsies (Leszczynski group)

Activity within the Danish mobile phone programme

Jens Zimmer Rasmussen,
University of Southern Denmark:

- Is the brain the target of RF radiation? –
 - UMTS and GSM exposure
 - Rat hippocampus slices in culture
 - End-points include cell survival, cell death, tissue architecture, electrophysiology, NMDA susceptibility