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Effects of 5G Electromagnetic Fields on Human Skin Cells

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The 5G protocol for transmitting large amounts of data in mobile communication technology is causing concerns and fears among the population, even though the frequencies used initially have been studied sufficiently. In contrast, the biological effects of future frequencies in the range of 27 GHz and over 40 GHz have only been addressed rarely. Since these electromagnetic fields in the centimeter and millimeter range are absorbed by the upper layers of the skin, the aim of our project is to investigate the effects of such fields on whole-genome gene expression and DNA methylation of human keratinocytes (HaCaT) and human dermal fibroblasts (HDF). Therefore, cells are exposed or sham-exposed for 2h or 48h, with a frequency of 27 GHz or 40.5 GHz, and a power flux density of 1mW/cm^2 or 10mW/cm^2. After exposure, RNA and DNA are collected and analyzed via RNA-Seq and methylation profiling microarray. Candidate target genes of the RNA-Seq will be validated using qRT-PCR analysis. A novel exposure facility is used, which was characterized for cell monolayer dosimetry in 60mm petri dishes and allows for standard in vitro incubation (37°C, 5% CO_2) during exposure [1]. The exposure facility enables a randomized and blinded application of parallel sham exposure and exposure in one incubator each. It is designed to monitor the temperature of the culture medium in real-time during experiments in identical cell culture dishes containing culture medium using fiber optic temperature probes. To avoid temperature effects in the exposed samples, the non-negligible temperature increase at the power flux density of 10mW/cm^2 is compensated by a reduction of temperature in the corresponding incubator. In addition to standard methods for analyzing transcriptome data and determining differential gene expression, the project will also focus on network analyses and the correlation of gene expression pattern and methylation status. This project will give an important insight into potential effects of electromagnetic exposure on human skin cells of the wavelengths and specific absorption rates mentioned above and is therefore necessary for the further improvement of protection and precautionary measures regarding the introduction of future 5G frequencies.

1. G. Schmid, R. Hirtl, I. Gronau, V. Meyer, K. Drees, and A. Lerchl, “Design and Dosimetric Characterization of a Broadband Exposure Facility for In Vitro Experiments in the Frequency Range 18−40.5 GHz”, *Bioelectromagnetics* **43**:25-39 (2022). doi:10.1002/bem.22376.