

BioEM2013*

There is a heightened public health concern about the influence of non-ionizing electromagnetic fields (EMFs), especially radiofrequency electromagnetic field (RF-EMF) radiation from mobile phones, wireless devices and cellular base stations on the well-being of the biosystem and ecosystem. The conference, BioEM2013, provided a platform to all researchers in the field of bioelectromagnetism to share their research work, which covered a wide range of topics including *in vitro*, *in vivo*, epidemiology – provocation studies, mechanisms of interaction, clinical devices and medical applications – theoretical and practical modelling, instrumentation and methodology, dosimetry, exposure standards, occupational exposure, public policy and risk assessment.

The plenary session opened with the therapeutic applications of electroporation, electrochemotherapy, electro gene transfer and low-frequency magnetic fields. The presentation by Julie Gehl (Copenhagen University Hospital, Denmark) dwelt on brief electric pulses, which cause transient permeabilization of cell membranes, enabling delivery of drugs (e.g. chemotherapeutic agents, ions, isotopes), and/or DNA, RNA and oligonucleotides to cells and tissues, which has already opened a plethora of possibilities in clinical use. Damijan Miklavcic (University of Ljubljana, Slovenia) elaborated on electrochemotherapy as an efficient local treatment of solid tumours in which a combination of a chemotherapeutic drug and electric pulses was used. Boris Pasche (University of Alabama, USA) discussed tumour-specific frequencies, which may block tumour growth. When the patients with a diagnosis of cancer were exposed to intratumorally administered electromagnetic fields, amplitude-modulated at frequencies identified in patients with the same tumour type, long-lasting responses were observed. Also, *in vitro* experi-

ments showed that the proliferation of cancer cells was decreased by the same frequencies. Victoria Benson *et al.* (University of Oxford, UK and International Agency for Research on Cancer (IARC), Section of Environment and Radiation, Lyon, France) through their prospective epidemiological study showed that there was an increased risk of acoustic neuroma for long-term users of mobile phones. Anja Moeller's team (University of Berne, Switzerland) presented the study on the effects of RF-EMF on stress response, including apoptosis in human neuroblastoma cells (SH-SY5Y) and murine microglia cells (N9) at different exposure times, and an increase in apoptosis was seen in both RF-EMF-exposed cell lines. Similarly, Nicoletta Marchesi's group (Università di Pavia, Italy) presented their results, which indicated that a specific EMF treatment determined a significant down-regulation of miR30a expression and consequently, an increase in Beclin1 expression in SH-SY5Y neuroblastoma cells. This EMF-induced molecular change might contribute to the activation of the autophagy process, by making available Beclin1 for the initial stages of nucleation process of autophagy, particularly important in beta-amyloid accumulation in Alzheimer patients.

Jukka Juutilainen (Department of Environmental Science, University of Eastern Finland, Finland) discussed the role of modulation in the biological effects of RF fields and concluded from a limited number of studies that the human central nervous system might be specifically affected by pulse-modulated RF fields. According to Joe Wiart *et al.* (France Telecom Orange Labs, France), since children are increasingly using wireless communication systems, there is a growing public concern regarding their health and safety, which has led to the need to assess the RF exposure of children. Taking advantage of the progress in image processing and high performance computing, efforts have been made to improve the numerical tools and human models used to assess the children-specific absorption rate (SAR). Workshops were held by C. K. Chou (Motorola Solutions,

USA) and Lloyd Morgan (Environmental Health Trust, USA) on the comparison of RF absorption in the heads of children and adults due to mobile phone exposure. According to Morgan, from the studies on the history of exposure limits from 1966 to the current exposure limits in United States, it is observed that children absorb more RF-EMF radiation than adults and they show presence of exposure hot spots. Azadeh Peyman (Health Protection Agency, UK) discussed the effect of ageing on dielectric properties of tissues and its relevance in assessment of the exposure of children to EMF. Yasemin Karadana (Suleyman Demirel University, Turkey) suggested that one of the ways to reduce the harmful effects of 2450 MHz Wi-Fi with uninterrupted communication was to have a small cactus plant (*Astrophytum ornatum*) on the working table. Cross-sectional geometry and dielectric parameter of the plant tissue showed that this could be likely true to some extent. Students from New Zealand, Italy, Germany, Switzerland, China, Belgium, USA, Sweden, Finland and The Netherlands presented their work on topics covering the effect of RF-EMF on children, gene expression modulation on exposure to low-frequency electric fields, SAR simulation models, dosimetry, protective effects of antioxidants against RF-EMF, MRI exposure in patients, and interaction of EMF and calcium.

Robert Kanaar and his group (Erasmus Medical Center, The Netherlands) made a presentation on their discovery of an ultra-sensitive DNA damage detection system for detecting spontaneously occurring DNA breaks through transfection of cells with plasmids. They had used a semi-quantitative proteomics approach coupled with bioinformatics analyses. Lucas Portelli *et al.* (University of Colorado, USA) demonstrated the spatial inhomogeneity in the order of several degrees centigrade which lasted from minutes to hours between identically treated biological samples under conventional culture conditions. These differences depended on the size of the incubator, location in the incubator, thermal capacity and placement modality

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of the cell container in the incubator. Rony Seger (Weizmann Institute Science, Israel) presented the activation of the ERK cascade as a sensitive readout for cellular responses due to non-thermal, non-ionizing electromagnetic fields. ERK was rapidly activated in response to cell phone-generated EMF, which is sensed by NADH oxidase, producing free radicals to activate metalloproteinase and consequently EGF receptor and ERK. Hugo Jimenez *et al.* (University of Alabama at Birmingham, USA and UAB Cancer Center, Birmingham, USA) demonstrated that *in vivo* tumour growth in mice was blocked by radiofrequency amplitude-modulated electromagnetic fields (RF AM EMF) and was associated with peritumoral fibrosis and activation of the DAG/IP3 pathway. It resulted in an increase in intracellular calcium, leading to downstream apoptosis and autophagy.

There are unexplained patterns of brain tumours in USA, according to Devra Davis *et al.* (Environmental Health Trust, USA). It was speculated that the increased use of diagnostic radiation through computed tomography induced excess cancers, requiring serious study. A nationwide cohort study from Switzerland by Dimitri Hauri *et al.* (Swiss TPH, Switzerland) revealed that RF-EMF exposure was not related to childhood leukaemia, but some indications for an association with the central nervous system tumours were obtained. Seung-Cheol Hong *et al.* (Occupational Health and Safety Engineering, Inje University, Korea) have undertaken a dosimetry study to evaluate the exposure of radiofrequency electromagnetic fields among 11- to 15-year-old children in large cities of Korea, where the age of starting to use cellular phones is relatively early. The level of individual exposure has been measured for 24 h using SPY-100 and research is ongoing. Hyun-Bong Kim *et al.* (Korea Communications Agency, Korea) indicated from their study on the exposure level analysis of EMF strength on people living around base stations in Korea that most of the measurement levels are much lower than ICNIRP guidelines for human exposure, but also noted that EMF exposure levels were found to rise every year. Rashmi Mathur (Jawaharlal Nehru University,

New Delhi) presented the effect of electromagnetic radiation (EMR) emitted from 3G mobile phone for 2 h per day for 45 days, on nociceptive behaviour in Wistar rats. Decreased forepaw lick-latency was observed at 45 days of 3G frequency band exposure. Chuan Liu's group (Third Military Medical University, China), shared the findings that RF-EMF radiation may produce genotoxicity through oxidative DNA base damage in male germ cells.

In a study presented by Bülent Ayas *et al.* (Ondokuz Mayıs University, Turkey), it was concluded that prenatal exposure to 900 MHz EMF not only decreased Purkinje cell number, but also destroyed its structure in the newborn rat cerebellum. In another study by the same team, it was found that 900 MHz EMF led to the decrease of the glomeruli density in rat kidney. A study by Kanu Megha (University of Delhi) suggested that RF-EMR exposure impaired learning and memory by altering the neurotransmitters in the brain of Fischer rats. The work by Lukas Margaritis *et al.* (University of Athens, Greece) was designed to explore basic responses and effects of wireless radiation emitted from a DECT phone and a Wi-Fi router on young and adult *Drosophila melanogaster*. Their findings revealed disturbance of odour-based memory performance and increase in reactive oxygen species levels in the heads of the flies, suggesting that free radical formation may be an early event affecting memory. An investigation on the effect of electromagnetic radiation from GSM mobile phones, Wi-Fi routers and DECT wireless phones on *Caenorhabditis elegans* by Michael Fasseas *et al.* (Biomedical Research Foundation of the Academy of Athens, Greece) revealed that even though the worm was not affected significantly, gene expression changes were noted in some cases. They had exposed synchronized populations of *C. elegans*, at different developmental stages, to electromagnetic radiation for various lengths of time. Wild-type and ageing-or stress-sensitive mutant worms were examined for changes in growth, fertility, lifespan, chemotaxis, short-term memory, increased ROS and apoptosis by using fluorescent marker genes or

qRT-PCR. Whole body exposure to 915 MHz RFID on rat pineal melatonin biosynthesis was studied by Young Hwan Ahn *et al.* (Ajou University School of Medicine, Korea). It was found that nocturnal exposure to the strong RFID causes reduction of melatonin biosynthesis. Sanjay Kumar *et al.* (Jawaharlal Nehru University) investigated the effect of 3G EMF exposure on male albino rats. They found a significant decrease in sperm count, increase in lipid peroxidation, and damage in sperm cell in the exposed groups. A reduction in seminiferous tubules and testicular weight of rat exposed to EMF was observed, which may adversely affect male fertility.

According to Cisco's Global Mobile Data Traffic Forecast Update, there will be 10 billion mobile-connected devices in 2016, including machine-to-machine modules exceeding the world's population at that time (7.3 billion). In 2011, the World Health Organization, International Agency for Research on Cancer, had classified electromagnetic radiation from mobile phones and other wireless devices as a 'possible human carcinogen', group 2B. The RF-EMF radiation, also known as the electrosmog, is an invisible environmental pollutant that is saturating our living space. Although the benefits of this technology, heavily dependent on the use of non-ionizing radiations, are immense, it may pose a health risk particularly for the vulnerable like children, pregnant women and the elderly. Hence, this conference devoted entirely to EMF research proved to be timely as well as a boon to public health.

Dariusz Leszczynski (Department of Research and Environmental Surveillance, STUK – Radiation and Nuclear Safety Authority, Helsinki, Finland) has published a critical review of this conference in his blog (<http://betweenrockandhardplace.wordpress.com/>), which would be helpful to those working in the field of EMF research.

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