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### ELF and RF electromagnetic fields (EMF) *in vitro* effects: our experience

In the last 20 years we performed a large number of experiments concerning the effects of ELF EMF on cellular systems and more recently on RF EMF *in vitro* effects.

The most relevant findings can be summarized as follows:

- a. using ELF pulsed magnetic fields (PMF) we observed a series of effects on lymphocytes, including changes in cell proliferation and cytokine production. Similar endpoints were studied with 50Hz sinusoidal magnetic fields without finding relevant effects. Other PMF effects, including intra-membrane protein clustering, were observed with other cell lines;
- b. using ELF PMF and sinusoidal magnetic fields we studied genotoxic effects on lymphocytes, mainly using the micronucleus (MN) test and, more recently, comet assay. Except small effects on MN frequency in some specific cases, the overall results were negative;
- c. using ELF PMF we observed interesting effects on gene expression on myocardial cells and, using ELF sinusoidal magnetic fields, specific effects on stem cell differentiation into myocardial cells;
- d. using ELF PMF and sinusoidal magnetic fields we found an effect on DNA transposition frequency in bacterial cells (*E. coli*) and changes in the expression of heat shock protein in bacterial cells and in heat shock protein localization in porcine endothelial cell cultures;
- e. using RF EMF we studied many different end points in human lymphocytes, including cell activation, mitochondrial membrane potential, apoptosis, cell proliferation, gene expression, etc. without finding any relevant effect;
- f. more recently we performed a series of experiments on neuronal cells using ELF and RF EMF, including different cellular endpoints and electrophysiological tests.

In conclusion we observed a number of biological effects, mainly with PMF while no relevant effects were observed with RF EMF. The meaning of these effects in terms of “health risk” is controversial.