Zorn 15

CDRH ~~CURRENT~~ present BIOLOGICAL INTRAMURAL PROJECTS

(ELECTROMAGNETIC RADIATION BRANCH, DLS, OST)

Rework

The FDA literature assessment and research indicates that the probable site of RFR ~~biological site of~~ interaction is the cell membrane with other possible sites in DNA. Behavioral and genetic effects have also been demonstrated to be sensitive indicators of RFR effects. Intramural projects therefore, fall into behavior, membrane and genetic studies.

BEHAVIOR STUDIES

PROJECT TITLE: Microwave Behavioral Effects Using Pharmacological Agents

DESCRIPTION: Microwave radiation has been shown to alter the behavioral response of rodents to certain drugs such as amphetamine, scopolamine, and chlordiazepoxide. This data indicates the cholinergic neurotransmitter system as one possible site of action for microwave-induced behavioral changes.

Various pharmacological agents will be used to manipulate the cholinergic system in combination with microwave exposure to investigate possible biochemical or anatomical substrates of microwave activity. (A variety of behavioral tests will be used to look at microwave induced changes).

These studies are particularly applicable to the clinical situation where medical devices are used in conjunction with drugs.

PROJECT TITLE: Continue Participation in the US-USSR Cooperative Health Agreement on Microwave Behavioral Effects

DESCRIPTION: The present study is part of a joint international effort under the auspices of the US-USSR Cooperative Health Agreement, and it should be noted that two additional replicates of this study are currently being conducted at NIEHS in the US and at the Marzeev Institute in the Soviet Union.

Behavioral testing is underway at this lab in an effort to examine the feasibility of duplicate studies and to develop mutually acceptable methodologies. To date the specific tests employed have not detected functional changes under the exposure condition employed but they have shown that duplicate studies are possible.

MEMBRANE STUDIES

(Includes empirical cellular responses, cellular biochemical responses, and biophysical ~~impedance~~ measurements)

PROJECT TITLE: Effects of Pulsed Electromagnetic Fields on Cells of the Immune System

DESCRIPTION: The effects of pulsed electromagnetic fields in the extremely low and radiofrequency ranges on modulation of immune cell function in vitro will be investigated for various field parameters. Macrophage chemotaxis, rosette formation, and phagocytosis will be assessed microscopically, colorimetrically and/or radiologically. Lymphocyte blastogenic responses to

specific cell mitogens will be measured by the incorporation of radiolabelled precursors into cellular nucleic acid and protein.

PROJECT TITLE: Effect of Electromagnetic Radiation on Cellular Membrane and Membrane-induced Bioeffects

DESCRIPTION: Model systems will be utilized to monitor and compare the chronological actions of purified growth regulatory factors on target cells in vitro in order to identify and characterize electromagnetic radiation sensitive events in the hormone-induced cascade of biological responses. Radioisotope labelled hormone will be used to evaluate the kinetics of ligand binding to cellular membrane receptors. Cellular membrane topographical modulation, including receptor-ligand clustering and processing, will be examined by radiological and immunological methods. Induction of enzymes and macromolecule (RNA, DNA, and protein) synthesis will be quantitated by the incorporation of radiolabelled precursors into metabolic products. Emphasis will be given to the identification of electromagnetic radiation field parameters that are most effective in producing modifications of biological responses and characterize the development, persistence and/or reversibilty of these responses.

PROJECT TITLE: Cell Membrane Impedance

DESCRIPTION: It is well known that certain time-varying electromagnetic fields (frequencies <100 MHz) can

modulate cell and tissue behavior. There is considerable evidence that the field acts via perturbation of molecular process of the cell membrane which leads to cellular response. Measurements of membrane impedance provides information about the kinetics of these processes which then suggests how the electromagnetic field should vary as a function of time in order to produce a response.

PROJECT TITLE: Multiple Pulse Electromagnetic Field Exposure Approach

DESCRIPTION: Evaluating what characteristics of pulse electromagnetic fields are required even for one specific cellular response is inefficient and time consuming because of many possibilities. Optimization techniques cannot be used until some responses are first observed. Another approach is to subject cells to multiple pulses in order to greatly increase the probability of observing a response. Then the required characteristics can be evaluated by eliminating pulses until the cellular response disappears.

GENETIC STUDIES

PROJECT TITLE: Empirical Genetic Dose Responses; Determine Sensitivity of Spermatogenic Cell Developmental Stages to Microwave Radiation

DESCRIPTION: Very few data are available on genetic risks associated with microwave (MW) and radiofrequency (RF) radiation exposure. The expanding applications of MW and RF generating devices (whole and partial body

exposures) make the exploration of this aspect of safety mandatory.

Previous studies demonstrated that 0.915, 2.45 and 9.4 GHz radiation can induce chromosomal abberations during spermatogenesis in mice. Recently completed study demonstrated that translocations induced in spermatocytes by 2.45 GHz exposure can be transmitted to offspring. Studies on synchronized spermatogenic cell populations using the spermatocyte test are being conducted to establish relative sensitivity of early meiotic stages to 2.45 GHz microwaves, and the dominant lethal test is used to establish sensitivity and dose-effect relationships following 2.45 GHz exposure over the whole spermatogenic cycle. A dominant lethal test using 27 MHz exposed males demonstrated that no biologically significant effects on offspring are to be expected following 2 weeks of exposure to dose rates of 1 to 6 mW/g. The studies have to be continued to explore possible genetic effects associated with exposures to other RF and MW frequencies and modulations used in practical applications. The genetic tests used are those recommended by the International Commission on Protection against Environmental Mutagens and Carcinogens for examining effects on mammalian germ cells.

PROJECT TITLE: Microwave Absorption Properties of DNA

DESCRIPTION: We are investigating the absorption of microwave energy by aqueous solutions of DNA at room temperature. Aqueous solutions, due to the polar nature of water, absorb significantly at microwave

frequencies. We have demonstrated that in additon to the background absorption of the solvent, DNA molecules in solution can resonantly absorb microwave energy. The microwave field directly couples into an acoustic vibration along the DNA molecule. The resonant frequency depends on the length and configuration of the DNA molecule.

Although there is no demonstrated relationship between this phenonmenon and reported genetic effects, these observations indicate that a mechanism exists for coherent frequency-specific deposition of microwave energy in DNA. This mechanism has surprising physical characteristics and intriguing implications for future polymer and biochemical research. It is unexpected that DNA solutions exhibit microwave resonances and it is fascinating that such sharp resonances occur in dense solutions at room temperature. It will be interesting to see if this mechanism can be used to alter biochemical processes, if similar phenomena exist in other symmetric macromolecules, and if acoustic modes possibly provide a mechanism for transporting coherent energy over large biochemical distances.