Infrared thermography will be employed in conjunction with microwave and acoustic heating to diagnose malignant tumors in rats, and the relationship between observable thermographic surface effects and tumor type and location will be investigated. Optimization of detection parameters using both photographic and computer-aided image analysis will be emphasized. In particular, excitation frequency will be employed as a variable to enhance differential tumor heating for early detection. The rationale for this work is based upon other recent experiments that show that because of inherent preferential tumor energy absorption, thermographic observability is greatly enhanced by in situ tumor selective heating. (funding period 5/78-4/79)

Supporting Agency:HEW, PHS, NIH, NCI

0415 EVALUATION OF MICROWAVE OVENS AS A POTENTIAL METHOD OF STERILIZATION. Lyon, T. C.; Brunner, D. (U.S. Army, Preventive Dentistry Div., Washington, DC 20012).

This project will evaluate the ability of microwave ovens to destroy bacterial spores on nonmetallic instruments and wound dressings and determine if such destruction is a function of heat alone. A commercially available microwave oven will be tested for its ability to destroy bacterial spores as a function of time, temperature, thermocouple placement, and power output. A variety of materials will be studied for their thermal capabilities during test sterilization procedures. (funding period 6/78-6/79)

Supporting Agency:U.S. Dept. Defense: Army, Medical Res. & Development Command

0416 RADIO FREQUENCY/MICROWAVE TERATOGENIC EFFECTS STUDY. Conover, D. (U.S. Dept. Health, Education, and Welfare, Natl. Inst. Occupational Safety & Health, Biomedical & Behavioral Science Div., 4676 Columbia Parkway, Cincinnati, OH 45226).

Human and animal studies have indicated that exposure to radio frequency (RF) radiation during gestation may induce teratogenic effects. However, little information is available concerning exposure conditions, and teratogenic data are not complete. In view of this, a pilot study will be initiated to determine the types of effects produced following irradiation of rats during gestation. Groups of animals will be irradiated at 27.12 MHz on days 1, 3, 5, 7, 9, 11, 13, and 15, after conception. Preimplantation, resorption losses, and skeletal and gross malformations will be evaluated. Follow-up studies will determine the threshold level for these effects. Work in progress under an Interagency Agreement with the National Bureau of Standards will lead to the development of a total power absorption analyzer system. The system will be employed to noninvasively determine the distribution and magnitude of absorbed RF power to aid in extrapolating the results of the animal studies to humans. (funding period 10/76-9/80)

Supporting Agency:HEW, PHS, Center Disease Control, NIOSH

0417 TERATOGENIC EFFECTS OF MICROWAVE RADIATION IN RATS. Conover, D.; Foley, E.; Lary, J. (U.S. Dept. Health, Education, & Welfare, Natl. Inst. Occupational Safety & Health, 4676 Columbia Parkway, Cincinnati, OH 45226).

Groups of pregnant Sprague-Dawley rats will be exposed to microwave radiation during days 1, 3, 5, 7, 9, 11, 13, and 15 of gestation. The animals will be sacrificed on day 20. Embryos and fetuses will be examined for teratogenic effects. The number of resorptions and the amount of preimplantation loss in each dam uterus will be determined by visual inspection, and external, spinal, and skeletal defects will be assessed. (funding period 10/77-9/78)

Supporting Agency:HEW, PHS, Center Disease Control, NIOSH

0418 EFFECTS OF MICROWAVE IRRADIATION ON EMBRYONIC BRAIN TISSUE. Rioch, D. M. (*Inst. Behavioral Res., Inc.*, 2429 Linden Lane, Silver Spring, MD 20910).

The behavioral effects of an 8-mo exposure to low-dose microwave radiation will be studied in rat litters. Following exposure, serial sections of two or more fetuses from each litter will be taken to determine the effects of microwave irradiation on embryonic brain tissue. (funding period 7/77-cont.)

Supporting Agency:U.S. Dept. Defense: Army, Medical Res. & Development Command, Environmental Protection Res. Div.

0419 RADIOFREQUENCY RADIATION MECHANISMS. Smith, G. (Georgia Inst. Technology, Sch. Engineering, Dept. Electrical Engineering, 225 North Ave. N.W., Atlanta, GA 30332).

The mechanisms of radio frequency radiation interaction with living tissue will be studied. A series of mathematical models will be developed describing the physical interaction of electromagnetic fields with tissue structures. The work will involve four levels of complexity in living tissues: (A) molecular physics, (B) details of biomolecular chemical reactions, (C) biomembrane phenomena, and (D) total tissue metabolism. The models will define the frequency dependence of the bioeffects under study, and for a given frequency, the models will suggest whether there is an amplitude threshold and/or window for the effect. For each of the above interactions, presently available models will be critically examined

in the light of current theory and experimental data. The critical examination of each model will include a thorough treatment of the underlying physical theories and detailed evaluations of all assumptions. For each interaction, the most promising model(s) will be extended. The extensions can synthesize elements from several models or focus on one model. Available models might be rejected in favor of a new model(s). Various calculations will be performed with particular attention paid to the physical units. (funding period 7/78-12/79)

Supporting Agency:U.S. Dept. Defense: Air Force, Sch. Aerospace Medicine

0420 ASSESS SPONTANEOUS ACTIVITY AND SOCIAL BEHAVIOR OF ANIMALS CHRONICALLY EXPOSED TO LOW LEVEL EMR. Reiter, L. (EPA, Health Effects Res. Lab., Durham, NC 27711).

The effects of chronic exposure to low-level electromagnetic radiation on central nervous system development in the rat were examined. Rats were exposed 8 hr/day to 100 MHz nonionizing radiation beginning on day 6 of gestation. Offspring were examined for exposure-induced changes in neurologic and behavioral development (e.g., reflex development and locomotor activity). No differences in treatment groups were found in either development of the righting and startle responses or in the age at eye opening. In addition, locomotor activity at 30 days of age was normal. (funding period 9/75-10/78)

Supporting Agency:EPA, Office Res. & Development, Health Effects Res. Lab.

0421 TERATOLOGIC EFFECTS OF 915 MHz IN RATS. Berman, E.; Carter, H. (EPA, Health Effects Res. Lab., Durham, NC 27711).

To determine the teratogenicity of 915 MHz radiation in rats, animals will be exposed daily during gestation and fetuses will be examined. Circularly polarized exposure units are being assembled and exposure will begin in 1979. (funding period 8/78-6/79)

Supporting Agency:EPA, Office Res. & Development, Health Effects Res. Lab.

0422 NONINVASIVE SENSING OF SUBCUTANEOUS TEMPERATURES. Barrett, A. H.; Myers, P. C. (Massachusetts Inst. Technology, Sch. Science, Dept. Physics, 77 Massachusetts Ave., Cambridge, MA 02139).

This work will continue evaluation of the potential of microwave radiometry for diagnosis of breast cancer and other medical problems having a thermal signature. The performance of radiometers operating at 1 and 6 GHz will be compared in their ability to detect breast cancer in the same set of patients. Clinical studies will be initiated involving attempts to detect deep venous thrombosis and abdominal infections. Laboratory work will involve attempts to develop antennas of improved resolution and to develop a reliable antenna scanner. (funding period 9/77-8/79)

Supporting Agency:HEW, PHS, NIH, Natl. Inst. General Medical Sciences

0423 MUTAGENICITY OF 915 MHz EMR. Berman, E.; Carter, H. (EPA, Health Effects Res. Lab., Durham, NC 27711).

To determine whether 915 MHz electromagnetic radiation is mutagenic in rats, a Dominant Lethal assay will be performed following chronic exposure of male rats. Exposure and assays will be performed in 1979. (funding period 10/77-12/79)

Supporting Agency:EPA, Office Res. & Development, Health Effects Res. Lab.

0424 IDENTIFY AND DEFINE PHYSIOLOGIC VARIABLES WHICH RESPOND TO LOW-LEVELS OF MICROWAVES. Berman, E.; Carter, H.; Smialowicz, R. (EPA, Health Effects Res. Lab., Durham, NC 27711).

The physiologic status of rats will be examined following electromagnetic radiation exposure. Body fluids and metabolic variables will be examined at conditions of exposure no higher than those that cause a 2 C increase in body temperature. Studies of dose response of body temperature are almost complete. (funding period 9/78-9/80)

Supporting Agency:EPA, Office Res. & Development, Health Effects Res. Lab.

0425 LIFELONG ASSESSMENT OF THE BEHAVIORAL EFFECTS OF PRENATAL EXPOSURE TO MICROWAVES. Mitchell, C. L. (U.S. Dept. HEW, Natl. Inst. Environmental Health Sciences, Dept. Behavioral & Neurologic Toxicology Lab., P.O. Box 12233, Durham, NC 27709).

As the uses and power of microwave-generating devices increase, the extent to which humans and animals are exposed to microwave energy will also increase. The health implications of exposure to this type of radiation have therefore come under intense investigation. The developing organism has been shown to be more sensitive than mature adults to chemical insult and the possible long-term effects of perinatal exposure to microwave energy deserve further investigation. One recent experiment has demonstrated a decrement in performance in a conditioned avoidance procedure in offspring of female rats receiving 915 MHz continuous wave microwave irradiation at a power density of 5 mW/cm^2 during pregnancy. No such effects were observed in rats irradiated after birth. Moreover, preliminary experiments at the National Institute of Environmental Health Sciences have indicated that embryonic Japanese quail exposed to 2,450 MHz continuous wave microwave irradiation at a power density of 5 mW/cm^2 exhibit immunologic deficiencies, which become more pronounced with age. In the proposed project, the consequences of

prenatal exposure to microwave irradiation on neurobehavioral functioning at various points during the lifetime of the progeny will be investigated. (funding period 00/78-n/a)

Supporting Agency:EPA, Office Energy Minerals & Industry

0426 EFFECTS OF MICROWAVE EXPOSURE ON INFECTIOUS AGENTS IN LABORATORY ANIMALS. Liddle, C. G. (EPA, Health Effects Res. Lab., Developmental Biology Branch, Durham, NC 27711).

To determine if microwaves alter the course of disease in animals exposed to an infectious agent, animals are infected with Type III *Streptococcus pneumoniae* and exposed to various frequencies and power densities of microwaves while the course of the disease process is monitored. The results should help to determine whether microwave exposure is deleterious to sick or debilitated individuals. This information will be useful in setting a standard for population exposure to microwaves. The first exposure group of mice infected and then exposed to 2,450 MHz microwaves at an incident power density of 10 mW/cm^2 for 5 hr/day for 6 days is being completed. Preliminary results indicate that at this frequency and power density there is no difference in acute mortality between the exposed animals and the sham irradiated controls. (funding period 9/77-9/81)

Supporting Agency:EPA, Office Res. & Development, Health Effects Res. Lab.

0427 EFFECT OF AM RADIANT ENERGY ON SMOOTH MUSCLE CONTRACTABILITY. Whitcomb, E. R. (EPA, Health Effects Res. Lab., Durham, NC 27711).

To determine if nonionizing electromagnetic energy can alter the contractability of smooth muscle in vitro, a segment of the duodenum was excised and bathed in circulating Ringer's solution. A frequency distribution of the rate of spontaneous contractions was determined before and during exposure to amplitude modulated radiant energy. The results indicated that nonionizing electromagnetic energy did not alter the myogenic properties of smooth muscle. (funding period 3/76-6/78)

Supporting Agency:EPA, Health Effects Res. Lab.

0428 GENETIC AND CELLULAR EFFECTS OF MICROWAVE RADIATION. Dutta, S. K. (Howard Univ., Sch. Liberal Arts, Dept. Botany, 2400 6th St. N.W., Washington, DC 20001).

Whether microwave radiation can affect normal cellular processes associated with the utilization of genetic information will be investigated. A battery of cellular systems, having a variety of genetic structures and functions, will be used to distinguish between perturbations caused solely by temperature rise and those caused by other mechanisms. Results to date indicate that no changes can be shown in normal cellular processes that could not be due to temperature changes in the medium. (funding period 6/75-6/79)

Supporting Agency:EPA, Office Res. & Development, Health Effects Res. Lab.

0429 MICROWAVE RELATED INSTRUMENTATION SUPPORT. All, J. S. (EPA, Health Effects Res. Lab., Durham, NC 27711).

This project is designed to assure the operation of critical instrumentation used for chronic long-term microwave studies. Calibration of microwave instrumentation is performed routinely to guarantee dosimetric accuracy. Special electronic instrumentation is designed as needed to facilitate microwave exposures and measurement of critical parameters. Operating manuals are prepared when necessary for microwave exposure facilities. Final outputs consist of completed electronic and microwave instrumentation, such as, the design of a dual experiment microcomputer controlled behavioral testing maze system--a twelve channel electroencephalographic amplifier. To date, a humidity control system has been installed in the 100 MHz microwave exposure system; the calibration capability in the microwave area has been extended to the 0.1 to 1.0 GHz range; and microcomputer control has been added to a behavioral testing maze system. (funding period 7/74-cont.)

Supporting Agency:EPA, Office Res. & Development, Health Effects Res. Lab.

0430 TERATOLOGIC EFFECTS OF 100 MHz IN THE RAT. Berman, E.; Carter, H. (EPA, Health Effects Res. Lab., Durham, NC 27711).

To determine whether 100 MHz electromagnetic radiation is teratogenic in rats, animals will be exposed daily during gestation. The pilot exposure group has been completed, and the highest dose level exposures will be conducted in early 1979. (funding period 6/77-10/80)

Supporting Agency:EPA, Office Res. & Development, Health Effects Res. Lab.

0431 NAVY ENVIRONMENT--EFFECTS OF PULSED MICROWAVE RADIATION FROM NAVY RADAR ON MAMMALIAN BLOOD CELLS. Cleary, S. F. (Virginia Commonwealth Univ., Sch. Medicine, Dept. Biophysics, 1200 E. Broad St., Richmond, VA 23298).

Much recent research has shown that pulse-modulated microwave fields can produce alterations in biologic systems. The mechanisms of the interactions that cause these alterations are not generally understood. As a major producer of such fields from radar and other equipment, the Navy is conducting a program to determine the extent of hazard to its personnel and the public. This study is aimed at elucidating the mechanisms at the membrane level. Pulsed x-band microwave fields will be used to expose cell model

systems consisting of human, dog, and rabbit blood cells. Studies will be made of effects on membrane permeability and cellular metabolism. The effects of the fields on membrane ion (Na^+ and K^+) fluxes will be studied to distinguish between active and passive transport alterations. In vitro studies will be carried out on the following mammalian cell lines: lymphocytes, thymocytes, polymorphonuclear leukocytes, and thrombocytes. In addition, osmotic fragility, intracellular proteins, oxygen consumption rates, and cell viability will be studied. Other studies will be carried out with the microwave field parameters as independent variables. (funding period 3/78-cont.)

Supporting Agency:U.S. Dept. Defense: Navy, Office Naval Res.

0432 ELECTROMAGNETIC INSTRUMENTATION TO ACCELERATE BONE HEALING. Bassett, C. A. (Columbia Univ., Sch. Medicine, Dept. Orthopedic Surgery, 630 W. 168th St., New York, NY 10032).

The recent demonstration in human patients that electromagnetic fields can assist in fracture healing is being exploited in a two-phase research program directed toward specifying the engineering factors required to design practical equipment for clinical evaluation in orthopedic and dental surgery. The first phase investigated pulse characteristics designed to stimulate bone repair with intermittent rather than continuous pulsing. Tissue culture procedures were used to survey a wide selection of possible pulse characteristics. These in vitro tests will be continued in the second phase. Promising pulse regimens will be tested in two animal models. The second phase will include biologic safety tests to establish that the prospective applications to reduce simple fracture repair time by half will not induce side effects. (funding period 10/76-3/80)

Supporting Agency:NSF, Div. Applied Res.

0433 DOSE-EFFECT RELATIONSHIP OF EXPOSURE TO EMR ON BLOOD-BRAIN BARRIER PERMEABILITY. Huang, A. T. (Duke Univ., Sch. Medicine, Dept. Internal Medicine, Box 3711, Durham, NC 27706).

The effect of microwave radiation on the blood-brain barrier (BBB) of the dog was studied using ^{131}I-albumin as a tracer molecule and cannulation of the cisterna magna and the femoral vein to permit multiple sampling of cerebrospinal fluid (CSF) and plasma. Measurement of the CSF:plasma distribution ratio of ^{131}I-albumin was carried out over a 5-hr period, after exposure of the dog's head for 20 min to various power densities of continuous wave microwaves at a constant frequency of 1.0 GHz. Control animals (n=11) were subjected to the same experimental conditions, but received no exposure. No effect on the BBB was observed in two dogs each at the following power densities: 2, 4, 20, 50, and 200 mW/cm^2. Eleven dogs were exposed to 30 mW/cm^2; in two animals the penetrance of the BBB by the ^{131}I-albumin was increased four to five times over controls, and two additional animals showed two- to four-fold increased penetrance. However, the CSF:plasma distribution ratios of the other animals receiving 30 mW/cm^2 did not differ statistically from controls. (funding period 4/75-10/78)

Supporting Agency:EPA, Office Res. & Development, Health Effects Res. Lab.

0434 INTERACTION OF AMPLITUDE-MODULATED (AM) NONIONIZING ELECTROMAGNETIC RADIATION WITH BIOLOGICAL SYSTEMS. Blackman, C. F. (EPA, Health Effects Res. Lab., Developmental Biology Branch, Durham, NC 27711).

The ability of amplitude modulated nonionizing radiation to cause changes in the physiologic activity of cell and tissue systems will be investigated using bench-top exposure facilities to confirm and extend previously reported results. The results to date confirm the presence of a frequency window cited by a previous researcher and demonstrate a power window in which calcium association with brain tissue is altered. (funding period 3/76-9/81)

Supporting Agency:EPA, Office Res. & Development, Health Effects Res. Lab.

0435 RELATIVE EFFECTIVENESS OF SHORT-TERM VERSUS LONG-TERM EMR EXPOSURE ON IMMUNE DEFENSE. Smialowicz, R. J. (EPA, Health Effects Res. Lab., Durham, NC 27711).

The effects of short-term versus long-term electromagnetic radiation exposure on the immune system of mice will be determined. And cellular and humoral immunocompetence will be determined in mice exposed to 2,450 MHz microwaves at several power densities from 0-30 mW/cm^2 for 15-30 min daily for 1-22 consecutive days. Parameters to be examined include: colonic temperature; blood counts; immunocompetence employing in vitro-mitogen stimulated lymphocyte response; frequencies of T- and B-lymphocytes; and antibody response to sheep erythrocytes. No significant differences in the hematologic or immunologic indices examined have been observed between sham- and microwave-exposed mice. The duration of microwave exposure does not appear to affect the immune function. (funding period 1/78-9/78)

Supporting Agency:EPA, Office Res. & Development, Health Effects Res. Lab.

0436 NAVY ENVIRONMENT: MICROWAVE DISPERSION AND ABSORPTION IN TISSUE: MOLECULAR MECHANISMS. Foster, K. R. (Univ. Pennsylvania, Sch. Engineering & Applied Science, Dept. Bioengineering, 4001 Spruce St., Philadelphia, PA 19104).

This research is part of the Navy's ongoing program to elucidate the basis for alterations in biologic tissue resulting from microwaves and other electro-

magnetic fields. This research specifically seeks to increase the data base relating to the dielectric permittivity of tissue on a macroscopic and microscopic level. The dielectric properties of various tissues over the frequency range of 0.1 to 18 GHz will be examined. Measurements will be made by confining the sample in a coaxial line or waveguide section that is terminated in a known impedance. Using a slotted line, the standing wave pattern in front of the sample will be measured allowing calculation of the dielectric properties of the material. Special emphasis will be placed on bound and free water. Molecular mechanisms that result in microwave absorption will be studied as functions of frequency and temperature. (funding period 4/78-cont.)

Supporting Agency:U.S. Dept. Defense: Navy, Office Naval Res.

0437 EFFECTS OF MICROWAVE RADIATION ON NEURAL RESPONSE AND THE CENTRAL NERVOUS SYSTEM.

McRee, D. I. (U.S. Dept. HEW, Natl. Inst. Environmental Health Sciences, P.O. Box 12233, Durham, NC 27709).

With the possible exception of thermal effects, the basic mechanisms of interactions between microwave radiation and biologic systems is largely unknown. Research is needed to detect and define the effects of microwave radiation on specific tissues and organs. Several reports have indicated that microwaves can affect the central nervous system and it has been suggested that microwave radiation may directly affect neuronal function. In view of this, isolated nerve preparations will be exposed to different microwave frequencies, intensities, and modulations to determine whether microwave radiation has a direct effect on nerve function. One possible site of interaction may be the neuronal membrane since it plays an important role in maintaining the ionic gradients that are necessary for the propagation of electrical impulses. Preliminary experiments have shown that microwave irradiation causes a faster rundown of nerves that are continuously stimulated. These experiments will be continued to determine whether microwaves have a direct effect on membrane permeability to cations. (funding period 00/78-n/a)

Supporting Agency:EPA, Office Energy Minerals & Industry

0438 FACTORS DETERMINING THE RADIOSENSITIVITY OF CANCER CELLS AND THEIR MODIFICATION.

Sugahara, T.; Yoshii, G.; Nikaido, O.; Aoyama, T.; Kano, E. (Kyoto Univ., Sch. Medicine, Dept. Experimental Biology, Yoshida-Konoe-chyo Sakyo-ku Kyoto, Kyoto, Japan 606).

Factors determining the radiosensitivity of tumor and normal cells will be analyzed and their possible modification will be tested in cultured cells and experimental tumors. New methods applicable to human tumor therapy will be proposed from these studies. Various tissue culture techniques of mammalian cells will be applied to analyze the modification of radiosensitivity by factors, such as, hypoxic sensitizers, chemical protectors, hyperthermia, PLDR inhibitors, cell cycle, radiosensitive human genetic disorders, and cell-to-cell interaction. Some of these factors will be tested on experimental tumors in which not only the cure rate and survival time but also quantitative hematologic markers will be used as criteria. A hyperthermia apparatus employing ultrasound and high frequency electromagnetic fields will be developed and tested. (funding period 00/78-n/a)

Supporting Agency:Japanese Ministry Education Science & Culture, Tokyo

5911 MICROWAVE TRANSMISSION THROUGH NORMAL AND TUMOR CELLS. *(Eng.)* Hershberger, W. D. (Dept. Electrical Sciences and Engineering, Sch. Engineering and Applied Science, Univ. California, Los Angeles, CA 90024). *IEEE Trans Microwave Theory Tech* 26(8): 618-619; 1978. (2 refs)

Variations in results from studies on microwave transmission through normal and tumor cells are discussed, with particular reference to methods used to control the frequency selectivity of the equipment employed. In one study where a frequency range of 66-76 GHz was used, curves displaying a cyclic resonance were obtained for eight different test substances including a variety of normal and tumor cells as well as such compounds as guanine and guanylic acid. These curves had a remarkable similarity, and it is suggested that it would be a striking coincidence if these diverse materials were characterized by similar frequency characteristics. In another study where a frequency range of 76-86 GHz was used, the corresponding curves displayed some dissimilarity, but a cyclic character was apparent in most of them. In both studies, the authors were not clear on the effectiveness of the means used to control standing waves, and they did not give a numeric value for the standing wave ratio in the system. The following procedure is proposed for distinguishing between losses due to the sample and the frequency selectivity of the microwave measuring system. The system is first adjusted for a standing wave ratio of unity. After this is done, if a frequency-dependent absorption arises on introduction of the sample or substitution of one sample for another is still observed, then the observed selectivity may be attributed to the material rather than to the measuring system. It is suggested that the above ambiguities in the results reported will be resolved only when more information on the procedures used to control frequency selectivity is presented.

5912 EFFECT OF MICROWAVES OF MILLIMETER RANGE ON HUMANS AND ANIMALS. *(Rus.)* Zaliubovskaia, N. P. (I. I. Mechnikov Kharkov Scientific Res. Inst. Microbiology, Vaccines and Sera, Kharkov, USSR); Kiselev, R. I. *Gig Sanit* (8): 35-39; 1978. (3 refs)

The effect of millimeter range waves on humans and CBA mice was studied. Seventy-two workers, aged 20-50 yr, who have been exposed occupationally to the radiation emitted by super-high-frequency generators for 1-10 yr, were under medical observation for 3 yr. They complained of fatigue, sleepiness, headache, and impaired memory. Reduced hemoglobin level and erythrocyte count, reduced color index of blood, tendency to hypercoagulation, reduced leukocyte count (to 4,100 from 4,710/mm^3 versus 5,980/mm^3 in the controls), increased lymphocyte count (30,300-37,800/mm^3 versus 22,900/mm^3 in the controls), 20% reduction of the segmented neutrophils, 18% reduction of the osmotic resistance, and 26% reduction of the acid resistance of the erythrocytes were observed. Immunologic investigations revealed reduced bactericidal activity of the skin (63-65.2 versus 79.9 in the controls), reduced lysozyme level (160 versus 320 in the controls), reduced complement titer (10 versus 20), reduced phagocytic activity (18.3-20.1 versus 25.7), and reduced phagocytic index (0.6-0.7 versus 1 in the controls). In another experiment, 250 mice were exposed to an electromagnetic field (wavelength 6.50 mm, energy density 1,000 $\mu W/cm^2$, 15 min/day for 20 days). The experiment revealed reduced leukocyte count (6,100/mm^3 versus 7,200/mm^3 in the controls), reduced phagocytic activity (19.6% versus 32.3%), lowered phagocytic index (0.56 versus 1), reduced lysozyme level (40 versus 160), reduced complement titer (10 versus 25), and reduced bactericidal activity of the skin (57% versus 98%). Increased plasma 17-oxyketosteroid level, reduced ascorbic acid level in the tissues, increased epinephrine levels in the blood, hypothalamus, and adrenals, increased norepinephrine levels in the blood and adrenals, and reduced norepinephrine level in the hypothalamus were measured. The findings indicate that exposure to microwaves induced depression of the immunobiologic reactivity and changes in the hypophyseal-adrenal and sympathicoadrenal systems.

5913 NEUROVEGETATIVE BALANCE AND DIENCEPHALIC FUNCTION IN PREDISPOSED SUBJECTS AND GEOMAGNETIC ACTIVITY CHANGES. *(Cze.)* Zdichynec, B. (Interni oddeleni nemocnice, OUNZ Pelhrimov, 394 64 Pocatky, Czechoslovakia); Valnicek, B. *Cas Lek Cesk* 117(25): 785-787; 1978. (8 refs)

The influence of geomagnetic activity changes on the neurovegetative balance and diencephalic function was studied in predisposed subjects (14 men aged 50-58 yr with ischemic heart disease, 12 men 48-59-yr-old with chronic cor pulmonale, and 10 men with transitory cerebrovascular episodes) and in 11 clinically healthy persons of the same age. Unlike in the healthy controls, the tests showed statistically significant changes in most of the predisposed patients on critical days of geomagnetic activity (15 gamma/min or higher). The test parameters increased on such days, and so did the necessary doses of nitroglycerine, Syntophylline, and diazepam. These changes were even more pronounced during the simultaneous occurrence of high geomagnetic activity and frequent meteorotropic front changes.

5914 EFFECT OF SINUS-MODULATED CURRENTS ON THE ^{32}P RESORPTION FROM THE SYNOVIAL MEMBRANE OF THE KNEE JOINT UNDER MUSCULAR ACTIVITY. *(Ukr.)* Derbish, G. V. (Odessa Inst. Agriculture, Odessa, USSR); Faitel'berg-Blank, V. R. *Dopov Akad Nauk Ukr* 13(6): 547-550; 1978. (9 refs)

The effects of treatment with sinus-modulated current (40 or 150 Hz, 50% modulation) under static, dynamic, and mixed loads on the resorption of ^{32}P from the knee joint into the blood were studied in 45 male dogs. The ^{32}P resorption was determined by measuring the radioactivity in blood drawn from the auricular vein. The resorption of

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^{32}P through the synovial membrane was increased by the electric current against the background of static and mixed loading, but it was inhibited by the current under dynamic loading.

5915 INVESTIGATION OF THE ACTIVITY OF CERTAIN ENZYMATIC SYSTEMS UNDER THE EFFECT OF SUPER-HIGH-FREQUENCY ELECTROMAGNETIC FIELD. *(Rus.)* Dumanskii, Iu. D. (A. N. Marzeev Kiev Scientific Res. Inst. General and Communal Hygiene, Kiev, USSR); Tomashevskaia, L. A. *Gig Sanit* (8): 23-28; 1978. (10 refs)

The effect of microwave irradiation (2,375 ± 50 MHz, energy density 10, 100, or 1,000 $\mu W/cm^2$, 2 hr/day, 4 mo) on the sub-cellular activity of enzyme systems of the liver and brain was studied in 160 male albino rats. Irradiation at the lowest intensity level caused no significant changes, but exposure to 100 and 1,000 $\mu W/cm^2$ caused a reduction by about 30% in the cytochrome oxidase activity in the liver mitochondria, and 20-40% reduction of the enzyme activity in the brain mitochondria. The enzyme activity returned to normal 2 mo after the irradiation. The glucose-6-phosphate dehydrogenase activity of the liver and brain increased by 25-35% during the irradiation. The irradiation at the intensities of 100 and 1,000 $\mu W/cm^2$ caused significant increase in the amidopyrine demethylating activity ($p<0.02$-0.05) and in the aniline hydroxylating activity of the liver ($p<0.02$-0.05) during the irradiation. Normalization was seen 2 mo after exposure. The findings indicate the marked effect of microwaves on major biochemical parameters.

5916 INHIBITION OF TUMOR GROWTH IN MICE BY MICROWAVE HYPERTHERMIA, POLYRIBOINOSINIC-POLYRIBOCYTIDYLIC, AND MOUSE INTERFERON. *(Eng.)* Szmigielski, S. (Center for Radiobiology and Radioprotection, 00-909 Warsaw, Poland); Bielec, M.; Janiak, M.; Kobus, M.; Luczak, M.; De Clercq, E. *IEEE Trans Microwave Theory Tech* 26(8): 520-522; 1978. (32 refs)

The tumor inhibiting effect of microwave hyperthermia alone or in combination with polyriboinosinic acid-polyribocytidylic acid (poly I-poly C) and/or mouse interferon was examined in mice bearing sarcoma 180 tumors. Mice were irradiated with 3,000-MHz microwaves at a power density of 40 mW/cm^2 for 2 hr daily from day 2 to day 15 after tumor transplantation. Some mice also received daily injections of poly I-poly C (2 µg/g) and/or mouse interferon (100 international units/g). Microwave irradiation, which produced a 3-4 C increase in rectal temperature, resulted in prolonged survival. On day 28 after tumor transplantation, 8 of 24 mice were still alive, while all control mice died before day 26. When microwave hyperthermia was combined with poly I-poly C, 12 of 24 mice were alive on day 28. While no tumor regression was noted in control mice, tumors regressed in 12 of 24 mice irradiated with microwaves. The combination of microwave irradiation, poly I-poly C, and interferon resulted in tumor regression in 16 out of 24 mice. Tumors harvested on day 16 after transplantation were significantly larger in control mice (mean, 1.36 g) than in mice exposed to microwave hyperthermia (mean, 0.96 g) or hyperthermia combined with other treatments. The combination of microwave hyperthermia, poly I-poly C, and interferon resulted in the most pronounced reduction in tumor mass (mean, 0.57 g). The rate of incorporation of radiolabeled thymidine, uridine, or glycine as well as the intracellular levels of cyclic adenosine monophosphate did not show a strict correlation with tumor mass or percentage of regressed tumors. In general, a decreased incorporation of thymidine and glycine was observed in mice exposed to microwave hyperthermia alone or in combination with poly I-poly C and/or interferon treatment.

5917 TECHNIQUES FOR UNIFORM AND REPLICABLE MICROWAVE HYPERTHERMIA OF A MODEL MOUSE CARCINOMA. *(Eng.)* Robinson, J. E. (Div. Radiation Res., Univ. Maryland Sch. Medicine, Baltimore, MD 21211); Cheung, A. Y.; Samaras, G. M.; McCulloch, D. *IEEE Trans Microwave Theory Tech* 26(8): 546-549; 1978. (11 refs)

Two techniques for localized 2,450-MHz microwave hyperthermia of experimental mouse carcinoma are described. In one approach, which involves free-field heating, 1-cm tumors are encapsulated within a 5-cm spherical mass of tissue-equivalent phantom material and are then placed in an anechoic chamber on an equipower surface. As currently developed, this free-field microwave technique may be used to administer local hyperthermia to a model 1-cm tumor system situated on the mouse flank. Encapsulation within a tissue-equivalent bolus yields excellent temperature uniformity within the tumor and a stable coupling geometry, which may be replicated for batch treatment of tumors in the far field. An applicator approach is also described in which tissues are immersed in a temperature-controlled tissue-equivalent liquid bolus (80% isotonic saline and 20% ethanol by weight) and are irradiated by time-multiplexed parallel-opposed beams. The liquid improves thermal coupling between the bolus and tumor. With the inherent ability of the liquid to be well stirred and temperature regulated outside of the microwave field, excellent heating results on flank tumors immersed in the solution have been obtained.

5918 INTERACTION BETWEEN 2450-MHZ MICROWAVES AND IONIZING RADIATION IN *TRIBOLIUM CONFUSUM*. *(Eng.)* Lai, P.-K. (Dept. Radiology, Univ. Pittsburgh Medical Sch., Pittsburgh, PA); Cain, C. A; Ducoff, H. S. *IEEE Trans Microwave Theory Tech* 26(8): 530-534; 1978. (26 refs)

The potentiating effect of a 2-hr treatment with 2,450-MHz microwave radiation (specific absorption rates of 680 or 760 W/kg in distilled water) on single or fractionated gamma radiation was investigated in the flour beetle *Tribolium confusum*. Microwave irradiation in immediate sequence with ionizing radiation enhanced the effect of the

latter, regardless of the order of application. When microwave treatment followed gamma irradiation, the interaction of the two modalities was detectable only if they were separated by less than 60 min. When microwave irradiation was performed before gamma irradiation, the enhancing effect persisted for at least 8 hr. At the higher specific absorption rate of 760 W/kg, the sparing effect of dose fractionation was completely abolished by microwave irradiation for interfraction intervals as long as 36 hr. Split dose repair was delayed for only 8-10 hr when the lower specific absorption rate of 680 W/kg was used for microwave irradiation, and eventually survival increased. All of these microwave effects are very similar to those of water immersion hyperthermia on the response to single or fractionated gamma irradiation, and it appears that the sensitizing effect of microwaves on damage caused by ionizing radiation can be attributed entirely to heating by the microwave irradiation. The above results emphasize the likelihood that the synergistic interaction between hyperthermia and ionizing radiation results from the impairment by heat of the capacity to repair DNA damaged by the ionizing radiation. Hyperthermia could impair this repair capacity by the denaturation of enzymes necessary for repair or by the alteration of the integrity of the DNA-nuclear protein-membrane lipoprotein complex, which appears to play a role in the repair.

5919 THE PERFORMANCE OF A NEW DIRECT CONTACT APPLICATOR FOR MICROWAVE DIATHERMY. *(Eng.)* Kantor, G. (Div. Electronic Products, Bureau Radiological Health, FDA, 5600 Fishers Lane, Rockville, MD 20857); Witters, D. M.; Greiser, J. W. *IEEE Trans Microwave Theory Tech* 26(8): 563-568; 1978. (8 refs)

A direct contact applicator designed for microwave diathermy at a frequency of 2.45 GHz is described. The applicator has an aperture diameter of 15.2 cm. The far field beamwidth is 55.5 degrees, and the maximum input power carrying capability is 300 W continuous wave. The housing, with a diameter of 9.5 cm, consists mainly of a circular waveguide. At its output end, the conical flare horn section with a diameter of 12.9 cm is surrounded by an annular choke to control leakage. Two sets of dual posts, opposite to each other, are placed in the forward part of the guide at 45 degrees to the probe to generate a circularly polarized field. The significant near field components of the therapeutic beam are in a transverse plane, parallel to the aperture. The maximum power density at the center of the therapeutic beam is 15.7 $mW/cm^2/W$ of forward power, and the minimum in front of the outside diameter of the choke is 0.13 $mW/cm^2/W$ of forward power. Heating patterns on the exposed surface of muscle phantoms and inside fat-muscle phantoms are spatially similar and relatively uniform. The maximum leakage for direct contact loading is 0.8 $mW/cm^2/100$ W of forward power and 4 $mW/cm^2/100$ W of forward power with an air space of 1 cm between the applicator and phantom. The applicator is also a viable candidate for hyperthermia.

5920 CELL LOSS AFTER COMBINED THERMORADIOGRAPHY. DETERMINATION IN VIVO OF CELL LOSS RATE OF EUOXIC AND HYPOXIC CELLS OF EXPERIMENTAL TUMORS. *(Ger.)* Dietzel, F. (Abteilung Nuklearmedizin, Zentrum fur Radiologie, Justus-Liebig-Universitat Giessen, Friedrichstrasse 25, 63 Giessen, W. Germany); Linhart, G.; Bierbrauer, J.; Heil, T. *Strahlentherapie* 154(8): 564-570; 1978. (27 refs)

The effects of x-ray irradiation (single tumor dose 2,000 R) and hyperthermia (461.04 MHz, 150 W, duration 2 min, 40.5 C), alone and in combination (with x-ray treatment immediately after or before hyperthermia) on tumor cell death was studied in NMRI mice with implanted solid Ehrlich carcinoma of the neck. The tumor volume was 1 ml at the time of the treatment. The cell death was measured as the reduction of DNA labeling between the 96th and 192nd hr after the intraperitoneal administration of ^{125}I-deoxyuridine before treatment. Both hypoxic and euoxic tumor cells were labeled. While x-ray irradiation alone tended to destroy mainly euoxic cells, intensive hyperthermia alone (4 min, 43 C) destroyed mainly hypoxic cells. Mild hyperthermia (2 min, 40.5 C) did not influence the x-ray induced cell loss significantly. When combined with x-ray treatment, mild hyperthermia increased the loss of hypoxic cells to the rate of the euoxic cells.

5921 STUDY OF THE EFFECT OF ELECTROMAGNETIC FIELDS ON THE ACTIVITY OF ENZYMES. *(Rus.)* Arber, S. L. (Moscow, USSR). *Elektron Obrab Mater* (1): 63-65; 1978. (10 refs)

General thermal analysis is used to explain the fact that electromagnetic fields either cause no change or reduce the enzyme activities in biologic systems. Enzymatic catalysis requires an exact orientation of the catalytic groups. If these groups are polar, exposure to an electromagnetic field slows down the enzymatic reaction in the biologic system exposed. The polar substrate may also be affected by the electromagnetic field.

5922 SELECTIVE HEATING OF CUTANEOUS HUMAN TUMORS AT 27.12 MHZ. *(Eng.)* Antich, P. P. (Mount Sinai Sch. Medicine, New York, NY 10029); Tokita, N.; Kim, J. H.; Hahn, E. W. *IEEE Trans Microwave Theory Tech* 26(8): 569-572; 1978. (5 refs)

Radiofrequency (27.12 MHz) heating of cutaneous tumors was performed in a preliminary study of 12 patients to determine if tissue temperature could be correlated with absorbed power and to investigate the possibility of a temperature differential between tumor and normal tissue. Distributions of the time at which the temperature reached its maximum and of the value of the maximum temperature were analyzed for both normal tissues and tumors. A normalized histogram of the time at which the maximum of temperature was reached showed that the curve was a Gaussian fit to the

normal tissue data with a mean value of 10.8 min and a standard deviation of 4.4 min. The normalized histogram of the maximum temperatures in normal and tumor tissue showed the Gaussian fit the normal tissue data and had a mean temperature of 40.6 C and a standard deviation of 1.4 C. The tumor distributions were broader and displayed tails for temperatures and times larger than those of normal tissues. A selective heating effect of tumors was observed, indicating that it is possible to induce localized hyperthermia by localized inductive heating, at least in the case of superficial tumors. A correlation was observed between absorbed power and average temperature, indicating that a dosimetry based on the measurement of absorbed power is capable of giving a degree of description of the ensuing thermal field. In this description, normal tissue temperatures would be well defined, while for tumors a range of temperatures would be obtained with a predictable minimum value.

5923 EFFECT OF WEAK MAGNETIC FIELDS ON GROWTH OF CELLS IN TISSUE CULTURE. *(Eng.)* Sutherland, R. M. (Ontario Cancer Treatment and Res. Foundation, Univ. Western Ontario, London, Ontario, Canada); Marton, J. P.; MacDonald, J. C.; Howell, R. L. *Physiol Chem Phys* 10(2): 125-131; 1978. (20 refs)

Normal Chinese hamster V79 lung cells were grown in vitro for more than 1 yr in a magnetic field of less than 10^{-7} tesla to test the hypothesized effects of weak magnetic fields on biologic systems. Within the limits of experimental errors inherent in these experiments, there was no difference in the growth rate, appearance, or colony size of cells grown in this low magnetic field versus control cells grown in a normal magnetic field. The results, however, cannot confirm or deny the hypothesis regarding the effects of low magnetic fields on biological systems, which includes a possible effect on cell growth. In its present stage of development, the hypothesis, which is based on the existence of biosuperconductivity, suggests only that normal cell growth in the absence of a magnetic field should be slower than in the normal geomagnetic field. If this difference is very small, its presence may be masked by random errors in the data.

5924 CORRELATION BETWEEN MAGNETIC STORMS DUE TO SOLAR SPOTS AND PIGEON HOMING PERFORMANCES. *(Eng.)* Schreiber, B. (Zoology Inst., Univ. Parma, 43100 Parma, Italy); Rossi, O. *IEEE Trans Magnetics* 14(5): 961-963; 1978. (18 refs)

Pigeon homing performance is studied in relation to solar spot-induced magnetic storms to determine if any correlation exists. In one study, observations concerning 18 pigeon races held from 1932-1957 involving a total of 12,000 pigeons were analyzed. There was a highly meaningful negative correlation (r = -0.7) between sun spot numbers and the percentage of pigeons that arrived before the first nightfall. In a second study involving races at two different locations between the years 1957 and 1976, the efficiency of homing was measured by the speed of the first arrival and the time elapsed between the first and the last arrived pigeon in the first 10%. For races at one location, a negative correlation between solar activity and homing capability was clearly demonstrated (r = -0.77). The results were further confirmed by the positive correlation between the Wolf numbers of solar spots and the spread of the first 10% of the arrivals. For the other location, the same correlation was not so evident, since the data were rather spread (r = -0.225). The reason for the differences between these two locations was not very clear. However, they may be due to differences between the two groups of races, which may have affected the performance of the birds. In general, however, it seems that the correlation between homing efficiency and solar spots is clearly demonstrated.

5925 CAN ELECTROMAGNETISM ACCOUNT FOR EXTRASENSORY PHENOMENA? *(Eng.)* Balanovski, E. (Dept. Mathematics, King's Coll., London WC2, England). Taylor, J. G. *Nature* 276(5683): 64-67; 1978. (10 refs)

Electromagnetic (EM) detectors covering a wide range of frequencies were used to search for unusual EM radiation emitted by subjects performing alleged extrasensory phenomena. No abnormal EM emission was detected from any of the subjects during the following activities: psychokinesis, metal bending, psychic healing, dowsing, and telepathy. In addition, tests of human sensitivity to low levels of EM radiation were performed using a tuneable radio frequency source in the frequency range of 220-950 MHz with a power output of 1 mW and a tuneable microwave source (both pulsed and continuous wave) in the frequency range of 6-17 GHz with a power level of 5 mW. No indication of human sensitivity to low levels of EM radiation was found.

5926 EFFECT OF PLEXIGLAS ANIMAL HOLDERS ON MICROWAVE ENERGY ABSORPTION. *(Eng.)* Ho, H. S. (Bureau Radiological Health, Food and Drug Admin., Rockville, MD 20852). *IEEE Trans Biomed Eng* 25(5): 474-476; 1978. (12 refs)

The patterns of microwave energy absorption in three homogeneous cylindrical muscle-equivalent models of small animals with and without cylindrical Plexiglas holders were calculated along with the perturbed exposure fields in plane wave irradiated empty holders to compare the relative magnitudes of the perturbation of these two dosimetric quantities. Calculations were made separately for polarizations where the electric field (TM) and the magnetic field (TE) of an incident 2,450-MHz plane wave were parallel to the axis of the cylinder. Three sizes of the animal cylinder corresponding to radii of 2, 3, and 5 cm were used. Two sets of holders were used for each phantom animal. One set of holders (type T) fit the phan-

toms exactly so that the inside radius of each holder was equal to the corresponding radius of the animal cylinder. Another set of holders (type A) had inside radii twice that of their corresponding animal cylinders so that air spaces existed between the animal cylinders and the walls of their holders. For each animal cylinder, the perturbations of the exposure field and the absorbed dose rate were smaller for the type T holder than for the type A holder. The TM polarized case showed more perturbation than the TE polarized case. Perturbations increased with the size and corresponding thickness of the holder to as much as 14.3 dB. However, the perturbation of the absorbed dose rate was typically less than 1 dB and was much smaller than that of the corresponding exposure field. The only exception was the -2.26 dB perturbation of the internal peak of the largest animal cylinder by the type A holder for the TM case. However, this internal peak was only 7% of the absolute peak at the surface. The above results indicate that large perturbations of the exposure field due to Plexiglas holders do not automatically result in a correspondingly large perturbation of the absorbed dose rate in the animal.

5927 CAPACITIVE STIMULATORY EFFECT IN MAGNETIC STIMULATION OF NERVE TISSUE. *(Eng.)* Ueno, S. (Dept. Electronics, Kyushu Univ., Fukuoka, 812, Japan); Matsumoto, S.; Harada, K.; Oomura, Y. *IEEE Trans Magnetics* 14(5): 958-960; 1978. (4 refs)

The capacitive stimulatory effect of two different contactless stimulating methods designed to avoid the deficiencies of conventional galvanic stimulation are studied in frog nerve-muscle preparations. The first method stimulated the nerve by means of voltage pulses through windings on a permalloy core through which the nerve bundle was threaded. Measurements of the pulse strength-duration curve indicated a chronaxy of 20 μsec, which is shorter by one decade than the 0.3 msec pulse duration for galvanic stimulation. This phenomenon can be simulated by a capacitive effect. A capacitor was inserted between the pulse generator and the nerve bundle, and the strength-duration curves were plotted for various values of capacitance. The chronaxy became 20 μsec at capacitances equal to 150-500 picofarads. The other contactless stimulating method involved exciting the nerve by means of a high frequency magnetic field generated in the airgap of a ferrite core driven by burst signals. The voltage threshold for nerve excitation reached a minimum near a frequency of 1 kHz. In this second method of contactless stimulation, the loop currents or eddy currents were induced locally in the nerve tissue by the high frequency magnetic field; whereas, in the first method, the membrane capacitance was charged directly by the electromotive force generated by the electromagnetic induction. In both cases, however, two typical characteristics, the strength-duration curve and the threshold-versus-frequency curve, were explained well by a capacitive coupling model.

5928 THERMOGRAPHIC TUMOR DETECTION ENHANCEMENT USING MICROWAVE HEATING. *(Eng.)* Thompson, J. E. (Coll. Engineering, Univ. South Carolina, Columbia, SC 29208); Simpson, T. L.; Caulfield, J. B. *IEEE Trans Microwave Theory Tech* 26 (8): 573-580; 1978. (24 refs)

Experiments with transplantable guinea pig liver hepatomas were performed to demonstrate that increased thermographic observability of the tumors can be obtained by microwave heating of the tumor area. The experiments showed that the temperature differential between healthy tissue and tumor tissue can be increased substantially by irradiating the examined area with microwave radiation. The increased spatial temperature gradients are then more easily observed using conventional thermographic techniques, resulting in an improvement in the sensitivity of the basic thermographic technique. When transplantable guinea pig hepatomas were irradiated for 75 sec with 2.45-GHz microwave radiation, a tumor temperature rise of 5.5 C was observed along with a rise of 2.5 C in the surrounding healthy tissue. The spatial gradient was 3 C, which compares with the relevant unheated spatial gradient of approximately 0.5 C. The thermographic raw data are produced in the form of temperature profile maps, and the spatial data obtained are used to determine the presence and location of a tumor. This is additionally facilitated by observing thermographically the temporal behavior of the tumor heating and cooling. These temporal data may prove to be useful in quantifying such tumor characteristics as depth, vascularity, or size. The microwave power and required irradiation times are small and result in a maximum healthy tissue temperature increase of only a few degrees Celsius.

5929 RADIOFREQUENCY THERMONEUROLYSIS OF PERIPHERAL NERVES FOR CONTROL OF TRIGEMINAL NEURALGIA. *(Eng.)* Gregg, J. M. (Dental Res. Center, The Univ. North Carolina, Chapel Hill, NC 27514); Banerjee, T.; Ghia, J. N.; Campbell, R. *Pain* 5(3): 231-243; 1978. (38 refs)

Radio frequency thermoneurolysis (RFTN) was performed in the peripheral infraorbital and inferior alveolar nerves of eight patients with either posttraumatic or idiopathic paroxysmal trigeminal neuralgias to achieve pain relief. Facial pain was significantly relieved in seven of these eight patients following RFTN. In these instances pain was typically reported to gradually subside over the first 2-3 postoperative days. Three patients rated pain severity at zero for the first 9 postoperative mo, and four patients reported pain to be improved to a mild level of less than 25%, a level that remained constant for 12 mo. Repeated study of subjective postoperative pain with the Melzack pain language questionnaire indicated a loss of the explosive, triggered, and paroxysmal pain component and the retention of a duller throbbing pain. Two of the seven successfully controlled patients experienced recurrences of symptoms at postoperative mo 12. Tests of tactile-discriminative functions

revealed small initial deficit at 1 wk after treatment, but no long-term significant measurable differences from preoperative baselines were evident. Significant post-treatment elevations of mean pain detection and pain tolerance thresholds were observed in this series. No major complications were observed. It is concluded that RFTN is an effective means of controlling the pain of trigeminal neuralgia. It is indicated when alternative medical and physiologic therapies are not effective or toxic, when the pain and triggering is confined to the distribution of a peripherally accessible nerve branch, and when test blocks of small nerve fibers with local anesthetic solutions relieve pain.

5930 OR RF--THE SECOND FACTOR. *(Eng.)* Fox, J. W. (Erlanger Medical Center, Chattanooga, TN); Rapp, T. L.; Wagner, D. W. *Am J Assoc Nurse Anesth* 46(5): 501-506; 1978. (44 refs)

The chronic exposure of operating room personnel to radio frequency (RF) fields from electrosurgery units is discussed from an occupational health standpoint. The operating room personnel are chronically exposed during the use of electrosurgical devices to field strengths generally in excess of current United States guidelines and always above the Eastern bloc standards. It has been shown that the RF spectral output of an electrosurgical spark-gap and tube unit widely used in North American operating rooms extends from 1 MHz to 1 GHz, with most of the energy below 100 MHz. Power density levels along the unshielded active lead exceed 150 mW/cm^2 at a distance of 5 cm. Many of the effects observed during and after exposure to unscavenged anesthetic agents are similar to the complex of symptoms called radio wave sickness in the Eastern European literature. Whether an additive or potentiating effect occurs with spent anesthetics and RF is difficult to state, but it would seem likely. It is recommended that RF field strength measurements be made and recorded in the operating room during surgical procedures.

5931 THE EFFECTS OF CONTINUOUS DIRECT CURRENT ON THE GROWTH OF THE ANTLER. *(Eng.)* Lake, F. T. (Dept. Oral Biology/Anatomy, Sch. Dentistry, Medical Coll. Georgia, Augusta, GA 30901); Davis, R. W.; Solomon, G. C. *Am J Anat* 153(4): 625-630; 1978. (15 refs)

The effects of continuous low level direct current (DC) on the developing bone of the deer antler were studied. The DC power units were connected by electrodes to the main shaft of the right antlers. The negative electrode (cathode) was sutured from side to side through the antler tip, while the positive electrode (anode) was sutured through the skin at the base of the same antler. Power was supplied by an 8.4-V mercury battery. The deer received either 0.066, 0.5, 2.0, or 2.0 μA of current during the entire 4-mo antler growth cycle. The application of cathodal DC over the range of 0.066-3.0 μA to the deer antlers during their entire growth cycle caused statistically significant reductions in length when compared with control antlers. Gross morphologic differences between experimental and control antlers were noted early in the experiment. The treated antlers showed abnormal branching patterns and grew in atypical directions. The data suggest that in a relatively stress-free system such as the antler the long-term application of low levels of constant cathodal DC to developing bone causes a reduction in longitudinal growth. In addition, the current may alter the normal morphology and direction of bone growth.

5932 THE ZAPPING OF AMERICA: MICROWAVES, THEIR DEADLY RISK, AND THE COVERUP (BOOK REVIEW). *(Eng.)* Anderson, D. M. (No affiliation given). *Bull At Sci* 34(9): 49; 1978. (1 ref)

A book entitled *The Zapping of America: Microwaves, Their Deadly Risk, and the Coverup* written by Paul Brodeur is reviewed. The author of the book cites evidence to show that man-made electromagnetic radiation is bombarding us from all sides and that it poses an awesome threat to human health. In particular, it is the capacity of microwaves to penetrate tissue and cause chromosome damage that makes their long-term effects dangerous according to the author. Also documented is a cover-up of evidence on the effects of microwaves on human beings carried out by the electronics industry and the military. Although the book "lacks coherence," it is felt that it "should not be missed."

5933 A SYSTEM FOR STUDYING EFFECTS OF MICROWAVES ON CELLS IN CULTURE. *(Eng.)* Chen, K.-C. (Dept. Biology, Wayne State Univ., Detroit, MI 48202); Lin, C.-J. *J Microwave Power* 13(3): 251-256; 1978. (14 refs)

An improved fluid-filled waveguide exposure chamber was used to investigate the effects of 2,450-MHz microwave radiation on Chinese hamster somatic cells in culture. The unique feature of this system is that instead of a petri dish or a flask, a 100 μl micropipette is utilized to hold the suspension of cells. Aliquots of a suspension of Chinese hamster somatic cells from the lung of a male animal were transferred to a micropipette sample holder and were subjected to microwave irradiation at a power density of 500 mW/cm^2 for an exposure period of 20 min. The cytotoxic effects of radiation were assayed over a 12-day incubation period in terms of cellular growth rate, morphologic change, and clone-forming ability. The growth rate of the irradiated cells decreased by nearly 30%. Furthermore, about 10% of the irradiated cells underwent a distinct morphologic transformation within 48 hr of incubation after irradiation. With continuing incubation of the cells for up to 12 days at a temperature of 37 C, the microwave-induced transformants finally exhibited a fibroblast type of growth. The observed cellular abnormality appeared to be irreversible. Since the temperature of 37 C, which was rigidly maintained throughout the experiment (within ± 0.1 C), is the optimal temperature for the growth of

this mammalian cell line under in vitro conditions and since an experimental temperature variance of 1 C above or below optimal did not alter the amount of morphologic difference, it is conceivable that a truly athermal influence was a contributing factor to the above observations. It may also be speculated that thermal microgradients were responsible for the observed cytotoxic effects. Further studies are needed to clarify these points.

5934 FIBROUS MUSCULAR CONTRACTURES: TREATMENT WITH A NEW DIRECT CONTACT MICROWAVE APPLICATOR OPERATING AT 915 MHZ. *(Eng.)* de Lateur, B. J. (Dept. Rehabilitation Medicine, RJ-30, Univ. Washington Sch. Medicine, Seattle, WA 98195); Stonebridge, J. B.; Lehmann, J. F. *Arch Phys Med Rehabil* 59(10): 488-490; 1978. (11 refs)

A new direct contact diathermy applicator operating at 915 MHz was used to treat a 61-yr-old man with bilateral contractures of the rectus femoris and brachial biceps due to 8 yr of intramuscular injection of pentazocine. The left leg, which was heated and stretched, increased in knee flexion until session 20 when a high of 127 degrees was reached. This value is within the normal range for knee flexion. The right leg, which was only stretched, did not increase in knee flexion as rapidly as the left leg. At session 20, the knee flexion for the right leg was 22 degrees less than that for the left leg. Contractures of the arms were much harder to treat. The left arm, which initially had the greatest contracture, stretched a total of only 9 degrees and had 75 degrees of residual contracture after heat and stretch treatments. This is not a functional range. The right arm had 44 degrees of contracture, and it was possible for the patient to use this arm in a reasonable fashion. Heat plus stretch seemed to relieve the contracture in the right arm more than stretch alone.

5935 USE OF MICROWAVE RADIATION IN SURGERY AND CANCER THERAPY. *(Eng.)* Osaka, A. (Dept. Internal Medicine, Sapporo City General Hosp., North 1, West 9, Sapporo, Japan). *J Microwave Power* 13(2): 155-161; 1978. (11 refs)

The capacity of microwaves to produce rapid protein coagulation and the potential usefulness of this fact in surgery and cancer therapy were investigated by irradiating livers in rabbit and malignant tumors in rats with 2,450-MHz microwaves. Livers of rabbits that were irradiated in vivo for about 3-4 min showed complete coagulation in the irradiated area, making resection very easy. Neither bleeding nor cholerrhagia from the cut surface of the liver was observed. When methylcholanthrene-induced spindle cell sarcomas in rats were irradiated for a period of 2 min, the tumor coagulated immediately after irradiation, and the tumor consistency became soft. The animals survived well for a long time without any symptoms until they were sacrificed for pathologic examination. In other experiments, malignant tumors after microwave irradiation could be resected with an ordinary knife and without bleeding. Sometimes tumor recurrence was observed after irradiation; however, these animals were kept alive by re-irradiation. Of all the rats used in these experiments, 53% survived for more than 2 yr.

5936 EVALUATION OF A THERAPEUTIC DIRECT-CONTACT 915-MHZ MICROWAVE APPLICATOR FOR EFFECTIVE DEEP-TISSUE HEATING IN HUMANS. *(Eng.)* Lehmann, J. F. (Dept. Rehabilitation Medicine, Univ. Washington Sch. Medicine, Seattle, WA 98195); Guy, A. W.; Stonebridge, J. B.; deLateur, B. J. *IEEE Trans Microwave Theory Tech* 26(8): 556-563; 1978. (24 refs)

A 13-cm square direct-contact 915-MHz microwave applicator with stripline feed was evaluated to determine the temperature distributions produced in tissue models and in the anterior thigh of human volunteers. From the experiments with tissue models, it was concluded that the applicator produces significant heating within the musculature, that a radome is necessary to prevent hot spots in the superficial tissues, and that air cooling is necessary to prevent excessive heating of superficial tissues. The applicator was then tested on human volunteers that were divided into two groups, the first having an anterior thigh fat layer of 1 cm or less and the second having a fat layer of 2 cm or greater. The subjects were irradiated with the radome in place with and without cooling. When cooling was not used, none of the subjects could tolerate a planned 20-min exposure. With the radome and forced-air cooling, the applicator was found to selectively elevate temperatures in the muscles (1-2 cm depth) to 43-45 C. It also appeared that by increasing power levels after blood flow has cooled this tissue it may be feasible to push these temperatures back to 43-45 C and hold them at these levels for longer periods of treatment. The possibility exists, therefore, for using this applicator to heat cancerous tumors in muscle. A comparison of calculations of the specific absorption rate in human thighs with those in models indicated that the models are highly reliable predictors of temperature distributions produced in human tissues.

5937 EFFECT OF ELECTROSTATIC FIELDS ON THE CHROMOSOMES OF EHRLICH ASCITES TUMOR CELLS EXPOSED IN VIVO. *(Eng.)* Mitchell, J. T. (Dept. Biology, Colgate Univ., Hamilton, NY 13346). Marino, A. A.; Berger, T. J.; Becker, R. O. *Physiol Chem Phys* 10(1): 79-85; 1978. (13 refs)

Mature female Swiss Ha/ICR mice bearing Ehrlich ascites tumor were exposed to vertical or horizontal electrostatic fields in the range of 80-160 V/cm over periods ranging from 2-15 wk to investigate the effect of such fields on tumor cell chromosome aberrations. Cells exposed to horizontal electrostatic fields for 2 wk had a significantly (at the 0.5% level) greater percentage of cells with abnormal chromosomes (22.5 ± 6.6%) than did control cells (8.8 ± 7.1%) or cells exposed

to vertical fields for 2 wk (5.8 ± 5.8%). The most numerous chromosomal abnormalities detected were chromatid exchanges (translocations) and isochromatid breaks. Extended exposure times of 4-15 wk resulted in the disappearance of aberrant chromosomes, suggesting that the affected cells were incapable of cellular replication resulting eventually in their disappearance via cell death. It is believed that the reported results are the first qualitative and systematic description of electrostatic field-induced effects at the chromosomal level, and it is suggested that the production of chromosomal abnormalities in tumor cells in mice following exposure to low strength electrostatic fields reinforces the proposal of electrostatic field-induced trigger phenomena in biologic systems.

5938 PROPOSED EXPOSURE LIMITS FOR MICROWAVE AND RADIOFREQUENCY RADIATIONS IN CANADA. *(Eng.)* Repacholi, M. H. (Non-Ionizing Radiation Section, Consumer and Clinical Radiation Hazards Div., Radiation Protection Bureau, Health and Welfare Canada, Ottawa, Ontario, Canada). *J Microwave Power* 13(2): 199-211; 1978. (51 refs)

Proposed exposure limits for microwave and radio frequency radiations in Canada are discussed. The Canadian Standards Association recommends a maximum permissible level (MPL) of exposure, which is similar to that of the American National Standards Institute, a maximum power density of 10 mW/cm^2 for continuous exposure to microwaves. This recommended standard applies to the frequency range of 10 MHz to 100 GHz. The Federal Department of Health and Welfare, which does not presently have a recommendation for open-beam exposure to microwave and radio frequency radiation, is considering the following limits. For any person exposed to microwave and radio frequency radiation, either continuous wave or pulsed, the following values should not be exceeded during any 1-hr period: an averaged energy flux of 1 mW/hr/cm^2, an averaged power density of 1 mW/cm^2, a root mean square (RMS) electric field strength of 60 V/m, an RMS magnetic field strength of 0.16 A/m, and an averaged (over 1 min) maximum power density of 25 mW/cm^2. The frequency range to which this recommendation applies is 10 MHz to 300 GHz. The proposal does not apply to deliberate medical exposure of patients to such radiation. This proposal has been modified slightly in that a ten-fold safety factor for exposure of the general public has been dropped. It is felt that present data on the biologic effects of microwave and radio frequency radiation do not justify a lower MPL. A 1 mW/hr/cm^2 MPL for general exposure, lying between the 10 mW/cm^2 value in the United States and the Russian value of 0.01 mW/cm^2, is proposed for the following reasons. The 10 mW/cm^2 value appears to be inadequate even on the assumption that only thermal effects pose a hazard. There are animal and human phantom data that indicate that localized heating may produce adverse effects from exposure at power densities of 10 mW/cm^2 and lower at frequencies generally below 500 MHz. The Soviet standard appears to be too strict (based on zero risk), and so-called nonthermal effects at low power densities have not been confirmed in the West.

5939 BIOELECTROCHEMICAL STUDIES OF IMPLANTABLE BONE STIMULATION ELECTRODES. *(Eng.)* Spadaro, J. A. (Dept. Orthopedic Surgery, Upstate Medical Center, Syracuse, NY 13210). *Bioelectrochem Bioenerget* 5: 232-238; 1978. (5 refs)

Cultured mouse bone marrow cells and fibroblasts were exposed to several metal cathodes in vitro to investigate the mechanism of electrically stimulated osteogenesis. Bone marrow cells were exposed to silver, platinum, gold, titanium, stainless steel 316L, and graphite cathodes carrying a constant current ranging from 0.5-20 μA, applied over a 4-hr period at 37 C. Most changes in cell populations were relatively independent of the current level over the above range. Both cell-specific and electrode-specific changes were observed near the electrodes. Five of the six cathodes produced a depression in neutrophil population. Lysis was elevated around the stainless steel, platinum, and possibly graphite cathodes. An extraordinary increase in eosinophilic cells was noted near the platinum cathode and anode. In a similar experiment, mouse fibroblasts were exposed to the same cathodes at a constant current of 2 μA, which was applied for 4 hr. These fibroblasts were generally insensitive to all of the cathodes, and it is concluded that fibroblasts do not seem to be unfavorably affected by these cathodes at this modest current density. When the current-potential behavior was measured for a number of implantable metals and alloys in a biologic medium, oxygen reduction was observed in the range reported for the successful bone stimulation around cathodes. This raises the possibility that the products of oxygen reduction may influence cells in the bone marrow or nearby tissues to begin the production or elaboration of bone. If the reduction of oxygen is an important factor in electrical bone formation, then it seems that the platinum electrode would be an efficient choice, providing the reactions observed in the bone marrow experiments are not detrimental to the tissues. Gold or silver might be logical alternative materials in that case.

5940 LANTHANUM INHIBITION OF ELECTRICALLY INDUCED DEDIFFERENTIATION IN FROG ERYTHROCYTES. *(Eng.)* Smith, S. D. (Dept. Anatomy, Univ. Kentucky Coll. Medicine, Lexington, KY 40506); Thomas, C. L.; Frasch, S. F. *Bioelectrochem Bioenerget* 5: 177-184; 1978. (11 refs)

Lanthanum inhibition of electrically induced dedifferentiation in frog *(Rana pipiens)* erythrocytes was studied to investigate whether blockade of divalent calcium transmembrane passage can in turn block dedifferentiation. Erythrocytes from adult northern grassfrogs were diluted in isotonic saline and isotonic calcium-magnesium-free phosphate buffered saline. When these cells were subjected to 100

mV square pulses at a frequency of 50 Hz (10 msec on and 10 msec off) over a period of 1 hr, they exhibited dedifferentiation in both media. When lanthanum chloride was added at concentrations of 10^{-4} molar or larger, transformation was effectively blocked. At concentrations of 10^{-5} molar or less, inhibition was minimal. Cellular dedifferentiation was also produced by adding 10^{-6} molar calcium ionophore A23187. When lanthanum chloride at a concentration of 10^{-4} molar was added to a culture containing 10^{-6} molar ionophore, transformation was blocked. The imposition of current reversed the blockage once more, allowing the cells to transform as though neither ionophore nor lanthanum chloride were present. It is concluded that transmembrane exchange of divalent calcium is a critical step in electrically induced dedifferentiation of these cells.

5941 COMBINED MICROWAVE THERAPY. *(Eng.)* Nelson, A. J. M. (21 McCourt St., Leederville, West Australia 6007); Holt, J. A. G. *Med J Aust* 2(3): 88-90; 1978. (11 refs)

The results of using 434-MHz radiowave hyperthermia in combination with cobalt radiotherapy and/or radioactive gold implants for the treatment of 52 patients with advanced head and neck cancer are reported. These results are also compared with those obtained in comparable series of patients receiving cobalt radiotherapy with hyperbaric oxygen (HBO) or conventional supervoltage therapy (SVT). The rise in temperature in the tumors was measured with a specially designed thermocouple probe. A temperature of up to 42.5 C was recorded at the end of 434-MHz hyperthermic treatment. Complete healing and disappearance of the tumor masses occurred after combined radiotherapy and hyperthermia in 94% of the patients compared with 62.5% for HBO-treated patients and 36.5% for SVT-treated patients. At 3 yr after treatment, the cumulative percentage of cases not having had persistent or recurrent local disease was 60% for patients treated with combined radiotherapy and hyperthermia compared with 23% for HBO-treated patients and 8% for SVT-treated patients. The 3-yr survivals for patients treated by combined radiotherapy plus hyperthermia, HBO therapy, or SVT were 54, 29, and 19%, respectively.

5942 REGENERATION IN DENERVATED LIMBS OF SALAMANDERS AFTER INDUCTION BY APPLIED DIRECT CURRENTS. *(Eng.)* Rose, S. M. (34 High St., Woods Hole, MA 02543). *Bioelectrochem Bioenerget* 5: 88-96; 1978. (33 refs)

Denervated stumps of the salamander *Triturus viridescens* received the same patterns of electricity as those observed in naturally regenerating limbs with nerves to investigate whether nerves support limb regeneration by controlling the bioelectric pattern. The tip of the stump was made either 20-30 mV positive or 20-30 mV negative to points on the skin just distal to a circular platinum contact that was placed around the stump 2-3 mm from the tip. When the tips of stumps were made 20-30 mV negative to the circular locus on the skin just distal to the circular contact, an electrical gradient was established that was similar in magnitude, sign, and length to the electrical gradient in limbs producing blastemas naturally. When three denervated stumps were made 20-30 mV negative at their tips twice for 2 hr at a time during each of 3 consecutive days, signs of regeneration appeared after only a 12-hr period with the tips negative plus an additional 24-hr period of no stimulation at 23 C. None of 15 denervated stumps made positive at the tip nor any of 10 denervated control stumps showed any signs of regeneration. In the stumps that showed regeneration, the beginning of a loss of old tissue structure was also observed, and some cells showed condensation of their chromosomes. It appeared that a primary action of nerves in regeneration was being replaced by the polarized current after only 12 hr of treatment. Continuation of treatments for 4 hr/day for more than 3 days caused greater than normal loss of structure in the soft tissues and some loss of bony matrix. To prevent excessive loss of structure, some tips were made positive during treatments for a few days, then negative, and then positive again. Three stumps treated in this way were allowed to regenerate to the fingerbud stage.

5943 REGIONAL LEVELS OF HISTAMINE IN RAT BRAIN AFTER MICROWAVE IRRADIATION: EVIDENCE FOR ARTIFACTS IN THE ENZYMATIC-ISOTOPIC ASSAY. *(Eng.)* Subramanian, N. (Institut fuer Pharmakologie und Toxikologie der Universitat Erlangen-Nuernberg, Universitaetsstrasse 22, D-8520 Erlangen, W. Germany); Schinzel, W.; Mitznegg, P.; Estler, C.-J. *Agents Actions* 8(5): 488-490; 1978. (12 refs)

Regional levels of histamine in the rat brain after microwave irradiation and after decapitation were measured by two different analytic techniques. Male Wistar rats that were maintained in a 12-hr dark-light cycle with water and standard diet available ad libitum were either decapitated or subjected to whole body microwave irradiation (4,900 W for 40 sec). Histamine levels in various regions of rat brain that were measured fluorimetrically were similar for rats killed by decapitation and microwave irradiation. However, when histamine was determined by an enzymatic-isotopic method, the histamine levels were 5-20 times higher after microwave irradiation than after decapitation. To test the possibility that an artifact was formed during microwave irradiation that interferes with the enzymatic-isotopic assay, the chloroform extracts prepared from whole brain homogenates were cochromatographed with standard methylhistamine. An examination of the radioactivity profile of a thin layer chromatogram of methylated products in the enzymatic-isotopic assay of histamine revealed that for decapitated rats only one peak existed, which corresponded to the standard methylhistamine. In contrast, microwave irradiation resulted in three peaks in the assay, corresponding to standard methylhistamine and two other unknown compounds.

This explains the falsely elevated histamine levels estimated by the enzymatic method. It is concluded that the combination of microwave irradiation and the enzymatic-isotopic assay yields erroneous results in the histamine analysis and that this procedure should be avoided.

5944 APPLICATION OF HIGH-POWERED MICROWAVE IRRADIATION FOR ACETYLCHOLINE ANALYSIS IN MOUSE BRAIN. *(Eng.)* Fujiwara, M. (Div. Neurochemistry, Inst. for Neurobiology, Okayama Univ. Medical Sch., 2-5-1 Shikata-cho, 700 Okayama, Japan); Watanabe, Y.; Katayama, Y.; Shirakabe, Y. *Eur J Pharmacol* 51(3): 299-301; 1978. (7 refs)

Acetylcholine levels are studied in whole brains and discrete areas of brains of mice sacrificed by decapitation, conventional microwave irradiation, or by high-power short-duration microwave irradiation. Microwave irradiation was performed using either the conventional method of delivering 1.3 kW of 2,450-MHz radiation for 2.0 sec or a new method by which 3.0 kW of 2,450-MHz radiation was delivered for 0.2 sec. Acetylcholine levels in whole brains homogenized within 1 and 2 min after decapitation were 21.6 ± 1.1 nmole/g tissue and 15.3 ± 0.7 nmole/g tissue, respectively. After high power microwave irradiation the acetylcholine level for the whole brain was 49.3 ± 2.4 nmole/g tissue compared with only 25.7 ± 1.4 nmole/g tissue after conventional microwave irradiation. Regional differences in acetylcholine levels in the brain were maintained when high-power microwave irradiation was used. Compared with conventional methods, these levels ranged from 1.5 times higher in the brain stem to 1.9 times higher in the diencephalon. Acetylcholine levels in both whole brains and discrete areas of brains varied according to the time required to inactivate the enzymes. The more rapid the inactivation, the higher the acetylcholine level. It is suggested that high-power short-duration microwave irradiation could result in more accurate acetylcholine measurements than does conventional microwave irradiation.

5945 ATTENUATION OF ELECTROMAGNETIC RADIATION FROM MICROWAVE OVENS BY MAGNETIC RESISTIVE SHEETS. *(Eng.)* Ramasamy, S. R. (Defence Electronics Res. Lab., Chandray anagutta Lines, Hyderabad 500 005, India). *J Inst Electron Telecommun Eng* 24(7): 305-306; 1978. (4 refs)

The use of magnetic resistive sheets (MRS) to reduce leakage radiation from microwave ovens is discussed from a theoretic standpoint. The MRS consists of rubber ferrite sheets backed by a metal plate and situated at the peripheral edges of the microwave cooker door. It is calculated that the attenuation of leakage radiation by MRS is expected to be only 10-12 dB when the door gap is between 0.5 and 1.0 mm. However, a much higher order of attenuation is expected if the MRS were arranged in the form of a corrugated structure because of its inherent attenuating nature. Since rubber is kneaded with ferrite and the weight ratio is 1:4, no adverse effect due to the rubber on the food contents of the oven is expected.

5946 ACUTE MICROWAVE IRRADIATION AND CATARACT FORMATION IN RABBITS AND MONKEYS. *(Eng.)* Kramar, P. (Dept. Ophthalmology RJ-10, Sch. Medicine, Univ. Washington, Seattle, WA 98195); Harris, C.; Emery, A. F.; Guy, A. W. *J Microwave Power* 13(3): 239-249; 1978. (13 refs)

Specific absorption rate (SAR) patterns and cataractogenic thresholds for rabbits and monkeys irradiated in the near field of a cavity-backed 2,450-MHz resonant slot radiator in a ground plane were studied to simulate the effects of microwave oven door leakage. Both immediate and delayed effects were noted in the irradiated eyes of the rabbits. Among the immediate effects were tearing, a constricted pupil, dilated conjunctival and iris vessels, a turbid anterior chamber, and a milky band in the posterior cortex of the lens. The delayed effects were confined to the lens and were seen 5-7 days after irradiation. These changes consisted of vacuole formation along the posterior suture line, followed by progressive opacification of the posterior cortex. The lowest incident power-time level at which the lens showed any change was 180 mW/cm^2 for 140 min. Although monkeys exposed to up to 500 mW/cm^2 for 60 min sustained facial burns, no lens damage was observed. These results were substantiated by computer thermal models. The good agreement between the measured and the computed temperature fields found in these experimental animals suggests that it is possible to predict the ocular temperatures and cataractogenic thresholds for man, if the blood flows and the SAR patterns are known.

5947 MICROWAVE POWER APPLICATIONS IN JAPAN. *(Eng.)* Kase, Y. (Range Div., Sharp Corp., Hirano, Osaka, Japan); Ogura, K. *J Microwave Power* 13(2): 115-123; 1978. (14 refs)

Domestic, industrial, scientific, and medical microwave power applications in Japan are reviewed. On the domestic scene, a gradual expansion of the microwave cooking oven market occurred after late 1971; however, sales have declined since the 1974 peak volume. The output power for most domestic microwave ovens is 600 W. A microwave leakage regulation became effective on December 31, 1970. Although power leakage is stipulated for microwave ovens by the Electrical Appliance and Material Control Law, no regulation has been provided for industrial equipment. Therefore, each equipment manufacturer has to set their own standard referring to the 5 mW/cm^2 standard for microwave ovens. The principal application fields of industrial microwave heating are food processing, insect killing, film and paper processing, and tire and rubber processing. Most of the microwave heating systems currently installed are in the food industry and typically consist of an oven-conveyor combination. Magnetrons are usually used as mic-