0394 ELECTROMAGNETIC RADIATION PRODUCT INVESTIGATION AT RADIO-FREQUENCIES. Ruggera, P. S. (U.S. Dept. HEW, BRH, Electronic Products Div., 5600 Fishers Lane, Rockville, MD 20852).

Products that generate high levels of potentially hazardous radio frequency (RF) electromagnetic radiation must be identified, and their emissions quantified. Three classes of RF-emitting products, investigated in light of their potential for significant impact on public health through direct radiation emission or through interference to critical life support equipment, have been studied in detail. The electric and magnetic field strengths from industrial RF sealers, citizen-band radios, and electrosurgical units have been quantified utilizing state-of-the-art instrumentation developed by the Bureau of Radiological Health (BRH). All preliminary investigations have confirmed that under typical use conditions these products can exceed the applicable safety exposure standards set by the American National Standards Institute and/or could severely affect the function of critical equipment through electromagnetic interference. Through cooperation with involved governmental agencies and manufacturers, BRH will define and attempt to minimize the potential hazard through technical and regulatory activities. The measured field strength data are available to researchers through presentation and publication to promote research under the exposre considtions of amplitude and frequency. (10/76-9/77)

Supporting Agency:HEW, PHS, FDA, BRH

0395 REPRODUCTIVE EFFECTS OF MICROWAVES/X RAYS. Rugh, R.; McManaway, M. (U.S. Dept. HEW, BRH, Biological Effects Div., 5600 Fishers Lane, Rockville, MD 20852).

The extent to which microwaves and x-ray radiation can be teratogenic to the CF1 mouse, and how such radiation affects reproductive capacity of exposed male and female mice will be determined. CF1 mice, time-mated to obtain pregnancies of known gestation age, will be exposed either to x-rays or microwaves under strictly controlled dosimetric conditions. On day 18 of gestation, the pregnant females will be sacrificed and dissected, and the mouse fetuses will be examined for anomalies. (10/76-9/77)

Supporting Agency:HEW, PHS, FDA, BRH

5774 THE INFLUENCE OF ELECTRICAL STIMULATION OF THE HYPOTHALAMIC SUPRAOPTIC ZONE ON THE LIPID METABOLISM AND DEVELOPMENT OF ATHEROSCLEROSIS. *(Rus.)* Zavodskaia, I. S. (Dept. Pharmacology, Inst. Experimental Medicine of USSR Acad. Medical Sciences, Leningrad, USSR); Moreva, E. V.; Sinitsyna, T. A.; Ryzhenkov, V. E.; Nikul'cheva, N. G.; Mosina, I. V. *Biull Eksp Biol Med* 85(6):661-664; 1978. (14 refs)

The effect of electrical stimulation (50 Hz, 1.5-2 V, impulse duration 0.1 msec, 1 hr/day for 7-25 days) of the supraoptic zone of the hypothalamus on lipid metabolism and the development of atherosclerosis was studied in 30 male rabbits. The animals had been on an atherogenic diet (0.5 mg/kg/day cholesterol administered through gastric tube) for 3-8 wk prior to and during stimulation. The control rabbits received cholesterol only. The stimulation of the supraoptic zone of the hypothalamus of test animals caused a greater increase in the blood cholesterol level and increased blood levels of free fatty acids, glucose, and triglycerides. There were, however, no significant differences between the test and control groups in the cholesterol and triglyceride levels in the liver and in the plasma 11-oxycorticosteroid level. After 3 wk of electrical stimulation of the supraoptic zone and the atherogenic diet, metabolic disorders in the myocardial tissue (reduced creatin phosphate and norepinephrine levels and increased inorganic phosphate and lactic acid levels) were observed. Similar disorders were observed in the control animals by a 4-mo diet of cholesterol only. The electrical stimulation also caused venous plethora, hyperemia of the capillary network, stasis, and hemorrhages. The findings indicate that the electrical stimulation of the supraoptic zone of the hypothalamus accelerates the development of the pathomorphologic and biochemical disturbances in the cardiovascular system in induced atherosclerosis.

5775 POSSIBLE ROLE OF THE HYPOTHALAMUS IN THE PATHOGENESIS OF VEGETATIVE DISTURBANCES DURING A BRIEF EXPOSURE TO CONSTANT MAGNETIC FIELD. *(Rus.)* Smirnova, N. P. (Moscow, USSR); Klimovskaia, L. D. *Patol Fiziol Eksper Ter* (3): 28-31; 1978. (17 refs)

The effect of whole-body exposure to constant magnetic field (1,000-4,000 Oe, length of exposure 1 or 24 hr) on the hypothalamic functions was studied in 20 rabbits with electrodes implanted into the hypothalamus. The exposure caused a shift toward higher frequencies in the hypothalamic bioelectric potentials, with rapid normalization after exposure. Exposure to 3,000-4,000 Oe caused a 130-150% increase in the hypothalamic potentials; a smaller increase was observed during exposure to lower intensities. The magnetic field enhanced the effect of high-frequency electrical stimulation (300 impulses/sec) of the hypothalamus on the rate of respiration (130% of the normal value before and 170% during exposure) and heart rate (97% of the normal value before exposure, and 80% during exposure). The findings suggest the involvement of the hypothalamus in the development of autonomic disturbances in response to exposure to high-intensity magnetic field.

5776 BONE MARROW CELL PROLIFERATION UNDER THE INFLUENCE OF CONSTANT MAGNETIC FIELDS OF VERY HIGH INTENSITY. *(Rus.)* Strzhizhivskii, A. D. (Inst. Medical-Biological Problems, Ministry of Public Health of the USSR, Moscow, USSR); Galaktionova, G. V. *Tsitologiia* 20(6):717-720; 1978. (3 refs)

The effects of constant electromagnetic fields (intensity 9.9-42.4 kOe, intensity gradient 0.2-3.5 kOe/cm, length of exposure 0.5-24 hr) on cellular mitotic activity, number, and chromosome aberrations of bone marrow cells were studied in 768 anaphase slides from 390 mice. The mitotic activity was increased by short-term exposure and reduced by long-term irradiation. The degree of mitotic inhibition caused by long-term treatment increased with increasing intensity and gradient, but even the fields with the highest intensity failed to inhibit the mitotic activity when the intensity gradient was below a critical range of 0.2-1.1 kOe/cm. The reduced mitotic activity returned to normal more slowly with increasing field intensity, but it was independent of the intensity gradient. The bone marrow cell count was reduced only by exposure to the field with very high intensity (78.6 ± 5.1% of the normal value following 3-hr exposure to a 39.4 kOe field with 1.1/cm gradient. The anaphase analysis showed no chromosome aberrations, but the possibility of subtle changes escaping analysis cannot be ruled out.

5777 EFFECTS OF X-RAYS AND MICROWAVES ON THE ABSORPTION FUNCTION OF THE SEROUS MEMBRANES IN RABBITS. *(Rus.)* Faitel'berg-Blank, V. R. (Odessa Agricultural Inst., Odessa, USSR); Kotova-Khromenko, L. K. *Radiologiia* 18(3): 386-388; 1978. (3 refs)

The effects of whole body x-ray irradiation (500 r, dose rate 43.1 R/min) and microwave irradiation (2,307 MHz, 12, 20 or 30.5 mW/cm^2 for 10 min, or 20 mW/cm^2 for 20 min) on the resorption of ^{32}P from serous cavities were studied in 473 chinchilla rabbits. The radioactivity in the blood, lungs, liver, spleen, stomach, kidneys, muscles, and knee joint was determined 3-120 min after isotopic administration into the serous cavities. Increased release of ^{32}P into the blood was seen after 10- and 20-min exposure to microwaves with 20 mW/cm^2 intensity. Exposure to 12 and 30.5 mW/cm^2 caused only slight increase in the permeability of the serous membranes compared with the normal values. The x-ray irradiation alone caused highly significant increase in the permeability of the serous membranes, but permeability was reduced by subsequent exposure to microwaves. The permeability of the serous membranes of the pleura, epicardium,

peritoneum and knee joint were normalized by microwaves in some experiments.

5778 EFFECT OF HYPERTHERMIA ON THE IMMUNOCOMPETENCE OF VX2 TUMOR-BEARING RABBITS. *(Eng.)* Shah, S. A. (Cancer Res. Unit, Univ. Dept. Clinical Biochemistry, Royal Victoria Infirmary, Newcastle upon Tyne, England); Dickson, J. A. *Cancer Res* 38(10):3523-3531; 1978. (49 refs)

The effect of local radio frequency (RF) heating and total body hyperthermia on the immunocompetence of VX2 tumor-bearing rabbits was invesgigated. Rabbits bearing a 15-20-ml tumor in the hind limb were treated by local heating of tumor to 47-50 C for 30 min using an RF generator operating at 13.56 MHz. Nine of 13 rabbits treated were cured, with the tumor regressing completely within 60-80 days after local heating. The nine cured rabbits are alive with no signs of tumor 2 yr after treatment and are immune to intramuscular challenge with up to 30 x 10^6 VX2 cells. In six of eight rabbits subjected to total body hyperthermia (42 C for 60 min on 3 successive days) 7 days after local RF heating, temporary restraint of tumor growth was followed by a return to an exponential increase in tumor volume and in the case of five animals, rapid death. The primary tumor in two rabbits regressed completely; however, one of these rabbits died with metastases in the iliac lymph node and lungs. At 4 wk after curative RF heating alone, only one of ten rabbits had a primary tumor with a volume greater than 40 ml; whereas, five of eight rabbits treated by local and total body hyperthermia had tumors with a volume of 40 ml or greater at 50 days. After curative RF heating, the change in skin reactivity to antigen and the increasing titer of antibodies was marked enough to be used as an index of successful treatment. Attempts to immunize normal rabbits with 7- and 17-day in situ RF-heated VX2 tumor resulted in tumor formation. Therefore, the only method found to produce immunity in the rabbit to the VX2 tumor was RF heating of the tumor in the host.

5779 ELECTROMAGNETIC THERAPY OF INFLAMMATORY DISEASES OF LARYNX AND TRACHEA. *(Rus.)* Tsyganov, A. I. (Dept. Oncology, Kiev Scientific Res. Inst. Otolaryngology, Kiev, USSR); Ozinkovskii, V. V. *Zh Ushn Nos Gorl Bolezn* (3): 38-41; 1978. (24 refs)

Treatment with pulsed electromagnetic field (50 Hz, intensity 500 Oe, 15 min/session, 3-15 sessions) was given to 34 patients (28-80 yr old) with inflammatory diseases of the larynx and trachea. Acute catarrhal laryngitis was diagnosed in 6 patients, chronic hyperplastic laryngitis in 10, reactive postoperative inflammation of the trachea and larynx in 4, and radiogenic chondroepichondritis of the larynx in 14. Marked improvement was seen in all 6/6 patients with acute laryngitis after 1-3 sessions, in 8/10 patients with chronic hyperplastic laryngitis, in 4/4 patients with reactive postoperative inflammations, and in 4/14 patients with radiogenic chondroepichondritis of the larynx. Two patients with chronic hyperplastic laryngitis and 8 with radiogenic chondroepichondritis showed no change, while two patients with radiogenic chondroepichondritis showed exacerbation. The findings indicate the effectiveness of electromagnetic treatment, however, it is contraindicated in patients with marked cardiovascular disorders.

5780 RADIOFREQUENCY RADIATION DOSIMETRY HANDBOOK (SECOND EDITION). *(Eng.)* Durney, C. H.; Johnson, C. C.; Barber, P. W.; Massoudi, H.; Iskander, M. F.; Lords, J. L. Ryser, D. K.; Allen, S. J.; Mitchell, J. C. (Dept. Electrical Engineering, Univ. Utah, Salt Lake City, UT 84112). 144 pp.; 1978. [available through USAF School of Aerospace Medicine, Aerospace Medical Division (AFSC) Brooks Air Force Base, TX 78235]. (115 refs)

A second edition of the radiation dosimetry handbook that extends dosimetric data presented in the first edition (limited mostly to the 10 kHz-1.5 GHz range) to frequencies in the range of 10 MHz-100 GHz is presented. Other improvements in the second edition include ground plane data, compilations of references to both theoretic and experimental work in the literature, empiric relations, heat response data, and results obtained from additional mathematic models of humans and animals (cylindrical model and block model). Some data are also given for inhomogeneous models of humans. The data are limited to the specific absorption rate for plane wave irradiation. Reference should be made to the first edition of the handbook (SAM-TR-76-35) for dosimetric data in the frequency range of 10 MHz to 10 kHz.

5781 TRANSIENT EFFECTS OF LOW LEVEL MICROWAVE IRRADIATION ON BIOELECTRIC MUSCLE CELLS PROPERTIES AND ON WATER PERMEABILITY AND ITS DISTRIBUTION: FINAL REPORT. *(Eng.)* Portela, A.; Llobera, O.; Michaelson, S. M.; Stewart, P. A.; Perez, J. C.; Guerrero, A. H.; Rodriguez, C. A.; Perez, R. J. [available through National Technical Information Services, Springfield, VA 22161, Document No. AD A050805]. (100 refs)

The effects of pulsed microwave radiation on electrical and osmotic properties of cells from sartorius muscles of the South American frog *(Leptodactilus Ocellatus)* were studied. Nerve muscle preparations were irradiated in a constant temperature perfusion chamber for 120 min at a power density of 10 mW/cm^2. The microwave generator had a frequency of 2.88 GHz, a pulse width of 0.67 μsec, and a pulse repetition rate of 900 pulses/sec. Transient changes were observed in specific membrane resistance, in membrane capacitance, and in the space constant of irradiated muscle cells. Microwave irradiation also evoked a transient increase in the maximum rate of rise and fall of the action potential, overshoot potential, sodium equilibration potential, and maximum amplitude of the ac-

tion potential. Peak inward sodium current and membrane negative conductance were also increased in irradiated cells. Microwave irradiation also transiently increased the rate constants for the foot of the action potential and for the terminal region of the action potential. Water membrane permeability and the fraction of the cell volume that is osmotically available were also transiently altered by microwave irradiation. The transient changes in the above parameters were greater in muscle cells from winter frogs than from summer frogs, recovering their initial control values within time constants of approximately 20 and 3 min, respectively. No such seasonal differences were observed in nonirradiated control frog muscle cells. Thermal effects on electrical parameters produced by non-electromagnetic heating at pre-set temperatures of 20-30 C were eliminated after setting the perfusion Ringer solution at 25 C, corresponding to time constants of between 1 and 2 min. These preliminary studies may indicate that the above observed transient effects may not be mainly due to thermal effects but rather to additional specific microwave actions on highly ordered macromolecular membrane functional activities.

5782 SLOW AND RAPID RESPONSES TO CW AND PULSED MICROWAVE RADIATION BY INDIVIDUAL *APLYSIA* PACEMAKERS. *(Eng.)* Seaman, R. L. (Dept. Physiology, Univ. Texas Health Science Center, 5323 Harry Hines Blvd., Dallas, TX 75235); Wachtel, H. *J Microwave Power* 13(1): 77-86; 1978. (30 refs)

Transmembrane potentials of individual pacemaker neurons in the abdominal ganglion of *Aplysia californica* were recorded during microwave irradiation to study the effects of microwaves on excitable cells. For every beating pacemaker studied, a slow change in firing rate, measured as interspike interval (ISI), was observed when the specific absorption rate (SAR) of the microwaves was sufficient. The firing rate reached a steady value with a time constant of about 1 min. For about half of the cells, radiation of sufficient intensity consistently reduced the firing rate; for the remainder of the population, effective intensities reduced the firing rate during most irradiations but increased the firing rate during others. For all beating pacemakers, post-irradiation firing rate returned to the pre-irradiation rate after 1-2 min. The smallest SAR that produced slow changes of firing rate was determined for 39 beating pacemakers from 29 ganglia and was found to be 7 mW/g. In addition to the slow, graded ISI changes, rapid changes in ISIs were also observed in eight beating pacemakers from eight different ganglia. A rapid change consisted of an increase in firing rate within one ISI of the onset of irradiation. Within 25 sec after the immediate decrease in ISI, the ISI gradually increased until it nearly reached the pre-irradiation value. The smallest SAR causing a rapid change in ISI was 1 mW/g. The microwave pulses in this case were of 0.5 μsec duration at a repetition rate of 5,000/sec, giving a peak SAR of 400 mW/g. Rapid changes in firing rate were seen for 2.45-GHz continuous wave (CW) and pulsed wave (PW) and for 1.5-GHz PW microwaves. The rapid changes appeared to be better defined for PW than for CW radiation, and the rapid changes also tended to occur at smaller averaged SARs for PW radiation. When 29 beating pacemakers were subjected to heating by microwaves versus warming by convection, some differences in slow responses were observed, and no rapid changes in firing rate were seen when cells were warmed or cooled by convection. The rapid changes seen in beating pacemakers as well as some phasic responses seen in experiments with bursting pacemakers could not readily be attributed to a thermal mechanism. One possible mechanism for the above changes is an effect on one or more of the membrane's components, perhaps by changing the ionic conductance or by altering a receptor's ability to combine with a chemical agent.

5783 ANALYSIS OF THE EFFECTS OF MICROWAVE ENERGY ON ENZYMATIC ACTIVITY OF LACTATE DEHYDROGENASE (LDH). *(Eng.)* Bini, M. (Istituto de Ricerca sulle Onde Elettromagnetische del C.N.R., Pisa, Italy); Checcucci, A.; Ignesti, A.; Millanta, L.; Rubino, N.; Camici, G.; Manao, G.; Ramponi, G. *J Microwave Power* 13(1): 95-99; 1978. (8 refs)

The effects of 3-GHz microwave energy on the enzymatic activity of lactate dehydrogenase (LDH) was studied under thermostatic and dynamic conditions at power levels of up to 6 W delivered into the sample. Under thermostatic conditions, no significant effects of microwave irradiation on LDH activity were seen. Similarly, no effect was observed when samples were irradiated with low intensities (100 mW) that caused no measurable significant temperature variations. Experiments under dynamic conditions for increasing microwave power levels showed two effects: a progressive acceleration of the enzymatic reaction, and starting from a power level of 4 W upward, a progressive increase in the enzyme denaturation process. The increase in enzymatic reaction velocity was due to the temperature rise consequent to microwave energy absorption. The thermal activation of the reaction velocity, caused by microwave irradiation, was in itself sufficient to give a good fit with the experimental time evolution of the enzymatic reaction.

5784 A REVIEW OF MICROWAVE OVEN SAFETY. *(Eng.)* Osepchuk, J. M. (Raytheon Res. Div., Waltham, MA 02154). *J Microwave Power* 13(1): 13-26; 1978. (32 refs)

Data on microwave leakage from noncertified and certified microwave ovens operating at a frequency of 2,450 MHz are reviewed. Typical leakage values imply exposure values well below the most conservative exposure standards in the world. The percentage of noncertified ovens leaking over 10 mW/cm^2 remains relatively constant at 10%, and the percentage of these noncertified ovens leaking less than 1.0 mW/cm^2 has remained between 45 and

60% over the years 1972-1977. The percentage of certified ovens leaking less than 0.1 mW/cm^2 according to the Bureau of Radiological Health's data has been increasing from about 30% in 1972 to about 60% in 1977. Continuing evidence that small numbers of ovens are leaking over the United States emission standard of 5 mW/cm^2 at 5 cm reflects the fact that some manufacturers still have not adopted the most advanced door-seal technique. However, adoption of the latter appears to be growing as field surveys disclose more and more ovens with leakage values below 0.1 mW/cm^2. Since 1973 emission standards on microwave ovens roughly equivalent to the United States' standard have been developed throughout the world. These include the emission standard in Canada, which specifies 1 mW/cm^2 at 5 cm with a minimum load, a standard of 5 mW/cm^2 at 5 cm developed by the International Electrotechnical Commission, and an emission standard of 0.01 mW/cm^2 at 50 cm in front of the door of an oven that is being developed in the USSR.

5785 MICROWAVES. *(Fre.)* Anonymous (No affiliation given). *Radioprotection* 13 (2):121-122; 1978. (0 refs)

Papers on the biologic effects of microwaves (300 MHz to 300 GHz) are reviewed. Distinction should be made between primary interactions and the biologic (specific) effects of microwaves. Continuous and pulsed microwaves have different biologic effects, and biologic effects are, in general, a function of frequency. The biologic effects of microwaves on cells, endocrine glands, and on the central nervous system cannot be explained simply by the thermal effects. Microwaves have been found to exert mutagenic effect on yeast cells and to kill such cells under certain circumstances during their action of DNA.

5786 ELECTROMAGNETIC RADIATION HAZARDS. *(Eng.)* Etheridge, J. D. (No affiliation given). *fathom* 10(1): 24-28; 1978. (0 refs)

Electromagnetic radiation hazards to shipboard Naval personnel are reviewed. Radio frequency (RF) burn hazards are caused by the existence of RF voltages on a ship at places where they are not intended and expected. Long lengths of metallic lines, particularly vertical lines, are efficient interceptors of RF energy. Potentially hazardous voltages have been found on lifelines, vertical ladders, launchers, gun mounts, rigging for underway replenishment, boat davits, and on aircraft spotted on carrier and helicopter flight decks. The Naval Ship Engineering Center has established that an open-circuit RF voltage exceeding 140 V on an object in an RF radiation field is hazardous. The primary shipboard sources of direct illumination of personnel by high-power microwave electromagnetic radiation, which may cause biologic, thermal, and neurologic effects are radars. Missile control radars are the most hazardous of all radars as they combine high-power transmitters with high-gain, narrow-beam antennas. Power densities as high as 300 mW/cm^2 may be achieved. The eyes and testes are the most vulnerable body organs to microwave radiation, and the overwhelming danger appears to be the hazard from thermal effects that are a function of radiation intensity and frequency, particularly in the 1-3 GHz range. The Bureau of Medicine and Surgery has established the following maximum personnel exposure levels in the frequency range between 10 MHz and 100 GHz: 10 mW/cm^2 average incident power density for exposures greater than 30 sec and 300 mJ/cm^2 for intermittent exposures between 3 and 30 sec.

5787 A REPORT ON ELECTROMAGNETIC RADIATION SURVEYS OF VIDEO DISPLAY TERMINALS. *(Eng.)* Moss, C. E.; Murray, W. E.; Parr, W. H.; Messite, J.; Karches, G. J. (Natl. Inst. Occupational Safety and Health, Div. Biomedical & Behavioral Science, Cincinnati, OH 45226). 25 pp.; 1977. [available through Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. DHEW (NIOSH) Publication No. 78-129]. (14 refs)

The results of a 1977 National Institute of Occupational Safety and Health's (NIOSH) survey of electromagnetic radiation hazards from visual display terminals (VDTs) at a newspaper facility are reported. Medical examinations had revealed the presence of bilateral cataracts in two newspaper employees (men: 29 and 35 yr old) at this facility who were operating the VDTs. Radiation measurements, with the detector probes in contact with the VDT screen face, were made of ultraviolet, visible, infrared, and radio frequency radiation from three VDTs located at the newspaper facility. The terminals surveyed were a Telco Model 40, a Harris Model 1500A, and an Incoterm SPD 10/20. The first two terminals had been used by the two employees who developed cataracts. Selected measurements were also made on numerous other terminals on various floors of the newspaper building. All of the radiation levels emitted from these VDTs were either non-detectable or well below the current safety standards. Data from previous radiation surveys of VDTs by NIOSH and others are also referenced.

5788 IMMUNE RESPONSE OF MICE TO 2450-MHZ MICROWAVE RADIATION: OVERVIEW OF IMMUNOLOGY AND EMPIRICAL STUDIES OF LYMPHOID SPLENIC CELLS. *(Eng.)* Wiktor-Jedrzejczak, W. (Cellular Immunology Div., Clinical and Experimental Immunology Dept., Naval Medical Res. Inst., Bethesda, MD 20014); Ahmed, A.; Czerski, P.; Leach, W. M.; Sell, K. W. *Radio Sci* 12(6s): 209-219; 1977. (34 refs)

Inbred male CBA/J mice received either single or triple exposures to 2,450-MHz microwave radiation over 30-min periods to investigate the effects of such exposures on their immune responses. The averaged microwave dose for single exposures was 13 ± 2.5 mW/g. The averaged dose rates for mice

that were exposed three times were 15.6 ± 1.2, 15.5 ± 0.9, and 13.3 ± 0.6 mW/g for the first, second, and third exposures, respectively. These studies demonstrated that the exposure of mice to 2,450-MHz microwaves in an environmentally controlled waveguide produced weak stimulatory effects on bone marrow derived (B) lymphoid cells of the spleen but not on thymus-derived (T) lymphoid cells of the spleen. A single exposure of mice neither increased the total number of splenic cells nor the frequency of either theta-bearing (T) cells or immunoglobulin $(Ig)^+$ (B) lymphoid cells. However, the single exposure caused a highly significant increase in the frequency of cells possessing complement receptors (CR) on their surface, which is a characteristic of mature B cells. In contrast, three 30-min exposures of mice to 2,450-MHz radiation induced an increase in the total number of splenic cells, in the total frequency of Ig^+ (B cells), and further increased the frequency of CR+ B cells but had no significant effect on the total number of T cells. The results indicate, at least at the dosages used, that microwaves act primarily on B-lymphoid cells and produce quantitative changes in the absolute frequency of B-cell subpopulations.

5789 NON-IONIZING RADIATION. *(Fre.)* Francois, H. (No affiliation given). *Radioprotection* 13(2): 120; 1978. (0 refs)

The problem of increased exposure of the public as well as industrial workers to nonionizing radiation was addressed at one of the sessions of the Fourth International Congress of the International Radiation Protection Association. It was proposed that an international organization be formed that would establish criteria, fundamental principals of protection, and standards.

5790 A NEW MICROWAVE DEVICE FOR RAPID THERMAL FIXATION OF THE MURINE BRAIN. *(Eng.)* Maruyama, Y. (Section Biochemical Pharmacology, Japan Upjohn Res. Lab., 168 Ohyagi, Takasaki, Gunma 370, Japan); Iida, N.; Horikawa, A.; Hosoya, E. *J Microwave Power* 13(1): 53-57; 1978. (23 refs)

The ability of a 2.45-GHz microwave applicator with an output power of 1.3 kW to rapidly fix enzymes in the mouse brain was compared with that of a 5-kW commercial microwave device and with that of other conventional fixation techniques. Whole-brain acetylcholine levels in ICR strain mice after microwave fixation for 1.5 sec with the 1.3-kW applicator (28.2 ± 0.76 nmols/g) were comparable to those observed after fixation for 0.3 sec with the 5.0-kW microwave device (26.4 ± 0.51) and were significantly higher than those observed after fixation by freezing with liquid nitrogen (16.6 ± 0.88) or by decapitation (10.6 ± 1.45). When decapitation was followed by microwave irradiation, acetylcholine levels of 24.0 ± 2.00 and 26.3 ± 2.06 nmols/g were observed for a 1.0-sec treatment with 5.0-kW microwave irradiation and for a 5.0-sec treatment with 1.3-kW microwave irradiation, respectively. Since enzymes that catalyze the synthesis and degradation of acetylcholine are destroyed when heated to 75-85 C, the temperature was measured in the midbrain of the mouse or rat as a function of the duration of microwave heating. With the 1.3-kW applicator, the temperature was elevated above 75 C within 2 sec in 25-35-g mice and to 85 C within 6 sec in 350-450-g rats. Microwave irradiation not only allows fast fixation of enzymes but also provides a clearer chromatogram when pyrolysis-gas chromotography is used for the analysis of acetylcholine.

5791 DIELECTRIC PROPERTIES OF HYDRATED PROTEINS AT 9.9 GHZ. *(Eng.)* Bone, S. (Workshop Natl. Foundation for Cancer Res., Sch. Electronic Engineering Science, Univ. Coll. N. Wales, Dean St., Bangor, Gwynedd LL57 1UT); Gascoyne, P. R.; Pethig, R. *J Chem Soc Faraday Trans I* 73(10): 1605-1611; 1977. (12 refs)

Dielectric measurements for bovine serum albumin, cytochrome-c, and lysozyme powders were made using a microwave resonant cavity technique at 9.95 GHz, and the hydration contents of the test powders were monitored using a sensitive quartz crystal technique. The hydration contents did not exceed 19% by weight, and the dielectric behavior at 9.95 GHz was considered to arise essentially from relaxations of sorbed hydration layers and was not influenced by effects associated with free bulk water. For hydration contents below 3% by weight, the permittivity components were relatively insensitive to changes in hydration but thereafter began to vary more rapidly. The permittivity values were found to be reversible and reproducible on changing the water vapor pressure. Multilayer hydration content analyses confirmed earlier conclusions that the dielectric loss at a frequency of about 10 GHz is principally associated with water in the secondary sorption sites. The results also indicate that the monolayer hydration layer is more strongly bound and rotationally hindered than previous measurements, using a standing wave method, indicated. Dielectric measurements such as these should aid in the development of electromagnetic cancer therapy techniques.

5792 SEAFARER: IMPACTS AND STUDIES OF THE EXTREMELY LOW FREQUENCY COMMUNICATION SYSTEM: A BIBLIOGRAPHY WITH ABSTRACTS. *(Eng.)* Lehmann, E. J., ed. (Dept. of Commerce, Natl. Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161). 174 pp; 1978. [available through National Technical Information Services, Springfield, VA 22161, Document No. NTIS/PS-78/0062]. (167 refs)

A bibliography containing 167 abstracts, 42 of which are new entries to a previous edition, of Government-funded research relating to the United States Navy's Seafarer global communication system, which employs extremely low frequency (ELF) radiowaves

is presented. The bibliography is divided into four parts and covers the following: the biological effects of ELF radiation on humans, animals, plants, and ecosystems; research on equipment, performance, feasibility, design, and transmission of ELF radiowaves; and environmental surveys for the Seafarer antenna in Texas and Michigan. The search period covered by this bibliography is from 1964 to January 1978.

5793 SUDDEN INFANT DEATH SYNDROME AND ELECTROMAGNETIC FIELDS: POINT OF VIEW. *(Eng.)* Schaefer, H. (Im Neuenheimer Feld 326, D-6900 Heidelberg, W. Germany); Silny, J. *Med Klin* 72(19): 871-872; 1977. (11 refs)

Criticism is presented of E. E. Ekert's work concerning the relationship between sudden infant death syndrome (SIDS) and electric and electromagnetic fields. The original work does not comply with the simplest rules of epidemiology: there were no controls used in the test made on children living near power lines. The original work misinterprets the significance of the epidemiologic findings: deaths/100 residents/hectare were made even when only one death was observed. The original work contains misinterpretations of physical parameters: no epidemiologic model was prepared, and no model exists showing a cause and effect relationship between power lines and crib death. Finally, there was not enough scientific information in the report on the relationship of low and high frequency fields on humans.

5794 CONCLUSION. *(Ger.)* Eckert, E. E. (14 Green Briar Lane, Newtown, CT 96470). *Med Klin* 72(19): 872-874. (11 refs)

Reply is presented to a criticism of a study by the author on possible relationships between electromagnetic fields and sudden infant death syndrome (SIDS). Many cases of SIDS occur in the vicinity of electric power lines, especially in basement and first-floor apartments. One-third of all cases are clustered in space, and many cases are clustered in time. The epidemiologic data suggest a relationship between man-made and abnormal natural electric and electromagnetic fields and SIDS. The study of the biologic potential of electromagnetic fields must take into account frequency, magnetic atmospheric components, abnormalities in terrestrial currents, modulations, interference, and ground interference of technical origin, and these parameters must be related to the habitats of SIDS victims over a period of two years.

5795 EFFECT OF SUPER-HIGH-FREQUENCY ELECTROMAGNETIC FIELDS ON THE CENTRAL STRUCTURES OF THE BRAIN. *(Rus.)* Faitel'berg-Blank, V. R. (Odessa Agricultural Inst., Odessa, USSR); Perevalov, G. M. *Dokl Akad Nauk SSSR* 239(1): 242-244; 1978. (8 refs)

The effect of an electromagnetic field (460 MHz, field intensity 2 and 5 mW/cm^2, length of exposure 10 min) on the overall and light-flash-stimulated impulse activity of the central structures of the brain was studied in 35 Chinchilla rabbits weighing 2-3 kg. The overall electrical activity was determined by means of nickel chromium electrodes; the impulse activity, by means of glass microelectrodes. The exposure caused desynchronization of the specific and nonspecific nuclei of the thalamus, hypothalamus, and reticular formation of the midbrain during the first minute after irradiation. The number of slow waves and spindles increased in the thalamic and hypothalamic nuclei 2-3 min after exposure to the 5 mW/cm^2-field. The electric activity of the brain returned to normal in 10-15 min. Light stimulation at 5-7 Hz frequency and exposure to 2 mW/cm^2 caused a considerable reduction of the potential synchronization coefficient and of the energy of the synchronized oscillations in the thalamus and hypothalamus, but an increase of these parameters was seen following stimulation at higher frequencies (13-25 Hz). Exposure to 5 mW/cm^2 improved the adoption of the light stimulation frequency in the sensorimotor cortex and hypothalamus at 5-11 Hz frequency, but it impaired the frequency adoption at higher frequencies. Following exposure to 2 mW/cm^2, the discharge frequency increased in 45.6% of the nerve cells and decreased in 39.7%, versus an increase in 2% and a decrease in 4% in the nonexposed controls. The number of neurons, which responded to the 2 mW/cm^2 field with increased impulse frequency, was highest in the hippocampus (64.3%) and hypothalamus (58.3%). The number of the nonresponding nerve cells was lowest in the medial preoptic region of the hypothalamus. Following exposure to 5 mW/cm^2 the number of brain cells, which responded by increased discharge frequency, was considerably lower than it was following exposure to 2 mW/cm^2. The findings indicate that the 2 mW/cm^2-field intensifies the electric activity of the brain and increases the discharge frequency of the nerve cells, while the 5 mW/cm^2-field intensifies the synchronization of the electrical activity, inhibits the adoption of the light flash rhythm during high-frequency stimulation, and reduces, in most cases, the discharge frequency of the nerve cells of the brain.

5796 CHEMILUMINESCENCE OF THE BLOOD SERUM DURING EXPERIMENTAL EXPOSURE TO PHYSICAL FACTORS. *(Rus.)* Baraboi, V. A. (Kiev Scientific Res. Inst. Roentgenology and Radiology, Kiev, USSR); Motuzkov, I. N.; Orel, V. E.; Sbirnaia, A. F.; Tatsii, Iu. A.; Shutenko, O. I. *Gig Sanit* (1): 49-51; 1978. (5 refs)

The effects of x-ray, ultraviolet (UV), and high-frequency electromagnetic radiation on the chemiluminescence of the blood serum and on other physiologic parameters were studied in rats. The effect of UV radiation was studied in 30 rats in a 2-mo experiment: one group was kept under UV deficiency conditions (exposed to 1/30-1/40 of the optimal UV dose); the second was exposed to the physiologically optimal dose, and the third group,

to 3 times the optimal dose. The chemiluminescence of the blood serum was highest in the second group (544 impulses/10 sec versus 294/10 sec in the first group and 301/10 sec in the third). The oxygen consumption (in ml O_2/100 g·hr) was 135 in the first group, 158 in the second, and 122 in the third. The serum alkaline phosphatase activity (in conventional units) was 18.4 in the first group, 15.4 in the second, and 21.7 in the third. The duration of hexenal-induced sleep was 37 min in the first group, 27 min in the second, and 38.5 min in the third. Forty other rats were exposed to high-frequency electromagentic field (2,840 MHz, 100 $\mu W/cm^2$, 3 hr/day), low-frequency noise (8 Hz, 110 dB, 2 hr/day) or their combinations (2 hr/day exposure to noise, followed by 3-hr exposure to the electromagnetic field) in a 3-mo experiment. The electromagnetic field alone increased the luminescence of the blood serum (365 impulses/10 sec versus 309/10 sec in the controls) and reduced the oxygen consumption (15-.8 ml/100 g·hr versus 201 ml/100 g·hr in the controls). Noise alone had a similar effect. Combined exposure diminished the differences from the control parameters, indicating the differences in the biologic action of noise and electromagnetic field. The chemiluminescence of the blood serum was 262 impulses/10 sec, and the oxygen consumption, 182.7 ml/100 g·hr.

5797 METHOD FOR RECORDING ELECTROCARDIOGRAMS OF THE INTACT FROG DURING SUPER-HIGH-FREQUENCY IRRADIATION. *(Rus.)* Parsadanian, A. Sh. (Inst. Biological Physics, USSR Acad. Sciences, USSR); Khafizov, R. Z.; Tigranian, R. E. *Biol Zh Arm* 30(7): 50-53; 1977. (13 refs)

A new method for recording the electrocardiogram (ECG) of intact frogs without opening the thoracic cavity during irradiation with super-high-frequency (SHF) field is described. The skin is removed in a small area (1 cm^2) in the cardiac region, and two artefact-free liquid electrodes are applied on the denuded area. The other end of the electrodes is connected with silicon rubber tubes, which are placed into a metallic screen at the boundary of the irradiated zone. The liquid-metal (silver electrode) contact is outside of the irradiated zone. Preliminary tests revealed that the artefact-free liquid electrodes permit the stable recording of the ECG of intact frogs and eliminate the interference of SHF signals in the ECG.

5798 CHANGE OF SOME PARAMETERS OF THE CLOTTING SYSTEM OF THE BLOOD IN SUPER-HIGH-FREQUENCY FIELD. *(Rus.)* Moskvitina, L. T. (Irkutsk Inst. Organic Chemistry, Siberian Branch of the USSR Acad. Sciences, Irkutsk, USSR); Platonova, A. T. *Gig Sanit* (1): 113; 1978. (1 ref)

The effect of single-time exposure to high-frequency electric field (wavelength 3 cm, intensity 10 mW/cm^2, length of exposure 6 hr) on the blood clotting system was studied in 10 rabbits weighing 2.5-3 kg. Ten other rabbits served as controls. The animals were followed up for 18 days. Compared with controls, the beginning of blood clotting was delayed immediately after exposure and remained so throughout the observation period. The thrombocyte count was increased immediately after exposure and remained so throughout the experiment; it was highest (157% of the control value) on day 8 after exposure. The stickiness of the thrombocytes increased highly significantly throughout the experiment, especially between days 4 and 6 after irradiation. The findings indicate that 6-hr exposure to a 10 mW/cm^2 electrical field causes substantial changes in blood clotting, and therefore the maximum permissible value, as adopted in the USA, must be revised.

5799 TOPICAL APPLICATION OF ULTRA-HIGH FREQUENCY IMPULSE THERAPY IN PROSTATITIS. *(Rus.)* Braitsev, A. V. (Central Scientific Res. Inst. Dermatology and Venereal Diseases, USSR Ministry of Public Health, Moscow, USSR); Grachev, Iu. I.; Ovchinnikov, V. I.; Voskresenskaia, G. A.; Kochetkov, V. D. *Vestn Dermatol Venerol* (5): 87-90; 1978. (10 refs)

Twenty-seven patients with subacute and 45 patients with chronic prostatitis received combined topical ultra-high-frequency impulse treatment with a 40-W generator (10 min/day, 6-10 sessions) and antibiotic therapy with penicillin, bicillin-3, monomycin, tetracycline or levomycetin. Three patients were under 20 yr of age; 32 were 21-30 yr of age; 20 were 31-40 yr of age; 10 were 41-50 yr of age; and 7 were aged over 60 yr. The prostatitis was of gonorrheal etiology in 23 patients. The length of the disease before combined treatment was less than 2 mo in 27 cases, 2-6 mo in 13, 6-12 mo in 11, and 1-3 yr in 6. The patients with chronic prostatitis had been treated unsuccessfully with antibiotics. The pulsed electric treatment caused complete disappearance or considerable alleviation of pains in all patients; it occurred after 2-3 sessions in 39 cases, after 4-5 sessions in 14, after 6-8 sessions in 19. Complete disappearance of the infiltration was observed after 5-7 sessions in 31 patients; considerable regression was seen in 29 patients; no regression, in 12. The electric therapy had no unfavorable effect on the spermatozoa. The investigation of spermatozoa from 18 patients for up to 60 days after the treatment and from 20 untreated healthy controls showed no differences in the morphology of the ejaculate, in the spermatozoa count per ml, nor in their motility. The findings indicate the therapeutic effectiveness of pulsed electric treatment in subacute and chronic prostatitis.

5800 ELECTRICAL ACTIVITY IN BONE. *(Eng.)* Simonis, R. (St. Thomas' Hosp., London, England). *Bull Hosp Joint Dis* 38(2): 87-89; 1978. (0 refs)

Literature dealing with the manifestation of physiologic electric currents in living bone and with the possibility of artificial stimulation of osteogenesis by the use of electricity is reviewed. Stud-

ies have shown that when a bone is fractured the whole limb becomes more electronegative with the highest negative point being over the fracture site itself. As the fracture unites, the electric potentials gradually revert to normal. Based on the assumption that where new bone is being laid down (at the metaphysis and fracture sites) there is a negative charge, attempts at stimulating osteogenesis and increasing the rate of fracture healing by the introduction of an artificial negative charge have been made. Three techniques appear to be successful at producing osteogenesis: invasive methods with the insertion of a battery, semi-invasive techniques with wires inserted through the skin from an external power source, and non-invasive techniques with the application of an electrostatic or magnetic field. Following animal experiments, these three methods have been used in humans in attempts to treat cases of non-union, and individually the results have been quite impressive. Following a double blind trial on dogs with non-union of the tibia, which showed that the application of a direct current significantly enhanced bony union, a multi-center trial on non-unions in humans has been initiated. Three case reports of the successful use of electrical stimulation to enhance bone healing in humans with non-unions of the tibia are briefly presented. Details concerning the electrical parameters employed are not specified.

5801 COHERENT EXCITATIONS IN BIOLOGICAL SYSTEMS. *(Eng.)* Froehlich, H. (Dept. Electrical Engineering, Univ. Salford, Liverpool, England). *Biophysics* 22(4): 777-778; 1977. (6 refs)

That coherent electric vibrations in the frequency of 10^{11} Hz excite biologic systems if an energy supply above a threshold is available is supported by a model calculation. Objections to the model are discussed. In the mathematic model used, a band of polarization waves with certain frequencies is considered to be in strong interaction with a heat bath and to have a supply of energy from metabolic energy sources at a certain rate of quanta. Coherent excitation is expressed in the form of a Bose condensation.

5802 THE APPLICATION OF PULSED MAGNETIC FIELDS TO THE STIMULATION OF BONE HEALING IN HUMANS. *(Eng.)* Watson, J. (Dept. Electrical and Electronic Engineering, Univ. Wales, Swansea, Wales); Downes, E. M. *Jpn J Appl Phys* 17(1): 215-217; 1978. (11 refs)

An orthopedic stimulator that produces a pulsed magnetic field for inducing small currents in human limbs is described along with its use in the non-invasive treatment of three cases of non-union of bones. The stimulator consists of a 30-V square wave generator, which is connected to an electromagnet. In use, the electromagnet pole ends slide into Textolite guides built into each side of the plaster cast. Hence, it can be withdrawn and replaced by the patient. A prototype of the stimulator was first used successfully to treat a 53-yr-old woman who had suffered a segmental open fracture of the tibial shaft, followed by complications and non-union over some 5 yr. In another case, the stimulator was used on a 28-yr-old man who had received conventional treatment for a severe open fracture of the distal shaft of the left tibia and fibula. X-ray evidence had shown that the fracture line was still visible 18 mo after the fracture had occurred and after initial treatment had been started. The stimulator was applied for 4 wk; after this, a below-knee weight-bearing cast was applied. After 3 wk, the fracture was no longer mobile, and X-ray examination showed evidence of new bone formation, which continued to full consolidation of the fracture after a further 8 mo. In the third case, the stimulator was applied on a 71-yr-old woman who had undergone an arthrodesis of the left knee for osteoarthritis. Sound bony union did not occur, and 14 mo later there was severe pain with obvious mobility of the arthrodesis. She underwent treatment with the stimulator for 4 wk, and 2 mo after the completion of this treatment, the arthrodesis united clinically, and X-rays showed progress towards sound consolidation.

5803 MICROWAVE-INDUCED HAZARDOUS THERMAL STRESSES IN THE OCULAR LENS OF THE HUMAN EYE. *(Eng.)* Neelakantaswamy, P. S. (Dept. Electrical Engineering, Indian Inst. Technology, Madras-600036, India); Ramakrishnan, K. P. *Biomed Tech (Berlin)* 23(5): 109-113; 1978. (11 refs)

A theoretic evaluation of microwave-induced thermal stresses in the human eye are presented, and the potential pathogenic conditions are discussed. A dielectric spherical shell model depicting the human eye was used to evaluate the temperature distribution within the eye exposed to a plane microwave irradiation at a frequency of 2,450 MHz. The rise in the temperature on the surface of the ocular lens was then used to calculate the thermal stresses developed in the lens medium. A thermoelastic equation of motion was formulated to examine the vibrating motions of the lens, which was assumed to be an isotropic circular plate clamped along its periphery. Although the maximum stress developed and the resulting bending moments were small in magnitude, it is concluded that the constancy of the strains developed as a result of prolonged microwave exposure, leading to micromassaging. Thus, mechanical strains and deformations, however small, can cause physico-chemical processes in the delicate tissue medium of the eye that result in pathogenic conditions which permanently impair the adaptive and accomodative actions of the eye.

5804 MAGNETIC FIELD DETECTION IS DISTINCT FROM LIGHT DETECTION IN THE INVERTEBRATES *TENEBRIO* AND *TALITRUS*. *(Eng.)* Arendse, M. C. (Lab. Comparative Physiology, State Univ., Utrecht, The Netherlands). *Nature* 274(5669): 358-362; 1978. (20 refs)

Orientation experiments with *Tenebrio molitor* L. (flour beetle) and *Talitrus saltator* Mont. (sandhopper) were performed to determine if light is a prerequisite for magnetic field detection. In a first experiment, *Tenebrio* cultured in an anisotropic light field were placed in darkness 2 days before directional preference was examined. From previous experiments, orientation was expected in a direction 26 degrees east of magnetic north, the dark direction in the culture container. The distribution of trail directions (on a starch covered platform) was not uniform, and their mean direction compared with the predicted direction. In a second experiment with *Tenebrio*, two tests were performed in total darkness at two different relative humidities, and a frequency distribution in 12 direction classes was obtained. From the tests it was concluded that *Tenebrio* displays a nonvisual orientation in total darkness that has all of the characteristics of the magnetomenotaxis observed previously in an isotropic light field. In a third experiment, *Talitrus* was placed in total darkness, and two frequency distributions were obtained—one for a local geomagnetic field (0.47 Oe) and one for a rotating magnetic field of the same strength. It was concluded that *Talitrus* is able to orientate in an ecologically important direction using magnetic field information. In a fourth experiment, *Tenebrio* was tested in an artificial magnetic field (0.44 Oe) with zero vertical component, which was supplied in an isotropic light field. As before, the beetles had been cultured in an anisotropic light field. Three tests were performed with beetles from containers differing in relative humidity and dark direction. In each of the experiments, the mean direction compared with the predicted direction. Overall, it is concluded that light is not a prerequisite for magnetic field detection in *Tenebrio* and *Talitrus* and that in *Tenebrio* the reaction is polar rather than axial.

5805 ELECTROMAGNETIC HYPOTHESIS OF THE TRANSMISSION OF MENTAL SUGGESTION. *(Eng.)* Arkad'yev, V. (No affiliation given). 20 pp; 1977. [available through National Technical Information Services, Springfield, VA 22161, Document No. AD A048995]. (2 refs)

An electromagnetic hypothesis for the transmission of mental suggestion is tested by mathematically examining the magnitude of excitation of the electromagnetic field by a given organism and the perception of this field by another organism. The radiating center of the physical stimulator is considered to be an electrical dipole with two opposing electric charges at a given distance from one another. These charges perform sinusoidal oscillations twice within a time period, which is called the period of electrical vibrations of the dipole (also can be called the oscillator). Under such oscillations electromagnetic waves of a length equal to the speed of light multiplied by the time period are formed. At a certain distance from the dipole, in the plane perpendicular to its length, an expression for the force of the magnetic field is derived from the theory of Hertzian waves. Two different cases are distinguished: at a short distance from the dipole, which is much less than the wavelength and at a greater distance from the oscillator, which is much greater than the wavelength. Magnetic field and electric field amplitudes are solved for both of these cases, and it is concluded that the force of these fields is too small to account for the transmission of mental suggestion.

5806 SCIENTIFIC EXPERIMENTS IN THE FLIGHT OF THE 1977 BIOLOGICAL SATELLITE (DRAFT PLAN). *(Eng.)* USSR Academy of Sciences, Interkosmos Council (Moscow, USSR). [available through National Technical Information Services, Springfield, VA 22161, Document No. N78-11171 (NASA-TM-75032)]. (0 refs)

Soviet biosatellite experiments planned for 1977 are outlined. The purpose of the experiments is to study the principles governing the adaptation of physiologic systems to the complex of factors involved in prolonged space flight as well as to study numerous fundamental questions of general biology, particularly those dealing with the role of gravity in the growth, development, and reproduction of organisms. Experiments will be performed with higher and lower plants, insects, and rats. The presence of a centrifuge on the biosatellite will make it possible to conduct artificial gravity experiments with mammals. The biologic investigations will include a study of the growth dynamics of higher and lower plants under weightless conditions as well as the physiology, anatomy, and genetics of insects. Previous studies of the modifying effect of weightlessness on the radiosensitivity of organisms have shown that the development and course of radiation sickness in space were practically identical to its development and course under terrestrial conditions. Centrifuge experiments done aboard the Kosmos-782 biosatellite showed that the biological effects of artificial gravity under space-flight conditions were essentially the same as those of normal terrestrial gravity. Experiments on three biosatellites showed for the first time that high-intensity electric fields, which are of interest as cosmic-radiation shields, can be generated and maintained under conditions of prolonged space flight.

5807 COMBINATION HYPERTHERMIA AND RADIATION THERAPY FOR CUTANEOUS MALIGNANT MELANOMA. *(Eng.)* Kim, J. H. (Dept. Radiation Therapy, Memorial Sloan-Kettering Cancer Center, New York, NY 10021); Hahn, E. W.; Tokita, N. *Cancer* 41(6): 2143-2148; 1978. (15 refs)

Patients with recurrent cutaneous malignant melanomas that were refractory to conventional therapy were treated with radiotherapy (RT) alone, inductive radio frequency (RF) heating (27.12 MHz) alone, or with a combination of the two modalities to investigate if RF heating would enhance the effect of RT in such tumors. When RF hyperthermia was applied, the aim was to achieve a minimal tumor temperature of 42.5 C for at least 30 min. When employed with hyperthermia, RT was given within 3-6

min after RF hyperthermia was terminated. Initially three lesions in two patients were treated with hyperthermia alone. One lesion responded with complete regression, but as with the other two lesions which partially responded, the lesions rapidly recurred within 3 wk. Thus, hyperthermia alone was discontinued. Treatment with RT alone was effective in producing a complete response in one lesion and produced partial responses in four other patients with seven lesions treated. Complete and permanent regression was observed in seven patients with 16 lesions that were treated with the combination of RT and RF hyperthermia. No unusual skin reactions developed after combined treatment except in two patients. The radiation dose necessary to achieve satisfactory local tumor control in combination with RF hyperthermia ranged from 3,000 rad (300 rad in 10 fractions over 4 wk) to 3,200 rad (400 rad in 8 fractions over 4 wk). The above results strongly suggest that a high local tumor control rate can be achieved by the combination of hyperthermia and RT with no disproportionate attendance of normal tissue complications.

5808 LAMINAR FLOW OF BLOOD IN AN ELASTIC TUBE IN THE PRESENCE OF MAGNETIC FIELD. *(Eng.)* Sud, V. K. (Biodynamics and Bioengineering, Aerospace Medical Res. Lab., Wright-Patterson AFB, OH 45433); Suri, P. K.; Mishra, R. K. *Stud Biophys (Berlin)* 69(3): 175-186; 1978. (10 refs)

The effect of a radial magnetic field on blood flow in an infinite flexible tube of uniform cross-section is theoretically examined to determine the reduction in the movement of blood flow caused by electromagnetic fields. Basic equations and boundary conditions are given, and the mathematic solutions for the velocity distribution equations contain Bessel functions with imaginary arguments. Hence, it is not possible to obtain the exact solutions for arbitrary values of the magnetic frequency (MF) parameter. However, the velocity profile solutions can be computed in two extreme cases, either for small values of MF or for large MF values. Computed results for the case of a femoral artery of a dog indicate that the effect of the magnetic field is to decrease the movement of blood and thereby stabilize the flow.

5809 THE INFLUENCE OF MICROWAVE EXPOSURE ON FUNCTIONAL MATURATION OF THE RAT. *(Eng.)* Michaelson, S. M.; Guillet, R.; Heggeness, F. W. (Dept. Radiation Biology, Univ. Rochester Sch. Medicine and Dentistry, Rochester, NY 14642). 38 pp; 1977. [available through National Technical Information Services, Springfield, VA 22161, Document No. AD A048880]. (35 refs)

In utero and neonatal exposures of Long-Evans rats to continuous wave 2,450-MHz microwaves were performed to investigate the influence of such exposures on functional maturation. In one experiment, gravid Long-Evans hooded females were exposed for 1 hr to 2,450 MHz microwaves at a power density of 10 mW/cm^2 on days 9 and 16 of gestation or at 40 mW/cm^2 on days 9, 13, 16, or 20 of gestation. There were no apparent developmental or growth rate differences in pups from irradiated or non-irradiated dams from birth to weaning on day 21. However, at ages 0-2 days, metabolic response to cold exposure was greater among offspring of exposed rats than among offspring of sham exposed (control) animals. Plasma corticosterone levels were significantly increased in neonates of rats exposed on day 16 of gestation to 40 mW/cm^2. Thyroxine levels tended to be decreased among 1-wk-old rats from dams exposed to 10 mW/cm^2 but increased during wk 2 of life. Among pups from 40 mW/cm^2-exposed dams, there was a statistically significant increase in thyroxine levels at 14-16 days of age. In a second experiment, pups were individually exposed to 2,450-MHz radiation at 40 mW/cm^2 for 5 min/day beginning on day 1 until day 6 of life. On day 7, adrenal responsiveness was tested by administering adrenocorticotropic hormone (ACTH: 10 munits/100 g, intraperitoneally) to one-third of the pups and comparing the response with pups exposed to a seventh microwave irradiation and with pups sacrificed immediately after removal from the nest. There was no significant difference in growth rate between exposed and control pups, but the exposed rats demonstrated a slightly greater growth rate during the first 6 days of life. In 7-day-old rats the basal corticosterone level was not altered by previous microwave exposure. Pups exposed to 40 mW/cm^2 of radiation showed an adrenal responsiveness not quantitatively different from that produced by ACTH administration. Adrenal wet weight and adrenal-to-body weight ratios in 7-day-old rats were significantly higher in microwave-exposed rats in comparison with controls.

5810 RADIOLOGIC EVALUATION OF THE TREATMENT OF NONUNION OF FRACTURES BY ELECTRICAL STIMULATION. *(Eng.)* Forsted, D. L. (Dept. Radiology, Mercy Catholic Medical Center, Fitzgerald Mercy Div., Lansdowne Ave. and Baily Road, Darby, PA 19023); Dalinka, M. K.; Mitchell, E.; Brighton, C. T.; Alavi, A. *Radiology* 128(3): 629-634; 1978. (7 refs)

The use of direct current electrical stimulation for the treatment of 107 patients with nonunion of fractures is reported. Four or more cathodes were implanted in most cases, being uniformly distributed within the fracture site. A 6-cm steel mesh rectangular plate was used as the anode and was taped to the skin. A 7.5-V battery power source in circuit with a field-effect transistor and resistors that allowed a constant continuous current was used to deliver 10-20 μA by each electrode over a 12-wk course. Of the 107 patients treated, 71 (66%) went on to osseous union. If 9 cases of congenital pseudoarthrosis and 11 patients treated with only 10 μA of current are eliminated, then 70 of 87 patients (80.5%) healed. The presence or absence of infection had no effect on the results of therapy. It is concluded that low-dose electricity induces callous formation and speeds fracture healing.

5811 THE INFLUENCE OF ELECTROMAGNETIC WAVES OF SUPER-HIGH FREQUENCY AND LOW INTENSITY ON HEMODYNAMIC CHANGES IN ANIMALS WITH ACUTE INFLAMMATION IN THE ABDOMINAL CAVITY. *(Rus.)* Bachurin, V. I. (Dept. Surgery, Zaporozh'e Medical Inst., Zaporozh'e, USSR). *Patol Fiziol Eksper Ter* (3): 28-31; 1978. (8 refs)

The effect of exposure to an electromagnetic field (300 MHz, 10 mW/cm^2, length of exposure 1 hr/day for 30 days) on the hemodynamic changes in the hind limbs and brain induced by ligation of the appendicular artery and subsequent appendectomy was studied in 26 rabbits. Fifteen other rabbits, serving as controls, were not irradiated. The hemodynamic disturbances, such as vascular spasm, blood stasis, especially of the limbs, as well as tachycardia persisted as long as 7 days after appendectomy in the irradiated rabbits. The hemodynamic changes caused by experimental appendectomy disappeared practically completely in 7 days in the non-exposed rabbits.

5812 EFFECT OF CONSTANT MAGNETIC FIELD ON REST POTENTIAL, IONIC CONDUCTIVITY AND NEUROMUSCULAR TRANSMISSION IN THE SMOOTH MUSCLES. *(Ukr.)* (Inst. Physiology, Kiev Univ., Kiev, USSR); Davidovs'ka, T. L. *Fiziol Zh* 23(5): 622-626; 1977. (16 refs)

The effect of constant magnetic field (300 and 600 Oe, impulse duration 0.2-0.3 msec) on the rest potential and inhibitory postsynaptic potentials of the isolated tenia coli was studied in guinea pigs. The constant magnetic field increased the amplitude of the inhibitory postsynaptic potentials and caused slight hyperpolarization and ionic permeability of smooth muscle cell membranes. The effects increased with the field intensity. The findings indicate that constant magnetic field increases the efficiency of synaptic transmission.

5813 EFFECT OF SUPER-HIGH-FREQUENCY ELECTROMAGNETIC WAVES ON THE COURSE OF EXPERIMENTAL APPENDICITIS. *(Rus.)* Bachurin, V. I. (Zaporozh'e Medical Inst., Zaporozh'e, USSR); Platash, V. I. *Klin Khir* (4): 71; 1978. (0 refs)

The effect of exposure to a super-high-frequency electromagnetic field (3,000 MHz, field intensity 10 mW/cm^2, exposure 1 hr/day for 3 mo) on the course of acute appendicitis induced by ligation of the appendicular arteries, veins and their small intestinal branches was studied in 41 rabbits. Of the 41 rabbits, 15 served as non-irradiated controls. Appendicitis was induced after exposure, and typical appendectomy was performed 12-14 hr later. Increase in the number of goblet cells with intensified synthesis and secretion of mucine, increased numbers of para-aminosalicylic acid (PAS)-positive and heparin-containing mast cells in the lamina propria, and increased phagocytic activity in the lymph follicles were found in the non-irradiated controls. The histologic investigations of the irradiated animals revealed a reduced number of goblet cells in the crypts, reduced mucin secretion in the glands, reduced production of neutral mucopolysaccharides, the appearance of degranulated heparin-containing mast cells in the connective tissue along with a sharp reduction in their number, and reduced phagocytic activity of the lymph follicles containing PAS-positive bacterial metabolites. The findings indicate that the exposure to the electromagnetic field caused more pronounced and earlier degenerative changes in the vermiform appendix during the development of the inflammatory process and impairment of the defense capacity of the body.

5814 ELECTROMAGNETIC FIELDS IN BIOLOGICAL MEDIA: PART I: DOSIMETRY—A PRIMER ON BIOELECTROMAGNETICS. *(Eng.)* Neuder, S. M. (Div. Electronic Products, Bureau Radiological Health, Food and Drug Admin., Rockville, MD 20857). 29 pp.; 1978. [available through Bureau of Radiological Health's Technical Information Staff (HFX-25), 5600 Fishers Lane, Rockville, MD 20857. HEW Publication (FDA) 78-8068]. (19 refs)

Physical and basic mathematic considerations of radio frequency and microwave radiation (10^4 to 3×10^{11} Hz) in lossy dielectric media are reviewed, and expressions for, and relationships between, the physical parameters pertinent to dosimetry are developed. The behavior of these parameters in various biologic tissues is also discussed. Specific topics covered include the dielectric constant and relative magnetic permeability, the loss tangent, the complex permittivity, the relationship between the free space wavelength and the propagation constant, perfect and lossy dielectrics, the internal wavelength, not-so-lossy dielectrics, the frequency and temperature dependence of electrical parameters, power absorption, dosimetric quantities, plane waves, normalization with respect to the incident field, and dosimetric determinations. Two appendices are also provided: one covering equivalent expressions for the Poynting vector and the other covering the conversion of normalization of incident power density.

5815 RAPID MICROWAVE FIXATION OF RAT BRAIN. *(Eng.)* Moroji, T. (Div. Psychopharmacology, Psychiatric Res. Inst. Tokyo, 2-1-8, Kamikitazawa, Setagaya-ku, Tokyo, Japan); Takahashi, K.; Ogura, K.; Toishi, T.; Arai, S. *J Microwave Power* 12(4): 273-286; 1977. (41 refs)

The use of a 2,450-MHz microwave device for rapidly inactivating rat brain enzymes is reported. In one set of experiments, two groups of rats with different body weights were exposed to two different power levels (0.8 and 4.5 kW). Temperature and weight of the brain as well as monoamine oxidase and acetylcholinesterase activities were determined at each power level. Heating at the higher power level versus the lower power level shortened the heating time and minimized the effects of animal

weight on duration of microwave irradiation, loss of brain water content, and heat-induced changes in enzyme activity during irradiation. In a second set of experiments, monoamines, their metabolites acetylcholine and choline, and cyclic adenosine monophosphate (AMP) and cyclic guanosine monophosphate (GMP) levels in the brain were measured after inactivation of relevant enzymes by microwave irradiation at a power level of 5 kW for 1.6 sec. There were no statistical differences in the levels of norepinephrine, dopamine (DA), and serotonin between microwave-irradiated rats and decapitated rats. Only the level of 3,4-dihydroxyphenylactic acid in the brain of rats killed by microwave heating was increased significantly. A tendency towards an increase in the level of DA was also observed in irradiated brains. A significant increase in the level of acetylcholine and a marked decrease in the level of choline was observed in irradiated brains compared with levels in brains from decapitated rats. There were no statistical differences in the cyclic GMP levels between irradiated and decapitated rats, but cyclic AMP levels were markedly reduced in irradiated brains compared with brains of decapitated rats. It is concluded that rapid and uniform inactivation of brain enzymes by microwave fixation is a suitable method for the measurement of compounds with a rapid turnover rate in the brain.

5816 ALL-UNION CONFERENCE ON "METHODOLOGICAL QUESTIONS OF THE HYGIENIC STANDARDIZATION OF NON-IONIZING RADIATION" (MOSCOW, JUNE 1977). *(Rus.)* Lobanova, E. A. (Moscow, USSR). *Gig Tr Prof Zabol* (3): 60; 1978. (0 refs)

The highlights of an all-union conference on the hygienic standardization of non-ionizing radiation, sponsored by the Institute of Industrial Hygiene and Occupational Diseases of the USSR Academy of Medical Sciences, are presented. The importance of in vivo experiments as well as of clinical observations on exposed groups was emphasized in several papers, which also dealt with the problems of extrapolating experimental data obtained from laboratory animals to humans. A uniform approach was recommended for the establishment of maximum allowable levels of non-ionizing radiation for different groups of persons including the general public.

5817 COMPILATION AND ASSESSMENT OF MICROWAVE BIOEFFECTS: A SELECTIVE REVIEW OF THE LITERATURE ON BIOLOGICAL EFFECTS OF MICROWAVES IN RELATION TO THE SATELLITE POWER SYSTEM. *(Eng.)* Justesen, D. R.; Ragan, H. A.; Rogers, L. E.; Guy, A. W.; Hjeresen, D. L.; Hinds, W. T.; Phillips, R. D. (Veteran's Admin. Hosp., Kansas City, MO). 92 pp; 1978. [available through Battelle Memorial Inst., Pacific Northwest Labs, Richland, WA 99352, Document No. PNL-2634]. (138 refs)

A literature review of the biological effects of microwaves in relation to the proposed microwave Satellite Power System (SPS) is presented. The SPS is designed to collect and to convert the sun's energy to 2,450-MHz continuous wave microwaves, which would be beamed to the earth's surface where a rectifying antenna would convert the microwaves to electrical current suitable for industrial and domestic use. An initial review of more than 1,000 English summaries and 200 original (or translated) papers on the biologic effects of microwave radiation with respect to the potential impact of the SPS on the biologic and ecologic systems indicates that verified experimental data are completely lacking with regard to the question of whether microwave radiation at a relatively high power density (about 23 mW/cm^2) near the center of each rectifying antenna will produce a disruption, debilitation, or death of airborne species that may attempt to fly through the beam. With regard to the effect on resident flora and fauna, including man, of relatively low power densities near the periphery of a rectifying antenna and beyond the area of exclusion, it is concluded that threshold of relatively short-term radiation for morbid biologic effects (e.g., cataracts, heart disease, hematological effects, immunologic disturbances, and genetic developmental defects) are well above the maximal power density (1 mw/cm^2) that is tentatively projected at and beyond the area of exclusion of the receiving antenna. However, no experimental study has been performed that even remotely approaches the 30 yr or more that the SPS would be operative.

5818 HEALTH ASPECTS OF RADIOFREQUENCY AND MICROWAVE RADIATION EXPOSURE: PART I. *(Eng.)* Stuchly, M. A. (Radiation Protection Bureau, Health and Welfare, Ottawa, Canada). 88 pp.; 1977. [available through Information Directorate, Dept. Natl. Health & Welfare, Brooke Claxton Building, Ottawa, K1A 0K9 Canada. Document No. 77-EHD-13]. (115 refs)

Biophysical and engineering considerations relevant to the health aspects of radio frequency and microwave radiation exposure over the frequency range of 10 MHz to 300 GHz are discussed, and the biological effects of microwave radiation are reviewed including satellite communication systems, radar systems, broadcast transmitters, and microwave power devices for heat production are covered. Microwave energy absorption and distribution are discussed in terms of biological medium characteristics, the impinging of plane waves on plane tissue layers, the exposure of spherical tissue to plane waves, prolate spheroidal and ellipsoidal models of man and animals, miscellaneous models and exposure conditions, and microwave dosimetry. Mechanisms of the interaction between induced electromagnetic fields and living matter are discussed both in terms of the macroscopic approach (Maxwell field theory and Debye theory of dielectrics) and in terms of quantum mechanics considerations.

5819 DOES A 50-CYCLE ALTERNATING FIELD CAUSE CENTRAL NERVOUS EFFECTS? *(Ger.)* Fischer, G. (Hygiene-Institut der Universitat, Universitatsplatz 4, A-8010 Graz, Austria); Udermann, H.; Knapp, E. *Zentralbl Bakteriol [Orig B]* 166(5): 381-385; 1978. (7 refs)

The effect of exposure to 50-Hz alternating current field (field intensity 5,300 V/m, up to 21 days)

on the norepinephrine level of the brain was studied in 24 female Wistar rats. Twenty-six intact animals were used as controls. Significant increase in the norepinephrine level was seen 15 min after the beginning of the exposure (0.415 µg/g of brain tissue versus 0.358 µg/g; $p<0.05$). Norepinephrine dropped to about the control level after 2 days of irradiation, and it became significantly lower than the control by day 10 of exposure (0.268 µg/g; $p<0.01$). The norepinephrine level showed a rise on day 21 of exposure (0.302 µg/g; $p<0.01$ relative to the control). The findings substantiate the hypothesis that the central nervous system is the site of attack of electrical fields.

5820 HIGH-FREQUENCY PULSED CURRENTS IN TREATMENT OF BEDSORES. *(Pol.)* Duma-Drzewinska, A. (Klinika i Katedra Rehabilitacji, Warsaw-Konstancin, Poland); Buczynski, A. Z. *Pol Tyg Lek* 33 (22): 893-894; 1978. (6 refs)

The therapeutic effect of high-frequency electromagnetic field on the healing of bedsores was studied in 27 paraplegics (21 men, 6 women, aged 20-63 yr) who suffered traumatic injury of the spinal cord. The duration of the therapy was 10 days to 6 mo. When the bedsore proper was irradiated, the modulating frequency was 600 Hz, and the duration of one session was 20 min. When the adrenal gland and hepatic regions were irradiated, the modulating frequency was 400 Hz, and the length of one session was 15 min. Fifteen patients had deep bedsores: four patients were healed by electromagnetic therapy; six showed considerable improvement; and five medium improvement. The other 12 patients had superficial bedsores: 11 patients were healed; another showed considerable improvement. Seven patients underwent electromagnetic treatment immediately after they developed bedsores; all seven were healed. Six patients were treated up to 3 mo after they developed bedsores; three were healed; one showed considerable improvement, two medium improvement. Nine patients were treated up to 1 yr after they developed bedsores: two were healed; five developed considerable improvement, and two showed medium improvement. Five patients were treated more than 1 yr after the development of bedsores: three were healed, and one each had considerable and medium improvement, respectively. The findings indicate the therapeutic effectiveness of pulsed electromagnetic treatment in patients with bedsores.

5821 TURNOVER OF COPPER, MOLYBDENUM, IRON AND MANGANESE IN RAT TISSUES AS AFFECTED BY 50 HZ ELECTRIC FIELD. *(Rus.)* Gabovich, R. D. (Dept. General Hygiene, A. A. Bogomolets Kiev Medical Inst., Kiev, USSR); Koziarin, I. P.; Mikhaliuk, I. A.; Fesenko, L. D. *Ukr Biokhim Zh* 50(2): 206-211; 1978. (14 refs)

The effect of long-term exposure to an electric field (50 Hz; field potential 7, 12, and 15 kV/m; exposure time 30 min/day for 4 mo) on the turnover rate and distribution of copper, molybdenum, iron and manganese was studied in 100 male albino rats. Of these 100 animals, 25 served as unexposed controls. The effect of the exposure increased with increasing field potential. Exposure to 7-15 kV/m caused significant ($p<0.05$ or $p<0.01$) reduction in the copper in the liver (586 µg% versus 721 µg% in the control) and significant increases in all other organs. The molybdenum level decreased significantly in the liver, spleen, brain, myocardium, skeletal muscles, skin, and blood and increased in the kidneys, bones, and teeth. The iron level decreased significantly in the liver, kidneys, brain, skin, bones, and blood (from 33 mg% in the controls to 24 mg% in the group exposed to 15 kV), increased in the kidneys (from 9.3 mg% in the controls to 12 mg% in the group exposed to 15 kV), and showed no change in the skeletal muscles, myocardium, and spleen. The manganese concentration increased significantly in the liver, spleen, brain, myocardium, skeletal muscles, and skin (from 5.5 µg% in the controls to 10 µg% in the group exposed to 15 kV), decreased in the bones (from 140 µg% in the controls to 82 µg% in the group exposed to 15 kV), and showed no change in the kidneys, teeth, and blood. The changes are interpreted as an adaptive response of the body to the exposure. The changes in the trace element distribution between the tissues of different organs proved to be a sensitive indicator of electric field effect.

5822 THE DEVELOPMENT OF MICROWAVE HYPERTHERMIA APPLICATORS. *(Eng.)* Sandhu, T. S. (Dept. Radiation Medicine, Roswell Park Memorial Inst., 666 Elm St., Buffalo, NY 14263); Kowal, H. S.; Johnson, R. J. *Int J Radiat Oncol Biol Phys* 4(5/6): 515-519; 1978. (17 refs)

The design of two types of direct-contact microwave applicators for localized hyperthermia treatment of solid tumors is discussed. A 2,450-MHz applicator was designed either to deliver microwaves alone or in conjunction with ionizing radiation. The applicator could be attached to an X-ray or electron machine head and used as a cone to deliver X-rays or electrons and microwaves simultaneously. A 915-MHz applicator was designed with provision for attaching a plastic bag at the application end through which a dielectric liquid could be circulated to cool the skin surface. Thermocouple measurements of the temperature distribution resulting from the applicators were made on the rear thigh region of pigs. For the 2,450-MHz applicator, the maximum temperature was found on the skin surface, and the temperature dropped by 3.5 C at a tissue depth of 2.83 cm. For the 915-MHz applicator, without dielectric circulating through the bag, the skin temperature was lower than that at a tissue depth of 1 cm. The temperature dropped by 1 C at a depth of 2.83 cm. With the dielectric liquid circulating through the bag, the skin temperature dropped considerably and was the same as that at a depth of 2.83 cm. The temperature peaked at about 1.5 cm where it was 1.0 C higher. By carefully manipulating the temperature of the dielectric liquid, the 915-MHz applicator could be used to heat the tissue to a depth of 3 cm with a maximum

deviation in temperature along the central axis of ± 0.5 C. The described direct-contact applicators allow the achievement of localized hyperthermia with no background radiation reflected from the skin.

5823 EFFECT OF ELECTRIC FIELD OF COMMERCIAL FREQUENCY OF DIFFERENT INTENSITY ON BALANCE AND METABOLISM OF COPPER, MOLYBDENUM AND IRON IN THE ORGANISM OF EXPERIMENTAL ANIMALS. *(Ukr.)* Koziarin, I. P. (Dept. General Hygiene, Kiev Medical Inst., Kiev, USSR). Mikhaliuk, I. A.; Fesenko, L. D. *Fiziol Zh* (3): 369-373, 1977. (6 refs)

The effects of exposure to an electrical field (50 Hz, intensity 1-15 kV/m, 4-mo exposure, 2 hr/day) on the copper, molybdenum and iron levels in the liver, kidneys, spleen, brain, myocardium, skeletal muscles, skin, bones, and teeth were studied in male albino rats. There were 25 rats in each group (5 groups in all), and unexposed rats served as controls. Exposure to 1 kV/m caused no significant changes in the trace metal levels in the organs, and regardless of the field intensity, there were no changes in the molybdenum level in the kidneys and myocardium nor in the iron levels in the myocardium and skeletal muscles. Exposure to higher doses caused a significant intensity-dependent decrease in the copper level in the liver (from 759.3 µg% in the controls to 288.7 µg% in the group exposed to 15 kV); a significant reduction of the copper level in the other organs, a significant reduction of the molybdenum levels in the liver (from 42.7 µg% in the controls to 23.5 µg% in the group exposed to 15 kV), spleen, brain, skeletal muscles, skin, bones, and teeth; a significant reduction of the iron levels in the liver, brain, skin, bones, and teeth; and a significant increase in the iron level of the kidneys (from 9.1 mg% in the controls to 10.9 mg% in the group exposed to 15 kV).

5824 A TECHNIQUE FOR THE MEASUREMENT OF TISSUE IMPEDANCE FROM 1 to 100 MHZ USING A VECTOR IMPEDANCE METER. *(Eng.)* Bottomley, P. A. (Dept. Physics, Univ. Nottingham, University Park, Nottingham NG7 2RD, England). *J Phys E* 11(5): 413-414; 1978. (8 refs)

The use of a commercially available variable-frequency vector impedance meter for measuring the impedance of biologic tissue is reported. Application of the device for this purpose relies on the fact that at radio frequencies the reactive component of the biologic impedance becomes comparable to the resistive component. This enables both the relative permittivity and the resistivity to be calculated from the amplitude and phase of the vector impedance. Complex impedance is measured directly over the frequency range of 0.5-108 MHz by comparing the ratio of voltage and current injected into the circuit under test. Curves for resistivity and relative permittivity as a function of frequency are shown for measurements taken from six freshly excised samples of rat liver tissue. Individual samples deviate from the curve by up to 5%. This variation can be attributed to a combination of experimental error and the natural heterogeneity of biologic specimens. The tissue results are in good agreement with results measured at 25, 50, and 100 MHz by other investigators. Results with a saline solution also agree with previously published results. Advantages of the above technique are that the specimen cell can be attached directly to the meter probe (minimizing the contribution of lead inductances to the net impedance) and that the measurements can be made easily and quickly.

5825 DENTAL IMPLANT FIXATION BY ELECTRICALLY MEDIATED PROCESS I. INTERFACIAL STRENGTH. *(Eng.)* Young, S. O. (Div. Interdisciplinary Studies, Coll. Engineering, Clemson Univ., Clemson, SC 29631); Park, J. B.; Kenner, G. H.; Moore, R. R.; Myers, B. R.; Sauer, B. W. *Biomater Med Devices Artif Organs* 6(2): 111-126; 1978. (48 refs)

Porous dental implants with solid polymethylmethacrylate cores around which platinum-13% rhodium wire electrodes were wound were implanted in the mesial socket of mandibular fourth premolars bilaterally to determine the effect of electrical stimution on alveolar bone tissue growth in the dog. The distal root socket was used to receive the positive electrode. The wires were buried subcutaneously on the buccal crest, and power packs (1.4-V mercury battery in series with a 180,000 ohm resistor) were placed over the masseteric fossa subcutaneously. Each animal had an experimental and a control implant. The in vivo current achieved with the power pack-electrode configuration was about 4-6 µA. Mechanical push-out tests for interfacial strength measurements, which were made over implant periods ranging from 13-39 days, revealed that the electrically stimulated side had a much higher interfacial strength than the non-stimulated control side for a given experimental animal. Preliminary results of X-ray and scanning electron microradiographs showed that there was definite bony growth into the pores of the implants. As the amount of bony tissue ingrowth increased, the interfacial shear strength increased accordingly. Thus, the study showed that alveolar bone can be stimulated by the constant current employed.

5826 GERMINATION RESPONSE OF SOME WOODY PLANT SEEDS TO ELECTRICAL TREATMENT. *(Eng.)* Nelson, S. O. (Richard B. Russell Agric. Res. Center, Dep. Agric., College Station, TX 77843); Bovey, R. W.; Stetson, L. E. *Weed Sci* 26(3): 286-291; 1978. (13 refs)

Seed lots of Macartney rose, yaupon, huisache, and honey mesquite were exposed to 10- and 39-MHz electromagnetic fields at various intensities and for various durations in an effort to increase their germination. The seeds were conditioned for at least 2 wk at 24 C and 40% relative humidity. In some experiments, seed samples were conditioned at temperatures ranging from -18 to -43 C for 48 hr prior to irradiation. In most experiments contin-

uous wave (CW) radiation was used, but in some experiments the 39-MHz signal was pulse modulated. Some treatment sequences also involved exposures to high intensity direct current and 60-Hz alternating current electric fields. The radio frequency radiation treatments did not increase the germination of Macartney rose, and no germination was observed in yaupon, regardless of the treatment employed. Some significant increase in germination was obtained by radio frequency irradiation of huisache seed, but the results were inconsistent between seed lots. Honey mesquite seed responded to radio frequency treatment with increased germination, but hard-seed percentages were low in the seed lots used, probably due to mechanical scarification during harvesting of the seed. Since inhibition of seed germination for these species, especially honey mesquite and huisache, is due partially to impermeable seed coats, further studies are needed to determine why different species respond differently to radio frequency treatments with respect to changes in seed coat permeability. Pulse modulation of the radio frequency fields, which permitted the use of higher field intensities, did not produce significant differences in germination compared with CW treatments producing similar final temperatures in the seed.

5827 RF APPLICATORS FIND JOBS ON FARMS, IN FACTORIES. *(Eng.)* Gupta, K. C. (Indian Inst. Technology, Dept. Electrical Engineering, IIT Post Office, Kanpur-208 016, India); Bahl, I. J. *Microwaves* 17(6): 52-53, 56, 58-60, 62-64; 1978. (22 refs)

Various designs of radio frequency (RF) applicators for industrial and agricultural RF heating and drying systems are described. Three basic types of applicators have been conceived to suit a broad variety of applications. Multimode cavity-type designs are widely used for microwave ovens and can be modified for continuous processing of materials in industry. Waveguide applicators, made of rectangular, circular, elliptical, or modified transmission lines, find many applications, including the heating of liquids. Planar applicators are suitable for sheet material and conveyor belt transport systems. The most significant considerations governing the design of an applicator for a particular system are efficient RF-to-thermal energy conversion, an even distribution of dissipated power in the material, and efficient moisture or vapor removal. When low-loss materials are heated in waveguide applicators, a substantial portion of the RF power does not couple to the material, even with longitudinal material flow. Although power absorption can be improved by making the applicator increasingly long, this is often impractical. An alternative is that uncoupled power can be recirculated by using a traveling-wave (or ring) resonator. A good example of a recirculating system has been developed to increase the tensile strength of polyester rope. In this system, a traveling-wave resonator is coupled to an input transmission line through a directional coupler. Incident power from a signal source is partially coupled into the ring resonator where it travels around the loop in a clockwise direction; energy accumulates due to recirculation.

5828 TRENDS IN NONIONIZING ELECTROMAGNETIC RADIATION BIOEFFECTS RESEARCH AND RELATED OCCUPATIONAL HEALTH ASPECTS. *(Eng.)* Dodge, C. H. (Science Policy Res. Div., Congressional Res. Service, The Library Congress, Washington, DC); Glaser, Z. R. *J Microwave Power* 12(4): 319-334; 1977. (25 refs)

A review of the international literature covering the period 1970-1977 on the biological effects of nonionizing electromagnetic radiation is presented. The international trend in setting exposure standards is becoming more complicated. In the USSR and East European countries, standards for exposure are becoming more frequency-dependent. There seems to be a trend toward more conservatism in the West in view of a recent proposal to change Canadian exposure standards. At the same time, the United States standard of 10 mW/cm^2 appears to have worked quite well in view of the lack of clinical data to the contrary. Western researchers are now more often reporting low-level microwave effects in animals similar to the effects reported by Russian and some East European researchers. American research has contributed such findings as changes in the blood-brain-barrier, changes in neuronal ion binding, and microwave hearing in response to microwave power densities well below 10 mW/cm^2. There continues to be no unanimous agreement as to the mechanisms of central nervous system responses to low-level microwave fields. Further complications are findings from studies of the effects of very low frequency electromagnetic fields or direct current electric and magnetic fields. It has been well established that certain birds, fish, and invertebrates can exhibit sensitivity to these weak fields as well as to the absence of such fields. There is some recent evidence to indicate that blood changes are to be expected in some animals in response to repeated exposure to relatively low-level microwaves. However, there seems to be no compelling evidence to indicate that shifts in blood chemistry are to be expected regularly in humans chronically exposed to very low-level (less than 1 mW/cm^2) microwaves. The literature on radio frequency/microwave bioeffects and potential health hazards has become voluminous; presently approximately 5,000 citations have been identified.

5829 POTENTIALLY HAZARDOUS MICROWAVE RADIATION SOURCES—A REVIEW. *(Eng.)* Stuchly, M. A. (Non-Ionizing Radiation Section, Radiation Protection Bureau, Health and Welfare Canada). *J Microwave Power* 12(4): 369-381; 1977. (38 refs)

Various microwave radiation sources are reviewed in terms of the basic characteristics so that a discussion of microwave radiation hazards can be presented. Sources covered include satellite communication systems, radar systems, communications systems on earth, and microwave power devices for heat