Newly developed and tested analog and digital control functions for eliminating electromagnetic interference (EMI) with demand cardiac pacemakers are described. A modified common configuration with analog control function is described in which a second EMI sensing channel is incorporated to minimize inhibition from pulsatile radio frequency (RF) artifacts that occur at normal cardiac rates. This second receiver channel is intentionally designed to be insensitive to QRS signatures by proper design of the EMI pass-QRS reject filter. Additionally, an input detector is employed in the EMI channel that is sensitive to and demodulates high level RF signals so that a mode control signal is developed to prevent inhibition of the resettable astable oscillator via the blocking function preceding the oscillator. A new demand pacemaker configuration employing digital control functions is also described. In this system, a basic clock is employed in conjunction with countdown and decoding circuitry to provide the basic fixed pacing rate, the development of a refractory interval, and the development of the rate and event counting discriminator required for the detection of continuous or burst interference with frequencies that fall within the QRS passband. These digital timing and control functions are under adaptive command of a dual channel receive system that is essentially identical to the dual input channels employed for protection against normal cardiac rate EMI in the analog functions described above. Both qualitative comparative tests and quantitative direct measures have provided evidence of the improved EMI performance of the new functions described. Both commercial devices and the new functions with the EMI channel omitted were subject to inhibition under a variety of direct input signal conditions and indirectly by the human sensor method. Prevention of inhibition was obtained with the new functions when the EMI detection channel was activated.

5730 EFFECTS OF WEAK ELECTROMAGNETIC FIELDS ON *PHYSARUM POLYCEPHALUM*: MITOTIC DELAY IN HETEROKARYONS AND DECREASED RESPIRATION *(Eng.)* Marron, M. T. (Univ. Wisconsin-Parkside, Kenosha, WI 53141); Goodman, E. M.; Greenebaum, B. *Experientia* 34(5): 589-591; 1978. (20 refs)

The effect of exposing *Physarum polycephalum* cultures to a 75-Hz electromagnetic field (2.0 G and 0.7 V/m) on respiration rate and mitotic cell cycle length was investigated. The rate of respiration in exposed cultures was depressed by about 15-20%, which was about the same depression rate as that observed for the mitotic cell cycle. The mean times to second post-fusion mitosis for exposed cultures ranged from 15.41-17.27 hr compared with 14.79-16.53 hr for control cultures. When microplasmodia from both control and exposed cultures were mixed in equal volumes, the onset of synchronous mitosis in the mixed culture was delayed such that the mean time to second post-fusion mitosis (14.99-16.78 hr) was between the values for control and exposed cultures. The length of the mitotic cycle in the mixture appeared to depend on the amount of each type of culture in the mixture; however, the data are too sparse to determine a precise relationship. It is suggested that weak low frequency electromagnetic fields may interfere with either energy generating processes or with the transport of essential metabolites in *Physarum*.

5731 DEVELOPMENT OF AN RF NEAR-FIELD EXPOSURE SYNTHESIZER (10 to 40 MHZ). *(Eng.)* Greene, F. M. (Electromagnetics Div., Natl. Bureau Standards, Boulder, CO 80302). 43 pp; 1977. [available through National Technical Information Services, Springfield, VA 22161, Document No. PB-266 442]. (14 refs)

The design, fabrication, and testing of a prototype radio frequency (RF) near-field synthesizer for use by NIOSH in evaluating RF biologic hazards to industrial personnel are outlined. The synthesizer is capable of simulating near-field exposure conditions commonly encountered in the work environment over a frequency range of 10-40 MHz. The synthesizer can be used to generate a fairly pure (high impedance) electric field and a fairly pure (low impedance) magnetic field over the above frequency range. These two fields can be adjusted essentially independently over wide ranges of magnitude, phase difference, and relative spatial orientation to simulate various near-field configurations. The maximum RF driving power required is 1 kW for each field system, depending on the frequency and field level used. Tuning data is available for nine calibration frequencies within the above frequency range.

5732 EFFECT OF STATIONARY MAGNETIC FIELD ON BIOLOGICAL SYSTEMS (COMMENT ON THE PAPER OF V. M. ABASHIN AND G. I. EVTUSHENKO). *(Rus.)* Bresler, S. E. (Leningrad Inst. Nuclear Physics, Leningrad, USSR). *Biofizika* 23(1): 180; 1978. (5 refs)

The statement, presented in another paper, that magnetic fields have no effect on biological objects is refuted. Liquid crystals and lipids, which are diamagnetic, occur generally in living organisms, are oriented by magnetic fields of medium intensity (scores of Oersteds), and form ideally oriented layers. Since biologic membranes contain enzymes, that are sterically oriented due to their hydrophobic properties, the change in the orientation of lipids in magnetic fields is bound to affect the orientation and activity of enzymes and transport systems. Therefore, the action of magnetic fields on biologic systems is fully possible and compatible with the laws of physics.

5733 AN ELECTROPHYSIOLOGICAL APPROACH TO NEURAL AUGMENTATION IMPLANTATION FOR THE CONTROL OF PAIN. *(Eng.)* Mullen, J. B. (Dept. Surgery, Div. Neurosurgery, Duke Univ. Medical Center, Durham, NC 27710); Walker, C. F.; Nashold, B. S. 2(1/2): 65-67; 1978. (3 refs)

An electrostimulation technique, which eliminates untoward side effects associated with the random

placement of stimulating electrodes on the nerve, for the management of chronic pain secondary to peripheral nerve injury is described. The anatomic organization of the injured nerve is first mapped in terms of sensory responses to 100-μsec square wave pulses that are applied to fasciculi at a 33-Hz repetition rate. After collating the sensory response data, the fasciculi that conduct sensory information from the painful area are dissected away from the remainder of the nerve, and permanently implantable biocompatible stimulating electrodes are then circumferentially placed on the isolated bundles. Using this implantable stimulation system, the isolated fasciculi are restimulated to ensure paresthesiae in the affected areas without creating a motor contraction. Upon achieving a satisfactory distribution of paresthesiae, the electrodes are secured around the isolated group of fascicles, and an inductively coupled radio frequency receiver is implanted subcutaneously in a location accessible to the patient for transmitter antenna placement. Several days postoperatively, the patient is given a low power radio frequency transmitter tuned to match his receiver. The transmitter and receiver together act as an alternating polarity pulse neural stimulator with no net direct current component. The most satisfactory results have been achieved with a stimulation frequency of 25-100 Hz. Amplitude and pulse width are adjusted to produce the greatest degree of pain relief. The results to date indicate that nerve mapping with interfascicular electrode placement has achieved a superior quality of pain relief with fewer side effects when compared with former random radial placement of electrodes.

5734 EFFECT OF SURFACE COOLING AND BLOOD FLOW ON THE MICROWAVE HEATING OF TISSUE. *(Eng.)* Foster, K. R. (Dept. Bioengineering, Univ. Pennsylvania, Philadelphia, PA 19174); Kritikos, H. N.; Schwan, H. P. *IEEE Trans Biomed Eng* 25(3): 313-316; 1978. (15 refs)

The effects of thermal convection due to blood flow and heat transfer from the tissue surface into space on the steady state temperature distribution in microwave-irradiated tissue were determined using a one-dimensional heat transport equation. The steady-state temperature increase in tissue following microwave irradiation with penetration depths equal to 0.1 and 1.0 cm (corresponding to 10 and 2 GHz, respectively) was calculated. In both cases the total absorbed power was 100 mW/cm^2, and the incident power was at least two-fold higher. Thermal convection (due to blood flow) and conduction were found to result in the heating of deeper tissue levels than expected from the microwave absorption profile. Assuming an incident microwave intensity of 10 mW/cm^2 that is totally absorbed by the tissue with a penetration depth of 1.0 cm, the steady state increase in surface temperature of the tissue was calculated when each of the three cooling mechanisms (thermal conduction, blood flow, and surface cooling) was sequentially turned off. In comparison with the situation of normal blood flow, surface cooling, and thermal conductivity where an increase of 0.8 C in surface temperature was calculated, increases in surface temperature of 1.0, 1.9, and 9.6 C were calculated for zero surface cooling, zero thermal conductivity, and zero blood flow, respectively. It is suggested that measurements of the temperature rise in microwave-irradiated models with the same shape and dielectric properties as tissue can be used to estimate the microwave power deposition pattern in tissue but not the resulting steady-state tissue temperature increase.

5735 MICROWAVE AND RADIOFREQUENCY RADIATION. *(Eng.)* Michaelson, S. M. (Dept. Radiation Biology and Biophysics, Sch. Medicine and Dentistry, Univ. Rochester, Rochester, NY). 101 pp; 1977. [available through Regional Office for Europe, World Health Organization, Copenhagen, Denmark, Document No. ICP/CEP 803]. (365 refs)

Literature on the biologic effects and health implications of exposure to microwave and radio frequency radiation is reviewed. General categories of information covered include biophysical properties of microwave and RF radiation, biomedical studies in experimental animals, and clinical and epidemiologic studies for the human population. The effects of microwave and RF radiation are reviewed in terms of the following specific subject areas: cellular effects, reproductive capacity, visceral pathophysiology, hematopoietic effects, endocrine and biochemical effects, cardiovascular effects, nervous system effects, cutaneous perception of microwaves, electromagnetic hearing, effects on the ocular lens, results obtained from epidemiologic and clinical studies, and protection guides and standards. Problems associated with studies in the above areas are discussed, and recommendations are made for future research in these areas.

5736 INCREASE IN BRAIN TISSUE OXYGEN AVAILABILITY INDUCED BY LOCALIZED MICROWAVE HYPERTHERMIA. *(Eng.)* Bicher, H. I. (Dept. Radiation Medicine, Roswell Park Memorial Inst., 666 Elm Street, Buffalo, NY 14263). *Adv Exp Med Biol* 94: 347-351; 1978. (8 refs)

The effect of localized hyperthermia on oxygen levels and on the delivery of oxygen to brain tissue upon breathing of gas was examined in 40 anesthetized cats. Oxygen electrodes were used to determine tissue pO_2 levels, and hyperthermia was produced by microwaves in the frequency of 2,450 MHz delivered through a specially designed 5-cm circularly polarized applicator. A rise in tissue pO_2 values paralleled the application of microwaves and closely followed changes in tissue temperature. TpO_2 increased shortly after the rise in temperature and then decreased as the brain cooled off. A small rise in blood pressure and cerebral blood flow was also seen. Breathing O_2 for 1 min caused a small rise in TpO_2. Local hyperthermia caused an increase in the response (threshold 37.5 C) that was proportional to local brain temperature. It is concluded that local hyperthermia is an effective

method for temporarily blocking oxygen autoregulation, thereby increasing brain tissue oxygen levels.

5737 EFFECTS OF A BRIEF MAGNETIC EXPOSURE ON CEREAL GERMINATION AND SEEDLING GROWTH. *(Eng.)* Gusta, L. V. (Crop Development Centre, Univ. Saskatchewan, Saskatoon, Sask. S7N 0W0); Kirkland, K. J.; Austenson, H. M. *Can J Plant Sci* 58(1): 79-86; 1978. (9 refs)

The effect of magnetic exposure (0-4,000 G) on seed germination, seedling growth, emergence rate, and membrane permeability was examined in Bonanza barley *(Hordeum vulgare L.)*, Neepawa wheat *(Triticum aestivum L.)*, and wild oats *(Avena fatua L.)* under controlled conditions. No significant effect on the germination rate of Bonanza barley or wild oat seeds was seen at 16 or 21 C; however, there was a significant increase in the rate of germination at 16 C of Neepawa wheat seed treated at higher strengths. The dry weights of Neepawa wheat, Bonanza barley, and wild oats were similarly unaffected by magnetic treatment. The emergence rates of control wheat seedlings were the same for seeds treated with 0, 375, or 4,000 G. However, barley seeds imbibed for 10 hr prior to exposure grew slower than seedlings from magnetically treated dry seeds. Neither the imbibition rate nor membrane permeability of barley and wheat seeds were affected by exposure to 0 and 375 G. It is concluded that under the controlled conditions, brief exposure of dry seeds of four species of cereals had little or no effect on germination, seedling growth, emergence rate, and membrane permeability.

5738 CORRELATION OF EEG WITH CLINICAL FINDINGS IN PERSONNEL OCCUPATIONALLY EXPOSED TO HIGH-FREQUENCY RADIATION. *(Cze.)* Klimkova-Deutschova, E. (Institut pro dalsi vzdelavani lekaru a farmaceutu, Belehradska 130, 120 00 Prague, Czechoslovakia); Salomanova, Z.; Schwartzova, K. *Cesk Neurol Neurochir* 40/74(3): 124-128; 1977. (10 refs)

Clinical and electroencephalographic (EEG) findings obtained for 103 persons occupationally exposed to high-frequency electromagnetic radiation (no data given) are presented. The personnel were aged 22-61 yr (av age 38.3 yr), and the length of exposure was 1-18 yr (av 4.6 yr). Clinical examinations revealed vegetative changes in 97 cases (Group 1), pseudoneurasthenia with minor organic symptoms in 32 (Group 2), and completely normal findings were obtained for 19 subjects (Group 3). In Group 1 the electrocardiographic (ECG) findings were normal in 24.5%, borderline in 45.6%; disturbed wakefulness was found in 19.3%. The EEG was abnormal in 29.8%; a midline lesion was found in 10.5%; focal changes were seen in 7%, and synchronization in 12.8%. In Group 2, the EEG was normal in 15.3%, borderline in 46.8%; disturbed wakefulness was seen in 18.7%. Abnormal EEG was seen in 21.8%, midline lesion in 18.7%, focal changes in 18.7%, and synchronization in 21.8%. In Group 3 (clinically normal subjects), midline lesion was not seen at all; the ECG was normal in 15.7%, borderline in 57.8%; disturbed wakefulness was seen in 32.5%. Abnormal EEG was seen in 31.5%, focal changes in 2.1%, and synchronization in 10.5%. The abnormal EEG showed high-amplitude sharp waves similar to spike potentials. The findings indicate that slight EEG changes were considerably more frequent than truely abnormal ones (synchronization and focal changes) and that EEG is valuable in the assessment of exposure to electromagnetic fields in clinically unremarkable cases.

5739 ARTIFICIAL OSSIFICATION OF A MUSCULAR FLAP USED FOR PLASTIC TRANSPLANTATION INTO A BONE CAVITY UNDER THE INFLUENCE OF ELECTRIC CURRENT. *(Rus.)* Tkachenko, S. S. (Dept. Military Traumatology and Orthopedics, S. M. Kirov Military Medical Acad., Leningrad, USSR); Mussa, M.; Rutskii, V. V. *Biull Eksp Biol Med* 85(3): 356-359; 1978. (10 refs)

The effect of direct current (19-20 μA) on the ossification of a gastrocnemius muscle flap implanted into an artificial tibial cavity was studied in adult rabbits. The size of the tibial defect was 7 x 10 mm. The flap was fixed in the cavity by a central feeding pedicle, and a silver wire electrode was implanted in the flap. Group 1 (18 animals) was treated with the direct current for 3-4 wk, using the electrode as an anode. Group 2 (16 animals) was treated in the same manner, after which the polarity of the electrode was changed for continued treatment for 4-8 wk. No ossification was seen in the untreated control after the surgery, but marked periosteal and endosteal osteogenic reaction without trabeculae was seen in Group 2 about 90 days after surgery. Compared with the control and Group 1, marked ossification, appearance of trabeculae, and restoration of the integrity of the tibia were seen in Group 2. The findings indicate the stimulating effect of electric current on ossification and on the restoration of the anatomic integrity of the bone.

5740 INFLUENCE OF ATMOSPHERIC ELECTRIC IMPULSE FIELDS ON DRIVING PERFORMANCE TEST. *(Ger.)* Kirmaier, N. (Inst. fur Biomedizinische Technik, Museuminsel, D-8000 Munich 22, W. Germany); Schauerte, W.; Beierlein, H. R.; Breidenbach, H. *Munch Med Wochenschr* 120(11): 367-370; 1978. (9 refs)

The effect of positive electrostatic constant field with imposed square-wave impulses (60 V, impulse voltage 4 V, 10 Hz) on the driving performance of 100 experienced drivers (18-55 yr old) was studied in a double-blind test. The electrical field, generated by a unit installed on the car's sun visor, improved the general driving performance by 8.5-11.5%, reduced the frequency of errors by 22.7%, slightly improved the recognition of traffic signs, caused a 3.9-4.5% increase in the average speed without any increase in the maximum speed, and reduced the reaction time by 2.7%. The flicker fusion frequency was increased by 0.7%. The incidence of subjective complaints after the driving

test (headache, fatigue, and nervousness) was significantly lower after driving test performed while exposed to the electric field than it was after tests without electric field.

5741 EXPERIMENTAL STUDY OF THE INFLUENCE OF ELECTROMAGNETIC FIELDS ON THE ELECTROCARDIOGRAPHIC INDICES. *(Rus.)* Tvildiani, D. D. (Tbilisi State Medical Inst., Tbilisi, USSR); Chlaidze, T. I. *Soobsch Akad Nauk Gruz SSR* 88(1): 221-224; 1977. (9 refs)

The effects of a constant magnetic field (55-125 Oe, length of exposure 5-60 min), a pulsed constant magnetic field (1.3-3.3 Hz, 38-48 Oe), a constant magnetic field with alternating polarity (125 Oe), and of a constant magnetic field of very low intensity (2-5 Oe, length of exposure 10-300 min) on the electrocardiogram (ECG) were studied in 40 rabbits. The high-intensity fields caused increased and deformed P and T waves, decrease and inversion of the P and T waves, and undulating changes in the R and S wave amplitudes. The changes produced by the magnetic field of very low intensity were similar and sometimes even more pronounced. The ECG changes were caused basically by the horizontal component of the magnetic field. The pulsed magnetic field and the field with alternating polarity caused more marked and persistent changes than the constant magnetic field.

5742 EFFECTS OF A HIGH-TENSION ELECTRIC FIELD ON THE SECRETION OF ANTIDIURETIC HORMONE IN RATS. *(Eng.)* Carmaciu, R. (Dept. Physiology, Inst. Medicine and Pharmacy, Bucharest, Romania); Groza, P.; Daneliuc, E. *Physiologie* 14(2):79-83; 1977. (16 refs)

White male Wistar rats were exposed to high-tension-type electric fields to examine the effects of such fields on the secretion of antidiuretic hormone (ADH). The mean plasma ADH concentration for 16 experimental rats exposed to an electric field of 100 kV/m at a frequency of 50 Hz over a single exposure period of 120 min was 7.33 ± 1.26 μunits/ml, which was significantly greater than the control value of 2.68 ± 0.54 μunits/ml. When rats were exposed to the same electric field over a period of 360 min, a 30% reduction in diuresis from 1.1 to 0.75 ml/hr/animal was observed in relation to controls. Exposure to the above electric field also resulted in behavioral changes, which included to and fro movements, piloerection, and after an interval of 5-10 min, a quiet and prostrate behavior.

5743 RADIATION SAFETY HANDBOOK FOR IONIZING AND NONIONIZING RADIATION. *(Eng.)* Kincaid, C. B. (Bureau Radiological Health, Food and Drug Admin., Public Health Service, 5600 Fishers Lane, Rockville, MD 20857). 71 pp; 1976. [available through National Technical Information Services, Springfield, VA 22161, Document No. PB-262 109]. (0 refs)

A radiation safety handbook for ionizing and nonionizing radiation has been developed primarily for users of radiation sources throughout the Food & Drug Administration. The safety procedures for nonionizing radiation apply to equipment that generates or utilizes radiation in the energy range below approximately 1,000 electron V. Included in the handbook are definitions of terms, the specification of units used throughout the handbook, procedures relating to warning signs and labels, and specific safety procedures for microwave and radio frequency sources, laser radiation, and ultraviolet radiation. The safety procedures include engineering controls and safety mechanisms on radiation sources, protective equipment for personnel, personal exposure limits, medical surveillance procedures, and responsibilities of employees working near radiation sources. Appropriate radiation protection standards are included in an appendix.

5744 RADIOLOGICAL QUALITY OF THE ENVIRONMENT IN THE UNITED STATES, 1977. *(Eng.)* Feldmann, K. L. (Office Radiation Programs, Environmental Protection Agency, Washington, DC 20460). 312 pp.; 1977. [available through National Technical Information Services, Springfield, VA 22161, Document No. PB-274 229]. (274 refs)

Individual and population dose data for ionizing and nonionizing radiation sources in the United States are reported as part of the EPA's dose assessment program for evaluating the radiologic quality of the environment. General environmental surveys of dose data relating to nonionizing radiation sources have been completed in seven cities in the Eastern United States, and the data and population exposure implications for the first four of these cities are presented in the present report. The results to date suggest that probably 99% of the urban population is exposed at levels which would be permitted even under the Soviet standard of 1 $\mu W/cm^2$. The general environmental data cannot be used to estimate the levels to which the remaining 1% of the population is exposed. Further information will require a detailed analysis of specific sources and a detailed knowledge of the locations of persons exposed to such sources.

5745 TEMPERATURE AND CORTICOSTERONE RELATIONSHIPS IN MICROWAVE-EXPOSED RATS. *(Eng.)* Lotz, W. G.; Michaelson, S. M. (Biomedical Div., Naval Aerospace Medical Res. Lab., Naval Air Station, Pensacola, FL 32508). *J Appl Physiol* 44(3): 438-445; 1978. (26 refs)

The influence of 2,450-MHz continuous wave whole-body exposure on the rat adrenal cortex was investigated by measuring plasma corticosterone and colonic temperature in unanesthetized male rats. The rats were exposed in the far field of a horn antenna for 30 or 60 min at power densities of 0, 13, 20, 30, 40, 50, or 60 mW/cm^2 or for 120 min at 0, 13, 20, 30, or 40 mW/cm^2. The average energy absorption rate of the rats was 0.16 W/kg absorbed per mW/cm^2 incident. Colonic temp-

erature was significantly elevated after exposures to power densities of 13 mW/cm^2 or greater; progressively larger increases occurred after higher intensity exposures. Plasma corticosterone was significantly elevated above control levels only after exposures at 50 or 60 mW/cm^2 for 30 or 60-min exposures and at 20, 30, and 40 mW/cm^2 for 120-min exposures. The relationship between the increased levels of circulating corticosterone and colonic temperature suggested that the increases in corticosterone levels may reflect a level of physiologic response to the body temperature elevations caused by microwave exposure.

5746 RF LESION GENERATION. *(Eng.)* Burton, C. V. (2545 Chicago Ave., Minneapolis, MN 55404). *Appl Neurophysiol* 39(2): 77-79; 1976/1977. (2 refs)

The medical technique of radio frequency (RF) lesion generation is discussed with particular emphasis on adverse effects, such as, skin burns resulting from improperly designed dispersive electrodes. In neurosurgical use, the usual current densities of RF lesion generation range from 100-500 mA at a frequency of approximately 100-500 kHz. Tissue coagulation is not due to the heating of the electrode itself but rather to the flow of current between the electrodes, with electron density being focused at the active electrode due to its relatively small surface area. Heat is generated by the resistance (impedance) of the surrounding tissue to this current flow. In such a system, no real difference exists between the active and indifferent (also termed dispersive) electrode, other than surface area. If the surface area of the dispersive electrode is not adequately large, heat lesions can also be produced in surrounding tissue. For this reason, particular attention must be directed at the dispersive electrode, which usually is not connected to a thermal monitoring system. Although the actual incidence of skin burns from improper dispersive electrodes has not been studied, informal industrial surveys indicate that the problem is quite significant. It has been recommended that the surface area of a dispersive electrode be a minimum of 100 times larger than the surface area of the active electrode.

5747 HIGH-ENERGY ELECTRICAL CURRENT AND MYOCARDIAL DAMAGE. *(Eng.)* Resnekov, L. (Hosp. Box 423, Univ. Chicago Medical Center, 950 East 59th St., Chicago, IL 60637). *Med Instrumen* 12(1): 14-26; 1978. (32 refs)

Clinical complications associated with the use of direct current shock for the management of cardiac dysrhythmias are reviewed. In one study, a complication incidence of 14.5% was recorded among 220 patients treated by synchronized electroversion using a standard damped sinusoidal waveform. The incidence of complications was 6% at an energy level of 150 J and increased to more than 30% at 400 J. Complications included elevation of serum enzyme levels, hypotension, electrocardiographic evidence of myocardial damage, pulmonary and systemic emboli, ventricular dysrhythmias, and evidence of cardiac failure. It is concluded that there is rarely an indication for exceeding an energy level of 300 J in patients presenting with long-standing atrial fibrillation. Animal studies using trapezoidal waveforms indicate that there may be a dose weight response; however, delivering more than 1 A/kg body weight is associated with morphologic changes in the myocardium and ultrastructural disruption of mitochondria. These effects become greater as the amperage is increased, and permanent myocardial fibrosis may result. Retrospective studies in man have not shown a good relationship between body weight, failure to defibrillate, and energy level settings with damped sinusoidal waveforms. It is recommended that the parameters for safe and efficient electrical defibrillation of the heart be studied and determined.

5748 RF CELL CULTURE IRRADIATION SYSTEM WITH CONTROLLED TEMPERATURE AND FIELD STRENGTH. *(Eng.)* Guy, A. W. (Bioelectromagnetics Res. Lab., Dept. Rehabilitation Medicine RJ-30, Univ. Washington Sch. Medicine, Seattle, WA 98195). 52 pp; 1977. [available through Dept. Health, Education, and Welfare, National Inst. Occupational Safety and Health, Div. Biomedical & Behavioral Sci., Cincinnati, OH 45226, Publication No. 77-182]. (11 refs)

A unique radio frequency (RF) cell culture irradiation system with controlled temperature and field strength is described. This method was used in determining human RF exposure thresholds in the frequency range from direct current to 1,000 MHz. With a power source capable of providing a net power of 600 W to the system, electric field strengths as high as 100 V/cm in a 5-ml sample can be achieved, producing a maximum specific absorption rate of approximately 2×10^5 W/kg. The culture medium temperature can be controlled and measured up to 100 MHz by monitoring the feedline impedance, which is dependent on culture medium temperature. Constant temperatures below 37 C can be maintained at field strengths in excess of 25 V/cm. The information that can be obtained with this system is needed to fill information gaps for standards criteria development.

5749 EFFECTS OF ELECTRIC FIELDS ON LARGE ANIMALS: SECOND INTERIM REPORT. *(Eng.)* Batelle Pacific Northwest Labs. (Batelle Blvd., Richland, WA 99352). 65 pp; 1977. [available through Electric Power Research Inst., 3412 Hillview Ave., Palo Alto, CA 94304, Document No. EPRI EA-458]. (4 refs)

The planning and construction of housing and experimental facilities for the chronic exposure of Hanford Miniature Swine to 30 kV/m electric fields at a frequency of 60 Hz are outlined. The swine will be kept in individual stalls fabricated from nonconducting grating placed on an embossed steel floor decking. There will be two rows of contiguous stalls separated by a central aisleway. Two separate enclosures will cover the experimental and

control groups of pigs, each a quonset-type modular structure of fiberglas-reinforced plastic with polyurethane foam thermal insulation. All hardware will be nonconducting. A steel ground grid will be in the concrete ground pad and will surround the enclosure to provide a fixed ground plane; all conducting materials in the facility will be bonded to this common ground. The electrode system with vibration damping is complete. Using a test transformer, the field over the area to be occupied by swine is vertical to within 2 degrees and constant in magnitude to within 6%. The system capacitance is 1,150 picofarads. Breeding of the F_0 generation of swine is nearing completion, and preliminary growth data and blood chemistry are being collected. The goal is to obtain 40 female piglets of similar size and shape so that dosimetry will be comparable. Using full-scale models of pigs, surface fields and dosimetry are being characterized. This data, plus data collected for a related study on small animals, will provide a basis for defining the internal dose received by the swine and for extrapolating results to man.

5750 MICROWAVE RADIATION-PATTERN MEASUREMENTS IN THE PRESENCE OF BIOLOGICAL SPECIMENS. *(Eng.)* Bigu Del Blanco, J. (Anatomy Dept. Queen's Univ., Kingston, Ontario, Canada); Romero-Sierra, C. *IEEE Trans Electromag Compat* 20(1):248-258; 1978. (27 refs)

Power density measurements at an X-band microwave frequency of 9.2 GHz were conducted in an anechoic chamber in the presence and absence of some biologic specimens to illustrate the limited validity of free-space power density as a bioiogic and behavioral exponent of microwave radiation effects. Thermographic analysis and microwave radiometry were used to complement the measurements. The biologic specimens used in the experiments included anaesthetized (to insure immobility) animals and plant vegetation. The physical dimensions of the specimens ranged from less than the free-space wavelength to approximately 10 times the free-space wavelength. Dramatic differences in the radiation patterns attributable to the large disturbance introduced by the biosystem on the imposed electromagnetic fields were observed. The disturbance of free-space power density measurements by the specimens depended on the specimen's physical size, shape, and orientation with respect to the microwave electric field.

5751 FIELD INTERACTION WITH BIOLOGICAL MATTER. *(Eng.)* Schwan, H. P. (Dept. Bioengineering, Univ. Pennsylvania, Philadelphia, PA 19174). *Ann NY Acad Sci* 303: 198-213; 1977. (43 refs)

Electric field interactions with biologic matter are reviewed. Field values of the order of kilovolts/centimeter are probably needed to orient polar macromolecules significantly. Various interactions at the cellular level depend strongly on cellular size and may occur at field levels as low as 1 V/cm or less for unusually large unicellular organisms. They appear to be largely caused by field-generated forces and the dipole moments induced by the electric field. These forces emerge above the thermal level at a threshold field-strength that is inversely related to cell size. For the usual cellular size, required field values produce significant heating, resulting from ionic movement. Strong membrane interactions leading to membrane breakdown correspond to the order of hundreds of millivolts across the membrane. Corresponding field-strength values in the medium are comparable to those that yield significant field-generated forces. Classical membrane excitation phenomena occur at field levels of the order of 1 V/cm and current densities of approximately 1 mA/cm^2. Corresponding membrane potentials are in the range of 1-10 mV. Weak membrane interactions corresponding to a fraction of a millivolt have been reported for central nervous system tissues. Some fish species display still higher sensitivities corresponding to values below 1 μV/cm, with the highest sensitivity near 0.01 μV/cm in sea water. These highest sensitivities are achieved by a sampling of the field over large distances with special organs and the use of narrow bandwidth characteristics. Corresponding membrane sensitivities are below 0.1 μV across the membrane and above noise level over a rather narrow frequency range of a few hertz. Extraordinary weak field effects have been reported corresponding to tissue field gradients of the order of 10^{-7} V/cm. These effects, if shown to be related to more complex interactions at the membrane level, would require the development of new concepts.

5752 BIBLIOGRAPHY OF REPORTED BIOLOGICAL PHENOMENA ('EFFECTS') AND CLINICAL MANIFESTATIONS ATTRIBUTED TO MICROWAVE AND RADIO FREQUENCY RADIATION. NINTH SUPPLEMENT TO BIBLIOGRAPHY OF MICROWAVE AND RF BIOLOGIC EFFECTS. *(Eng.)* Glaser, Z. R.; Brown, P. F.; Allamong, J. M.; Newton, R. C. (Nat'l. Inst. for Occupational Safety and Health, Div. Criteria Documentation and Standards Development Priorities and Res. Analysis Brank, Rockville, MD 20857). 66 pp.; 1977. [available through Nat'l. Inst. Occupational Safety & Health, 5600 Fishers Lane, Rockville, MD, DHEW (NIOSH) Publication No. 78-126]. (575 refs)

Approximately 575 additional references on the biologic responses to radio frequency and microwave radiation are included in a ninth supplement to the bibliography of world literature. This supplement brings to more than 4,600 the number of listed references. Although particular attention has been paid to the effects on humans of nonionizing radiation at the radio frequency and microwave frequencies, this supplement includes a few references to recently issued reports on biologic studies involving pure electric or magnetic fields (alternating or static), extremely low frequency fields, and ultrasound. Other citations include such topics as biomedical studies using electromagnetic pulse radiation, high voltage (Kirilian) photography, biologic dosimetry, the effects of electromagnetic radiation (EMR) on implanted electronic cardiac pacemakers, some therapeutic applications of EMR (including wound healing and bone regeneration),

microwave exposure limits, regulations and standards, and such diverse applications as tissue fixation, insect control, and electroanesthesia. The citations are arranged alphabetically by author (where possible) and contain as much information as possible so as to assure effective retrieval of the original documents. Soviet and East European literature is included in detail. Relevant presentations (unpublished as yet) made at technical meetings are included in a separate section of the supplement. Another section contains unsigned reports and articles, arranged in chronologic order. A chronology of the previous supplements (and the addenda and revisions) is listed in an appendix to the supplement.

5753 HIGH GRADIENT MAGNETIC SEPARATION OF ERYTHROCYTES. *(Eng.)* Owen, C. S. (Dept. Pathology, Dept. Biochemistry and Biophysics, Univ. Pennsylvania Medical Sch., Philadelphia, PA 19104). *Biophys J* 22(2): 171-178; 1978. (7 refs)

A high gradient magnetic separation (HGMS) technique was used to retain red blood cells (RBC) containing paramagnetic methhemoglobin (induced by oxidizing the iron atoms in cell hemoglobin to the ferric state) from cell suspensions that also contained diamagnetic cells. The physical retention of paramagnetic cells was effected by flowing a cell suspension through a high magnetic field (33,000 G) in a column packed with fine steel wire. In one experiment washed packed cells from freshly drawn human whole blood were used in the separation of RBS containing methhemoglobin from diamagnetic RBC containing oxyhemoglobin. More than 90% of the cells in the diamagnetic cell sample were passed by the column, and more than 90% of the paramagnetic cells were retained by the column in this experiment. The degree of retention decreased with increased fluid flow velocity or with decreased magnetic field. At flow rates ranging from 1.4-3.3 cm/min, the percentage of cells retained varied from 86-96% in a 30,000-G field. When the field was lowered to 15,000 G, the same flow rates yielded smaller retention values ranging from 76-92%. In a second experiment, paramagnetic RBC were separated from white blood cells using a fresh suspension of spleen cells from a mouse. At a flow rate of 1 cm/min, the passed fraction typically contained 6-20% of the amount of hemoglobin in the original cell suspension and 60-90% of the original number of small nucleated cells that resisted lysis in Tris-ammonium chloride. The recovered RBC amounted to 60-80% of the original amount.

5754 CHROMOSOME BAND INDUCING EFFECT OF HIGH FREQUENCY ELECTROMAGNETIC FIELD. *(Eng.)* George, K. (Dept. Botany, Univ. Jos, Nigeria); George, M. *Indian J Exp Biol* 16(3): 390-393; 1978. (21 refs)

Germinated broad bean seedlings *(Vicia faba)* were grown in paper pots kept at a distance of 10 cm from a tesla coil transmitting high frequency (1.6 MHz) electromagnetic radiation (peak-to-peak voltage, 45 V) to study the effects of such a field on chromosomal aberration. The plants were subjected to this treatment for periods ranging from 6-24 hr before the root tips were fixed for microscopic examination. An examination of chromosomes of treated cells undergoing mitosis revealed that most of the aberrations produced were of one type--bandedness due to apparent fragmentation of chromosomes. This type of aberration was noticed during all stages of mitosis and for all exposure periods studied. The bandedness and fragmented appearance of the chromosomes seemed to be due to the dispersal of chromatin material from specific regions giving rise to gaps of achromatic lesions. A possible mechanism of the gap formation in chromatids and consequent band production on chromosomes is that these phenomena are the result of localized unfolding and despiralization of chromatin fibers at the interband regions. This could be effected by solubilization and dispersal of deoxyribonucleic acid (DNA) binding heterochromatin specific nucleosteric proteins from the microenvironment around the interband regions by the high frequency radiation directly or indirectly by the concentrated stimulation of DNA-dependent histone inactivating enzymes. It is concluded that high frequency is characteristically a chromosome band inducing agent.

5755 ELECTROMAGNETIC POLLUTION - HOW SAFE IS SAFE? *(Eng.)* Peat, D. (No affiliation given). *Sci Dimension* 10(1): 20, 22; 1978. (0 refs)

Hazards of electromagnetic pollution are discussed in light of the increasing number of electromagnetic-generating devices in the United States. To assist in the establishment of realistic safety standards for electromagnetic radiation exposures, the National Research Council and the Department of Defense are collaborating in a program of research aimed at a better understanding of the biologic effects of electromagnetic radiation. The research falls into two broad areas: the use of phantom models to accurately measure the amount of radiation absorbed by the body at different frequencies and the use of laboratory animals to examine the harmful effects of radiation both with high dose rates for short times and low dose rates over long periods. Heating effects, changes in the blood-brain barrier, damage to the testes, and possible changes in the central nervous system will be investigated.

5756 PUBLIC AWARENESS OF RADIATION HAZARDS. *(Eng.)* Anonymous (No affiliation given). *Med Res Eng* 12(5): 2, 4-5, 15; 1977. (0 refs)

The rapidly increasing public awareness of the proven and potential risks of man-made radiation in the environment is discussed. One example involves a proposed 765-kV electric line for which a construction permit was issued in 1976 by the New York State Public Service Commission (NYSPSC). As a result of a continuing series of actions and

objections by a local organization, Upstate People for Safe Energy Technology, the staff of the NYSPSC has now reported that chronic exposures to the 765-kV transmission lines probably would cause biologic effects in humans. Moreover, the originally proposed 250-ft wide right-of-way has now been changed to a protective zone of about 550 ft wide under the lines. As another example of public and scientific awareness of potential radiation hazards, scientists from the Woods Hole Oceanographic Institute have joined with the local population in Massachusetts to question the safety of radar bases on Cape Cod. The United States General Accounting Office has stated in a report that the "EPA admits that it does not know the scope of the radiation danger, that it does not have the resources to find out, and that its limited staff is unable to develop needed standards and guidance based on what it does know." A relatively comprehensive list of radiation hazards to which American people are exposed has recently become available in a report from the National Council on Radiation Protection and Measurements. However, the report deals with radiation exposure from consumer products and does not include such potential sources as television and radio transmitters and high-voltage power lines.

5757 DIFFERENTIAL BLOOD CELL SEPARATION USING A HIGH GRADIENT MAGNETIC FIELD. *(Eng.)* Paul, F. (Dept. Haematology, Faculty Medicine, Southampton General Hosp., South Lab. and Pathology Block, Tremona Road, Southampton SO9 4XY, England); Roath, S.; Melville, D. *Br J Haematol* 38(2): 273-280; 1978. (9 refs)

A technique for separating erythrocytes from whole blood using a high gradient magnetic field is described. The technique makes use of the magnetic property of iron in reduced hemoglobin and employs a cylindrical filter containing stainless steel wire mesh, which is placed between the poles of an electromagnet. A sodium dithionite solution is used as both the reducing agent and the carrier. In one experiment, using applied magnetic fields of 0-1.4 tesla and flow rates ranging from 1.9-12.9 x 10^{-4} m/sec, it was shown that above 0.5 tesla the capture of erythrocytes was directly proportional to the applied magnetic field at all flow rates. In another experiment with the flow rate set at 3.0 x 10^{-4} m/sec and the applied magnetic field set at 1.2 tesla, it was shown that only erythrocytes were retained by the filter. To ensure that a large number of leucocytes and platelets were injected into the column during this experiment, the column was deliberately overloaded with blood. This resulted in only 41.4% of the erythrocytes being captured compared with over 90% under ideal conditions. Scanning electron microscope photographs of erythrocytes before and after separation did not indicate any sign of surface damage to the red blood cells. The present study demonstrates that the intrinsic magnetic property of hemoglobin may be used to separate erythrocytes from other blood cells. It is also demonstrated that the level of separation depends on the ratio of the applied magnetic field to the flow velocity. Therefore, for a given separator, if the magnetic field strength is doubled, the same level of separation can be obtained at twice the flow rate.

5758 MICROWAVE RADIATION LEAKAGE FROM MICROWAVE-EXCITED LIGHT SOURCES (LETTER TO EDITOR. *(Eng.)* Outred, M. (Dept. Physics, The Polytechnic North London, Holloway Road, London N7 8DB, England); Howard, C. *J Phys E Sci Instrum* 11(3): 276-277; 1978. (2 refs)

Microwave radiation leakage measurements were recorded at 10 cm from an inert gas-filled electrodeless discharge tube (EDT) using a probe calibrated at 2.45 GHz. Sealed fused silica tubes filled with various low pressure inert gases were used together with two 3/4-wave Broida cavities—one having a small aperture capable of accepting a 7-mm outer diameter tube and the other having a larger aperture for accepting 10-mm outer diameter tubes. There was no measurable microwave power leakage from the cavity provided that the discharge was contained within the cavity. However, microwave leakage appeared as soon as the discharge emerged above the top of the cavity and reached a maximum when the discharge completely filled the EDT. At incident powers of 150 W, the maximum leakage for the small aperture ranged from less than 1.0 mW/cm^2 for helium gas to 12.7 mW/cm^2 for argon gas; for the large aperture, the leakages were greater ranging from 3.2 mW/cm^2 for helium to 18.0 mW/cm^2 for argon. In another experiment, the cavities were placed onto an EDT blank, which was connected to a vacuum system. This was done since a microwave discharge, using the appropriate inert gas, is normally run as part of the degassing procedure in the preparation of EDTs. The EDT blank was placed just within the 3/4-wave cavity, and 200 W were fed into the cavity. The discharge extended for several centimeters beyond the top of the cavity, and for both 3/4-wave cavities the microwave power leakage radiation was considerably higher than for the sealed EDT. A 1/4-wave cavity was also used and was placed on the EDT blank in such a way that the discharge extended symmetrically about the cavity position. The highest microwave power leakage occurred for the 1/4-wave cavity, and values greater than 10 mW/cm^2 were recorded, even at distances of 50 cm from the discharge tube for all inert gases. The small aperture cavity gave the lowest microwave power leakage values, and for all cavities, the leakage radiation was highest for argon and lowest for helium.

5759 PROTON RELAXATION OF MALIGNANT AND EMBRYONIC MOUSE CELLS. *(Eng.)* Vucelic, D. (Inst. Physical Chemistry, Faculty Sciences, Studentski trg 16, P.B. 550, 11000 Beograd, Yugoslavia); Macura, S.; Neskovic, B.; Djuric, L. J.; Ajdaric, Z. *Stud Biophys* 68(3): 179-185; 1978. (20 refs)

Proton relaxation times at 90 MHz for malignant L-929 cells and normal embryonic cells from C_3H mice were measured in 0.8% sodium chloride solution using nuclear magnetic resonance spectrometry. The

relaxation time of the pure cells was about twice to three times shorter than that for the corresponding tissue. In the temperature range of 4-37 C, the relaxation time was not temperature dependent. Using a pulse gradient method, a coefficient of self diffusion was obtained that was about one order of magnitude lower than that for pure water. In the temperature range of 4-37 C, malignant cells had a relaxation time that was about 30-40% higher than that for normal cells. This difference is considerably less than that for the corresponding tissues where differences ranging from 30-300% have been reported.

5760 A DANGEROUS INTIMACY: THE ZAPPING OF AMERICA (BOOK REVIEW). *(Eng.)* McGinty, L. (No affiliation given). *New Scientist* 78(1099): 163; 1978. (1 ref)

A book about the way in which research into the hazards of microwave radiation has been blocked by the military and business establishments in the United States is discussed in relation to the differences in opinion which exist between American and Soviet scientists concerning such hazards. The book is a meticulous and careful documentation of the influence that the Pentagon and the giant corporations exerted to reinforce the prejudices of American scientists against Russian microwave research. Opposition to the American view that electromagnetic radiation causes no ill effects, other than those from heating, surfaced when physicians began to notice that many of their patients were radar technicians or worked in the electronics industry. The most prominent example was from an opthlamologist who noticed an extraordinarily high number of eye cataracts among patients in these industries. The discovery in 1962 that Russians were beaming low level microwave power at the United States embassy in Moscow has led to serious work on low level electromagnetic radiation, and such research is slowly eroding the American consensus position on microwaves.

5761 POTENTIAL HAZARDS: THE ZAPPING OF AMERICA. (BOOK REVIEW). *(Eng.)* Anonymous (No affiliation given). *Science* 200(4342): 643-644; 1978. (1 ref)

The Zapping of America is critically reviewed. The central theses of the book are that exposure to low-level radio frequency and microwave radiation does have hazardous biologic effects and that the Defense and State Departments have misled the public concerning their knowledge of these effects. The book covers research on nonthermal effects done in the West over the past decade and the exchange of information between the East and the West on the subject. There are numerous reports of electromagnetic radiation effects on hematopoiesis and on the central nervous system in animals, and there are studies suggesting a microwave-induced neurasthenic syndrome (in East European occupational groups) and increases in chromosomal aberrations as well as cataract formation at high levels of exposure. The book notes several specific cases of accidental human exposure with subsequent pathology but often implies causal relations without obvious grounds for doing so. There are some technical errors in the book, and there is no way to connect citations in the text with the references listed. Moreover, the use of cited materials is sometimes careless. The book does draw attention to some important issues, including the potentially high occupational exposure from radio frequency plastic sealers and the lack of Western epidemiologic studies on the effects of microwave exposure.

5762 PREFACE: SPECIAL ISSUE ON ELECTROMAGNETICS AND CANCER. *(Eng.)* Johnson, C. C. (No affiliation given). *J Bioeng* 1(5/6): 465; 1977. (0 refs)

Selected papers from a workshop on electromagnetics and cancer, which was held in conjunction with the 1977 International Microwave Symposium and sponsored by the Institute of Electrical and Electronic Engineers' Microwave Theory and Techniques Society, are briefly discussed. The topics covered include biologic and clinical studies, one of which describes the early clinical results of using 434 MHz radiation for cancer therapy. Other topics discussed are thermometry (including new methods for electromagnetic radiation), microwave hyperthermia systems, and dosimetry. Contributions to the development of microwave applicators and hyperthermia systems are described, and a theoretic technique for analyzing microwave power distribution in homogeneous tissue is discussed.

5763 ELECTROSURGICAL DEVICE INTERFERENCE WITH IMPLANTED PACEMAKERS (LETTER TO EDITOR). *(Eng.)* Furman, S. (Montefiore Hosp. and Medical Center, Bronx, NY); Parker, B.; Ruggera, P. S. *JAMA* 239(18): 1910; 1978. (5 refs)

Problems that can arise from the use of an electrosurgical apparatus in a patient with an implanted pacemaker are discussed along with methods for their prevention. Inhibition of the pacemaker will occur only if the plate or tip of the cautery is immediately adjacent to the pulse generator or electrode. If separated by several centimeters, normal pacemaker function or reversion to fixed-rate operation is expected. If the plate of the electrosurgery is placed on the skin directly over the generator or intracardiac electrode and the tissue layer is thin, the circumscribed current flow may cause local necrosis or so intensely affect the generator as to cause its permanent malfunction. A large plate with good electrical contact, remote from the generator, will avoid this problem. If the generator or lead comes into contact with the cautery, current flow will occur through the heart, causing myocardial burn and possible ventricular fibrillation. Application of the plate or active cauterizing electrode at least 15 cm from the pulse generator or electrode tip in the heart and brief applications of current should avoid any difficulty. The current draft of the *Proposed Standard for Per-*

formance and Safety of Electrosurgical Devices warns about the possible interference of electrosurgical devices with cardiac pacemakers.

5764 BIOLOGIC EFFECTS OF ELECTROMAGNETIC FIELDS (LETTER TO EDITOR). *(Eng.)* Pastakia, B. (Univ. Wisconsin Hosp., Madison, WI 53706). *New Engl J Med* 298(24): 1366; 1978. (14 refs)

The biologic effects of electromagnetic fields are discussed in relation to the possible hazard associated with magnetic fields and radio frequency energy utilized in nuclear magnetic resonance (NMR) zeugmatography. Alternating magnetic field above 100 G (varying at 10-100 Hz) evoke a visual response (magnetophosphene) in the retina. A preliminary study in man showed that a 1-G (45 Hz) magnetic field has a slight but statistically significant effect on cognitive skill. Moreover, experiments associated with the Navy's proposed project Sanguine have shown that mitotic delay occurs in slime molds exposed to 60-75 Hz at levels of 2 G, a low level compared with the 1,000-G fields necessary for whole-body NMR zeugmatography. A Soviet survey of industrial workers has related pathologic changes in the hands and cardiovascular system to magnetic fields of moderate strength (hundreds of gauss at the hands and somewhat less at the trunk). Another study indicated that serum levels of triglycerides are elevated a day or two after exposure to a magnetic field of 1 G (45 Hz). It is concluded that it still remains to be proved that magnetic fields and radiowaves used in NMR whole-body zeugmatography are less hazardous than the ionizing radiations used by imaging devices now available.

5765 TYROSINE HYDROXYLASE ACTIVATION AND TRANSMITTER RELEASE FROM CENTRAL NORADRENERGIC NEURONS BY ELECTRICAL FIELD STIMULATION. *(Eng.)* Bustos, G. (Dept. Neurobiology, Inst. Biological Sciences, Catholic Univ., Santiago, Chile); Roth, R. H.; Morgenroth, V. H.; Hancke, J. L. *Naunyn Schmiedebergs Arch Pharmacol* 301(3): 149-156; 1978. (37 refs)

To investigate tyrosine hydroxylase activation and transmitter release from central noradrenergic neurons, an in vitro system was developed. Hippocampal tissues slices from adult male Sprague-Dawley rats were electrically stimulated with monophasic rectangular pulses of 4-msec duration at frequencies of 5-40 Hz (60 V) for periods of up to 20 min in superfusion chambers, which permitted continuous superfusion during stimulation. A stimulus-dependent increase in tyrosine hydroxylase activity was found after a stimulus was applied for 5 min at frequencies of 5, 10, and 20 Hz. Tyrosine hydroxylase activity was directly related to the number of pulses applied; however, the enzyme activity per pulse of stimulation remained constant regardless of the time period and frequency of stimulation used. The superfusion system was also used to study the spontaneous and electrically evoked release of labelled norepinephrine from hippocampal slices. Stimulation of the slices for only 1.0 min at 40 Hz produced a marked increase in the release of exogenously taken up tritiated norepinephrine. The electrically evoked release of labeled norepinephrine previously taken up into hippocampal slices was dependent on the presence of calcium in the superfusion medium and on the number of pulses of stimulation applied. The electrically evoked release of labeled norepinephrine increased continuously and in a non-linear fashion as the frequency of stimulation was raised from 5 to 10 to 20 to 40 Hz. A rapid release of label per pulse of stimulation occurred up to frequencies of 10 Hz. Thereafter, and up to frequencies of 40 Hz, the label released per pulse of stimulation occurred at a slower rate. These experiments demonstrate that the concomitant use of superfusion and electrical stimulation of hippocampal slices seems to provide a simple and reliable system for studying transmitter synthesis regulation and its relationship, if any, to transmitter release in central noradrenergic neurons.

5766 BIOLOGICAL EFFECTS OF ELECTRIC AND MAGNETIC FIELDS OF EXTREMELY LOW FREQUENCY. (BOOK REVIEW). *(Eng.)* Schwan, H. P. (No affiliation given). *Health Phys* 34(3): 283-284; 1978. (1 ref)

Biological Effects of Electric and Magnetic Fields of Extremely Low Frequency is reviewed. The book covers much of the same material as the National Academy of Sciences-National Research Council's report on "Biologic Effects of Electrical and Magnetic Fields Associated with Proposed Project Seafarer;" however, it frequently arrives at different conclusions. Most of the book deals with experimental literature citing hematologic, biochemical, physiologic, and behavioral effects. Biologic effects of magnetic fields are discussed in the last chapter, and an extended table summarizes the literature from more than a hundred references. The text does not discuss the extensive knowledge that has been gained with regard to the interaction of electricity with biologic systems. The book is valuable in its coverage of macroscopic and bioengineering considerations, including how electrical fields in air couple into the human or animal body. The book is recommended for the health physicist and environmental biophysicist.

MEETING ABSTRACTS

5767 HYPERTHERMIA AND ACUTE DEATH IN MICE EXPOSED TO MICROWAVE WITH AND WITHOUT HEAD SHIELDING (MEETING ABSTRACT). *(Eng.)* Nakamura, W. (Aichi Cancer Center, Nagoya, Japan); Nishimoto, Y. *J Radiat Res* 19(1): 43-44; 1978. (0 refs)

The effects of uniform microwave hyperthermia was investigated in 12-wk-old LAF_1 and ddy/SLC mice of both sexes. A domestic microwave oven (National NE-4500; frequency 2,450 MHz, wavelength 12 cm,

output power 400 W) was used as microwave generator. Using radish as a phantom, it was shown that fairly uniform and constant heating was possible in an acrylic acid resin tube when the latter was kept in an iron can and separated from the radiator with a water layer. In the tube, the extent of increase in anal temperature of mice was reciprocally proportional to the body weight of the animals. The elevated temperature in abdomen, liver, lung, and brain was 81, 75, 71 and 57% of that induced in the rectum, respectively. The anal temperature that was critical for acute death was estimated to be around 44 C. Shielding of the head with aluminum foil did not protect the mice from acute death.

5768 ON THE FATE OF IRON DEPOSITED IN THE HYPOTHALAMUS DURING ELECTRICAL STIMULATION (MEETING ABSTRACT). *(Eng.)* Clark, J. S. (Dept. Anatomy, Univ. Bristol, Bristol BS8 1TD, England). *J Physiol (Lond)* 277: 18P-19P; 1978. (7 refs)

A modification of the metal sulphide precipitation technique was developed to determine the fate of iron deposited in the hypothalamus during electrical stimulation. Adult female rats were anaesthetized with sodium pentobarbitone and an insulated steel electrode (20 μm diameter) was lowered into the anterior hypothalamus, and a direct current of 30 μA (anodal) was passed for 180 sec. After fixation of the brain in a 1% double aldehyde fixative in phosphate buffer pH 6.2 and sectioning at 60 μm on a freezing microtome, the iron was precipitated with a 0.25% solution of ammonium sulphide. The localization of the iron precipitate was then emphasized by application of the sulphide-silver method for intensification of heavy metals. Neurones and their processes in the area around the electrolytic lesion were stained with Golgi-like clarity, due to the uptake of the deposited iron. The distribution of the iron in the brain and the time course of its removal was investigated, and the electrophysiologic implications of the results are discussed.

5769 STUDIES CONCERNING THE EFFECTS OF PROTRACTED PRENATAL EXPOSURE TO A NON-THERMAL LEVEL OF 2450 MHZ MICROWAVE RADIATION IN THE PREGNANT RAT (MEETING ABSTRACT). *(Eng.)* Jensh, R. P. (Dept. Anatomy, Thomas Jefferson Univ., Philadelphia, PA); Ludlow, J.; Weinberg, I.; Vogel, W. H.; Rudder, T.; Brent, R. L. *Teratology* 17(2): 48A; 1978. (0 refs)

To determine the effects of protracted prenatal exposure to nonthermal microwave irradiation, pregnant Wistar rats (12) were exposed to 2,450 MHz microwave radiation in an anechoic chamber 8 hr daily throughout pregnancy (mean=115 hr). Concurrent control animals were placed in the chamber for similar time periods. All animals were killed on day 22 of gestation; their uteri exteriorized; and fetal positions and resorption sites recorded. All fetuses were dissected using Wilson's cross-sectional technique. Data were analyzed and compared with historic baseline control groups. No significant differences among groups were observed for the following parameters: initial maternal weight, term maternal weight, maternal weight gain, embryonic and fetal resorption rates, abnormality rate, and term fetal and placental weights. Using these parameters as indices, the results indicate that exposure of pregnant rats to a nonthermal but threshold level of 2,450 MHz microwave radiation does not adversely affect the offspring.

5770 INFLUENCE OF A 5000 GAUSS MAGNETIC FIELD ON THE BIOLOGICAL SYSTEMS (MEETING ABSTRACT). *(Eng.)* Iwasaki, T. (Natl. Inst. Radiological Sciences, Chiba, Japan); Ohara, H.; Matsumoto, S.; Matsudaira, H. *J. Radiat. Res.* 19(1): 48; 1978. (0 refs)

The possibility that exposure to an almost uniform strength 5,000 G magnetic field can affect biologic systems was investigated. Chinese hamster ovary (CHO) cells, growing in a plastic flask, were exposed to the magnetic field for 8 hr at room temperature. After the exposure, the cells were dispersed and replated to examine cellular growth and multiplicity, and colony forming ability. Naturally synchronous plasmodia of *Physarum polycephalum* were exposed at S-G_2 or M-S-G_2 for 7-8 hr at 24 C and examined for mitosis delay. Fertilized or early cleavage eggs of *Xenopus laevis* also were exposed (up to 72 hours) to evaluate delay in embryonic development. No biologic effects occurred in the three systems studied.

5771 SUPPRESSION OF MURINE ALLOGRAFT REJECTION BY WHOLE-BODY MICROWAVE HYPERTHERMIA (MEETING ABSTRACT). *(Eng.)* Liburdy, R. P. (U.S. Air Force Sch. Aerospace Medicine, Brooks Air Force Base, TX 78235). *Fed Proc* 37(6): 1281; 1978. (0 refs)

To test for possible effects on immune function, allograft rejection of EL-4 cells in microwave-pretreated Balb/c mice was investigated. Microwave pretreatment consisted of brief 10-min thermogenic exposures to 2.6 GHz radiation (25 mW/cm^2; 1.5 C increase in core temperature) delivered at 0900 and 1500 hr for 10 days. On day 11 mice were challenged with a subcutaneous transplant of EL-4 cells. Rejection phase to EL-4 cells began at 9.3 ± 0.6 (n=20) days in the microwave-pretreated group compared with 7.5 ± 0.3 (n=20) days in sham-irradiated mice. Nonthermogenic microwave pretreatment (5 mW/cm^2) did not alter allograft response. Plasma corticosteroid levels were elevated in mice immediately following thermogenic microwave exposure only: 150 ± 15 ng/ml compared with 45 ± 7 ng/ml for sham-irradiated mice. Intramuscular administration of hydrocortisone sodium succinate at 4 mg/kg for 10 days prior to EL-4 transplant suppressed the allograft response; onset of rejection occurred at 10.1 ± 0.6 (n=20) days compared with 7.4 ± 0.5 (n=20) days for the steroid and control groups, respectively. The results suggest that thermogenic microwave stress is associated with steroid release and immunosuppression of the allograft response.

5772 EFFECTS OF CHRONIC NON-THERMAL EXPOSURES OF PULSED MICROWAVES ON A REPAIR-DEFICIENT MUTANT OF *ESCHERICHIA COLI* (MEETING ABSTRACT). *(Eng.)* Dutta, S. K. (Howard Univ., Washington, DC); Nelson, W. H.; Blackman, C. F.; Brusick, D. J. *Mutat Res* 53(1): 91-92; 1978. (0 refs)

Fractions of the *Escherichia coli* repair-deficient mutant, *polA*$^-$, and a normal strain, *polA*$^+$, were exposed to pulsed microwaves of 1, 10, and 20 mW/cm^2 at 8.6, 8.8, and 9.0 GHz for 1, 5, 10, and 15 hr to determine the effects of chronic non-thermal microwave irradiation. At 1 mW/cm^2, no significant deviations could be detected in the repair indices (the ratio of percent survival of the repair-deficient mutant to the percent survival of the normal strain). When the cells were irradiated at 10 and 20 mW/cm^2, repair indices of 0.4 to 0.9 were observed for exposures of $\geq$10 hr. Heating/cooling curve data, which were used to establish absorbed energy, demonstrated that the temperature rises associated with 10 mW/cm^2 were approximately 2 C to 4 C, and with 20 mW/cm^2 they were approximately 6 C to 8 C. Experiments were conducted to determine whether changes in the repair indices at prolonged exposures were due to a rise in temperature of the samples. The results showed that temperatures up to 39 C did not produce repairable DNA damage. It was apparent that the lower repair indices obtained were due to nonthermal effects of pulsed microwaves at 10 mW/cm^2. Effects obtained at power levels above 10 mW/cm^2 could be due to combined effects of both heat and microwave exposures.

5773 FUNDAMENTAL DIFFERENCES BETWEEN SIMPLE HYPERTHERMIA AND 434 MHZ EFFECTS: PROOF OF THERMIC AND NON-THERMIC EFFECTS OF 434 MHZ E.M.W. (MEETING ABSTRACT). *(Eng.)* Holt, J. A. G. (Inst. Radiotherapy and Oncology, Leederville, Western Australia 6007, Australia). *Am J Roentgenol* 130(1): 188; 1978. (0 refs)

The thermal and non-thermal effects of microwave radiation are discussed with emphasis on the therapeutic implications. The radiosensivity value of various cancers has been calculated from clinical observations of their responses to X-ray therapy. Microwave radiation at 434 MHz does heat normal tissues but preferentially heats living cancer tissue. Measured temperatures in cancer colonies after 434 MHz radiation do not exceed the temperatures reached by simple hyperthermia. However, the X-radiation sensitivity increase may be 5 to 10 times greater after 434 MHz than after 41.8 C. Such large increases in X-ray sensitivity cannot be demonstrated when 434 MHz microwaves follow the X-ray therapy. Therapeutic regimens of sequential 434 MHz and X-ray therapy, while preventing a cancer temperature rise of more than 2 C during the 434 MHz radiation, reveal similar large increases in X-ray sensitivity. The magnitude of the ratio of X-ray sensitivity of human cancer after 434 MHz microwaves radiation and simple heating to similar temperatures indicates that 434 MHz microwave radiation affects cancer, independent of the temperature rise it creates.

AUTHOR OF CURRENT LITERATURE INDEX

ADEY, W.R.
05696*
AJDARIC, Z.
05759
ALAM, M.T.
05726*
ALEKSANDROV, N.N.
05682*
ALLAMONG, J.M.
05752
ALOIANTS, G.A.
05724
ALTENAHR, E.
05677
ATKINSON, E.R.
05711*
AUSTENSON, H.M.
05737
AUSTIN, B.P.
05699
BABB, T.L.
05691
BATELLE NORTHWEST
05749*
BATEMAN, J.B.
05674*
BAXTER, B.
05697
BEAMER, J.L.
05727
BECK, E.
05690
BECKER, R.O.
05689, 05699
BEIERLEIN, H.R.
05740
BEL'SKII, A.I.
05686*
BERGER, T.J.
05699
BERTEAUD, A.J.
05723*
BICHER, H.I.
05736*
BICHLER, K.H.
05677
BIGU DEL BLANCO, J.
05750*
BIRMANN, L.
05678*
BLACKMAN, C.F.
05772
BOTSTEIN, C.
05690
BRANNEN, J.P.
05681, 05698*
BREIDENBACH, H.
05740
BRENT, R.L.
05769
BRESLER, S.E.
05732*
BROWN, P.F.
05752
BROWN, P.V.
05694*
BROWN, W.J.
05691*
BROWNLEE, R.R.
05729*
BRUSICK, D.J.
05772
BURDETTE, E.C.
05707*
BURTON, C.V.
05746*
BUSTOS, G.
05765*
CAIN, C.A.
05683*, 05702
CARMACIU, R.
05742*
CHANTRAINE, A.
05687*
CHEN, K.M.
05704*
CHEN, M.M.
05702*
CHLAIDZE, T.I.
05741
CHOU, C.K.
05708*
CHRISTENSEN, D.A.
05697, 05700*
CLARK, J.S.
05768*
CRANDALL, P.H.
05691
DANELIUC, E.
05742
DEDENKOV, A.N.
05685
DELAHAYE, R.P.
05722*
DIAMOND, S.S.
05703
DIEBOLT, J.R.
05675*
DIETZEL, F.
05677
DJURIC, L.J.
05759
DURNEY, C.H.
05709
DUTTA, S.K.
05772*
DWYER, M.J.
05680*
EKSTROM, M.E.
05703
ELDER, J.A.
05718*
ERDMANN, D.
05677
FELDMANN, K.L.
05744*
FOSTER, K.R.
05734*
FRADKIN, S.Z.
05682
FRIEDEL, R.O.
05713
FRIEDENTHAL, E.
05690
FRIEDRICI, R.
05678
FURMAN, S.
05763*
GEORGE, K.
05754*
GEORGE, M.
05754
GERICKE, D.
05677
GLASER, Z. R.
05752*
GOODMAN, E.M.
05730
GREENE, F.M.
05731*
GREENEBAUM, B.
05730
GREENLEAF, J.F.
05697
GRIFFIN, D.W.
05715*
GROZA, P.
05742
GUBIEV, IU.K.
05684
GUNDAKER, W.E.
05720*
GUSTA, L.V.
05737*
GUTMAN, W.
05714
GUY, A.W.
05708, 05717*, 05748*
HANCKE, J.L.
05765
HART, F.X.
05699
HARZMANN, R.
05677*
HJERESEN, D.L.
05727
HOLT, J.A.G.
05695*, 05773*
HOOPES, J.E.
05712
HOWARD, C.
05758
HOWES, R.M.
05712*
HUGHES, H.C.
05729
IWASAKI, T.
05770*
JENSH, R.P.
05769*
JOHNSON, C.C.
05709*, 05762*

JOHNSON, S.A.
05697*
KAROW, A.M.
05707
KAUNE, W.T.
05727*
KINCAID, C.B.
05743*
KIRKLAND, K.J.
05737
KIRMAIER, N.
05740*
KLIMKOVA-DEUTSCHOVA, E.
05738*
KRITIKOS, H.N.
05734
KRUPP, J.H.
05705*
KULIKOVA, L.S.
05684
LAM, K.L.
05702
LEEPER, D.B.
05680
LENOX, R.H.
05694
LEVIN, S.G.
05703
LIBURDY, R.P.
05771*
LIEB, J.P.
05691
LIN, J.C.
05710*
LIPSON, S.D.
05712
LOPATIN, V.F.
05685*
LOTZ, W.G.
05745*
LUDLOW, J.
05769
MACURA, S.
05759
MAGIN, R.L.
05706*
MARINO, A.A.
05689*, 05699*
MARRON, M.T.
05730*
MARTIN, R.B.
05714*
MATEJKA, M.
05692
MATHEWSON, N.S.
05703*
MATSUDAIRA, H.
05770
MATSUMOTO, S.
05770
MCDOUGALL, J.A.
05717
MCGINTY, L.
05760*
MELVILLE, D.
05757
MENDECKI, J.
05690*
MEYERHOFF, J.L.
05694
MICHAELSON, S.M.
05735*, 05745
MILNER, M.
05728
MOELLER, K.
05719*
MORGENROTH, V.H.
05765
MULLEN, J.B.
05733*
MULLIN, J.
05702
MUSSA, M.
05739
NAKAMURA, W.
05767*
NASHOLD, B.S.
05733
NAUMANN, S.
05728*
NEFF, P.H.
05729
NELSON, W.H.
05772
NESKOVIC, B.
05759
NEWTON, R.C.
05752
NISHIMOTO, Y.
05767
NOWOGRODZKI, M.
05690
OFF RADIAT PROGRAMS
05716*
OHARA, H.
05770
OOSTA, G.M.
05703
OTTINO, C.A.
05691
OUTRED, M.
05758*
OWEN, C.S.
05753*
PAGLIONE, R.
05690
PANZRAM, H.
05721*
PARKER, B.
05763
PAS, A.I.
05725*
PASTAKIA, B.
05764*
PAUL, F.
05757*
PEAT, D.
05755*
PETERSON, W.D.
05710
PHILLIPS, R.D.
05727
PLENK, H.P.
05709
POPADICH, I.A.
05684*
RAJAGOPALAN, B.
05697
REBROV, V.G.
05724
RESNEKOV, L.
05747*
RICHARDSON, R.L.
05727
RISSMANN, W.J.
05683
ROATH, S.
05757
ROBINSON, J.E.
05693*
ROESSNER, P.
05692*
ROMERO-SIERRA, C.
05750
ROTH, R.H.
05765
RUDDER, T.
05769
RUGGERA, P.S.
05763
RUKSPOLLMAUNG, S.
05704
RUTSKII, V.V.
05739
SACREZ, A.
05678
SALOMANOVA, Z.
05738
SAVCHENKO, N.E.
05682
SCHAUERTE, W.
05740
SCHWAN, H.P.
05734, 05751*, 05766*
SCHWARTZOVA, K.
05738
SEALS, J.
05701
SHANBERG, S.M.
05713
SOPER, H.V.
05691
SOUKUP, J.F.
05713*
STERZER, F.
05690
TAYLOR, L.S.
05679*
TERESCHENKO, A.I.
05688*
TIKHONCHUK, V.S.
05676*

TKACHENKO, S.S.
05739*
TOLER, J.
05701*
TVILDIANI, D.D.
05741*
TYERS, G.F.
05729
USHAKOV, A.A.
05724
VATIN, A.E.
05685
VOGEL, W.H.
05769
VUCELIC, D.
05759*
WALKER, C.F.
05733
WAYLAND, J.R.
05681*, 05698
WEBB, M.D.
05717
WEINBERG, I.
05769
ZHAVRID, E.A.
05682
ZHGUN, A.A.
05724*

Unclassified

Security Classification

DOCUMENT CONTROL DATA - R & D

Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Franklin Research Center Science Information Services Organization Philadelphia, PA 19103	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3. REPORT TITLE

Biological Effects of Nonionizing Electromagnetic Radiation

4. DESCRIPTIVE NOTES (Type of report and, inclusive dates)

Quarterly Report: June, 1978-September, 1978 (Volume III, Number 1)

5. AUTHOR(S) (First name, middle initial, last name)

Bruce H. Kleinstein, Ph.D., J.D., Project Manager
Elena P. Saboe, Managing Editor

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
September, 1978	47	

8a. CONTRACT OR GRANT NO	9a. ORIGINATOR'S REPORT NUMBER(S)
b. PROJECT NO	80G-C5003-01
c.	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)
d.	

10. DISTRIBUTION STATEMENT

~~Previous issues of the di~~ ~~Services (NTIS), Springfi~~ ~~issues are listed below.~~

DISTRIBUTION STATEMENT A
Approved for public release; Distribution Unlimited

~~National Technical Information~~ ~~ession numbers for these~~

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY

13. ABSTRACT

This quarterly digest presents current awareness information on the biological effects of nonionizing electromagnetic radiation. (microwave and radio frequency) in the range of 0 Hz to 100 GHz. The effects of magnetic and electric fields (static and alternating) are also covered. Each issue contains abstracts of English and foreign current literature, summaries of ongoing research investigations, news items, and a directory of meetings and conferences.

Accession Numbers

AD-A034926 I(1-2): June-Sept., 1974
AD-A034423 I(3): Dec., 1974
AD-A034893 II(1): Mar., 1975
AD-A034426 II(2): Jun., 1975
AD-A034429 II(3): Sep., 1975
AD-A034430 II(4): Dec., 1975
AD-A034166 I(1): Oct., 1976
AD-A034895 I(2): Jan., 1977
AD-A039956 I(3): Apr., 1977
AD-A040681 I(4): Jun., 1977
AD-A043458 II(1): Sep., 1977
AD-A047647 II(2): Dec., 1977
AD-A052779 II(3): Mar., 1978
AD-A055569 II(4): Jun., 1978

DD FORM 1 NOV 65 1473 (PAGE 1)

S/N 0102-014-6700

Unclassified

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
biologic effects						
electric fields						
electromagnetic						
magnetic field						
microwaves						
nonionizing radiation						
radio frequency						