hyperthermia in eight fractions for malignant melanoma, in two patients receiving 30 min of hyperthermia in six fractions for mycosis fungoides, and in one patient receiving 30 min of hyperthermia in three fractions for lymphoma cutis. The skin surface temperature in these cases was 43.5 ± 0.5 C. A partial regression was observed in one patient receiving 30 min of hyperthermia (43.0 C) in five fractions for lymphoma cutis. At 27.12 MHz, the depth of heat penetration is limited, and the inductive heat distribution is modified to an extent by the thickness of the subcutaneous fat tissue. No unusual disproportionate normal skin teactions were observed in patients receiving fractionated radiation therapy followed by hyperthermia as compared with patients receiving radiation alone.

5183 LOW-TEMPERATURE EXPERIMENTS IN RADIATION BIOPHYSICS. *(Nor.)* Moan, J. (Biofysisk Avdeling, Norsk Hydros Institut for Kreftforskning, Det Norske Radiumhospital, Oslo, Norway). *Fra Fysikkens Verden* 39(2): 33-36; 1977. (0 refs)

The high-speed biochemical reactions induced by ionizing and non-ionizing radiation in biologic substances (tryptophan, adenosine, bacteriophage T_1, trypsin) in vitro can be slowed down for more convenient study by irradiating them at cryogenic temperatures. The damage to bacteriophage T_1, irradiated in dry state in a magnetic field of 506 G at 130 K appears to be due to the reaction of H atoms formed by the irradiation with DNA molecules.

5184 PHYSIOLOGICAL EFFECTS OF NAACH VOLTAGES. *(Eng.)* Jacobson, F. H. (Crew Systems Dept., Naval Air Development Center, Warminster, PA 18974). 29 pp., 1976. [available through National Technical Information Services, Springfield, VA 22161, Document No. AD A033679]. (16 refs)

Acute and chronic experiments with cats to determine possible hazards associated with the Navy's non-acoustic audio coupling to the head (NAACH) earphone are reported. No evidence of direct current (dc) flow between or around NAACH electrodes was observed. In acute experiments with audio signal voltages as high as 750 V (root mean square) biased by dc voltages as high as 900 V, the measured integral of the total rectified electrical activity of the trapezius muscle increased with each increase in the voltage of the audio signal applied to the NAACH electrodes. This increase in the integral was accompanied by increased audiofrequency current passing through the head and being picked up by the muscle electrodes or their connectors to a Winchester plug mounted on the head. One cat that was exposed to 4-hr daily NAACH receptions of a 3-kHz signal at the above voltages 4 days/wk for 4 wk exhibited a small increase in spindle and slow-wave sleep on the 5th day of each week but not in rapid-eye-movement sleep. Three other cats received NAACH-transmitted speech daily except on days 7, 12, and 17. The speech signal voltage fluctuated continuously between nearly 0 and 1,000 V with a mode of about 400 V and was biased by 1,020 V dc. No consistent effects on sleep time or stages were detected as a result of NAACH exposure. A single-channel electrocardiogram was recorded in six cats during presurgical anesthesia and during surgical-level anesthesia after 6-14 days of exposure to NAACH voltages. Clinically significant effects were not observed, although one cat developed a sinus tachycardia. A causal effect between NAACH exposure and the tachycardia was not demonstrated. Overall, no impairment of alertness or disturbance of sleep that would preclude exposing human subjects to NAACH voltages was discerned.

5185 THE ELECTRICAL RESISTIVITY OF AQUEOUS CYTOPLASM. *(Eng.)* Foster, K. R. (Armed Forces Radiobiology Res. Inst., Defense Nuclear Agency, Bethesda, MD 20014); Bidinger, J. M.; Carpenter, D. O. 23 pp.; 1976. [available through National Technical Information Services, Springfield, VA 22161, Document No. AD A033257]. (19 refs)

Electrical resistivity measurements of aqueous cytoplasm were made for neurons and muscle fibers of the sea slug, *Aplysia californica*. Each cell was penetrated by a metal microelectrode whose complex impedance was measured as a function of frequency between 500 kHz and 5.7 MHz using an active radio-frequency vector impedance meter. By plotting the measured impedance data on the complex Z plane and extrapolating the data to infinite frequency, the substantial effects of electrode polarization were overcome. The extrapolated cytoplasmic specific resistivities for *Aplysia* giant neurons and barnacle muscle fibers were 40 ± 14 ohm-cm and 74.1 ± 29.0 ohm-cm, respectively. Excluding one experiment where the electrode tip was possibly pushed through the cell and into the seawater below, the average resistivity of barnacle fibers was 82 ± 21 ohm-cm. Electrical polarization impedance in the barnacle muscle fiber was not greatly different from that in a potassium chloride solution of similar resistivity. When the *Aplysia* neuron was penetrated with the electrode, the frequency-dependent part of its impedance increased tenfold in magnitude. The results indicate that there is a significant resistance of some intracellular membranes. However, by extrapolation to infinite frequency and therefore avoiding the effects of both membranes and polarization impedance, the data show that neither water nor ions are bound to an extent greater than that for most other tissues. These results, indicating relatively little bound water, suggest but do not prove that radiation does not act via effects on bound water in the central nervous system.

5186 FORMATION AND RESEALING OF PORES OF CONTROLLED SIZES IN HUMAN ERYTHROCYTE MEMBRANE. *(Eng.)* Kinosita, K. (Dept. Physiological Chemistry, Johns Hopkins Univ. Sch. Medicine, Baltimore, MD 21205); Tsong, T. Y. *Nature* 268(5619): 438-441; 1977. (11 refs)

Erythrocytes in an isotonic sodium chloride solution were treated with a 3.7 kV/cm, 20-μsec pulse, and

the subsequent change in cell volume was monitored by light scattering measurement. Under these conditions, intracellular potassium ion leaked out and was replaced with sodium ion within a few minutes. Further entry of sodium chloride caused swelling of the red cells. When the volume reached 1.1 times the volume of untreated cells, a small amount of isotonic solution of various substances was added to the suspension. The cells kept swelling because of the continuous influx of sodium chloride. However, when the same amount of sucrose solution was added, the swelling immediately stopped. When the added substance was xylitol (molecular weight of 152 as compared with 342 for sucrose), only partial blocking of the cell swelling was achieved. The permeability of the pulse-treated membrane to 11 different carbohydrates was measured under various conditions. Data for untreated control cells revealed that molecules larger than erythritol do not enter the cells to any appreciable amount except D-glucose, which is carried by a specific transport system. Treatment of the cells with a 3.7 kV/cm, 20-μsec pulse increased the critical size for permeation, with molecules smaller than sucrose penetrating the membrane and the rate decreasing with molecule size. The exception to this was D-glucose where the specific transport system seems to be intact even after the pulse treatment. The addition of a sufficient amount of impermeant substance to the suspension of pulse-treated erythrocytes retarded the hemolysis indefinitely. While the cells were prevented from lysis, the membrane spontaneously resealed, with the resealing process being strongly temperature-dependent. Electric pulsation followed by an appropriate resealing procedure makes it possible to prepare erythrocytes with altered intracellular compositions. Although alteration of cellular cations can also be achieved by lactose treatment or chemical modification of the cell membrane, the present method allows for the incorporation of larger molecules such as sucrose by introducing pores of adequate size.

5187 TUMOR ERADICATION IN THE RABBIT BY RADIOFREQUENCY HEATING. *(Eng.)* Dickson, J. A. (Cancer Res. Unit, Univ. Dept. Clinical Biochemistry, Royal Victoria Infirmary, Newcastle upon Tyne, England); Shah, S. A.; Waggott, D.; Whalley, W. B. *Cancer Res* 37(7): 2162-2169; 1977. (37 refs)

Radiofrequency (RF) equipment for heating tumors consisting of a generator circuit with a crystal-controlled oscillator operating at 13.56 MHz (22 m wavelength) and a resonator circuit tuned to the generator circuit is described. The circuits are linked by capacitive coupling with two flat paddle electrodes, and the tissue becomes part of the output circuit. Compensating inductance coils tuned to the circuit, contained in the paddle, maximize the heating component of the current in the tissue. Efficient contact between the paddles and skin (hairless) is crucial, as is the length of the tissue cylinder heated in relation to its diameter. Other important factors include the use of the lower end of the short-wave diathermy spectrum with its greater depth of penetration in tissue and minimal current spread beyond the electrodes, use of the electrostatic (condenser) field technique, and incorporation of compensating coils in paddle handles. Temperatures were measured by thermistor probes and a 12-channel direct-reading electric thermometer and thermocouple sensors. In vitro metabolic studies were used to determine the minimal operational temperature of 47 C for destruction of the solid intramuscular VX2 tumor in New Zealand White rabbits. At low power outputs (up to approx 6 W), the analog meters (thermistor and thermocouple systems) were unaffected by the RF field; at 10-12 W, only the potentiometer readings remained unaffected, while the thermistors read consistently 1.0-1.5 C high. Temperature was routinely monitored with thermistor sensors and the RF field off. Ten VX2 carcinomas (12-22 ml in volume; tumors relatively non-necrotic and metastases present in regional, iliac, and paraaortic lymph nodes and in lungs) were heated at 47-50 C for 30 min. At 47 C, temperature differential of 2-3 degrees was usually seen between multiple sensors in a large tumor; rectal temperature was within normal range. Seven animals were cured, with tumors regressing in 6-8 wk; in three rabbits, limb paralysis (not specifically associated with RF heating) required their sacrifice within 3-4 wk of therapy, but there was no increase in tumor volume during this time. The presence of tumor in the muscle did not significantly alter the electrical resistance of the leg(s), and results suggest that selective RF heating of this carcinoma may be conditioned by poor blood flow through the tumor compared with normal adjacent tissue.

5188 EFFECT OF THE ELECTRICAL FIELD OF POWER TRANSMISSION LINES ON LINEMEN. *(Rus.)* Kaliuzhnyi, V. F. (No affiliation given); Mikhailov, M. I. *Elektrosviaz* (3): 30-34; 1977. (6 refs)

The permissable distances between three-phase alternating current power transmission lines of 330-1,200 kV and telecommunication lines were calculated in view of the dangers of generated electric fields for linemen working on telecommunication lines. The maximum permissible electric field potential is 5 kV/m. The minimal distances between the vertical projections of the outer conductor of power lines and telecommunication lines should be 5-6 m for a line voltage of 330 kV, 10 m for 500 kV, 15 m for 750 kV, and 25 m for 1,200 kV.

5189 INFLUENCE OF MICROWAVES ON THE RESTING POTENTIAL OF GIANT NEURONS OF THE MOLLUSK *HELIX POMATIA*. *(Rus.)* Arber, S. L. (Moscow, USSR). *Elektronnaia Obrabotka Materialov* 6(72): 78-79; 1976. (8 refs)

The effect of microwaves (2.45 GHz, absorbed energy 15.5 mW/cm^3, exposure time 1 hr) on the resting potential of the giant neurons of the mollusk *Helix pomatia* was studied in vitro by means of implanted microelectrodes. The resting potential was 51.1 ± 2.5 mV without irradiation. Irradiation caused

hyperpolarization by 1.5 ± 0.3 mV after exposure for 25-30 min; by 3.2 ± 0.6 mV after exposure for 1 hr, and by 4.6 ± 0.8 mV 1 hr after the 1-hr exposure. No hyperpolarization was observed at pH 4, and it was reduced by ouabain. The findings indicate that microwaves cause an increase in the membrane permeability for potassium and sodium ions that leads to the intracellular accumulation of sodium and subsequently to an activation of the "electrogenic sodium pump". This activation accounts for about 60% of the radiation-induced hyperpolarization.

5190 DO ELECTRICAL FIELDS HAVE BIOLOGICAL EFFECT? *(Dut.)* Anonymous. (No affiliation given). *Elektrotechniek* 55(7): 461; 1977. (0 refs)

Rats were exposed to an electrical field of 100 kV/m for 1 yr to verify Soviet findings that exposure to 5-20 kV/m fields causes disturbances in the central nervous system and changes in the heart rate and blood pressure in workers. The animal experiments revealed no significant differences between the experimental and control animals in terms of weight gain, motor activity, escape reaction, circadian rhythm, heart rate, and differential blood picture.

5191 BIOMAGNETIC EFFECTS: A CONSIDERATION IN FUSION REACTOR DEVELOPMENT. *(Eng.)* Mahlum, D. D. (*Battelle Pacific Northwest Lab., Richland, WA 99352*). 35 pp; 1976. [available through National Technical Information Services, Springfield, VA 22161, Document No. BNWL-1973]. (64 refs)

A summary of the current state of knowledge concerning the biological effects of magnetic fields alone and in combination with ionizing radiation is presented in connection with potential biologic hazards associated with fusion reactor systems. The most extensive calculations of magnetic field patterns have been performed for reactor designs that produce toroidal and poloidal fields. The toroidal field may vary from 10,000 G in the area surrounding the nuclear island to less than 1 G at the outer edge of the reactor building (about 50 m). Poloidal fields as high as 70-450 G may be encountered by people working in the transport and hot cell regions. People working in the region immediately surrounding the reactor building and associated facilities could be subjected to field strengths of 1-70 G for substantial periods. Changes in the electrical activity of the brain and heart have been found after exposure of humans, monkeys, rabbits, and pigeons to fields of 500-91,000 G. Some investigations suggest that preexisting lesions may be exacerbated in the presence of magnetic fields. The genetic effects of magnetic fields have been studied primarily in lower organisms, houseflies, and flour beetles. Changes in mortality and the induction of wing abnormalities have been reported. Evidence for an influence of magnetic fields on growth and development has come from studies on frogs, salamanders, fruit flies, sea urchins, and mice; however, most of the studies have been performed at field strengths above 2,500 G, and the results varied markedly from no effect to complete prevention of development. In general, studies which examine the response of biologic systems to magnetic fields have produced results that are highly variable and often nonreproducible.

5192 PROTECTION AFFORDED BY THE METAL CAPSULE OF PACEMAKERS AGAINST EXTERNAL ELECTROMAGNETIC EFFECTS: FACT OR FICTION? *(Fre.)* Grand, A. (Service de Medecine, Centre Hospitalier de Valence, B.P. 831, F26008 Valence Cedex, France); Drouin, B.; Ferry, M.; du Charlat, G.; Tabet, R.; Morel, C. *Nouv Presse Med* 6(10): 855; 1977. (1 refs)

The function of various models of pacemakers, implanted subclavicularly, in the presence of electric toilet articles (e.g., razors, tooth brushes) was tested. The effect of electromagnetic interference on the pacemaker is unpredictable: constant for a given apparatus, null for an identical one of the same make implanted in the same place. A titanium capsule (ELA Stanium SM, Telectronics P 150B) did not always prevent interference; boxes in acid (Biotronik IDP 54) appeared to be better protected. Other pacemakers without metal capsules (Intermedics C-MOS 1, Medtronic Xytron 5951) appeared to be perfectly isolated from electromagnetic interference. More important than the metal capsule appeared to be the quality of isolation of the electronic circuits and the stimulator probe.

5193 THE HYPNOGENIC EFFECT OF MODULATED ELECTROMAGNETIC FIELD. *(Rus.)* Sudakov, K. V. (P. K. Anokhin Inst. Normal Physiology, USSR Acad. Medical Sciences, Moscow, USSR); Antimonii, G. D. *Biull Eksp Biol Med* 34(8): 146-149; 1977. (8 refs)

Behavioral and electrocardiographic changes were studied in strainless male and female rats exposed to modulated electromagnetic field (40 MHz, modulation frequency 50 GHz, modulation factor 80-100%, field potential 100-120 V/m) for 2-150 minutes. The animals displayed four distinct phases of the behavioral changes during the course of the exposure. The first phase, observed in 54% of the animals after an exposure time of 5-20 min, showed local epileptiform activity in the dorsal hippocampus. The second phase, observed in 75% of the animals after exposure for 20-45 min, was characterized by epileptiform activity in the hippocampus, hypothalamus, septum, amygdala, as well as in the temporal and occipital regions of the brain cortex. During the third phase, observed in 86% of the animals after exposure for 45-60 min, the epileptiform activity spread over all brain structures investigated. Slow waves with 150-200 μV amplitude or depression on the electroencephalogram were observed during the first phase in 35% of the animals after exposure for 90-150 min. Catalepsy

was observed in 5% of the rats during this phase. The exposure also caused disturbances in the conditioned food and defense reflexes of the animals. The findings indicate that the behavioral changes induced by modulated electromagnetic field are due to changes in the normal cortico-subcortical relationships.

5194 GALLOPING OF PACEMAKER DURING HIGH-FREQUENCY THERAPY. *(Ger.)* Effert, S. (Lehrstuhl fur Innere Medizin I, Technische Hochschule, 5100 Aachen, Goethestr. 27-29, W. Germany). *Dtsch Med Wochenschr* 102(24): 909; 1977. (0 refs)

A 62-yr-old man with an implanted CPI model pacemaker received microwave therapy (wavelength 69 cm corresponding to 433.92 MHz) for arthritis in the left shoulder joint. The first three sessions were without any complication, but the patient died suddenly during the fourth session. The cause of death could not be established by autopsy; the pacemaker was operating at normal frequency. The pacemaker was then irradiated with the same therapeutic radiation source at 12 cm distance, which caused a rise in the pacemaker frequency up to 214/min. The death is assumed to have been due to the rise in the pacemaker frequency during the irradiation. The patient may have been at greater distance (about 18 cm) from the microwave generator during the first three sessions.

5195 STUDY OF THE INACTIVATION OF VIRUS-CONTAINING WATER BY MEANS OF ELECTRICAL CURRENT. *(Rus.)* Muzychuk, N. T. (Kiev, USSR); Kul'skii, L. A.; Vorob'eva, A. M.; Matskevich, V. S. *Elektronnaia Obrabotka Materialov* 6(72): 76-78; 1976. (9 refs)

The effect of direct current (30 V/m, current density 8-16 mA/cm^2) on the inactivation (elimination) of *Escherichia coli* B. bacteriophage T_2 in water was studied in the presence of aluminum sulfate or lanthanum chloride (usually 0.88 mg-equivalent/l). Aluminum sulfate alone caused 56% deactivation vs. 82.3% after 1-min treatment with a current density of 14 mA/cm^2, and 90.5% after 4-min treatment with 16.6 mA/cm^2. Lanthanum chloride alone had a deactivation rate of 10%, while electric treatment (1-7 min, current density 8-12 mA/cm^2) of the water containing lanthanum chloride inactivated the bacteriophages at rates of 97.3-99.2%. The reduction of the virus concentration was caused by deactivation by the electric field and the salts and not by the transfer of the viruses to the electrodes or to adsorption.

5196 INFLUENCE OF TECHNICAL ALTERNATING ELECTRIC FIELD OF HIGH TENSION ON THE ORGANISM. *(Ger.)* Schaefer, H. (Im Neuenheimer Feld 326, D-6900 Heidelberg 1, W. Germany); Silny, J. *Int Arch Environ Occup Health* 39(2): 83-96; 1977. (47 refs)

The effects of an electric field (50 Hz, 80 kV/m) on some physiologic parameters were studied in 82 immobilized rats and 46 non-immobilized cats. The animals, kept in Teflon cages, were exposed for two 4-hr phases with 4-hr intervals. In rats, the heart rate showed a 21% increase during the first 4 hr of exposure, which was followed by a slow decline during the 4-hr pause and the next 4-hr exposure. The respiration rate and the blood pressure showed only insignificant changes. Seven immobilized rats died during the exposure with symptoms suggesting hyperthermia: collapse after a sharp rise in the heart rate and increased skin temperature. The alpha- and beta-bands of the electroencephlogram of cats showed a 60% decline during exposure. This phenomenon, as well as the hyperthermia observed in the rats, can be interpreted as the result of hair vibration which causes a stress in the animals. The stress leads to increased myotonia, which results in increased heat production by the muscles. The findings indicate that the electric field has no harmful effect on non-immobilized animals.

5197 INTRODUCTION. *(Eng.)* Baranski, S.; Czerski, P. *In: Biological Effects of Microwaves.* (Stroudsburg: Dowden, Hutchinson & Ross, Inc.) pp. 11-23; 1976. (refs)

Equipment generating radiofrequency and microwave radiation is discussed with emphasis on the risk of exposure to non-ionizing radiation-emitting sources. From the point of view of biomedical considerations three basic parts of microwave equipment may be distinguished. These include the transmitter where the generation and amplification of microwaves occurs, the power transmitting and guiding system, and the receiver. The receiver may absorb all the transmitted energy, or it may be a radiating element (antenna) that emits radiant energy into the surroundings. For hygienic considerations in the use of microwave equipment, an arbitrary distinction of intended and nonintended radiation must be made. The radiation of the frequency, direction of propagation, and point of origin that conform to and are determined by the destination (intended use) of the equipment are designated intended radiation. However, because of physical laws and despite the perfection of design of the transmitter, nonintended radiation may be generated. Unlike intended radiation, nonintended radiation is predictable only to a limited extent, and it constitutes one of the principal sources of health risks. Nonintended radiation is insufficiently considered or even completely omitted in the evaluation of exposure or analysis of occupational health risks. Additionally, in certain instances nonintended radiation is not considered when experimental situations for research purposes are devised or when the bioeffects of microwaves are evaluated on the basis of animal experimentation. It is concluded that source characteristics, propagation of the radiation in the environment, penetration of radiation into the biologic object, and energy absorption inside it must be taken into account in considerations of the biologic effects of microwaves.

5198 PHYSICAL CHARACTERISTICS OF MICROWAVES. *(Eng.)* Baranski, S.; Czerski, P. *In: Biological Effects of Microwaves.* (Stroudsburg: Dowden, Hutchinson & Ross, Inc.) pp. 24-45; 1976. (refs)

The basic physical characteristics of electromagnetic waves, the components of microwave equipment, and the modes of microwave generation and emission are discussed. Time-varying currents are the source of electromagnetic waves, and these waves may be represented as a field consisting of an electric vector and a magnetic vector. The velocity of propagation of the electromagnetic wave through a given medium is determined by the dielectric constant, inductivity, and permeability of the medium. Partial transmission and partial reflection of the electromagnetic wave occur at the boundary of media with different electric properties. Microwave power is distributed by transmission lines and waveguides and is absorbed by receivers or radiating elements (antennas). There are various modes for the generation and emission of microwaves including harmonic waves where the electric and magnetic field vectors oscillate according to the law of sines or cosines (sinusoidal waves) and modulated waves where the amplitude, phase, or frequency may be changed in an arbitrary manner. It is stressed that in analyzing hygienic exposure conditions the source characteristics and the spatial relationship of the source and target should be taken into account.

5199 INTERACTION OF MICROWAVES WITH LIVING SYSTEMS. *(Eng.)* Baranski, S.; Czerski, P. *In: Biological Effects of Microwaves.* (Stroudsburg: Dowden, Hutchinson & Ross, Inc.) pp. 46-77; 1976. (refs)

The interaction of microwaves with living systems is discussed with respect to the penetration of microwaves into a biologic target and their propagation within it, the primary interaction of microwaves with living matter (mechanism of microwave absorption), and the secondary effects induced by the primary interaction. Results of studies on microwave penetration and propagation in biologic material warrant the following conclusions: theoretic models of microwave propagation inside biologic objects must be carefully analyzed as to their applicability; multilayered planar models are admissible to a limited extent; more sophisticated approaches for approximating the complex geometry of the body shape and of internal organs are needed, i.e., multilayered spherical or cylindrical models; thermography of irradiated phantom models or test animals seems to be the best practical solution for wider use at present; and advanced measuring techniques and the development of implantable probes are needed. From the results of basic theoretic and experimental investigations on the absorption of microwave and radiofrequency energy in biologic media, it is theorized that the primary effects of electromagnetic radiation at the molecular level include primary heating, effects on mono- and poly-H_2O, segmental rotation of biopolymers, conformation changes in biopolymers, and excitation of ionic currents in ion distribution. These effects may lead to temperature rises, metabolic rate effects on biochemical reactions through conformation changes, excitation, changes in ion distribution, and structural changes in subcellular elements. At the subcellular and cellular level the primary effects may include interference with biomembranes, semi-conductor effects, and changes in bound water. The secondary chain of events may involve chromosomal effects, lymphoblastoid transformation, interference with mitosis, genetic effects, carcinogenic and/or leukemogenic effects. In organs and systems focal thermal stimulation and/or lesions may occur leading to local and/or generalized cardiovascular effects, peripheral receptor stimulation and disorganization of nervous system function, disorganization of endocrine system function, and changes in metabolic rate and/or abnormal metabolites. In highly organized living systems microwave radiation may possibly interfere with electromagnetic wave transmission and/or reception of biologic information causing stress effects, adaptive responses, disadaptation, and interference with biorhythms and their synchronization.

5200 BIOLOGICAL EFFECTS OF MICROWAVES. EXPERIMENTAL DATA. *(Eng.)* Baranski, S.; Czerski, P. *In: Biological Effects of Microwaves.* (Stroudsburg: Dowden, Hutchinson & Ross, Inc.) pp. 78-152; 1976. (refs)

A comprehensive review of the biologic effects of microwave irradiation is presented. Inhomogeneity of the heating system of irradiated animals presents serious difficulties in quantifying the heat-balance characteristics. Power densities over 100 mW/cm^2 are a high level of exposure and cause death from overheating in a majority of laboratory animals in a short time. Power densities of 10-100 mW/cm^2 cause varied body rectal temperature increases in rabbits, guinea pigs, rats, and mice; in small laboratory animals thermal death may be obtained within this power density range. No lethal effects are obtained, except in mice, at 10 mW/cm^2. In principle, exposure at power density levels below 10 mW/cm^2 do not lead to body rectal temperature increases exceeding the compensatory possibilities of thermoregulatory mechanisms, even in small laboratory animals; 1 mW/cm^2 may be considered the "athermal" exposure level, even at higher ambient temperature and air humidity. Exposure to microwaves, especially in the decimeter range, at power densities of about 1 mW/cm^2 (according to certain authors within the 0.2- to 10-mW/cm^2 power density range) may disturb normal unconditioned and conditioned reflexes in dogs when the whole body or head is irradiated. Attempts to use microwave exposure as a conditioned stimulus did not succeed in most experiments; however, certain experiments obtained a negative defense reflex to 20-sec irradiation with 2,200-MHz waves at 20 mW/cm^2 after 30 to 50 exposures accompanied by an electroshock. Microwave exposures affect the behavior of various animals, mainly rats and mice. It has been demonstrated that electromagnetic fields modulated at extreme low frequencies (8-16 Hz) interfere with

calcium ion binding to the greater neuronal membrane. A quantum mechanical explanation of this phenomenon and its significance for the interpretation of electroencephalogram changes has been offered. It has also been found that exposure to power density levels sufficient to cause temperature increases induces a hemodynamic response related to the thermoregulatory compensatory reaction. Cholinergic, adrenergic, modern cardiovascular drugs, and various inhibitors could be applied for an exploration of the mechanisms involved in cardiovascular responses to microwave exposure. Although the endocrine and metabolic effects of microwaves need further investigation, particularly with respect to the course and dose dependence of the described phenomena and the mechanisms involved, several effects are well documented. These include alterations of the hypophysis, adrenals, and thyroid gland function. Additionally, morphologic observations have demonstrated changes in the pineal body. Other effects include disturbance in protein metabolism, carbohydrate metabolism, and oxido-reductive processes. In experimental animals, microwave irradiation of the male genital system at power density levels that cause temperature increases results in reversible testicular lesions, particularly damage to spermatogenesis. Similar damage to the female genital system, particularly the ovaries, may be expected. Temperature effects seem to play the most important role in fetal development: early stages of development are more sensitive, and microwave exposure at these stages may cause serious injury. Chromosomal aberrations and changes in the duration of particular phases of mitosis (mitotic abnormalities) are reported in human lymphocyte cultures and cultures of monkey kidney cells following exposures at 3-7 mW/cm^2 to 10-cm pulse width and continuous wave microwaves. No satisfactory evidence of microwave-induced genetic effects or fetal damage in mammals exists. In an investigation of the effects of a 10-cm microwave exposure on several generations of white outbred mice, a decrease in fertility and slower body weight-gain in young animals was found, but no definite abnormalities or inborn genetic defects were found. A survey of studies on the effects of microwaves on the chest, abdomen, and digestive tract revealed on necropsy various macroscopic and microscopic lesions seen in animals exposed to particular microwave bands at different power densities. Lesions were seen most frequently in the liver, in certain instances in the kidneys, or in the spleen. Results of experiments point to disturbances in secretion and absorption, which may be related to vascular responses and changes in blood flow. The effects of microwaves on blood and the blood-forming system are well-documented. Single exposures to high-power density microwaves cause various peripheral blood picture changes attributable to and explained by temperature increases and the resulting displacement of blood or of water in the body. Low-dose repeated exposure in short-term experiments at or below 1 mW/cm^2 do not affect the peripheral blood picture to any significant degree. After pulse width repeated or prolonged exposures, peripheral lymphocytosis accompanied by stimulation of lymphopoiesis may occur. Microwave irradiation (repeated low-dose exposures) may affect iron metabolism and red cell production; the mechanism of this effect merits special attention. Prolonged periods of repeated low-dose exposures induce changes in nuclear structure and mitotic abnormalities in lympoid cells and erythroblasts; chromosomal effects are a possibility. One of the best known effects of microwave exposure at high-power-density levels is the formation of lens opacities and cataracts. Although it has been established that exposure of eyes at high power densities causes either the appearance of immediate massive cataracts or delayed cataracts or opacities, sufficient data do not exist for the determination of threshold values for lenticular damage following prolonged periods of repeated exposures.

5201 HEALTH STATUS OF PERSONNEL OCCUPATIONALLY EXPOSED TO MICROWAVES, SYMPTOMS OF MICROWAVE EXPOSURE. *(Eng.)* Baranski, S.; Czerski, P. *In: Biological Effects of Microwaves.* (Stroudsburg: Dowden, Hutchinson & Ross, Inc.) pp. 153-169; 1976. (refs)

Literature regarding the health effects of occupational exposure to microwave radiation is surveyed, and the symptoms of overexposure to microwaves are characterized. Except for microwave-induced cataracts, no incidence of injury following acute microwave exposure is revealed. Soviet, Polish, Czechoslovakian, United States, United Kingdom, and French studies document the existence of central nervous system and vegetative disturbances and asthenic syndromes in personnel occupationally exposed to microwave irradiation, though the origin and development of these syndromes remains controversial. Abnormal findings occur only at conditions of overexposure (>5-10 yr of work) and are characterized by neuro-vegetative symptoms. Individual variations in adapting to the microwave environment involve initial subjective complaints of headaches, nausea, and fatigue; these complaints are followed by a period of adaptation, the length of which varies with individuals. Later, complaints recur and objective symptoms occur on neurologic and electroencephlographic examinations. Depending on the duration and exposure conditions, acute exposure over 10 mW/cm^2 produces various thermal injuries. Limited repeated thermal stimulation of the nervous system, endocrine glands, or liver may induce delayed or secondary effects. It is stressed that most available data concern adult male exposure, and investigations on the effects of intermittent or continuous exposure of children is needed.

5202 SAFE EXPOSURE LIMITS AND PREVENTION OF HEALTH HAZARDS. *(Eng.)* Baranski, S.; Czerski, P. *In: Biological Effects of Microwaves.* (Stroudsburg: Dowden, Hutchinson & Ross, Inc.) pp. 170-187; 1976. (refs)

The biomedical aspects of existing radiation exposure standards are reviewed, and the requirements for determining safe exposure limits are discussed. The safe exposure regulations of Western countries

including the United States and Canada are mostly based on human thermal balance characteristics, which consider that the principal bioeffect of microwaves is the temperature increase in the irradiated object; that the heat balance characteristics of man allow infinite exposure at 10 mW/cm^2 and short term exposure at higher values; that lens opacities are expected at power densities below 100 mW/cm^2; that functional disturbances may occur following repeated exposures at 50 mW/cm^2; and that no evidence of untoward effects of microwave irradiation in man at power densitites below 10 mW/cm^2 has been presented. Safe exposure limits in Eastern European countries are based on different biomedical considerations. Results of animal experimentation and the effects of occupational exposure in man are the basis of USSR regulations, while in Poland the new safe exposure limits are based on discussions of Soviet, Czechoslovakian, and American findings as well as radiation protection guides and statistic and epidemiologic analysis of the health of personnel professionally exposed to microwaves. To determine safe exposure limits the following basic principles may be used: the principle of zero interaction where no effects are demonstrated; the principle of maximal comfort where certain signs are observed but no differences in functional efficiency are demonstrated at optimal conditions and on exposure; and the principle of the limit of physiologic compensation where exposure causes various reversible disturbances and imposes a stress on compensatory mechanisms. It is recommended that safe exposure limits be initially set at lower values and considered temporary and that adequate periodic examinations and constant medical surveillance be the main safeguards in the prevention of health damage during occupational exposure.

5203 FINAL COMMENTS. *(Eng.)* Baranski, S.; Czerski, P. *In: Biological Effects of Microwaves.* (Stroudsburg: Dowden, Hutchinson & Ross, Inc.) pp. 188-192; 1976. (refs)

Comments and recommendations are finalized, and the accomplishments of several microwave bioeffects meetings, held post-writing, are discussed. The authors conclude that much of the experimental and human exposure data are incomplete and that multidiscipline research programs are needed. Further studies should clarify the primary interaction of microwaves with living matter, examine the chain of events leading to secondary and delayed effects, and standardize measuring methods and techniques. The lack of conclusive data is emphasized, and it is suggested that the bioeffects of lower frequency radiation may be a more serious health hazard than microwave radiation. The authors review the principal recommendations of the international symposium held at Laughborough University in England (1973), of the international symposium held in Warsaw (1973), and of the New York Academy of Science Conference (1974) and stress the need for continuing international exchange of information.

5204 HYGIENIC ASSESSMENT OF THE METHOD OF MAGNETIC TREATMENT OF WATER IN THE HOT WATER SUPPLY SYSTEM. *(Rus.)* Tsyplakova, G. V. (F. F. Erisman Moscow Scientific Res. Inst. of Hygiene, Moscow, USSR). *Gig Sanit* (5): 8-12; 1977. (6 refs)

The hygienic effect of magnetic treatment of hydrocarbonate type tap-water was studied in vitro and in vivo. The water was exposed to 1,300, 2,000 or 5,000 Oe. The treatment had no direct effect on the chemical and organoleptic properties of the water, but it accelerated the decomposition of calcium dicarbonate. The magnetic field also enhanced the in vitro amylolytic activity of the saliva, depending on the composition of the water and of the field intensity. After oral administration, water treated with magnetic fields of 1,300 and 2,000 Oe caused no functional disturbances in the blood cells, cardiovascular system, central nervous system, salt and histamine turnover, nor on the hematologic barriers in experimental animals (species not given). Water treated with 5,000 Oe caused qualitative and quantitative changes in the blood cells (increased leukocyte and erythrocyte counts, appearance of more stable erythrocyte populations), tendency to reduced blood cholesterol level, and increased lability of the cortical cells of the brain. Hydrophil swelling of the cells of the cornea was observed in rabbits. A survey of 4,000 persons, who were supplied with water treated with 1,300 or 2,000 Oe, revealed no complaints. The findings suggest that water should be treated with magnetic fields not stronger than 1,300-2,000 Oe to avoid possible hazards.

5205 EFFECT OF ELECTROMAGNETIC FIELD OF INDUSTRIAL FREQUENCY ON THE GENERATIVE FUNCTION IN RATS. *(Rus.)* Andrienko, L. G. (A. N. Marzeev Kiev Scientific Res. Inst. General and Communal Hygiene, Kiev, USSR). *Gig Sanit* (6): 22-25; 1977. (9 refs)

The effect of exposure to electromagnetic field of industrial frequency (field potential 5 kV/m) on the reproductive functions of 500 sexually mature albino rats (270 males and 230 females) was studied. The animals were exposed to the electromagnetic field for 1.5-4.5 mo and mated with intact animals at different stages of the exposure. Prolonged exposure caused an increase in the time necessary for fertilization, a reduction in the litter size (7.7-8 for males and females mated after exposure for 4.5 mo, vs. 8 in the control), a reduction in the live births (85-88 per group vs. 120 in the control), an increased number of stillborn rats (2.2-4.3% vs. 0% in the control), a reduction of the mean weight of the neonates at birth (5.65-5.8 g vs. 6.7 g in the control), and an increased mortality rate during the first 21 days of life (12.-14.7% vs. 7.6% in the control). Increased incidence of hematomas (especially of the head and spine) and of developmental anomalies (retarded growth of hair, defects of the front legs, reduction of the number of estrous

cycles and of normal cycles) was observed in the offspring. Plethora of the uterus and ovaries, dystrophy of the epithelial cells of the secondary follicles, and desquamation of the granulosa cells from the basal membrane were found in exposed females. The exposed males showed reduced number of spermatozoa (40,000,000/ml after 3.5 mo exposure vs. 56,000,000/ml in the control, $P<0.05$), increased percentage of dead spermatozoa (46.4 ± 4.7% vs. 23 ± 4.6% in the control, $P<0.05$) and of atypical forms (39.1 ± 5.55% vs. 16.2 ± 3.7% in the control, $P<0.01$). The findings indicate the deleterious effect of the electromagnetic field on the reproductive function and the need for a revision of the maximum permissible field potential in industrial environment.

5206 INFLUENCE OF AN ADDITIONAL MAGNETIC FIELD ON HORNET NEST ARCHITECTURE. *(Eng.)* Kisliuk, M. (Dept. Electronics, Sch. Engineering, Tel-Aviv Univ., Tel-Aviv, Israel); Ishay, J. *Experientia* 33(7): 885-887; 1977. (12 refs)

The influence of weak (1.3 Oe) and strong (23.3 Oe) additional magnetic fields on the behavior and nest building activity of hornets was studied using artificial breeding boxes, which were placed both inside a magnetic coil where the magnetic field is uniform and outside the coil where the magnetic field rapidly decreases with distance from the coil's winding. Under both field strength conditions, adult hornets died within 4-5 days without performing any building. Juvenile hornets built at least one comb in each breeding box, commencing in the regions of high field intensity and proceeding in the direction of field intensity decrease. During the first 4-5 days of exposure, the juvenile hornets were almost motionless, and their building activity began 5-7 days after that of control hornets. Larvae did not survive the fourth or fifth instar when exposed to the magnetic field. In an artificial breeding box provided with an inverted comb and subjected to a nonuniform weak magnetic field of 0.3-0.6 Oe, the hornets built upwards instead of downwards, constructing a stalk on the surface of the original comb with a knob-like comb on top of it. The openings of the cells were oriented in all directions of the horizontal plane. The queen oviposited in the inverted cells, and the workers attended the larvae. As the distance of the new cells from the coil's winding reached 7-8 cm, their openings gradually began to face downwards. Upon switching off the coil's current and placing inside the coil three incadescent lamps, which dissipated about 70 W of heat and restored temperature of the breeding box to that of the coil-on condition, the hornets continued to build cells whose openings were gradually oriented downwards.

5207 USAF EXPOSURE STANDARDS FOR RADIOFREQUENCY/MICROWAVE HAZARDS CONTROL. *(Eng.)* Mitchell, J. C. *In: AGARD Conference Proceedings No. 202 on Special Aspects of Aviation Occupational and Environmental Medicine.* 8 pp.; 1976. [available through National Technical Information Services, Springfield, VA 22161, Document No. AD A039173]. (11 refs)

United States Air Force exposure standards for radio frequency (RF)/microwave radiation (10 kHz to 300 GHz) are discussed. Based on the fact that radiation insult to man is frequency dependent, permissible exposure levels for Air Force personnel are set at 50 mW/cm^2 for emissions in the 10 MHz frequency range and at 10 mW/cm^2 for emissions in the 10 MHz to 300 GHz range. These exposures can be adjusted to allow higher power densities for exposure times of 6 min or less, but the exposures cannot exceed the time averaged exposure levels of 3,600 $mW/sec/cm^2$ for the 10 MHz to 300 GHz frequency range and 18,000 $mW/sec/cm^2$ for the 10 kHz to 10 MHz range. An additional exposure limitation is that single pulses of RF emission to which personnel may be exposed shall not exceed an electric field level of 100 kV/m. With regard to biologic effects, studies on the effects of RF radiation on the nervous system and human behavior are not sufficiently conclusive to justify changes in current RF exposure safety criteria. With regard to lenticular opacities of the eye, the bulk of experimental evidence supports the position that RF radiation exposures greater than 100 mW/cm^2 for periods longer than 1 hr are required to produce lens opacification. However, questions remain concerning possible changes in the injury threshold due to intensely pulsed fields and due to the cumulative effects of fractionated longer-term exposures. With regard to cardiac pacemaker interference, about 50% of the pacemakers in use now meet the 200 V/m criterion as recommended by the Air Force to the FDA, and essentially all pacemakers should be compatible with pulsed fields of at least 200 V/m by 1977-78.

5208 1976 ANNUAL REPORT: ADMINISTRATION OF THE RADIATION CONTROL FOR HEALTH AND SAFETY ACT OF 1968 PUBLIC LAW 90-602. *(Eng.)* U. S. Dept. Health, Education, and Welfare. 93 pp.; 1977. [available through National Technical Information Services, Springfield, VA 22161, Document No. PB 265 793]. (139 refs)

An annual report is presented that covers the detailed operation of the Bureau of Radiological Health's day-to-day administration of the Radiation Control for Health and Safety Act of 1968 for the calendar year 1976. There are six standards (television receivers, cold-cathode gas discharge tubes, microwave ovens, diagnostic x-ray systems, cabinet x-ray systems, and laser products) now in effect. A total of 118 compliance actions, affecting more than 588,560 radiation producing products, were in progress during 1976. During the year, 230 television receiver models, eight major components of x-ray systems, six complete x-ray systems, and 85 production or preproduction microwave ovens were laboratory tested. Research activities and technologic development, particularly in the areas of calibration and testing of equipment, have been pursued in the fields of ionizing radiation, radio-

frequency-microwave radiation, light, and ultrasound. In terms of reported accidental exposures to nonionizing radiation, there were eight incidents involving 73 persons exposed to ultraviolet radiation, one incident involving the accidental exposure of two persons to microwave radiation, and one incident involving the exposure of one person to infrared radiation.

5209 INFLUENCE OF EXTREMELY LOW FREQUENCY ELECTRIC AND MAGNETIC FIELDS UPON GROWTH DEVELOPMENT AND BEHAVIOR IN DOMESTIC BIRDS. *(Eng.)* Durfee, W. K. (Dept. Animal Science, Univ. Rhode Island, Kingston, RI 02881); Polk, C.; Smith, L. T.; Keefe, T. J.; Muthukrishnan, S. 47 pp.; 1976. [available through National Technical Information Services, Springfield, VA 22161, Document No. AD A034526]. (5 refs)

The influence of continuous exposure to modulated extremely low frequency (ELF) fields of low intensity on the growth and development of the chick embryo, the early postnatal growth of the chick, the subsequent growth of the sexually immature bird, and on the social interaction of sexually mature female birds was investigated. The fields used were modulated between 72 and 80 Hz (76 ± 4 Hz). The magnetic fields were maintained at intensities of 1 or 8 G. The electric fields were maintained at either 10 V/m, 1 V/m, 10 V/m plus 60 Hz, 3.5 V/m, or 1 V/m plus 60 Hz, 3.5 V/m. Uniform fields at identical frequencies and amplitudes were provided for continuous exposure of embryos and chicks during the preincubation holding period, incubation and hatching periods, and during the first 28 days of brooding. Statistical analyses of the results revealed that neither the magnetic nor electric field had significant or consistent effects on the following: hatchability of fertile eggs, embryo survival during the most critical stages of development, early posthatching growth and development, growth and development of the sexually immature bird, carbon dioxide production of the developing embryo, subsequent aggressiveness (as adults) of females exposed early in life, and hematocrits of birds at 4-6 wk or at 8 mo of age. The fields may have prolonged the incubation period slightly but not enough to interfere with hatchability. More precise procedures are necessary to better evaluate the effects of exposure to these ELF fields on the length of incubation period and on the growth of chicks which have been removed from field exposure soon after hatching. The ELF fields examined do not appear to have been detrimental to the survival or well-being of the exposed chicks.

5210 HOW BIRDS FOLLOW INVISIBLE MAPS. *(Eng.)* Cherfas, J. (No affiliation given). *New Scientist* 75(1063): 292-294; 1977. (0 refs)

Evidence for magnetic sensitivity in birds is reviewed. In one study where restless robins were put into an octagonal cage, the birds reversed their preferred migratory direction of north-northeast to geographic west-southwest (magnetic north-northeast) when the horizontal component of earth's magnetic field around the cage was reversed with Helmoltz coils. When the vertical component alone was reversed, the same result was obtained. When both the horizontal and vertical components were reversed, the orientation of the birds was normal. When the vertical component was completely removed to produce a field with only horizontal lines of force, the robins were disorientated completely. Experiments with pigeons equipped with bar magnets or electromagnets have shown that under cloudy sky conditions the flight direction of such birds is influenced by the magnetic field. Artificial magnetic fields around gull chicks have also been reported to result in a disruption in flight orientation. The conditioning of pigeons to discriminate between the presence and absence of a magnetic field has also been reported. Night migrant birds flying over the Navy's project Seafarer radar antennae have reportedly changed altitude more often when the radar is on than when it is off.

5211 THE NATURAL HISTORY OF ELECTRICAL INJURY. *(Eng.)* Solem, L. (Univ. Minnesota Burn Center at Saint Paul-Ramsey Hosp., Saint Paul, MN 55101); Fischer, R. P.; Strate, R. G. *J Trauma* 17(7): 487-492; 1977. (12 refs)

The natural history of electrical injury, exclusive of electrical flash burns, was determined in 64 patients (60 males and 4 females; mean age, 28 yr) treated over a 10-yr period. Three-fourths of the patients were injured by electrical potentials in excess of 1,000 V. The mean burn area was 11%. There were 114 major complications in 46 patients. Cardiac arrhythmias or electrocardiographic abnormalities developed in 36% of the 64 patients. Neurologic sequelae were observed in 16 patients and involved the central nervous system in eight cases and the peripheral nervous system in eight cases. A total of 19 patients required 32 amputations, with 17 involving the digits, one the hand, two the foot, three the leg, and nine the arm. Electrical vascular injury with subsequent arterial occulsion was responsible for many of the major amputations. Cataracts developed in four patients; three of them were bilateral. There were two entrance wounds of the head and two of the arm. All four patients sustained high-voltage injuries. This correlation between entrance site, voltage, and subsequent cataract formation is a common observation. Early patient referral and vigorous fluid resuscitation minimized renal failure (1.5%) and mortality (3.1%). Early fasciotomy and vigorous debridement appeared to decrease wound sepsis (8%) but had little effect on major limb salvage.

5212 ELECTRICAL STIMULATION OF PREGANGLIONIC NERVE INCREASES TYROSINE HYDROXYLASE ACTIVITY IN SYMPATHETIC GANGLIA. *(Eng.)* Zigmond, R. E. (Dept. Pharmacology, Harvard Medical Sch., 25 Shattuck St., Boston, MA 02115); Ben-Ari. Y. *Proc Natl Acad Sci* 74(7): 3078-3080; 1977. (16 refs)

The effect of synaptic stimulation on tyrosine hydroxylase activity in the superior cervical ganglion of Long-Evans rats was studied. The preganglionic cervical sympathetic trunk of anesthetized rats was stimulated unilaterally with 100 μA of current at a frequency of 10 Hz and a pulse duration of 2 msec for a period of 30 min. Beginning 48 hr later, tyrosine hydroxylase activity was 33% higher on the stimulated than on the control side, and the enzyme activity remained elevated in the stimulated ganglia for up to 96 hr after stimulation. These stimulation experiments were performed in decentralized animals to avoid changes in sympathetic activity resulting from the anesthesia and surgery or from the possible central effects of stimulation. However, when rats that had not been decentralized were stimulated unilaterally with silver wire electrodes placed on the intact preganglionic trunk, tyrosine hydroxylase activity was 38% higher on the stimulated side than on the control side when measured 72 hr after stimulation. Preganglionic stimulation at a frequency of 50 Hz was pertormed in freely moving animals, and tyrosine hydroxylase activity was increased in the stimulated ganglia by an average of 64% when measured 72 hr after stimulation. These results show that electrical stimulation of the preganglionic trunk for a short period in animals, either under anesthesia or moving freely, results in a delayed increase in tyrosine hydroxylase activity in the superior cervical ganglion and that the enzyme activity remains elevated for at least 2 days.

5213 A COMPARISON OF INTRINSIC NERVE SUPPLIES OF TWO MUSCULAR LAYERS OF DUODENUM. *(Eng.)* Anuras, S. (Div. Gastroenterology, Veterans Admin. Hosp., Iowa City, IA 52242); Christensen, J.; Cooke, A. R. *Am J Physiol* 233(1): E28-E31; 1977. (17 refs)

Muscle strips of the duodena of opossums and cats were stimulated with 5-sec trains of 50-70-V electrical rectangular pulses at a frequency of 10 Hz and a pulse duration of 0.5 msec. Electrical field stimulation caused contraction in longitudinal strips (strips cut in the direction of the oral-caudal axis), and this contraction was abolished by atropine (10^{-7} molar). Electrical field stimulation caused relaxation of circular strips (strips cut at 90 degrees to the oral-caudal axis); this relaxation was abolished by tetrodotoxin (10^{-7} M), but it was not affected by antagonists to adrenergic and cholinergic transmission nor by some gastrointestinal hormones. Reserpinization (1 mg/kg for 3 days) of opossums did not affect or alter the relaxation of circular strips or the contraction of longitudinal strips. When circular muscle and longitudinal muscle strips were exposed to frequencies ranging from 0.1-50 Hz without changing the other parameters, relaxation in circular muscle strips appeared at 0.8 Hz and was maximum at 8 Hz; contraction appeared in longitudinal muscle strips at 0.5 Hz and was maximum at 8 Hz. Although propranolol (10^{-4} M) abolished the relaxation and contraction of circular and longitudinal muscle strips, respectively, direct electrical field stimulation of the muscle with a longer pulse duration (5 msec) caused contractions in both circular and longitudinal muscle strips, indicating that the muscle was still viable in propranolol. This was probably a nonspecific effect of propranolol due to the high dose used. Overall, the findings suggest that the longitudinal muscle is dominated by an excitatory cholinergic innervation and that the circular muscle is dominated by a nonadrenergic, noncholinergic inhibitory innervation.

5214 EFFECT OF MILLIMETER RADIOWAVES IN COMBINATION WITH FTORAFUR ON THE HEMATOPOIETIC SYSTEM. *(Rus.)* Sevast'ianova, L. A. (No affiliation given); Potapov, S. L.; Vasil'eva, N. N.; Krusanova, N. I.; Kubatkina, E. I.; Vilenskaia, R. L. *Biol Nauki* (12): 27-31; 1976. (7 refs)

The effect of radiofrequency irradiation (1 to 3 irradiations, duration 1 hr, wavelength 7.1 mm, intensity 2.5 mW/cm^2) on the regeneration of the hematopoietic system following administration of ftorafur (5-fluoro-1-(tetrahydro-2-furyl)-uracil: 100 mg/kg x 1-3 or 500 mg/kg x 1 was studied in the femoral bone marrow of male hybrid mice. In ftorafur-treated irradiated mice, the bone marrow cell count decreased to 90% of the initial level and normalized in 5 days. Without irradiation, ftorafur decreased the bone marrow cell count to 60%, and the count normalized on day 10 only. With and without irradiation, the cell count normalized in 10 days following the administration of three 100 mg/kg doses of ftorafur on 3 consecutive days, but the degree of depression was smaller in irradiated animals (20% vs. 35% in the control on the third day). The protective effect of radiation was mainly due to the accelerated regeneration of the erythroblasts, reticulocytes, mature granulocytes, and partly due to the myeloid cells. The irradiation enchanced the biosynthesis of uroporphyrine, coproporphyrine and protoporphyrine in the erythrocytes, liver, and muscles. The irradiation did not prevent the toxic action of ftorafur on the lungs, liver, and intestines.

5215 BIOLOGICAL EFFEC OF MILLIMETER RANGE RADIOWAVES. *(Rus.)* Zaliubovskaia, N. P. (Mechnikov Kharkov Scientific Res. Inst. of Microbiology, Vaccines, and Sera, Kharkov, USSR). *Vrach Delo* (3): 116-119; 1977. (7 refs)

The complex biologic effects of microwaves (wavelengths 5-8 mm, intensity 1 mW/cm^2, exposure 15 min/day for 60 days) were studied in Wistar rats and CBA mice. Deformation of the receptor apparatus, pronounced reactive changes, hypertrophy and partial demyelinization of nerve fibers were seen in the skin. Hemodynamic disorders, changes in the permeability of the vascular membranes, micronecroses, and dystrophy of tissues were found in the myocardium, liver, kidneys, and spleen. Eosinopenia, neutrophilia, lymphopenia, reduced hemoglobin level, and reduced erythrocyte count were found in the blood. The exposure caused disturbances in the conditioned reflex activity. The increased plasma 17-oxycorticosteroid level (22.62 μg/100 ml vs.

14.98 μg/100 ml in the control) and a 32% drop of the ascorbic acid level in irradiated rats indicates the effect of radiowaves on the hypothalamo-hypophyseal-adrenal system. Increased catecholamine level was found in the blood, while the epinephrine level was increased, and the norepinephrine level was decreased in the hypothalamus. The irradiation caused 64% inhibition of the phosphorylation processes in the liver and kidneys. Reduced nucleic acid levels and reduction of ^{14}C-thymidine incorporation in DNA and of ^{14}C-uridine incorporation in RNA were observed in the liver, spleen, kidneys, and lungs. Irradiation caused a reduction of the serum albumin level and an increase in the globulin level. Similar biochemical changes were found in 97 workers exposed to microwave radiation.

5216 INFLUENCE OF STATIC AND LOW-FREQUENCY MAGNETIC FIELD ON BEHAVIORAL AND VEGETATIVE REACTIONS OF HUMAN OPERATOR. *(Rus.)* Medvedev, M. A. (Chair of Normal Physiology, Medical Inst., Tomsk, USSR); Urazaev, A. M.; Kulakov, Iu. A. *Zh Vyssh Nerv Deiat* 26(6): 1131-1136; 1976. (28 refs)

The influence of direct current (dc) and alternating current (ac) (50 Hz) magnetic fields (tension 8,000 A/m on the head) on behavioral and vegetative reactions was studied in 68 practically healthy men aged 19-26 yr. The test persons were required to push a button upon randomly repeated signals, and various physiologic parameters were measured along with the reaction time. Without irradiation, significant increase was observed in the length of respiratory cycles in 18 men, significant reduction in 22 men ($P<0.05$ in each case). The period of cardiac contractions increased in 20 and decreased in 25 individuals. The skin resistance increased in 13 and decreased in 32 individuals. In dc field, the length of the respiratory cycle increased in 40 individuals, decreased in 14. The length of the cardiac contractions increased significantly in 45, decreased in 15. The skin resistance increased in 39, decreased in 13 men. In the ac field, the length of the respiratory cycle increased in 10; the length of the cardiac contractions increased in 12; the skin resistance increased in 9 cases; while the length of the respiratory cycle decreased in 40; the length of the cardiac contractions decreased in 46; and the skin resistance decreased in 50 individuals. DC magnetic field intensified the sympathetic reaction in compensating the effect of the magnetic field and the vegetative back-up of the conditioned reflex activity, while the ac field had a contrary effect.

5217 MECHANISMS OF THE EFFECT OF STATIONARY MAGNETIC FIELD ON INDUCED CARCINOGENESIS. *(Rus.)* Kogan, A. Kh. (Dept. Pathophysiology, I. M. Sechenov First Moscow Medical Inst., Moscow, USSR); Kulitskaia, V. I. *Patol Fiziol Eksp Ter* (2): 63-68; 1977. (38 refs)

The effect of a stationary magnetic field (350 ± 30 Oe), induced by subcutaneously implanted magnetic plates, on chemical carcinogenesis was studied in 330 male rats. The carcinogens, which were introduced with the magnetic plate, were 2 mg of 3,4-benzo(a)pyrene in Group 1 and polyvinyl chloride film in Group 2. Magnetic plates without carcinogens were implanted into control animals. The tumor development progressed through the same stages with and without the magnetic field. However, the magnetic field increased the average latency of the tumors (sarcomas) from 3 mo 2 wk to 4 mo 2 wk in Group 1 ($P<0.01$) and from 12 mo to 13.5 mo in Group 2 ($P<0.05$). Regardless of exposure, the minimal latency time was 2 mo 3 wk in Group 1 and 7 mo in Group 2. The magnetic field caused an increase in the growth rate of the sarcoma: the tumor-somatic coefficient rose from 2% to 5.2% ($P<0.05$) in Group 1 and from 8.28% to 11.5% in Group 2 ($P<0.05$). The incidence of less differentiated (polymorphocellular) sarcomas was 50% in Group 1 vs. 29.4% in the control and 19.5% in Group 2 vs. 9.5% in the control. The overall tumor incidence was 84% in Group 1 compared with 93.3% in the control and 27% in Group 2 vs. 28.4-34% in the control. The peroxide-free radical type lipid oxidation was potentiated by the magnetic field at all stages of the precancerous period. This action facilitates the accumulation of lipid peroxide compounds and free radicals, which are known to have mutagenic and carcinogenic effects.

5218 STREPTOMYCIN RESORPTION FROM THE PLEURA UNDER THE EFFECT OF INDUCTOTHERMY CURRENTS. *(Ukr.)* Popova, A. M. (Dept. Pathophysiology and Biophysics, Odessa Agronomic Inst., Odessa, USSR); Faitel'berg-Blank, V. R. *Fiziol Zh* 22(4): 546-548; 1976. (16 refs)

The influence of inductothermy (electromagnetic field with anode currents of 120-280 mA, frequency 13.56 MHz, length of exposure 10-20 min) on the resorption of streptomycin (2.25 μcuries/100 g) from the pleural cavity into the blood, liver, kidneys, spleen, and lungs was studied in Wistar rats. The percentages of radioactivity found in the blood (after 30 min), liver, kidneys, spleen, and lungs (10 min after injection) were 13.74%, 13.43%, 12.18%, 10.45%, and 11.70%, respectively. Under the influence of inductothermy (120 mA, 20 min), the corresponding percentages measured after 10 min were 16.45%, 20.01%, 20.05%, 10.92%, and 24.61%. The corresponding percentage were 19.6%, 22.27%, 28.55%, 15.12%, and 33.01% after exposure to a field of 200 mA for 10 min. After exposure to a field of 280 mA for 10 min, 19.77% of the radioactivity was found in the liver, 33.24% in the kidneys, 13.59% in the spleen, and 35.58% in the lungs. The findings indicate that inductothermy increases the rate of resorption of streptomycin from the pleural cavity.

5219 BIOLOGICAL EFFECTS OF ELECTROMAGNETIC FIELDS. *(Eng.)* Royal Swedish Academy of Engineering Sciences. (Stockholm: Royal Swedish Academy of Engineering Sciences): 160 pp.; 1976. (196 refs)

Studies on electromagnetic radiation sources and fields, their biological effects, and techniques for measuring such sources and effects are reported. The investigations cover the frequency range of 0-300 GHz and include microwaves, radiowaves, power-frequency electric and magnetic fields, and static electric and magnetic fields. The investigations cover sources of natural and artificial electromagnetic fields; biologic effects in man and animals, including particular effects on biologic organs; techniques for measuring nondisturbed and disturbed electromagnetic fields; and safety aspects. Examples of biologic effects over the above frequency range include: changes in cell division frequency in the bone marrow and liver, light sensation caused by electric or variable magnetic fields, the stimulation of nerve-muscle preparations in magnetic fields, the influence of pulse-modulated microwave fields on heart frequency, the occurrence of sound sensations in intense radar fields, behavioral disturbances in experimental animals exposed to high frequency electromagnetic fields, and eye lens turbidity resulting from long-term exposure to microwaves. It is suggested that additional research is needed in the development of measurement techniques, with particular reference to the calculation and measurement of the distribution of electric and magnetic fields around a human body. An inventory of radiation sources is recommended as background for epidemiologic field studies.

5220 THE CARDIOVASCULAR SYSTEM OF MAN UNDER THE EFFECT OF SUPER-HIGH FREQUENCY ELECTROMAGNETIC FIELDS. *(Rus.)* Medvedev, V. P. (S. M. Kirov Inst. Postgraduate Medical Studies, Leningrad, USSR). *Gig Tr Prof Zabol* (1): 18-22; 1977. (35 refs)

Studies and observations on the effects of super-high frequency electromagnetic fields on the cardiovascular system of occupationally exposed personnel are reviewed. Hypotension has been observed in 6-61% of the subjects examined by various authors, but hypertension has also occurred in 5.8-29%. Changes in the electrocardiogram were found in 16-95%. Bradycardia, tachycardia, sinus arrhythmia, prolonged intraatrial and intraventricular conduction, a few cases of atrioventricular block, atherosclerosis of the coronary arteries, hypodynamia cordis, increase of the systolic and minute volume, increase or decrease of the vascular tonus and of the peripheral resistance, neurocirculatory dystonia, dystrophy of the myocardium, and coronary insufficiency were observed under super-high frequency electromagnetic fields. Most of these changes became aggravated with increasing length of service and are characterized by slight reversibility.

5221 SANGUINE/SEAFARER EXTREMELY LOW FREQUENCY ELECTROMAGNETIC FIELDS: EFFECT OF LONG-TERM EXPOSURE ON SOIL ARTHROPODS IN NATURE. *(Eng.)* Greenberg, B. (Dept. Biological Sciences, Univ. Illinois at Chicago Circle, Chicago, IL 60680). 45 pp.; 1976. [available through National Technical Information Services, Springfield, VA 22161, Document No. AD A027513]. (16 refs)

The results of a study on the long-term biologic impact of the Navy's SANGUINE and SEAFARER projects for developing an extremely low frequency (ELF) low energy communications system at the Wisconsin Test Facility are presented. The studies involve population analyses of soil arthropods and a floral survey of nine exposed and six control plots. Since March 1971, the test facility has been operated at an antenna current of 300 A, using either a north-south or east-west antenna or both antennas simultaneously. The operating schedule has been roughly 5 days/wk, 6 hr/day, at 42 or 45 and 75 or 76 Hz. Some experiments have been performed for continuous wave operation, and others have been performed with low chip modulation (roughly 16 Hz). Comparisons with floral surveys taken 3 or 4 yr earlier suggest normal vegetational changes and succession in exposed plots. After 6 yr of exposure to nonionizing ELF radiation, the ratio of *Cryptostigmata* to *Collembola* in the original Hazleton test plot is almost exactly the same as in 1969 before the test facility was energized. Since 1972, the average annual production of *Collembola* in the Main test and control subplots has been practically the same: 1,488 in the former and 1,432 in the latter. The above and other data do not support the hypothesis that low-level nonionizing ELF fields have had a demonstrable impact on populations of soil arthropods and surrounding flora after 6 yr of exposure.

5222 ON THE EFFECT OF FREQUENCY IN ELECTROMAGNETIC INTERACTIONS WITH BIOLOGICAL SYSTEMS. *(Eng.)* Wayland, J. R. (Sandia Lab., Albuquerque, NM 87115). 12 pp.; 1976. (5 refs)

An equation is derived for predicting the effect of frequency on reaction rate in biologic systems using the theory of absolute reaction rates. However, a lack of measurements of the dielectric constant over large frequency ranges presents a problem of finding suitable biologic systems to which to apply the derived equation. As an illustrative example, yellow birch is considered in the presence of only an electric field. The example clearly shows that changes in reaction rate of the order of 400 times can occur for biologic materials with similar dielectric constants.

5223 RADIOFREQUENCY RADIATION DOSIMETRY HANDBOOK. *(Eng.)* Johnson, C. C. (Dept. Bioengineering, Univ. Utah, Salt Lake City, UT 84112); Durney, C. H.; Barber, P. W.; Massoudi, H.; Allen, S. J.; Mitchell, J. C. 128 pp.; 1976. [available through National Technical Information Services, Springfield, VA 22161, Document No. AD A030874]. (17 refs)

A radiofrequency radiation dosimetry handbook is presented, which gives the best estimates of the

calculated dosimetry for human and animal models over a relatively wide frequency range (10^{-2} to 10^{4} MHz). The primary purpose of the document is to enable the user to estimate the specific absorbed power in man at a given frequency as a function of the incident power density and to make corresponding calculations for experimental animals so that animal experimental data can be extrapolated to hazard implications for humans. Specific absorbed power calculations are made at low frequencies by a perturbation method, at frequencies up to the first resonance for human models by extended boundary condition method, and at the upper frequency limits by geometric optics approximation. All of the specific absorbed power data are for planewave irradiation in free space with an incident power density of 1 mW/cm^2. Calculated dosimetric data for the average specific absorbed power of humans and various animals irradiated by planewaves in free space are presented graphically and are calculated from both prolate spheroidal and ellipsoidal models for the standard polarizations.

Preceding Page BLANK - FILMED

AUTHORS OF CURRENT LITERATURE INDEX

[Entry numbers followed by an asterisk indicate primary authors]

AKHTAR, M.
05115
AL-BADWAIHY, K.
05171*
ALBERTI, S.
05106*
ALLEN, S.J.
05124, 05223
ANDRIANOVA, L.A.
05163*
ANDRIENKO, L.G.
05205*
ANTIMONII, G.D.
05193
ANURAS, S.
05213*
ARBER, S.L.
05189*
ARTSRUNI, G.G.
05108
BAKER, R.J.
05175*
BANKOSKE, J.W.
05139
BARANSKI, S.
05197*, 05198*, 05199*
05200*, 05201*, 05202*
05203*
BARBER, P.W.
05223
BATTISTA, S.
05166
BAYER, A.
05136
BEAL, J.C.
05165
BEN-ARI, Y.
05212
BERNARD, D.L.
05132
BERNARDI, P.
05155*
BERTEAUD, A.J.
05133*
BIDINGER, J.M.
05185
BIGU-DEL-BLANCO, J.
05147*, 05165*
BLIOT, F.
05130
BLOCK, J.B.
05166*
BOGUCKA, A.
05154*
BONDARYENKO, S.I.
05148
BOOKMAN, M.A.
05114*
BOOTZ, A.
05136
BOWMAN, R.R.
05116
BRANNEN, J.P.
05181
BRENT, R.L.
05129
BRINKMAN, J.
05136
BURDETTE, E.C.
05170*
CAIN, F.L.
05170
CALDERWOOD, S.K.
05142
CARPENTER, D.O.
05185
CARTER, R.F.
05112
CATRAVAS, G.N.
05121, 05137*
CETAS, T.C.
05141*
CHAMNESS, A.F.
05124
CHERFAS, J.
05210*
CHEUNG, A.L.
05143*
CHEUNG, A.Y.
05169*
CHRISTENSEN, J.
05213
CLEARY, S.F.
05119*
COOK, R.
05153
COOKE, A.R.
05213
CZERSKI, P.
05197, 05198, 05199,
05200, 05201, 05202,
05203
D'AMBROSIO, G.
05172*
DAMATO, A.N.
05115
DEFICIS, A.
05173*
DENISOVA, E.A.
05118
DETWILER, R.E.
05124
DICKSON, J.A.
05142*, 05187*
DJOKOVIC, V.
05111
DJORDJEVIC, Z.
05111*
DROUIN, B.
05192
DRUCKMANN, S.
05161
DU CHARLAT, G.
05192
DURFEE, W.K.
05209*
DURNEY, C.H.
05223
DUYSENS, L.N.M.
05109
EDRICH, J.
05135*, 05144
EFFERT, S.
05194*
ELDER, J.A.
05153
FAITEL'BERG-BLANK, V.R.
05218
FERRIS, B.G.
05153*
FERRY, M.
05192
FISCHER, R.P.
05211
FLANIGAN, W.F.
05116*
FOSTER, K.R.
05176, 05185*
FOWERAKER, A.R.
05150*
FRAZER, J.W.
05124*
GABOVICH, R.D.
05164
GEITHMAN, G.A.
05128
GEVORKIAN, M.I.
05108
GLICK, H.A.
05146
GOLDSTEIN, A.
05143
GRAND, A.
05192*
GRAVES, H.B.
05139
GREENBERG, B.
05221*
GREISER, J.W.
05174
GRIFFEN, D.W.
05134*
HAFIZ, S.A.
05171
HAHN, E.W.
05182
HAHN, G.M.
05120
HAHN, N.
05120
HARDINGHAM, T.E.
05150
HARTZELL, R.H.
05124
HAWKINS, S.F.
05131*
HAWKINS, T.D.
05127
HILLIER, T.M.
05112
HIROSE, F.
05166

HO, H.S.
05179*
HOFF, A.J.
05109*
HOLT, J.A.G.
05168*
HORVATH, S.M.
05153
HUET, C.
05180
ISHAY, J.
05206
ISLES, M.
05150
ISMAILOV, E.SH.
05178*
JACOBSON, F.H.
05184*
JASIEWICZ, M.L.
05142
JENNINGS, B.R.
05150
JENSH, R.P.
05129*
JOHNSON, C.C.
05138*, 05223*
JONES, D.J.
05158*
JUSTESEN, D.R.
05151*
KALLUZHNYI, V.F.
05188*
KANE, L.
05175
KANTOR, G.
05174*
KATZ, J.B.
05137
KEEFE, T.J.
05209
KIM, J.H.
05182*
KINOSITA, K.
05113*, 05186*
KISLIUK, M.
05206*
KLEMM, J.
05149*
KNIERIEM, K.M.
05123*, 05157*
KOBE, L.
05175
KOGAN, A.KH.
05217*
KORENSTEIN, R.
05161
KORNBERG, H.A.
05139*
KOZIARIN, I.P.
05164*
KRITIKOS, H.N.
05176*
KRUSANOVA, N.I.
05214
KUBATKINA, E.I.
05214
KUKSINSKII, V.E.
05162
KUL'SKII, L.A.
05195
KULAKOV, IU.A.
05216
KULITSKAIA, V.I.
05217
LA MANNA, V.
05172
LAMOLA, A.
05153
LAZAREVIC, N.
05111
LEBOVITZ, R.M.
05122*
LEEDS, C.J.
05115*
LENOIR-ROUSSEAUX, J.J.
05180
LEROY, Y.
05130
LIN, J.C.
05152*
LOTT, J.R.
05167*
LOWELL, W.R.
05116
LUDBROOK, J.
05112
LUDLOW, J.
05129
LVOVSKAYA, E.N.
05118
MAGIN, R.L.
05170
MAHLUM, D.D.
05191*
MAMOUNI, A.
05130*
MARMOR, J.B.
05120*
MASSOUDI, H.
05223
MATSKEVICH, V.S.
05195
MAXWELL, G.M.
05112
MC MANAWAY, M.
05179
MCCULLOCH, D.
05169
MCKEE, G.W.
05139
MCLELLAN, T.
05124
MEDINA, M.A.
05123, 05131, 05157
MEDVEDEV, M.A.
05216*
MEDVEDEV, V.P.
05220*
MERRITT, J.H.
05124
MIKHAILOV, M.I.
05188
MILLS, W.A.
05153
MITCHELL, J.C.
05207*, 05223
MOAN, J.
05183*
MOORE, F.R.
05126*
MOREL, C.
05192
MORRIS, M.E.
05181
MOSCHETTO, Y.
05130
MUIR, H.
05150
MULYNDINA, G.I.
05107
MUTHUKRISHNAN, S.
05209
MUZYCHUK, N.T.
05195*
NIKONOVA, K.V.
05118
NISCE, L.Z.
05182
NORDBERG, A.
05160*
OLIVA, S.A.
05121*
OLSEN, R.G.
05128*
OSCAR, K.J.
05127*
OTTOLENGHI, M.
05161
PATEL, B.M.
05110
PATERSON, D.C.
05112*
PETERSON, M.D.
05132
PHILLIPS, T.L.
05175
POLK, C.
05209
POLLAK, M.
05146*
POPOVA, A.M.
05218*
POPOVICH, V.M.
05164
POTAPOV, S.L.
05214
PRIOU, A.
05173
PURDY, J.A.
05132
RADEMAKER, H.
05109

RATLIFF, J.A.
05124
REITE, M.
05144*
ROBINSON, J.E.
05169
ROMERO-SIERRA, C.
05147
RUDDER, T.
05129
RUSIAEV, V.F.
05107*, 05162*
SADCHIKOVA, M.N.
05118*
SAFONOVA, T.S.
05148
SAMARAS, G.M.
05169
SAVAGE, J.P.
05112
SCHAEFER, H.
05196*
SCHNEITER, A.
05165
SCHRADER, D.H.
05110*, 05128
SCHWAN, H.P.
05176
SEALS, J.
05170
SEAMAN, R.L.
05122
SERVANTIE, B.
05159*
SEVAST'IANOVA, L.A.
05214*
SHAH, S.A.
05187
SHEFTEL', I.E.
05162
SHERMET, V.I.
05148
SHINAR, R.
05161*
SILNY, J.
05196
SMIRNOVA, N.P.
05163
SMITH, G.H.
05167
SMITH, L.T.
05209
SMITH, V.
05175
SMYTH, C.J.
05135
SNEGOVA, G.V.
05118
SOLDATOVA, V.A.
05118
SOLEM, L.
05211*
SOSNICKY, A.P.
05125*
STAVINOHA, W.B.
05123, 05131, 05143, 05157, 05158
STIMMER, H.
05117*
STORER, J.B.
05153
STRATE, R.G.
05211
SUDAKOV, K.V.
05193*
TABET, R.
05192
TAKENAGA, J.
05137
TCHAO, Y.H.
05180*
TOKITA, N.
05182
TOLER, J.C.
05170
TOVMASIAN, V.S.
05108*
TSONG, T.Y.
05113, 05186
TSUTSAEVA, A.A.
05148
TSYPLAKOVA, G.V.
05204*
TYLER, P.E.
05156*, 05159
URAZAEV, A.M.
05216
VAN GRONDELLE, R.
05109
VASIL'EVA, N.N.
05214
VILENSKAIA, R.L.
05214
VOGEL, W.H.
05129
VON GIERKE, H.E.
05153
VOROB'EVA, A.M.
05195
VYORKIN, B.I.
05148*
WAGGOTT, D.
05187
WALSH, P.
05153
WAYLAND, J.R.
05181*, 05222*
WEINBERG, I.
05129
WHALLEY, W.B.
05140*, 05187
WHITMIRE, D.P.
05132*
WITTERS, D.M.
05174
WITTKE, G.
05136*
YAMAURA, I.
05177*
YURCHENKO, G.G.
05148
ZALIUBOVSKAIA, N.P.
05215*
ZIGMOND, R.E.
05212*
ZIMMERMAN, J.
05144
ZIMMERMAN, J.E.
05144

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 Institute Research Laboratories
Science Information Services, Biomedical Resources
Philadelphia, Pa. 19103

2a. REPORT SECURITY CLASSIFICATION
Unclassified

2b. GROUP

3. REPORT TITLE
Biological Effects of Nonionizing Electromagnetic Radiation. Volume II, Number 2, December 1977.

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)
Quarterly Report: Sept[illegible] 1977-Decem[illegible] 1977

5. AUTHOR(S) (First name, middle initial, last name)
Bruce H. Kleinstein, Ph.D., J.D., Project Manager
Elena P. Saboe, Production Manager, Editor

6. REPORT DATE
Dec[illegible] 1977 (12) 55p.

7a. TOTAL NO. OF PAGES
51

7b. NO. OF REFS

8a. CONTRACT OR GRANT NO
TP-7AC024

b. PROJECT NO
80G-C4735-01 (14) FIRL-C-4735-01

c.

d.

9a. ORIGINATOR'S REPORT NUMBER(S)
Volume II, Number 2

9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

10. DISTRIBUTION STATEMENT
Previous issues of the digest can be obtained from the National Technical Information Service (NTIS), Springfield, Virginia 22151. The accession numbers for these issues are noted below.

11. SUPPLEMENTARY NOTES
(15) TP-7AC024

12. SPONSORING MILITARY ACTIVITY
U.S. Navy 142 925

13. ABSTRACT

This quarterly digest presents current awareness information on the biological effects of nonionizing electromagnetic radiation (microwave and radiofrequency) 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): Sept., 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-A043450 II(1): Sept., 1977

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						
radiofrequency						