5048 INFLUENCE OF VARIOUS PHYSICAL FACTORS ON THE DEVELOPMENT OF *ARTEMIA SALINA* EGGS. *(Fre.)* Gaubin-Blanquet, Y. (Laboratoire de Biologie medicale, Faculte de Medecine, 37 allees Jules Guesde, 3100 Toulouse, France); Pianezzi, B.; Massue, J. P. *C R Soc Biol (Paris)* 170(6): 1305-1310; 1976. (5 refs)

The effects of acceleration, vibration, low temperature, vacuum, and magnetic fields on the hatching capacity of normal dry eggs of *Artemia salina* were studied. Exposure to a permanent magnetic field for 3-24 hr caused no reduction in the hatching rate compared with the control (93.33-94.48% after exposure to 15,000 kOe and 91.20-95.77% after exposure to 25.25 kOe vs 94.67% in the control). Exposure to a pulsed magnetic field (150 kOe, 50 or 100 pulses/min) also did not reduce the hatching rates; they were 92.23% and 90.97%, respectively. The hatching rate was practically the same as in the control after exposure to 0.00015 Oe (66% vs 67% in the control after 16 hr, 88% vs 86% in the control after 21 hr, and 89% vs 87% in the control after 42 hr).

5049 MUTAGENIC ACTION OF NON-IONIZING RADIATIONS: ITS IMPLICATION IN RADIATION PROTECTION. *(Eng.)* Madhvanath, U.; Subrahmanyam, P.; Sankanrarayanan, N.; Singh, D. R. *In: IVth International Congress Proceedings, Vol. 2, held in Paris, France on April 26-27th.* International Radiation Protection Association. pp. 333-336; 1977. (6 refs)

Reversion to prototrophy of the diploid yeast strain BZ34 following exposure to electromagnetic radiation ranging from cobalt-60 gamma rays to 2,450 MHz microwaves was investigated. The intrinsic efficiency of different radiations (in absorbed energy, erg/cell) to induce 100 revertants/10^6 survivors was as follows: 1.54×10^{-5} for gamma radiation, 0.92 for ultraviolet (254 nm) radiation, 6.5 for near ultraviolet (313 nm) radiation, and 645 for black light (365 nm). No increase in the reversion frequency was observed for visible light (480 nm). Exposures to short pulse (5 sec) and long pulse (60 sec) infrared laser beams at fluences of 48 and 120 J/cm^2 also resulted in no increase in the reversion frequency. Reversion frequency was also not increased by exposure to 2,450 MHz microwave radiation. Even at energy densities sufficient to raise the temperature to 55 C, only 37% of the yeast cells survived. Therefore, nonionizing radiation appears to be mutagenic only up to wavelengths of about 450 nm; above this wavelength, mutagenicity is not observed.

5050 CURRENT RADIO-FREQUENCY ELECTROMAGNETIC RADIATION SAFETY STANDARDS AS APPLIED TO MOBILE AND PORTABLE TELECOMMUNICATIONS TRANSMITTERS. *(Eng.)* Thiel, J. F.; Wukasch, M. C. *In: IVth International Congress Proceedings, Vol. 2, held in Paris, France on April 26-27th.* International Radiation Protection Association. 5 pp.; 1977. (9 refs)

Radiofrequency electromagnetic radiation safety standards as applied to mobile and portable transmitters are discussed, and power density measurements of the reactive near field of a citizens-band radio transmitter (27 MHz) are presented. Using NBS techniques, reactive near field measurements were made for a 27 MHz transmitter operating at radiated powers of 185 W with a 1.0 m top-loaded antenna, 100 W with a 0.5 m top-loaded antenna, 180 W with a 1/4 wave stainless steel antenna, and 150 W with a 1/4 wave fiberglass antenna. The measured left, rear, and right fields in mW/cm^2 for the above sources were: 0.7, 1.0, 0.7, respectively; 0.5, 0.2, 0.3, respectively; 0.3, 0.2, 0.3, respectively; and 0.3, 0.2, and 0.3, respectively. It is suggested that near field energy densities associated with mobile and portable telecommunications equipment may exceed currently accepted Occupational Safety Standards. The current occupational exposure standard as found in the American National Standards Institute Standard (ANSI) C95.1-1974 (1) is as follows: for normal environmental conditions and for incident electromagnetic energy of frequencies from 10 MHz to 100 GHz, the continuous wave radiation protection guide is 10 mW/cm^2 and the equivalent free-space electric and magnetic field strengths are approximately 200 V/m (root mean square) and 0.5 A/m (root mean square). For modulated fields, the power density and the squares of the field strengths are averaged over any 0.1 hr period. Current evaluation techniques for near field radiation hazards present problems, since the propagation times of the field parameters generated by the various elements of the antenna result in a significant phase difference.

5051 MICROWAVE DIATHERMY EQUIPMENT. *(Eng.)* Darby, C. F. (BioEngineering and Medical Physics Unit, PO Box 147, Liverpool Univ., Liverpool L69 3BX, United Kingdom). *J Med Eng Technol* 1(1): 44-45; 1977. (3 refs)

Possible hazards associated with the use of microwave diathermy equipment are discussed. Between 50 and 75% of the incident microwave energy is reflected back off the patient, and almost 100% is reflected off the instrument case into the treatment room. Thus, due to this chance reflected microwave radiation and the rather wide microwave beam produced by some microwave applicators, the possibility of excessive microwave exposure to the physiotherapist or patient exists. It is important that the most sensitive parts of the human anatomy, that is, the eyes, are not subjected to excessive microwave radiation levels. The monitoring of microwave power levels and microwave field distribution is recommended. A simple monitoring device for this purpose, which can be used as a teaching aid or to indicate approximate microwave levels in the absence of more accurate and expensive monitoring equipment, is schematically illustrated.

5052 A MEASUREMENT OF RF FIELD INTENSITIES IN THE IMMEDIATE VICINITY OF AN FM BROADCAST STATION ANTENNA. *(Eng.)* Tell, R. A. (Environmental Protection Agency, Office of Radiation Programs AW-461, Washington, D. C. 20460). 12 pp.; 1976. [available through National Technical Information Serv-

vices, Springfield, VA 22161, Document No. PB-257 698]. (14 refs)

Electric field energy density measurements were made on a frequency modulated (FM) broadcast antenna tower to determine the radiofrequency (RF) exposure levels to which personnel performing repair and maintenance work on such towers would be exposed. The transmitting power of the radio station was 105 kW (effective radiated power) in both the horizontal and vertical planes. The tower was 120 feet high, and the antenna center of radiation was about 80 feet above ground. Power density levels on the tower ranged from 1.9 to more than 180 mW/cm^2. It was estimated that in order to prevent a worker's exposure from exceeding the OSHA standards (10 mW/cm^2 for 6 min or longer to 500 mW/cm^2 for 7.2 sec) the worker could work in this field for only 20 sec in each 6-min period. Since this is impractical, it is suggested that tower work be performed only when the transmitter is not operating.

5053 EFFECT OF UHF FIELD OF SMALL INTENSITY ON INDICES OF THE CARDIOVASCULAR AND RESPIRATORY SYSTEMS. *(Rus.)* Rudnev, M. I. (Lab. Biological and Hygienic Studies, Kiev Scientific Res. Inst. of General Communal Hygiene, Kiev, USSR); Nozdrachev, S. I.; Tarasiuk, N. E. *Vrach Delo* (4): 131-132; 1976. (0 refs)

The effect of induced renal hypertension, exposure to ultra high frequency (UHF) irradiation (50 μW/cm^2, 7 hr a day for 10 days), and their combination on the heart and respiration rates was studied in rats. Neither induced renal hypertension nor irradiation alone produced any appreciable changes in the electrocardiagram and respiration rates, but irradiation of rats combined with renal hypertension caused a statistically significant increase in the respiration rate ($p<0.05$) (122/min versus 97/min in the irradiated group, 86/min in the group with renal hypertension, and 88/min in the intact controls).

5054 VASCULAR CHANGES IN ANTERIOR SEGMENT OF THE EYE IN WORKERS SUBJECTED TO THE ACTION OF LOCAL VIBRATION AND HIGH-FREQUENCY ELECTROMAGNETIC RADIATION. *(Rus.)* Katorgina, O. A. (Dept. Eye Diseases, Lvov Medical Inst., Lvov, USSR); Semenova, G. S.; Andrianova, E. I.; Fil'ts, M. A.; Buzalo, A. F.; Zhernokova, S. A. *Oftalmol Zh* 31(3):273-277; 1976. (24 refs)

Industrial workers exposed to high frequency electromagnetic fields were examined for vascular changes in the anterior segment of the eye. Ninety-six workers were exposed to electromagnetic fields with frequencies of 2-15 kHz; and 134 workers were exposed to fields with frequencies of 400-1,000 kHz. The field intensity was 3-5 V/m. At the end of the workshift, complaints about eye fatigue, lacrimation, "veil before the eyes", pain in the eyeballs, headache, and sensation of a foreign body in the eye were expressed by 87% of the workers. The biomicroscopic examinations revealed vascular changes in 70.9% of the workers exposed to the lower frequency and changes in 76.9% of the workers exposed to the higher frequency fields. The biomicroscopic changes included spastic-atonic changes of the vessels of the conjunctiva and episclera (spasm of arteries, arterioles, variations in their diameters, disturbances in the tonus of the veins, blood stasis), petechial hemorrhages, dilatation and hypervascularization of the limbus, and dystrophic changes of the stroma of the iris and of the inner edge of the iris. The frequency of the vascular changes increased with length of service.

5055 EFFECT OF ELECTROMAGNETIC OSCILLATIONS IN THE MICROWAVE RANGE ON THE IRON, COPPER, AND ALLIED METALLOPROTEIN CONCENTRATIONS IN BLOOD AND ORGANS (EXPERIMENTAL STUDY). *(Rus.)* Mints, S. M. (Dept. Pathophysiology, Ivano-Frankovsk Medical Inst., Ivano-Frankovsk, USSR); Padalka, E. S.; Lazarovich, V. G. *Vopr Kurortol Fizioter Lech Fiz Kult* (3): 44-46; 1976. (1 ref)

The effect of microwave irradiation (60 mW/cm^2, 10 min/day for 7-28 days) on iron saturation of serum transferrin, ceruloplasmin, iron, and copper levels in the blood and organs was studied in male rats. Significant reduction of the iron concentration was found in serum transferrin (0.14 conventional units on day 28 versus 0.22 conventional units in controls), blood (44.71 mg% on day 28 versus 60.86 mg% in controls), muscles (1.66 mg% on day 28 versus 1.85 mg%), and in the heart (7.08 mg% on day 28, 7.06 mg% on day 7 versus 8.25 mg%). The iron level in the muscles tended to normalize by the end of the experiment (1.23 mg% on day 21, 1.66 mg% on day 28). The iron levels in the liver were 19.95 mg% on day 7, 15.58 mg% on day 14, 13.15 mg% on day 21, and 14.33 mg% on day 28 versus 13.88 mg% in controls. Irradia- mg% on day 28 versus 0.18 mg% in controls), liver (0.46 mg% on day 28 versus 0.42 mg% in controls), muscles (0.30 mg% on day 28 versus 0.20 mg% in con trols), and in the heart (0.35 mg% on day 28 versus 0.30 mg% in controls). The increase in the copper level in the liver was not significant. Irradiation caused insignificant increase in the serum ceruloplasmin level (59.11 conventional units on day 28 versus 54.16 conventional units in controls).

5056 HEALTH HAZARDS FROM TELEMETRY RF EXPOSURE? A REVIEW ON THE INTERACTIONS BETWEEN ELECTROMAGNETIC FIELDS AND BIOSYSTEMS. *(Eng.)* Neukomm, P. A. *In: Biotelemetry III. 3rd International Symposium on Biotelemetry, Pacific Grove, California, May 17-20, 1976.* (New York: Academic Press): 41-44; 1976. (12 refs)

Possible health hazards associated with telemetry radio frequency (RF) exposure are reviewed. Low power densities of RF radiation can produce both thermal and nonthermal effects in biologic organisms. A power density of 10 mW/cm^2 produces less heat than the metabolic rate (1.3 W/kg) for the total human body and is therefore harmless from a thermal viewpoint. The lowest RF level for irreversible damage

is evidenced by lens opacity of the rabbit's eye and is either 100 mW/cm^2 of 2.4 GHz for more than 1 hr or 10 mW/cm^2 for 7 hr. Regarding nonthermal effects, teratogenic effects of 9 GHz radiation at power levels down to 170 μW/cm^2 have been observed when pupae of the darkling beetle *Tenebrio molitor* were exposed to this level. Electrophysical investigations of isolated frog nerves and muscle fibers revealed slowed conduction of impulses, increased synaptic delay, lengthening of latent and refractionary periods, and changes in action potentials at exposures to 5 μW/cm^2 of RF radiation. Alteration in electroencephalograms, conditioned reflex activity, and in several metabolic processes were observed in rats and rabbits after irradiation with less than 10 μW/cm^2 of 50 MHz radiation for 12 hr/day. The United States standard for RF exposure is 10 mW/cm^2, averaged over 0.1-hr periods at an energy density of 1 mW/hr/cm^2 for a frequency range of 10 MHz to 100 GHz. This standard applies to both partial and whole body irradiation. Most telemetry equipment operates over a frequency range of 10-1,000 MHz, with the radiated power varying from a few μW to about 2 W.

5057 PERSPECTIVES ON SATELLITE SOLAR POWER. *(Eng.)* Glaser, P. E. (Arthur D. Little, Inc., Cambridge, MA). *J Energy* 1(2): 75-84; 1977. (31 refs)

The possible development of a Satellite Solar Power Station (SSPS), which utilizes microwaves for the transmission of solar power to earth, is discussed along with its possible biologic impact. The design concept of the SSPS involves the conversion of solar energy in the geosynchronous orbit to a 2.45 GHz microwave signal that can be transmitted to the earth for subsequent conversion (rectification) to a direct current (dc) output signal. This signal is designed for either direct interface with high voltage dc transmission networks or conversion to 60-Hz alternating current. The SSPS design is intended to incorporate several fail-safe features to assure control of the microwave beam pointing and instantaneous shutoff of power to the microwave generators. Failure of the microwave beam-pointing system is not expected to result in exceeding the international standards for microwave exposure. Predictions, analyses, and measurements of the SSPS's specific microwave-induced biologic effects will be an essential component of the development program. Possible effects on birds flying through the microwave beam will have to be established. Preliminary evidence indicates that birds can be affected at microwave exposures of greater than 25 mW/cm^2.

5058 MODULATED ELECTROMAGNETIC FIELD AS A FACTOR OF SELECTIVE EFFECT ON THE MECHANISMS OF PURPOSEFUL BEHAVIOR IN ANIMALS. *(Rus.)* Sudakov, K. V. (P. K. Onokhin Scientific Res. Inst. of Normal Physiology, USSR Acad. of Medical Sciences, Moscow, USSR). *Zh Vyssh Nerv Deiat* 26(5): 899-908; 1976. (26 refs)

The effect of an electromagnetic field (39 MHz, potential 30-120 V/m), modulated sinusoidally with 50 Hz, on the purposeful behavior (synthesis, decision making, acceptance of action results) of rats was studied. Exposure to the field for 5-45 min caused an inadequate defensive reaction to the replacement of a white wall of the cage by a black one, while exposure for 45-60 min suppressed the reaction totally. Prolonged exposure depressed the motor activity. Exposure for 5-15 min increased fluctuations in the reaction time to conditioned food stimulus; prolonged exposure caused an increase in the reaction time. The modulated electromagnetic field considerably inhibited the extinction of the conditioned alimentary reflex. The experiments demonstrate that modulated electromagnetic fields have a selective effect on the emotional reactions; greater disturbances are observed in the mechanisms of appraisal of action and of decision-making and anticipation of future results of actions.

5059 MICROWAVES INDUCE AN INCREASE IN THE FREQUENCY OF COMPLEMENT RECEPTOR-BEARING LYMPHOID SPLEEN CELLS IN MICE. *(Eng.)* Wiktor-Jedrzejczak, W. (Div. Cellular Immunology, Dept. Clinical and Experimental Immunology, Naval Medical Res. Inst., Bethesda, MD 20014); Ahmed, A.; Sell, K. W.; Czerski, P.; Leach, W. M. *J Immunol* 118(4):1499-1502; 1977. (17 refs)

A single 30-min exposure of CBA/J mice to 2,450 MHz amplitude-modulated 12 Hz microwaves (12-15 mW/g body weight) in an environmentally controlled waveguide facility induced a 33.5% increase in the proportion of complement-receptor positive lymphoid cells in the spleen on day 6 after exposure. When mice were exposed to 2,450 MHz microwaves for 30 min/day for 3 days, separated by 3-day intervals and under the same conditions, this effect was further enhanced. Additionally, a significant increase in the proportion of cells bearing surface immunoglobulin was noted on day 6 after the last exposure. The proportion of cells bearing theta antigen on their surface and the total number of spleen cells remained unchanged. The increase in the frequency of complement-receptor positive lymphoid cells after exposure to microwaves was not secondary to microwave-induced increases in body temperature. The temperature inside the waveguide was maintained at 25 C, which caused the body temperature after exposure to be slightly lower than before exposure.

5060 IN VITRO AND IN VIVO INHIBITION OF VIRUS MULTIPLICATION BY MICROWAVE HYPERTHERMIA. *(Eng.)* Szmigielski, S. (Center Radiobiology and Radioprotection, Warsaw, Poland); Luczak, M.; Janiak, M.; Kobus, M.; Laskowski, B.; De Clercq, E.; De Somer, P. *Arch Virol* 53(1/2): 71-77; 1977. (19 refs)

The effects of microwave (3 GHz) hyperthermia (41 and 43 C) on virus multiplication were studied in vitro with herpes simplex virus type 1 (HSV-1)-infected primary rabbit kidney cultures and in vivo with mice infected with HSV-1 or vaccinia virus. In vitro, virus yields were significantly decreased when the

cells were exposed to hyperthermia within the first hours after infection. Hyperthermia applied for periods of 3 or 12 hr decreased virus yield without detectable impairment of cell viability. Heating of cells for 3 hr prior to infection had no effect. In mice inoculated intranasally with HSV-1, microwave hyperthermia (mean field power density of 40 mW/cm^2) applied immediately after infection resulted in a significant decrease in mortality rate, that is, 8/22 and 4/18 and 6/22 for three groups of heat-treated animals as compared with 30/32 for a control group. A significant decrease in the number of specific tail lesions (0.8 versus 17.9 for controls) was observed in mice inoculated intravenously with vaccinia virus and exposed to microwave hyperthermia within the first 3 days after infection; no protection was observed when the hyperthermia was restricted to the pre-infection period or delayed until 3 days after virus challenge. It is suggested that microwave hyperthermia interferes directly with the virus multiplication cycle both in vitro and in vivo.

5061 PACEMAKERS AND EXTERNAL INTERFERENCE. *(Eng.)* Elmqvist, H. (Siemens-Elema AB, Solna, Sweden). *Acta Med Scand* (596, Suppl.): 83-86; 1976. (2 refs)

Common sources of external electromagnetic interference and their effect on different types of pacemakers are reviewed. Remote interference sources are primarily microwave ovens, radar installations, and radio transmitters as well as some electrical machines under certain circumstances. Microwaves can influence all types of pacemakers, but the required power densities are large and of the same magnitudes as those considered safe for the human body. However, a microwave oven with a radiation leak might induce interference at a distance of up to 0.5 m. Direct contact interference sources include diathermy, defibrillation, and short wave treatment equipment, as well as household appliances or other electrical machines with inferior insulation. Although amplifying and detection circuits of pacemakers are designed to distinguish between signals from the heart and external signals, signals emanating from 50-60 Hz power lines are easily detected. Pacemaker interference filters are ineffective against microwave and high frequency fields acting directly on the timing circuit. Metal encapsulation of modern pacemakers can effectively reduce the effect of microwave radiation and to some extent the influence of other high frequency fields.

5062 CHANGES IN RATE OF GROWTH, AND BRAIN AND LIVER ENZYMES IN RATS LIVING IN 45 Hz ELECTRIC FIELDS (ABSTRACT). *(Eng.)* Noval, J. J. (Temple Univ. Medical Sch., Philadelphia, PA 19140); Sohler, A.; Reisberg, R. B.; Coyne, H.; Straub, K. D.; McKinney, H. *Fed Proc* 36(3): 517; 1977. (0 refs)

Approximately 500 adult male Sprague Dawley rats were maintained 30-40 days in 45 Hz vertical electric fields, varying from 100 V/m to 0.1 V/m in eight experiments to assess changes in rate of growth and in brain and liver enzymes. Rats were kept without contact with electric sources in plastic cages housed in air-conditioned railroad cars, which shielded experiments from ambient extremely low frequency (ELF) electric fields. Exposure to 45 Hz fields produced statistically significant changes, which were similar in fields from 100 to 0.1 V/m, as compared to unexposed controls: (1) a 20-30% decrease in rate of body weight gain; (2) a marked decrease in abdominal fat deposits; (3) an 18-20% decrease in activity of the neuronal enzyme, choline acetyltransferase (ChAc), in the brainstem; whereas, ChAc levels in the cerebrum of exposed rats remained normal; and (4) a large increase in liver tryptophan pyrrolase activity (TPA). Exposed rats were similar to controls in food and water intake and appeared healthy. The data suggest that rats have brainstem neurons that are especially responsive to ELF fields. Brainstem neurons regulate body growth, fat deposition, and levels of adrenal hormones, which induce liver TPA.

5063 THE EFFECTS OF MICROWAVE RADIATION ON MICROTUBULES AND AXONAL TRANSPORT. *(Eng.)* Paulsson, L-E. (Res. Lab. Electronics, Chalmers Univ. Technology, Goeteborg, Sweden); Hamnerius, Y.; McLean, W. G. *Radiat Res* 70(1): 212-223; 1977. (21 refs)

The in vitro effects of 3.1 GHz pulsed microwave radiation on colchicine-binding properties, on axonal transport, and on microtubules of brain extracts obtained from albino rabbits were studied. When the effect of microwave irradiation on the colchicine binding activity of rabbit brain extracts was measured, no significant effect was observed with absorbed microwave energy in the range of $3.4\text{-}21.9 \times 10^7$ $Wsec/m^3$. Viscometric measurements of the effect of microwave irradiation on microtubule assembly at absorbed power densities of 4.3×10^5 W/m^3 revealed a mean difference of $-4.2 \pm 5.8\%$ between the specific viscosity of 16 control and 16 irradiated samples, indicating no significant microwave effect. Studies of the transport of tritiated-leucine-labeled proteins in rabbit vagus nerves exposed to microwave irradiation also failed to reveal any microwave effect at absorbed power densities of $10^4\text{-}10^5$ W/m^3.

5064 ELECTRO-ACUPUNCTURE ANALGESIA IN MONKEYS: A BEHAVIORAL & NEUROPHYSIOLOGICAL ASSESSMENT (ABSTRACT). *(Eng.)* Sandrew, B. B. (College Physicians and Surgeons, Columbia Univ., New York, NY 10032); Yang, R. C. C.; Wang, S. C. *Fed Proc* 36(3): 561; 1977. (0 refs)

To study the analgesic effect of electro-acupuncture, monkeys were initially trained to press a lever to escape noxious electrical stimulation applied to electrodes on one leg. During testing sessions monkeys were presented with electrical stimuli (1-3 sec duration) of successive intensity increments beginning at zero intensity with random interstimulus

intervals (ISIs). If the monkey made a lever-press, the stimulus intensity was immediately dropped to zero. The same sequence of increasing stimuli was then presented with a new series of random ISIs. After the establishment of a stable threshold measure of lever-pressing, 30 min of electro-acupuncture (6 V, 180 ppm) was applied to traditional points on both legs. The results revealed that electro-acupuncture dramatically increased (100-300%) the lever pressing threshold for approximately 16 min, indicating an analgesic effect. In acute monkey preparations immobilized with gallamine, spike activity of single neurons in n. Parafascicularis of the thalamus, evoked by noxious electrical stimulation (3 pulse train, consisting of 1 msec biphasic pulses, 1 mA intensity) to the sciatic nerve, was recorded. The evoked activity of only nociceptive specific neurons was either eliminated or markedly reduced for at least 1 hr following 30 min of electro-acupuncture applied to traditional points on both legs. The observations made by these two experimental approaches suggest that electro-acupuncture exerts an analgesic effect on artifically induced nociception.

5065 EFFECTS OF RADIOFREQUENCY RADIATION ON MURINE PERIPHERAL WHITE BLOOD CELL POPULATIONS (ABSTRACT). *(Eng.)* Liburdy, R. P. (USAFSAM, Brooks Air Force Base, TX 78255). *Fed Proc* 36(3): 1059; 1977. (0 refs)

Radio frequency electromagnetic radiation (RF-EMR) induced a transient in vivo shift in mouse peripheral white blood cell populations. Brief exposure (10-15 min) to RF-EMR at 5 or at 26 MHz for an E-field intensity of 5200 V/m each resulted in a marked lymphopenia and neutrophilia maximal at 3 hr followed by a gradual recovery to pre-exposure values at 72 hr. Triple exposure at 3-hr intervals achieved a sustained marked lymphopenia and neutrophilia for a 12-hour period. Exposure at 26 MHz resulted in a 2-3 C increase in mouse colonic temperature, while exposure at 5 MHz resulted in no measurable increase in animal core temperature. Size distribution of the white blood cell population in the same animals showed a marked decrease in small leukocytes (10μ) over that of relatively large leukocytes (17μ) maximal at 3 hr postexposure. Populations reverted to normal size distributions by 48-72 hr. These results indicate that RF-EMR at 5 or at 26 MHz leads to transient shifts in white blood cell subpopulations corresponding to lymphopenia and neutrophilia and that these shifts can be maintained by multiple exposures.

5066 DIFFERENTIAL HEATING OF CELL-TYPES OF ABSORPTION OF MAGNETIC ENERGY (ABSTRACT). *(Eng.)* Czerlinski, G. H. (Northwestern Univ., Chicago, IL 60611). *Fed Proc* 36(3): 693; 1977. (0 refs)

A new temperature jump method, which utilizes absorption of magnetic energy by special mediators, may be utilized to heat cell types selectively. Phagocytotic cells pick up intravenously injected ferromagnetic mediator particles directly, and to the extent phagocytosis may be directed by agents, accumulation in various types of cells differs substantially and causes highly differentiated heating. While phagocytosis is believed to involve energy consumption, a nonenergy consuming particle transport is believed to be involved in instances where vesicles are used consisting of lipid components of the membrane. Particles of considerable size (up to at least 5,000 Å length) can be transported by this latter method using lecithin-containing mixtures. To the extent this latter type of particle transport into cells can be directed by agents, accumulation would differ among cell types and thus allow highly differentiated heating. Magnetic coupling to mediators is of much greater value than electric coupling (to ferroelectric mediators), as the latter is also associated with (unspecific) dielectric (and conductive) heating at high frequencies (as periodically damped pulses).

5067 CATARACT AFTER EXPOSURE TO NON-IONIIZING RADIANT ENERGY. *(Eng.)* Zaret, M. M. (1230 Post Road, Scarsdale, NY 10583); Snyder, W. Z.; Birenbaum, L. *Br J Ophthalmol* 60(9): 632-637; 1976. (16 refs)

Two case reports of cataract development after exposure to non-ionizing radiant energy are presented. The reports involve a 46-yr-old wife and a 55-yr-old husband, each with different histories of exposure. Each individual developed a specific type of ocular lesion relatable to exposure. The woman, who received medical diathermy treatment for a back injury and in later years cooked on an electric oven and range, developed capsular cataracts in both eyes. The delayed type of cataractogenesis after diathermy therapy, instead of remaining latent, appeared to be exacerbated and hastened by additional exposure to infrared emission from the stove. Her husband, who had a longer history of exposure to the electric range only, developed first a retinopathy and later a lens capsule opacity, both resembling injury from non-ionizing radiation.

5068 EXPERIMENTAL ARRANGEMENT FOR IN VIVO X-RAY AND MICROWAVE IRRADIATION OF SMALL ANIMALS (ABSTRACT). *(Eng.)* Baker, R. J. (Univ. California, San Francisco, CA 94143); Smith, V. *Phys Med Biol* 22(1): 147-148; 1977. (0 refs)

An apparatus for studying the synergistic effect of combined X irradiation and microwave-induced hyperthermia in small laboratory animals is described. The test device consists of a microwave power source and an industrial X-ray cabinet. The X-ray cabinet is used for the microwave irradiation and the therapeutic X irradiation, as well as for radiologic in situ examination of the position of various test components. Radiofrequency (RF) power is fed to the enclosure via a coaxial cable, which terminates in a coax-to-waveguide adapter then feeds the applicator. The enclosure is lined with a microwave absorbing material, providing an anechoic volume. Two RF power sources are available. One is a basic high

frequency—very high frequency—ultra high frequency generator that accepts various plug-in cavity oscillators. The two plug-in modules currently available provide continuous wave power, which is continuously adjustable from 50 mW to 65 W at any frequency from 500-2,000 MHz. The second RF power source is a 100 W C-band (5-45 GHz) generator.

5069 DETERMINING INTRAVITAL CHARACTER AND TIME OF POSTMORTEM INJURY OF TISSUES AND ORGANS BY SUPERHIGH RADIOFREQUENCIES. *(Rus.)* Kriukov, V. N. (Dept. Forensic Medicine, Altai Medical Inst., Barnaul, USSR); Mazur, V. F.; Martsinkevich, V. N.; Ten'kov, A. A. *Sud Med Ekspert* 19(2): 16-19; 1976. (0 refs)

The dielectric constant of the brain and of muscles was measured at super high frequency (not reported) in 50 human cadavers to establish the time of death and time of injury (intravital or postmortem) to the brain. The dielectric constant of the brain increased constantly during the first 13-15 days after death, but it remained practically unchanged for several months thereafter. The increase paralleled the putrefaction process, regardless of the cause of death. The dielectric constant of muscular tissue, which was traumatized postmortem, was always lower than that of the nontraumatized tissue, and the dielectric constant of muscular tissue traumatized intravitally was even lower than that of muscles traumatized postmortem ($p<0.0001$).

5070 EFFLUX OF CALCIUM AND AMINO ACIDS FROM CEREBRAL TISSUE WITH WEAK LOW-FREQUENCY ELECTRIC FIELDS (ABSTRACT). *(Eng.)* Adey, W. R. (Dept. Anatomy & Physiology, Univ. California, Los Angeles, CA 90024); Bawin, S. M. *Fed Proc* 36(3): 589; 1977. (0 refs)

This study examines effluxes of $^{45}Ca^{2+}$, ^{3}H-GABA and ^{3}H-β-alanine from isolated chick cerebral hemispheres equilibrated for 30 min with a calcium Ringer's solution containing 0.434 nM $^{45}Ca^{2+}$ (specific activity 11.5 Ci/g Ca), or 0.0109 nM of ^{3}H-GABA (specific activity 36.73 Ci/nM), or 0.0111 nM of ^{3}H-β-alanine (specific activity 36.0 Ci/nM). Washed tissue was exposed to a 20 V/m, 16 Hz field for 20 min. Efflux was then measured in 0.2 ml supernatant and compared with the efflux from unexposed control samples. A significant reduction in calcium efflux occurred; however, only nonsignificant reductions occurred in the GABA efflux, and the β-alanine efflux remained unchanged.

5071 CATARACTS IN AVIATION ENVIRONMENTS (LETTER TO EDITOR). *(Eng.)* Zaret, M. M. (New York Univ. Sch. Medicine, New York, NY); Snyder, W. Z. *Lancet* 1(8009): 484-485; 1977. (8 refs)

The occurrence of a capsular cataract in nine aviation workers who were exposed to nonionizing (hertzian) radiation is reported. Three of the workers were radar technicians aboard aircraft, five were air-traffic controllers, and one was an airline pilot. Histologic examination of one of the cataracts confirmed the presence of a capsular lesion, vacuolization, and degeneration of the subcapsular epithelium and capsular adhesions. These findings were consistent with the clinical diagnosis of chronic hertzian radiation cataract, a capsular cataract which develops slowly over the years after repeated irradiations at non-thermal intensities without any evidence of burn. The lesion, instead, resembles a delayed-type purely radiation effect.

5072 INFLUENCE OF A 1400-GAUSS MAGNETIC FIELD ON THE RADIOSENSITIVITY AND RECOVERY OF EMT6 CELLS IN VITRO. *(Eng.)* Rockwell, S. (Dept. Therapeutic Radiology, Yale Univ. Sch. of Medicine, 333 Cedar St., New Haven, CT 06510). *Int J Radiat Biol* 31(2): 153-160; 1977. (15 refs)

EMT6 mouse mammary tumor cells in vitro were exposed to an almost uniform 1,400-G magnetic field during or after irradiation with 120-kV X-rays. Exposure of unirradiated control cultures to this field for up to 48 hr did not alter the viability or growth of the cells. The exposure of exponentially-growing cultures to the magnetic field during irradiation did not alter the survival curve over radiation doses of 250-1,250 rads. When exponentially-growing cultures were exposed to the magnetic field between two 500-rad doses of X-rays, the pattern or magnitude of recovery from sublethal damage was not significantly altered. The exposure of plateau phase cultures to the magnetic field after irradiation with 1,000 rads did not alter significantly the pattern or magnitude of recovery from potentially lethal damage. Thus, the effects of the above exposures on the production and repair of radiation damage appeared to be minimal in this system.

5073 INTERFERENCE WITH CARDIAC PACEMAKER FUNCTION. *(Eng.)* Ohm, O. J. (Medical Dept. A, Univ. Bergen, Sch. Medicine, Bergen, Norway). *Acta Med Scand* (596, Suppl.): 87-95; 1976. (54 refs)

Factors affecting cardiac pacemaker function are reviewed in terms of external and internal interference and pacemaker defects. While asynchronous pacemakers are little affected by external interference, demand pacemakers (i.e., QRS-inhibited and QRS-triggered pacemakers) are rather sensitive to electromagnetic interference. Electrical equipment emitting continuous wave energy with a frequency of 50-60 Hz can interfere with pacemaker function. Household appliances and electrocardiographic recording equipment are capable of causing such interference. Interference may also occur if the pacemaker is near pulsed energy sources, such as, radio transmitters, radar, telemetry devices, motor vehicle ignition systems, and arc welders. Interference can occur by direct contact with electrical razors and various household appliances. Diathermy equipment is particularly dangerous because of current leakage.

A survey of 2,200 patients with pacemakers uncovered only 10 patients who were affected by electromagnetic interference. There were no serious or fatal complications. Four of the 10 cases were patients with pacemakers that were no longer in use. Improved shielding of pacemaker pulse generators with steel or titanium appears to have reduced the danger of interference from electromagnetic radiation.

5074 CELLULAR CHANGES IN THE BONE MARROW UNDER THE INFLUENCE OF SUPER HIGH FREQUENCY RADIATION COMBINED WITH IMIPHOS. *(Rus.)* Sevastianova, L. A. (No affiliation given); Potapov, S. L.; Vasileva, N. N.; Krusanova, N. I.; Kubatkina, E. I.; Vilenskaia, R. L. *Biol Nauki* (7): 36-39; 1976. (8 refs)

The combined effect of super high frequency irradiation (wavelength 7.1 mm, intensity 2.5 mW/cm^2, irradiation time 1 hr) and 3-[Bis(1-aziridinyl)phosphinyl]-2-methyl-thiazolidine (imiphos: single dose of 50 mg/kg, or 10 mg/kg 3x/wk for 5 wk, ip) on bone marrow cells was studied in C_{57}BlxCBA male mice. The animals were irradiated once or repeatedly after imiphos administration. The reduction of the bone marrow cell count was less pronounced with irradiation than with imiphos alone. Myeloid cell count was also less reduced under combination treatment. Imiphos caused a smaller increase in the lymphocyte and reticulum cell counts than when combined with irradiation. The erythroblast count dropped to lower values after combined treatment than after administration of imiphos alone. Necrosis of the germinal epithelium of the testes, and almost complete absence of spermatozoa in the canaliculi of the testicular appendage were observed after repeated irradiation with imiphos treatment. The findings indicate the protective effect of irradiation on the bone marrow.

5075 BIOLOGICAL EFFECTS OF LOCALLY APPLIED MICROWAVES ON THE THYROID GLAND OF DOGS. *(Eng.)* Magin, R. L.; Lu, S. T.; Michaelson, S. M. *In: Microwave Power Symposium 1975 Proceedings held May 28-30, 1975 at University of Waterloo, Waterloo, Ontario, Canada.* International Microwave Power Institute. (Edmonton, Alberta, Canada): pp. 117-124; 1975. (8 refs)

A series of localized microwave exposures were undertaken in the anesthetized dog to study the effects of microwaves on the thyroid gland. One thyroid gland was exposed with a dielectrically loaded waveguide applicator (2 inches by 1 inch) at a frequency of 2,450 MHz, while the other gland was used as a control. The temperature of both glands was measured continuously during each experiment using a thermistor near the unexposed gland and a liquid crystal fiber optic temperature probe near the exposed gland. When the left thyroid gland was locally exposed to microwaves with a measured net forward power of 3 W, the temperature of the left gland increased by 3 C to approximately 39 C. A slight elevation of the thyroxine release rate (TRR) was also observed for the microwave heated gland. When thyroid-stimulating hormone (TSH) (10 IU) was administered prior to localized microwave exposure (5 W power), the microwave-heated gland showed a significant rise in temperature to approximately 42 C, while the temperature of the control gland remained between 36 and 37 C. The TRR of the control gland increased during the experiment, a normal response of a thyroid gland to TSH; the microwave-heated thyroid gland showed an irregular TRR response with respect to exposure duration, with the TRR less than that of the control gland. The TRR of both glands were parallel after the microwave power was turned off. The results indicate that the secretory output of the thyroid gland can be altered by microwave exposure, and the temperature of the exposed gland seems to be the factor that determines the degree of effect.

5076 MEASUREMENT OF RF POWER-ABSORPTION IN BIOLOGICAL SPECIMENS (10 TO 100 MHZ). *(Eng.)* Greene, F. M. (Electromagnetics Div., Natl. Bureau of Standards, Boulder, CO 80302). 26 pp.; 1976. [available through Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402, Catalog No. C13.46:687]. (11 refs)

A method for accurately determining the radiofrequency (rf) power being absorbed by a biological specimen during non-ionizing radiation exposure testing using the NBS RF Near-Field Synthesizer in the frequency range of 10-100 MHz is described. The method is based solely on measuring the forward and reflected power on the transmission line feeding the synthesizer, and commercially available rf wattmeters can be used for this measurement. An automatic data acquisition system can be used to read the meters and rapidly calculate, display, and record the rf power flow. The method has the advantage that the exact measuring point on the feed line is not critical in contrast to methods employing direct impedance measurements. Also, the required measurements can be made without interfering with the exposure tests.

5077 LOW-LEVEL M'CROWAVE INTERACTION WITH ISOLATED MAMMALIN HEARTS. *(Eng.)* Olson, R. G.; Durney, C. H.; Lords, J. L.; Johnson, C. C. *In: Microwave Power Symposium 1975 Proceedings held May 28-30, 1975 at University of Waterloo, Waterloo, Ontario, Canada.* International Power Institute. (Edmonton, Alberta, Canada): pp. 76-78; 1975. (2 refs)

The effect of low-level microwave energy on isolated rat heart preparations was studied. The isolated heart preparations were back-perfused through the aorta with a pumped, oxygenated, and heated mammalian Ringer's solution. Microwave energy was applied to the heart using a stripline configuration that opened into parallel plates between which the heart was placed. The heart was allowed to stabilize for 30 min, and microwave power was applied during a 30-min period following stabilization. Within 2 min after the application of 1.5-2.5 mW/cm^3 absorbed

power (calculated from liquid crystal optical fiber temperature probe measurements), a pronounced bradycardia occurred. In some experiments, the heart rate showed a regular decrease to a value of 15-40% below the pre-irradiation rate; in other experiments, temporary cessations of heart contractions, lasting from 5-12 sec, occurred. In instances when transitory bradycardia was observed, the heart rate initially slowed and then returned to the pre-irradiation value within 2-8 min during irradiation. Bradycardia was not expected as a result of the application of microwave power because heating of any consequence would be expected to produce tachycardia.

5078 THE OCULAR LENS AND CATARACT. *(Eng.)* Michaelson, S. M.; Magin, S. W. *In: Microwave Power Symposium 1975 Proceedings held May 28-30, 1975 at University of Waterloo, Waterloo, Ontario, Canada.* International Microwave Power Institute. (Edmonton, Alberta, Canada): pp. 111-112; 1975. (0 refs)

The relationship between microwave exposure and cataract development in the human is discussed. Although cataracts have been produced in some animals after exposure to microwaves at certain power density/time relationships, there is no unequivocal case of a microwave-induced cataract in humans. Investigations, which may prove useful in clarifying the possible role of microwave exposure in human cataractogenesis, should concern the following: the incidence of the principle types of cataracts as a function of age, sex, and occupation; the frequency of cataract occurrence; thermal influences on the lens (i.e., infrared, microwave); the effect of other radiant energy influences on the lens; similarities and differences between cataracts produced by physical agents, chemicals, degenerative or metabolic diseases, and senility; an analysis of latency periods and cumulative effect versus threshold; and a review and analysis of literature on radio frequency- and microwave-induced cataracts.

5079 ELECTRON MICROSCOPIC EVALUATION OF THE LENSES OF RABBITS EXPOSED TO LONG-TERM 2450 MHZ CONTINUOUS MICROWAVE ENERGY AT 10 MW/CM^2. *(Eng.)* Williams, P. J.; McKee, A.; Finch, E. D.; Fulk, D. W. *In: Microwave Power Symposium 1975 Proceedings held May 28-30, 1975 at University of Waterloo, Waterloo, Ontario, Canada.* International Microwave Power Institute. (Edmonton, Alberta, Canada): pp. 113-114; 1975. (0 refs)

An electron microscopic evaluation of eye lens damage in New Zealand white male rabbits exposed to long-term continuous microwave energy at a frequency of 2,450 MHz and a power field density of 10 mW/cm^2 was performed. The exposures were given repeatedly, usually from 1-2 hr/day, 5 days/week, for a total of 175 hr of exposure over a period of 7 mo. At the end of the experiment, nine irradiated animals could not be distinguished from three controls on the basis of slit-lamp biomicroscopy. However, when sections of the lenses were examined by scanning and transmission electron microscopy, changes in the posterior subscapular and equatorial regions of irradiated lenses were observed. These alterations consisted of local vacuolization of fibers and densification and reduplication of fiber membranes.

5080 ENERGY DEPOSITION IN HOMOGENEOUS AND MULTILAYER TISSUE SPHERES AND EFFECT OF CIRCULATION. *(Eng.)* Schwan, H. P.; Kritikos, H. N. *In: Microwave Power Symposium 1975 Proceedings held May 28-30, 1975 at University of Waterloo, Waterloo, Ontario, Canada.* International Microwave Power Institute. (Edmonton, Alberta, Canada): pp. 5-9; 1975. (0 refs)

Calculations on the normalized absorption differential crossection (NADC) (i.e., ratio of absorbed power volume density to incident power surface density) caused by microwaves impinging on spherical models of man's head were performed. The relative peak of the NADC occurred near the center of the sphere; for a small sphere (radius of 5 cm) at a radiation frequency of about 1,000 MHz, the peak became pronounced and was approximately the same (1 cm^{-1}) for both uniform and multilayer spheres. Temperature elevation calculations for the case where a sphere with a radius of 5 cm was irradiated with an incident power of 10 mW/cm^2 (1,000 MHz frequency) indicated a peak temperature rise of 0.5 C (blood and tissues), assuming normal blood flow. This peak temperature rise occurred in approximately 600 sec. A peak temperature rise of 1.2 C under similar conditions was calculated for the case where no blood flow exists, indicating the importance of blood flow as a convective mechanism for the removal of heat. These findings infer that the potential hot spots occurring at the 10 mW/cm^2 incident power level do not necessarily pose a serious hazard.

5081 A MODEL FOR THERMAL CATARACTOGENESIS. *(Eng.)* Foster, M. R. *In: Microwave Power Symposium 1975 Proceedings held May 28-30, 1975 at University of Waterloo, Waterloo, Ontario, Canada.* International Microwave Power Institute. (Edmonton, Alberta, Canada): pp. 115-116; 1975. (0 refs)

A physical model for microwave heating in the eye is presented based on the assumption that cataracts are the result of a lesion produced when the temperature in the eye exceeds a critical value, called the lesion temperature. Using a sphere to approximate the vitreous body as a heat sink, the heat diffusion equation of this lossy dielectric, with an internal heat source and fixed peripheral temperature, is solved. The solution gives the steady-state transient temperature distribution (time constant of approximately 1 min) in this spherical model of the eye. A hyperbolic threshold-for-damage curve is derived from plotting power absorbed against exposure duration. The curve results from a linear

rise in temperature with respect to time for exposure durations, which are short compared with the time constant (assuming a critical lesion temperature). For exposure times which are long in comparison to the time constant, the temperature rise of the heat sink (which results from a rise in temperature of the blood of the entire animal), if linear, again results in a hyperbolic curve but with a different slope. Although the problem becomes more complicated by involving a physiologic response of the animal, the peripheral circulation must be included in the analysis of the thermal dose to the eye proper for exposure times which are long compared with the time constant. A significant fraction of the heat will be convected away from the eye proper, and experimental measurements of blood flow are, therefore, needed. *It is also concluded* that the relationship between the biologic stress associated with elevated temperature and the magnitude of the temperature elevation should be studied experimentally.

5082 LIGHT AND ELECTRON MICROSCOPIC OBSERVATIONS ON HAMSTERS AFTER MICROWAVE IRRADIATION. *(Eng.)* Albert, E. N. *In: Microwave Power Symposium 1975 Proceedings held May 28-30, 1975 at University of Waterloo, Waterloo, Ontario, Canada.* International Microwave Power Institute. (Edmonton, Alberta, Canada): pp. 125-126; 1975. (0 refs)

Histologic and electron microscopic observations on Chinese hamster brain, liver, and heart after whole body irradiation at power densities of 10, 25, and 50 mW/cm^2 and frequencies of 1,700, 2,450, and 3,000 MHz are reported. The hypothalamus seemed the most susceptible brain tissue to microwaves; while the cerebral cortex, cerebellar cortex, thalamus, pons, medulla, and spinal cord were resistant to microwave radiation at the above parameters. After fixation, sectioning, and staining of brain sections, the neurons of the hypothalamus showed vacuolation and chromatolysis. *Some axonal degeneration*, dendritic swelling, and vascular congestion were also observed. Electron microscopic studies of the liver revealed that the mitochondria of hepatocytes were swollen, their cristae disrupted, and dense granules present in their matrix. All of these observations are signs of injury and cell death. Adenosine triphosphate levels, however, were no different in experimental and control animals. Myocardial cells exhibited swelling of the endoplasmic reticulum and disruption of the myofibrillae.

5083 OCULAR EFFECTS OF 35 AND 107 GHZ CW MICROWAVES. *(Eng.)* Birenbaum, L.; Kaplan, I. T.; Rosenthat, S. W.; Metlay, W.; Zaret, M. M. *In: Microwave Power Symposium 1975 Proceedings held May 28-30, 1975 at University of Waterloo, Waterloo, Ontario, Canada.* International Microwave Power Institute. (Edmonton, Alberta, Canada): pp. 105-110; 1975. (4 refs)

The ocular effects of 35- and 107-GHz continuous wave microwave exposures on anesthetized rabbits were investigated. The animals were positioned with the eye in gentle contact with the rim of a circular horn applicator (1.27 cm in diameter). The waveguide tuner was adjusted to cancel reflections from the eye; the power level was adjusted to the desired level; and the eye was irradiated for a predetermined time interval. A total of 67 animals were exposed to 35 GHz over exposure times ranging from 15-80 min. Powers entering the eye varied from 5-50 mW. Observable damage to the corneal epithelium (outermost cellular layer) occurred at absorbed power levels of 5 mW or more and for exposure times of 30 min or more at 35 GHz. This damage was reversible at power levels of 50 mW or less. An absorbed power level of 50 mW and an exposure duration of 30 min produced injury not only to the corneal epithelium but also to the underlying stroma. A definite threshold power level (not specified) as a function of exposure time existed for stromal injury. A similar threshold was not found for epithelial injury; in this case, the extent of injury decreased with decreasing absorbed power but was still present after 30-min exposures to 5 mW. The results of exposures at 107 GHz are currently being evaluated.

5084 NEUROENDOCRINE AND CARDIODYNAMIC RESPONSE OF THE DOG SUBJECTED TO CRANIAL EXPOSURE TO 2450 MHz MICROWAVES. *(Eng.)* Lu, S.; Jones, J.; Pettit, S.; Lebda, N.; Michaelson, S. *In: Microwave Power Symposium 1975 Proceedings held May 28-30, 1975 at University of Waterloo, Waterloo, Ontario, Canada.* International Microwave Power Institute. (Edmonton, Alberta, Canada): p. 63; 1975. (0 refs)

Neuroendocrine and cardiodynamic responses of the dog subjected to localized cranial microwave exposure (2,450 MHz continuous wave, 40 mW/cm^2) revealed an alteration in threshold for excessive skin (paradoxical) cooling. This level of microwave exposure affected heat conservation by causing a decrease in peripheral circulation and consequently a decrease in heat loss to the environment. Thus, an activation of the heat conservation center in the microwave-exposed animal was demonstrated. Measurement of growth hormone levels confirmed earlier observations that exposure of the head to a power of 40 mW/cm^2 influences growth hormone release and/or degradation. Under the same conditions of anesthetization and microwave exposure, secondary changes in T4 levels were evidenced by a deviation from the effects of anesthesia.

5085 ELECTROMAGNETIC THAWING OF FROZEN GRANULOCYTES. *(Eng.)* Burns, C. P.; Burdette, E. C.; Popovic, V. P. *In: Microwave Power Symposium 1975 Proceedings held May 28-30, 1975 at University of Waterloo, Waterloo, Ontario, Canada.* International Microwave Power Institute. (Edmonton, Alberta, Canada): pp. 105-110; 1975. (5 refs)

An electromagnetic process for thawing frozen granulocytes is described. By placing different

dielectric materials in a 3-inch by 6-inch rectangular horn designed for operation at 2,450 MHz, an effective match was obtained for thawing a 2-inch by 6-inch bag of frozen white blood cells. A larger flared rectangular horn was similarly constructed for thawing 3-inch by 9-inch clinical bags. The use of a powdered dielectric consisting of a combination of silicon dioxide and titanium dioxide allowed the blood bag to be in direct contact with the dielectric and resulted in rapid and uniform thawing of bags of frozen rat and human granulocytes, monocytes, and lymphocytes. In vitro viability and phagocytosis tests were performed on granulocytes and monocytes, and a trypan-blue dye-exclusion analysis was performed on lymphocytes. Positive results were obtained in each case for lymphocyte viability and in a number of cases for granulocyte and monocyte viability. Experiments to determine the sensitivity of white blood cell viability to variations in exposure time, power level, and total energy absorbed revealed that optimum results were obtained when a relatively rapid thawing rate was used at a power level not so high as to cause a thermal runaway condition. A power level of approximately 300 W with an exposure sequence of 10 sec "on" and 10 sec "off" yielded the greatest numbers of viable cells. For cells frozen to -70 C, about 40 sec of "on" time was needed; cells frozen to liquid nitrogen temperature required 70-90 sec of "on" time, depending on dimethylsulfoxide (a cryoprotectant added to the blood before freezing) concentration and cell concentration. Freezing and microwave thawing techniques are useful for maintaining long-term supplies of granulocytes which can be used for treating leukopenia in cancer patients receiving anticancer drug therapy.

5086 BIOLOGICAL ALTERATIONS OBSERVED UNDER MICROWAVE IRRADIATION. *(Eng.)* Deficis, A.; Dumas, J. C.; Laurens, S. *In: Microwave Power Symposium 1975 Proceedings held May 28-30, 1975 at University of Waterloo, Waterloo, Ontario, Canada.* International Microwave Power Institute. (Edmonton, Alberta, Canada): pp. 48-58; 1975. (9 refs)

Biological alterations observed in Swiss male mice exposed to microwave radiation (300 mW, continuous wave) in cylindrical cavities were investigated. Irradiations were given during 9 nights over 15-hr periods/24-hr cycle. Microwave irradiation at a frequency of 3 GHz increased the total dose of the curar drug, gallamine (administered via 500 µg/ml/min intraperitoneal perfusions) required to produce the appearance of breathing spasms and definitive breath stops in 150 mice. Experiments in which sheep red blood cell antibodies were induced in 380 mice, which were exposed to different microwave frequencies, indicated that the antibody rate was generally not modified by irradiation. However, it increased slightly at frequencies of 2.4 and 3.9 GHz and decreased considerably at 4.9 GHz. Studies of the granulopectic activity of the reticulo-endothelial system (RES) in 520 mice revealed that microwave exposure usually resulted in a decrease in the phagocytosis activity of the RES. A clear decrease in the corrected granulopectic index was noted at a frequency of 2.4 GHz. It was concluded that the tests on more than 1,000 animals show a non-negligible effect of weak electromagnetic waves on the mouse.

5087 EFFECTS OF RF FIELDS ON NERVOUS ACTIVITIES. *(Eng.)* Kritikos, H.; Takashima, S.; Schwan, H. P. *In: Microwave Power Symposium 1975 Proceedings held May 28-30, 1975 at University of Waterloo, Waterloo, Ontario, Canada.* International Microwave Power Institute. (Edmonton, Alberta, Canada): pp. 64-65; 1975. (0 refs)

The effects of low frequency and radiofrequency fields (10 Hz to 30 MHz) on the nervous activity of isolated single axons (300-800 micron in diameter) from squids and myxicolas were investigated. The field was applied to axons directly by the use of platinum electrodes at low frequencies; at high frequencies, capacitive coupling was used within a small cavity. Observations of the firing of action potential over frequencies of up to 10-20 kHz for squid axons and 2-5 kHz for myxicola axons revealed that such firings depended on the carrier frequency but not on the repetition rate of pulses provided that the pulse interval was longer than the refractory period and that the pulse duration was not too short. The cutoff frequency of the firing for pulsed fields was about the same (not specified) as that for continuous waves. Thus, pulsed fields do not appear to be particularly effective in triggering action potentials from isolated single nerve axons. Attempts to excite nerve axons above these cutoff frequencies up to a frequency of 30 MHz generated negative results. Nerve activity in the presence of alternating current (AC) fields was studied by first triggering action potentials by direct current (DC) pulses and then applying AC fields in addition to the DC field. The threshold voltage and the height of action potential were used as the criteria for the effect of AC fields. No attenuation of action potentials and no elevation of threshold voltage was observed in the presence of pulsed AC fields. However, if a large current was applied, the AC field became rectified due to nonlinear electrode processes; and a frequency modulation of firing was observed under these conditions. The application of AC fields under conditions where the calcium concentration in the external medium was low appeared to change the rate of spontaneous firing induced by the low calcium concentration. The significance of this observation remains to be clarified by statistical analysis.

5088 LOW LEVEL MICROWAVE EFFECTS ON THE TOTAL IRON BINDING CAPACITY OF PREGNANT RATS. *(Eng.)* Travers, W. D.; Vetter, R. J. *In: Microwave Power Symposium 1975 Proceedings held May 28-30, 1975 at University of Waterloo, Waterloo, Ontario, Canada.* International Microwave Power Institute. (Edmonton, Alberta, Canada): pp. 59-62; 1975. (2 refs)

The effect of low level microwave exposure on the

total iron binding capacity (TIBC), and thus serum protein transferrin level, of pregnant rats was investigated. Starting on the 6th day of pregnancy, rats were exposed daily for 15 days to 0, 5, or 25 mW/cm^2 of 2,450 MHz continuous wave microwave radiation over exposure periods of 10 or 20 min. Serum iron and unsaturated iron binding capacity (UIBC) were determined by light spectroscopic analysis of blood samples that were taken intracardially before irradiation (day 5 of pregnancy) and following exposure periods on days 10, 15, and 20 of pregnancy. Elevation of the TIBC was found to occur with increasing power density. A significant drop in TIBC (apparently due to stress) after 5 days of irradiation was observed in animals exposed to 0 or 5 mW/cm^2 of microwave. This drop was observed both for animals receiving 10-min and 20-min exposures. Animals receiving either 10-min or 20-min exposures to 25 mW/cm^2 of microwave power did not demonstrate this initial decline in TIBC, and the animals exposed to 25 mW/cm^2 for 20-min durations showed a statistically significant increase in TIBC. The serum iron component of the TIBC varied almost directly with the TIBC. The UIBC levels of animals exposed to 25 mW/cm^2 were significantly higher after 5 days than those of animals exposed to 0 and 5 mW/cm^2. Increased TIBC levels following 15 days of exposure to either 5 or 25 mW/cm^2 microwave power levels indicated an increase in the level of the protein transferrin. This suggests that the microwave exposure stimulated protein synthesis.

5089 A NEW TECHNIQUE FOR MEASURING POWER DEPOSITION PATTERNS IN PHANTOMS EXPOSED TO EM FIELDS OF ARBITRARY POLARIZATION--EXAMPLE, THE MICROWAVE OVEN. *(Eng.)* Guy, A. W.; Webb, M. D.; McDougall, J. A. *In: Microwave Power Symposium 1975 Proceedings held May 28-30, 1975 at University of Waterloo, Waterloo, Ontario, Canada.* International Microwave Power Institute. (Edmonton, Alberta, Canada): pp. 36-47; 1975. (2 refs)

A technique for measuring power deposition patterns in phantoms exposed to electromagnetic fields generated by microwave ovens was developed using bisected models. The models were fabricated of styrofoam and were filled with synthetic biologic tissue. Each half section of the model was covered with a silk screen so that good adhesion and electrical coupling could be achieved between the two hemispheres. Several models with the electrical properties of human or beef muscle were constructed in the form of spheres ranging from 6-14 cm in diameter and ellipsoids with axial ratios of 2:1 and lengths of 17.2 cm. The models were exposed to microwave fields in three different microwave ovens, including two operating at a frequency of 2,450 MHz and one operating at a frequency of 918 MHz. Each intact model was exposed in each oven for 5-60 sec, and thermograms of the plane of separation were taken before and after exposure of the phantom model. Scans were made of the half models corresponding to the three major planes of orientation. Up to 50 thermogram rasters were stored on a magnetic disk memory unit, and photographs were taken of intensity, profile, and single scans for each case. The net power to the oven and the maximum absorbed power density was calculated from the thermograms. The absorbed power density at various locations in the model was estimated by comparing the various heights of the profile to the maximum height, which is equivalent to the maximum absorbed power density. The data indicate a pronounced focusing of the cavity fields into the center of the smaller spheres; they also show a marked superiority of the 918 MHz oven in terms of power penetration and absorbed power uniformity in the larger objects.

5090 THE GENERATION OF ACOUSTIC SIGNALS IN MATERIALS IRRADIATED WITH MICROWAVE PULSES --A THEORETICAL ANALYSIS. *(Eng.)* Borth, D.; Cain, C. *In: Microwave Power Symposium 1975 Proceedings held May 28-30, 1975 at University of Waterloo, Waterloo, Ontario, Canada.* International Microwave Power Institute. (Edmonton, Alberta, Canada): pp. 95-98; 1975. (0 refs)

A theoretic analysis of the stress gradients produced in materials irradiated with electromagnetic energy was conducted by solving a one-dimensional nonhomogeneous wave equation for liquids confined to planer geometries. A closed-form solution was found that consisted of a stationary part, whose effect is important only in the immediate region of the incident electromagnetic wave, and a traveling part, which propagates unattenuated through an ideal liquid. To qualify these results, a numeric example using physiologic saline was considered, and it became apparent that thermal expansion was approximately four orders of magnitude more effective than radiation pressure in converting electromagnetic energy to acoustic energy. A study on the effect of varying incident microwave pulse widths on the power spectral density of the induced acoustic wave was conducted for a 3 GHz microwave pulse incident on a constrained surface with a peak transmitted intensity of 10 W/cm^2 and a distance of 10 cm within the liquid. Pressure waveforms generated by thermal stress alone were obtained for microwave pulse widths of 1, 10, and 100 μsec, and the frequency dependence of the acoustic waveforms on microwave pulse width was obtained by taking the Fourier transform of the stress waveforms and then normalizing the results. These results may be useful in interpreting the conflicting reports concerning the dependence of the auditory thresholds for microwave pulses on microwave pulse width and microwave pulse energy.

5091 STRIPLINE TECHNIQUES IN THE STUDY OF MICROWAVE BIOLOGICAL EFFECTS ON ISOLATED NEURAL PREPARATIONS. *(Eng.)* Seaman, R. L.; Wachtel, H.; Joines, W. T. *In: Microwave Power Symposium 1975 Proceedings held May 28-30, 1975 at University of Waterloo, Waterloo, Ontario, Canada.* International Microwave Power Institute. (Edmonton, Alberta, Canada): pp. 99-102; 1975. (0 refs)

The use of stripline for studying the effects of microwaves on isolated neural preparations is dis-

cussed. Holes in the ground conductor of the stripline allow for direct access to the preparation during irradiation and illumination. Absorbed power within the sample is obtained as a function of input power to the stripline. Intracellular recordings from neurons of the marine mollusk *Aplysia* revealed that endogenous patterns of electrical activity exhibited by certain neurons were sensitive to absorbed power levels of a few mW/cm^3. A preliminary study indicated that synaptic efficiency may be affected by absorbed powers on the order of 10 mW/cm^3. A study was also made to determine the effect of microwaves on a photo response by the Limulus eye, with recordings being made with a suction electrode from the optic nerve of an excised eye. The study indicated that microwaves down to levels of a few mW/cm^3 influence neural output. The most important advantage of using the stripline irradiation techniques is that the power to the preparation and the electrical activity of the preparation are monitored during irradiation, thus providing information about direct action on the preparation. The extremely low leakage from the stripline allows for essentially artifact-free electrical recording.

5092 EFFECT OF MICROWAVE FIELD ON MUSCLE CONTRACTION. *(Eng.)* Chou, C. K.; Guy, A. W. *In: Microwave Power Symposium 1975 Proceedings held May 28-30, 1975 at University of Waterloo, Waterloo, Ontario, Canada.* International Microwave Power Institute. (Edmonton, Alberta, Canada): pp. 79-86; 1975. (4 refs)

In vitro experiments of the effects of microwaves on isolated rat diaphragm muscle in a modified S-band waveguide are reported. The muscle was fixed at one end of the waveguide and connected to a tension transducer with a sensitivity of 1 V/10 g of force at the other. In one series of experiments, the isolated muscle at the center of the waveguide was exposed to 2,450 MHz microwave pulses producing peak power absorption densities of 0.3, 3, 30, and 220 kW/kg. The pulse widths were 1 and 10 μsec with recurrence rates of 1,000 and 100 pulses/sec, respectively. Continuous waves were also applied, producing absorbed power densities of 0.3, 3, 30, 300, and 1,500 W/kg in the muscle preparation. Tests for possible direct influence of microwave fields on muscle tension were performed in the absence of electrical stimulation with average absorbed microwave power densities of 1,500 W/kg for continuous wave and 220 kW/kg peak for pulsed fields. Exposure of isolated rat diaphragm muscle to either continuous wave or pulsed microwave power did not result in either amplitude or time course changes in contractile tensions induced by electrical stimulation when the temperature of the solution was held constant at 37 C. There were also no observed changes in muscle tension during continuous or pulsed microwave exposure when the electrical stimulation was turned off. At the maximum applied power levels, the muscle twitches were smaller in amplitude and shorter in latency; this was consistent with a 1 C rise in the bathing solution temperature. After irradiation was discontinued and the temperature returned to 37 C, the time course of the twitch was restored, but a complete recovery of the amplitude was not observed for either heat- or microwave-mediated changes. During tetanic contractions, neither continuous nor pulsed microwave irradiation produced any effects on the tensile characteristics of the muscle.

5093 MEDICO-SOCIAL ASPECTS OF LABOR PERFORMED WITHIN THE RANGE OF ELECTROMAGNETIC HIGH FREQUENCY RADIATION. *(Pol.)* Korniewicz, H. (No affiliation given). *Ochrona Pracy* (12): 6-7; 1976. (0 refs)

Regulations dealing with the protection of individuals employed within the range of high frequency electromagnetic radiation are discussed. In 1963, the chief contraindications for work exposure to microwave radiation were determined, and the general medical certification procedures leading to temporary or permanent removal of a worker in the event of certain medical contraindications were introduced. A complementing regulation consisted of gynecologic examination (1x/yr) and electroencephalogram (1x every 5 yr), apart from general checkups, ophthalmologic, neurologic examinations, laboratory tests and electrocardiogram. Physicians were also expected to certify whether individuals with impairments could continue to work or could be shifted to a substitute occupation in the same plant. A system of prophylactic shift rotation, which would accommodate the interests of industry and workers, was suggested.

5094 BIOPHYSICAL ASPECTS OF HIGH WAVELENGTH ELECTROMAGNETIC RADIATION. *(Ita.)* Carletti, L. (Servizio di Fisica Sanitaria, Ospedale Civile di Padova, Padova, Italy); Avanzo, R. C. *Quad Radiol* 40(3): 171-187; 1975. (11 refs)

The biological effects of electromagnetic radiation are best understood by considering the chemical components of living matter and the fundamental physical processes that take place within matter. The interaction of cellular molecular structure and function that interplay with electromagnetic radiation of different wavelengths are described. The study of radiation-living matter interactions distinguishes three types of radiation. High energy electromagnetic radiation, which is far greater than the biomolecular ionizing radiation, essentially affects the atomic electrons, produces photoelectric and Compton-effects, and creates electron couples. Charged particle radiation ionizes and directly excites, producing the same effects as high energy electromagnetic radiation. Neutral particle radiation collides with the nuclei and essentially creates charged energy particles, which ionize and excite by coulomb interaction. When the radiation's energy is high and greater than that of the cell's levels of electronic and molecular excitation, destructive molecular eruptions and excitation occur. Also damaging are the eventual chemical reactions, which may occur with the highly reactive biomolecular fragments. When

exposed to low energy electromagnetic radiation, the biomolecules usually acquire, in part or completely, the photon's energy without damaging effects. A new device, the R.S. 25, is described which produces electromagnetic radiation and is especially appropriate to study the principles described.

5095 CONDITIONED TASTE AVERSIONS IN THE RAT INDUCED BY A SINGLE EXPOSURE TO MICROWAVES. *(Eng.)* Lovely, R. H.; Guy, A. W. *In: Microwave Power Symposium 1975 Proceedings held May 28-30, 1975 at University of Waterloo, Waterloo, Ontario, Canada.* International Microwave Power Institute. (Edmonton, Alberta, Canada): pp. 87-94; 1975. (18 refs)

Conditioned taste aversions were induced in Wistar rats by single exposures to microwaves. After an adaptation period, rats in individual cages were presented with 0.1% sodium saccharin in water during a 20-min drinking period. Immediately following the drinking session, six rats each were either sham-irradiated or were exposed for 10 min to 918 MHz continuous wave microwave radiation at incident power densities of 5, 20, 25, 30, 35, 40, and 45 mW/cm^2. The day after the microwave exposure, each rat in each group was given a two-bottle preference test between water and saccharin. Sham-irradiated rats as well as rats exposed to 5 and 20 mW/cm^2 microwave power showed strong saccharin preferences, while those exposed to incident power densities of 25 mW/cm^2 or more showed a significant decrease in saccharin consumption, drinking only half as much as the control rats. The above behavior effects appeared to correlate with peak absorbed power densities of approximately 22.5 W/kg.

5096 CHANGES OF BACKGROUND AND EVOKED RHYTHMS OF BRAIN POTENTIALS IN RABBITS IN A STRONG STATIC MAGNETIC FIELD. *(Rus.)* Smirnova, N. P. (Moscow, USSR); Klimovskaia, L. D. *Zh Vyssh Nerv Deiat* 26(2): 403-410; 1976. (7 refs)

Rabbits with electrodes implanted in the sensorimotor and optic regions of the cerebral cortex, in the dorsal hippocampus, in the preoptic region, in the medial parts of the hypothalamus, in the reticular formation of the midbrain, and in the vermis cerebelli were exposed to a static electromagnetic field of 1,000-4,000 Oe intensity for 1 hr to study the background and light flash-induced brain potentials. Intensification of the bioelectrical activity, especially in the range of the alpha- and beta-frequencies, was observed, while there were no marked changes in the intensity of the delta- and theta-rhythms. This effect intensified with increasing field intensity. Exposure to 1,000 Oe tended to facilitate the photic driving after stimulation with a flashing light with a frequency increasing from 2 to 24 Hz. The driving reaction was weakened by exposure to 3,000 Oe, but it was rapidly restored after cessation of the exposure.

5097 USE OF DIADYNAMIC CURRENTS IN THE TREATMENT OF INJURIES OF JOINTS. *(Rus.)* Zaremba, S. I. (Lvov Div. Railroad Hosp., Lvov, USSR); Keselman, S. A. *Vopr Kurortol Fizioter Lech Fiz Kult* (3): 33-34; 1976. (6 refs)

A total of 146 patients with trauma (contusion with or without hemarthrosis and sprain) of the joints of the hands, legs, and feet were treated with diadynamic current. (Specific data not reported). The cathode was applied to the traumatized area. The patients received five to ten treatments. Continuous current was applied for 2 min and intermittent current, for 2 min. The direction of the current was changed because of pain or other conditions. As a result of the treatment 111 patients were cured, and 30 improved. The findings indicate the therapeutic effectiveness of diadynamic current in the treatment of traumas of the joints.

5098 EFFECT OF STATIC ELECTRICITY ON THE HUMAN ORGANISM UNDER THE CONDITIONS PREVAILING IN THE CITY OF FRUNZE. *(Rus.)* Manuilenko, Iu. I. (Kirgiz Scientific Res. Inst. of Epidemiology, Microbiology, Hygiene, Frunze, USSR); Frolov, A. F.; Zimskaia, Z. G. *Zdravookhr Kirg* (1): 11-14; 1976. (0 refs)

The health status of workers exposed to high static electricity in a knitting mill was studied. Charge densities of 6-16 μCoulombs/m^2 were measured on the workers' body. Negative potentials of 300-900 V were measured on their shoes and clothes, and the corresponding charge densities were 2-3 μCoulombs/m^2. Many workers complained about headache (54.5%), irritability (51.2%), epicardial pains (50.3%), sleep disorders (34.4%), and epigastric pains (29.5%). The medical investigations revealed pathologic changes of the nervous system (vegetative-vascular dystonia, impaired visual acuity, conjunctivitis, blepharitis, and keratitis) in 31.1%, diseases of the ear, nose and throat in 28.4%, cardiovascular diseases (hypertension, hypotension, myocardiac dystrophy, sclerosis of the coronary and cerebral vessels) in 23.5%, and respiratory diseases in 8.7%.

5099 EFFECT OF IMPULSE ELECTRICAL CURRENT ON REPARATIVE REGENERATION OF THE BONE TISSUE. *(Rus.)* Landa, V. A. (N. N. Priorov Central Inst. Traumatology and Orthopedics, Moscow, USSR); Poliakov, A. N.; Baranov, V. K. *Ortop Travmatol Protez* (10): 55-59; 1976. (14 refs)

The effect of weak pulsed current (5-15 mA, pulsed duration 1 sec at 4-sec intervals) on reparative regeneration of the resected diaphysis of the radius was studied in rabbits. The cathode or the anode was placed into the bone defect, and the other electrode was placed 1.5 mm from the edge of the defect. Starting 2-3 days after traumatization, the animals were treated 1-1.5 hr daily five times a wk for 21 days. With the cathode in the bone defect, current of 8-10 mA intensity had pronounced stimulating effect on osteogenesis, which manifested in an in-

creased amount of bony tissue at the expense of cartilaginous and fibrous tissue. There was, however, no change in the maturation and mineralization processes compared with the control. The stimulating effect was less marked at a current intensity of 5-8 mA. Stimulating effect was also observed at a current intensity of 11-15 mA with the anode placed in the bone defect, but it was accomplished by suppurative and inflammatory processes at the implantation site. The incidence of these processes increased with the current intensity.

5100 LONG-TERM CONTROL OF MYOCARDIAL THRESHOLD MEASURED BY MEANS OF A RADIOFREQUENCY SYSTEM (RADIOCOR) DESIGNED FOR IMPLANTATION IN SERIES WITH ANY KIND OF PACEMAKER. *(Ita.)* Rossi, P. (Divisione di Cardiologia, Ospedale Maggiore della Carita, Novara, Italy); De Bellis, F.; D'Aulerio, M.; Ellena, O.; Calafiore, A. M. *Minerva Cardioangiol* 24(10): 705-710; 1976. (15 refs)

A radio frequency system, Radiocor, was implanted in series within various types of pacemakers in 685 patients to monitor the chronic threshold of myocardial stimulation. The threshold was determined every 15 days or 3 mo for 1 to 4 yr. The pacemakers were also calibrated by direct threshold measurement upon implantation or replacement. Marked chronic threshold variations were observed during the first few days after implantation. There was an excellent correspondence between the two monitoring methods. The Radiocor was sensitive to within 0.1 mA. A constant chronic threshold of 3.6-9.5 mA was observed in 240 patients. The threshold displayed moderate transitory variations of about 20% in 50 patients and marked fluctuations of about 40% in 25 patients. The latter group was treated with cortisone, and the threshold stabilized in 18 cases. There was a progressive increase in the chronic threshold in 35 patients. The Radiocor can be used as an emergency stimulator in case of a pacemaker breakdown or to treat arrhythmia.

5101 UHF TREATMENT AND CALCIUM ELECTROPHORESIS IN THE THERAPY OF PYELONEPHRITIS IN CHILDREN. *(Rus.)* Gromova, V. N. (Moscow Inst. Fediatrics and Pediatric Surgery, Russian SSR Ministry of Public Health, Moscow, USSR); Korovina, N. A.; Orlova, G. I.; Nikitinskaia, L. S. *Vopr Kurortol Fizioter Lech Fiz Kult* (2): 39-42; 1976. (16 refs)

A total of 58 children 3-12 yr of age with primary pyelonephritis were treated with ultra high frequency (UHF) radiation in 10-12 sessions of 7-10 min each. The electrodes were separated from the dorsal and ventral skin surfaces by air gaps and 2-3 cm. The UHF treatment caused a decrease in the urine leukocyte count in 25/28 patients with moderate leukocyturia, while the urinary erythrocyte count remained normal. An initial increase in leukocyturia was of no significance for the therapy result. Significant increase was observed in the ammonia and hydrogen ion clearance in 26/32 patients investigated after the treatment. Disappearance of dysuria and abdominal pains, and increased minute diuresis were also observed. The findings indicate the therapeutic effectiveness of UHF irradiation in patients with primary pyelonephritis.

5102 CLINICAL EPIDEMIOLOGICAL CHARACTERIZATION OF CHRONIC LYMPHOID LEUKEMIA. *(Rus.)* Plotnikov, I. K. (First Dept. Clinical Therapy, D. I. Ulianov Kuibyshev Medical Inst., Kuibyshev, USSR). *Vopr Onkol* 22(12): 69; 1976. (0 refs)

Clinical epidemiologic data are presented concerning 434 cases of chronic lymphoid leukemia registered in the Kuibyshev Oblast during the 1965-1974 period. All patients were 32-79 yr of age. The average annual morbidity rate was 1.60/100,000: 2.41/100,000 for men and 1.07/100,000 for women. The incidence of occupational exposure to petroleum products, organic dyes, exhaust gases of internal combustion engines, ionizing radiation, and to ultra high- and super high frequency fields was 1.3 times higher in the leukemia patients than in the control group.

5103 EFFECT OF SHF ELECTROMAGNETIC ENERGY AND OF CONSTANT MAGNETIC FIELD ON MUTAGENESIS IN THE PRESENCE OF ANTIBIOTICS. *(Rus.)* Danilenko, I. I. (Kiev, USSR); Mirutenko, V. I. *Elektronnaia Obrabotka Materialov* (3): 66-67; 1976. (5 refs)

The effect of super high frequency (SHF) electromagnetic fields and of constant magnetic field on mutagenesis induced by N-methyl-N-nitro-N-nitrosoguanidine (MNN) in *C. tropicalis* D-2 in the presence of puromycin was studied. Neither constant magnetic field alone nor SHF field alone had an effect on the survival of *C. tropicalis* compared with the control; however, the morphologic variability doubled. Exposure to MNN and constant magnetic field with an intensity of 500 Oe in the presence of puromycin resulted in a reduction of the survival to 43±7%, vs 67±6% without the antibiotic. The morphologic variability increased considerably with puromycin. Exposure to SHF in the presence of MNN and puromycin resulted in a reduction of the survival to 72±4% of the control value and in an increase in the morphologic variability to 72±6%. Increased percentage of prototrophic mutants was observed both in SHF and in constant magnetic fields.

5104 EFFECTS OF SOME PHYSICAL ENVIRONMENTAL FACTORS ON INDICES OF WATER-SALT BALANCE. *(Rus.)* Grin, A. N. (A. N. Marzeev Kiev Scientific Res. Inst. of General and Communal Hygiene, Kiev, USSR). *Vrach Delo* (12): 116-117; 1976. (0 refs)

The effects of super high frequency irradiation (single exposure to 500 $\mu W/cm^2$, or to 50 and 500 $\mu W/cm^2$ on 10 consecutive days) with and without artificially induced hypoxia on the water-salt balance were studied in adult albino rats. Reduction in the daily diuresis by 15%, increase in the urine pH from 6.9 to 8.0, and reduction in the total chloride con-

tent and in the chloride concentration of the urine were observed after exposure to 50 $\mu W/cm^2$ for 10 days. These changes were more pronounced after irradiation with a single 500 $\mu W/cm^2$ dose. However, irradiation with one dose at 500 $\mu W/cm^2$ 1 mo after 10 irradiations with 50 $\mu W/cm^2$ had a weaker effect on diuresis and on the urine content. While 20-min hypoxia immediately after the 10-day irradiation course failed to modify the effect of irradiation, it diminished the irradiation-induced changes when applied 1 mo after the irradiation, indicating that such irradiations render the organism less susceptible to hypoxia.

PREPRINT

5105 "EMISSION AND EXPOSURE STANDARDS FOR MICROWAVE RADIATION" (SUMMARY). *(Eng.)*
Repacholi, M. H. (X-rays and Radiation Devices Div., Radiation Protection Bureau, Health and Welfare Canada, Ottawa K1A 0L2, Canada); Stuchly, M. A. [Paper presented at the IEEE Conference and Exhibit, Toronto, Canada, September 26-28, 1977]. (4 refs)

The difficulties involved in formulating maximum permissable microwave exposure levels in Canada are discussed with reference to the differences in international microwave exposure standards (Eastern bloc and Western countries). The Federal Department of Health and Welfare's Radiation Protection Bureau proposes that for exposure to pulsed or continuous wave microwave radiation, the average energy flux shall not exceed 1 mW hr/cm^2 for whole body exposure in any one period, and the average power density shall not exceed 25 mW/cm^2. This exposure applies to the frequency range of 10 MHz to 300 GHz. Canadian maximum permissible levels are set between the US and the USSR values, since the US value does not take into consideration the large body of evidence on nonthermal effects presented by Eastern bloc countries.

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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.

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