creased in the irradiated but not in the hyperthermal group, as was the dopamine content of the corpus striatum and hypothalamus. The changes in the neurotransmitters in the brain areas were in the same direction for both irradiated and hyperthermal animals. It is suggested that these changes are a result of thermoregulation mechanisms on brain cells and not a direct effect of 1.6 GHz radiation on neuronal components. (13 refs.)

4959 A PROBE FOR MEASURING TEMPERATURE IN RADIO-FREQUENCY-HEATED MATERIAL. (Eng.) Bowman, R. R. (Electromagnetics Div., U.S. Dept. Commerce, National Bureau Standards, Boulder, CO 80302). *IEEE Trans. Microwave Theory Techniques* 24(1): 43-45; 1976.

The sensitivity, stability, and range of a newly-developed temperature probe, which measures material heated by radiofrequency fields, are discussed. The probe consists of two pairs of very-high-resistance leads connected to a small high-resistance thermistor. The thermistor resistance is sensed by injecting a constant current through one pair of leads and measuring the voltage developed across the thermistor by means of a high-impedance amplifier connected to the other pair. The design goals are described, and the performance of the test model is discussed. (9 refs.)

4960 ELECTRIC-FIELD DISTRIBUTION ALONG FINITE LENGTH LOSSY DIELECTRIC SLABS IN WAVE-GUIDE. (Eng.) Liu, L. M. (Dept. Electrical Engineering, Washington Univ., St. Louis, MO 63130); Rosenbaum, F. J.; Pickard, W. F. *IEEE Trans. Microwave Theory Techniques* 24(4): 216-219; 1977.

Calculations are presented on the magnitude of an electric field along a dielectric slab, on the transmission and reflection coefficients, and on the percentage of incident power absorbed. The biologic speciman was modeled as a lossy dielectric slab of finite length inserted along the center line of a rectangular waveguide. The magnitude squared of the electric field along the slab was calculated to predict the inhomogeneous heat input to the sample. These results were compared with experimental measurements on several materials and the pupae of *Tenebrio molitor*. (16 refs.)

4961 EFFECTS OF MICROWAVE RADIATION ON THE LENS EPITHELIUM IN THE RABBIT EYE. (Eng.) Van Ummersen, C. A. (Biology Dept., College II, Univ. Massachusetts, Harbor Campus, Boston, MA 02125); Cogan, F. C. *Arch. Opthalmol.* 94: 828-834; 1976.

To determine the effects of continuous wave microwaves on the lens epithelium, the right eye of 82 New Zealand white rabbits (4-5 mo old) was exposed for 7 min to 280 mW/cm^2 radiation at 2.45 GHz. After microwave exposure, the animals were killed at intervals from 6 hr to 1 mo. One hr before animals were killed, tritiated thymidine was injected into the anterior chamber of both eyes. Epithelial peels (74 experimental and 21 control) were made, and each irradiated and control nonirradiated eye was examined to identify and count tritium-labeled cells and mitotic figures. Comparison of counts from experimental and control lens epithelia revealed two patterns, depending on the presence or absence of vesicle strings. The lens with vesicle strings displayed a rise in DNA synthesis on the fourth to fifth day after irradiation. The lens without vesicle strings showed a suppression of mitotic activity followed by a gradual return to normal levels. (17 refs.)

4962 ANESTHESIA AS AN EFFECTIVE AGENT AGAINST THE PRODUCTION OF CONGENITAL ANOMALIES IN MOUSE FETUSES EXPOSED TO ELECTROMAGNETIC RADIATION. (Eng.) Rugh, R. (U.S. Dept. Health, Education, Welfare, Public Health Service, Food Drug Admin., Bureau Radiological Health, Div. Biological Effects, 5600 Fishers Lane, HFX-120, Rockville, MD 20852); McManaway, M. *J. Exp. Zool.* 197: 363-367; 1976.

To determine if immobilization during radiation alters the production of congenital anomalies, deaths, and resorptions, 130 pregnant mice (CF_1) were individually subjected to microwave radiation at 7.3 W for 4 min with and without anesthesia (2,450 MHz wavelength). The fetuses of irradiated but unanesthetized (free to move) mice showed the greatest damage: 32% resorption, 5.7% deaths, and 2.3% anomalies. Anesthetized mice held in one of three positions during irradiation showed the least mean absorbed dose, the lowest incidence of resorption, only one anomalous fetus, and one death. Immobilization, particularly in the broadside position, protected the fetuses against teratogenic damage from radiation. Although microwave radiation elevated the body temperature, anesthesia caused a reduction in body temperature that balanced it out and protected the mother and fetus against the thermal effects of microwave radiation. The results indicate that the primary effect of high level microwave radiation are thermal. (9 refs.)

4963 ON THE INDUCTION OF CHROMOSOMAL ABERRATIONS BY 2450 MHz MICROWAVE RADIATION (MEETING ABSTRACT). (Eng.) Leach, W. M. (Bureau Radiological Health, Food Drug Admin., U.S. Dept. Health, Education, Welfare, Rockville, MD 20852). *J. Cell Biol.* 70: 387a; 1976.

The chromosomal effects of 2450 MHz radiation were examined in Chinese hamsters (*Cricetulus grisens*). Animals were injected with 0.1% solution of Colcemid either 0.25 hr before or after, or 2 hr after irradiation (incident power density, 200 mW/cm^2, duration, 0.25 hr). Bone marrow cells were removed from femurs and prepared for mitotic and chromosomal evaluations. The mitotic index was depressed in preparations made at 5 hr from animals irradiated after injection, compared with either sham irradiated injected animals or animals irradiated prior to

injection. The overwhelmingly prevalent chromosomal response at 5 hr was chromosomal stickiness between chromosomes and sister chromatids. Chromatin bridges were also observed between nuclei suggesting that cells with chromosomal stickiness escaped the Colcemid block. In one series, such bridges were evident in 10-15% of cells completing cytokinesis. One week after irradiation, bone marrow cells from irradiated animals showed a reduction in stickiness phenomena, but chromosome structural aberrations were significantly higher than in controls. The appearance of chromosomal aberrations after microwave radiation exposure suggests that multiple mechanisms may exist for radiation breakage of chromosomes. (No refs.)

4964 ALTERATION OF BBB: A STUDY TO EXPLORE NEW THERAPY FOR CNS LEUKEMIA (ABSTRACT). (Eng.) Chang, B. K. (Dept. Medicine, Duke Univ. Medical Center, Durham, NC); Huang, A. T. *Blood* 48(6): 994; 1976.

Modification of the central nervous system with low power density microwave radiation was undertaken to facilitate drug transfer across the blood brain barrier (BBB) to circumvent the difficulties in treating meningeal leukemia. This report presents initial attempts to alter the BBB. In three dogs, the penetrance of a test substance, ^{131}I-albumin, increased transiently 4- to 10-fold over baseline values 60 min after the animals received cranial microwave radiation at density of 2 mW/cm^2. Cerebral spinal fluid (CSF) was sampled serially via a cisternal puncture, and penetrance was expressed as the ratio of CSF to plasma concentrations of ^{131}I-albumin (C_{CSF}/C_{plasma}). Furthermore, radiation at this density also caused a 50% increase in the uptake of ^{3}H-methotrexate (0.06-0.2 μM) by human lymphocytes, granulocytes, and leukemic cells. The data suggest that 20 min of low power density microwave radiation not only enhances entry of substances into the CSF that do not ordinarily pass the BBB but also increases the intracellular concentration of methotrexate in human leukocytes. (No refs.)

4965 CYTOGENETIC EFFECT OF VARIABLE ELECTROMAGNETIC SHF FIELD. (Rus.) Kapustin, A. A. (Kiev Scientific Res. Inst. General and Communal Hygiene, Ukrainian SSR Ministry Public Health, Kiev, USSR); Rudnev, M. I.; Leonskaia, G. I.; Knobeeva, G. I. *Tsitol. Genet.* 10(5): 400-402; 1976.

The effect of a variable super high frequency electromagnetic field with a wavelength of 12 cm and intensities of 50 and 500 μW/cm^2 on chromosome aberrations was studied in the bone marrow of inbred albino rats *in vivo*. The animals were irradiated for 10 days, 7 hr daily. Irradiation at both intensities caused a significant initial increase in the frequency of cells with chromosome aberrations, mainly in the form of polyploidy, aneuploidy, chromatid deletion, acentric fragments, and chromatid gaps. The incidence of the aberrations was higher 2 wk after the irradiation than immediately after irradiation in the group exposed to 50 μW/cm^2, but the aberration frequency decreased by the end of wk 2 in the group exposed to 500 μW/cm^2 due to the elimination of damaged cells. Hypoxia (corresponding to 8,000 m altitude for 20 min) during and after irradiation reduced the incidence of cells with chromosome aberrations. (7 refs.)

4966 CHANGES IN THE SELF-STIMULATION REACTION IN RATS UNDER THE ACTION OF MODULATED ELECTROMAGNETIC FIELD. (Rus.) Antimonii, G. D. (P. K. Anokhin Inst. Normal Physiology, USSR Acad. Medical Sciences, Moscow, USSR); Badikov, V. I.; Kel, A. A.; Krasnov, E. A.; Sudakov, S. K. *Biull. Eksp. Biol. Med.* 82(10): 1163-1165; 1976.

The effect of modulated electromagnetic field (39 MHz, field intensity 100-120 W/m; modulation frequency 2, 7, and 50 Hz) on the self-stimulation reaction was studied in 30 male and female rats with electrodes implanted in the anterior or posterior lobes of the hypophysis or in the septum. The modulation frequency of 2 Hz caused a primary increase in the self-stimulation reaction, followed by a depression. The 7 Hz frequency first failed to alter the self-stimulation reaction, and then led to a gradual reduction of the incidence of this reaction and to complete disappearance in 10 min. The modulation frequency of 50 Hz depressed the self-stimulation reaction practically from the very beginning. The above changes in the self-stimulation reaction were independent of the localization of the electrodes. (6 refs.)

4967 LOW INTENSITY MICROWAVE EFFECTS ON THE SYNTHESIS OF THYROID HORMONES AND SERUM PROTEINS (MEETING ABSTRACT). (Eng.) Travers, W. D.; Vetter, R. J. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 91; 1976.

The effects of chronic low level microwave exposure on the levels of triiodothyronine, thyroxine, and thyroid-stimulating hormone and on the serum protein composition in rats were investigated. Animals were exposed to no more than 10 mW/cm^2 of 2,450 MHz microwaves 8 hr per day for 21 consecutive days. Serum hormone levels were determined weekly by radioimmunoassay techniques, and serum protein composition was analyzed electrophoretically. The results and their significance on the low level exposure of man to microwave radiation are discussed. (No refs.)

4968 OBSERVATIONS CONCERNING BIOLOGICAL ACTIVE, NATURAL ELECTROMAGNETIC RADIATION OF EXTREMELY LOW INTENSITY (MEETING ABSTRACT). (Eng.) Szul, R.; Szul, M. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 118; 1976.

Data concerning biologically active natural electromagnetic radiation of extremely low intensity are reviewed. Existence of the natural sources of the coherent electromagnetic radiation in the frequency range of about 1,420 MHz has been stated. This radiation is supposedly generated by molecular generators exposed to geomagnetic fields. In those generators, magnetic dipole transitions occur under the influence of the perturbations of these fields. The main source of this radiation is water excited by alternating magnetic or electromagnetic fields. Other natural materials and plastics exhibit similar effects. Using indirect methods the power densities can be estimated from a dipole antenna fed with power in the range of 10^{-18} to 10^{-22} W. The shape of the radiation pattern of the field sources depends upon the mode of excitation and the shape of the source. It has been confirmed that for some power densities this radiation is attenuated very little in material media immersed in magnetic field. This phenomenon can be explained by quantum physics. The radiation reacts only with molecular and macroscopic resonant elements, causing changes of the radiated field and other parameters. It has been found that man and animals have specific centers generating coherent electromagnetic radiation in the frequency range of about 1,420 MHz that react with radiation generated by natural and artificial sources down to the threshold value of extremely low intensity. (No refs.)

4969 RADIOFREQUENCY RADIATION DOSIMETRY HANDBOOK (MEETING ABSTRACT). (Eng.) Johnson, C. C.; Durney, C. H.; Barber, P. W.; Massoudi, H.; Allen, S. J. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 119-120; 1976.

A radiofrequency radiation dosimetry handbook is described that attempted to develop theoretic methods for relating absorbed energy in man and animals to the incident radiation intensity to provide a link between biologic effects observed in irradiated animals and corresponding biologic effects that might occur in man. Homogeneous spheroidal and ellipsoidal models of humans and animals were used to calculate the data. Extensive graphs of calculated specific absorbed power versus frequency for typical monkeys, baboons, dogs, rabbits, guinea pigs, rats, mice, eggs, pupae, as well as several typical human forms in plane wave radiation were included. The handbook should prove valuable to researchers in microwave biologic effects because it will provide a convenient means of estimating the specific absorbed power in the animal in terms of the incident fields or power density, and extrapolating observed animal effect to humans. For example, an experimenter who desires to study possible effects produced in humans irradiated by a plane wave of 10 mW/cm^2 power density at 20 MHz with a specific orientation in the fields could look at a curve in the handbook and find the calculated specific absorbed power density in an average man. He could then look at other curves and find the required incident plane wave power density required to produce the same specific absorbed power density in experimental animals. As an example, the incident plane wave power density required for a mouse would be about 27 times greater than that for the man for the same average specific absorbed power. (No refs.)

4970 HYPERTHERMIA BY LOCAL EM HEATING (MEETING ABSTRACT). (Eng.) Chen, K. M.; Guru, B. S. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 139; 1976.

A study was conducted to investigate the distribution of power deposition in a biologic body with a cancerous part, when the body was illuminated partially by an electromagnetic (EM) field. It was found that the cancerous part with a lower conductivity dissipated more power, causing a high temperature increase. The scheme of heating a local region of a biologic body by utilizing the whole-body EM illumination and changing the conductivity of the local region was also studied. It was found that when the frequency of the EM field was in the range of 1 to 100 MHz, the increase of the conductivity of the local region usually caused a decrease instead of an increase in the absorbed power in that local region. It is suggested that for a microwave EM field, there may exist an optimum conductivity for the local region to gain the most effective EM heating. (No refs.)

4971 A COMPARATIVE HEATING PATTERN STUDY OF DIRECT CONTACT APPLICATORS IN MICROWAVE DIATHERMY (MEETING ABSTRACT). (Eng.) Kantor, G.; Cetas, T. C. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 139; 1976.

A comparative study of direct contact applicator heating patterns was conducted that included inhomogeneously filled rectangular waveguides, circularly polarized antennas, and other radiators appropriate for microwave diathermy. In addition, low power emitters (usually operating at power levels of less than 10 W), the only direct contact radiators presently in clinical use, were investigated. Multilayered planar and limb phantoms consisting of simulated bone (1 cm thick) and muscle material were irradiated at a frequency of 2.45 GHz, and the midplane of each phantom was then exposed to an infrared thermographic camera. Temperature profiles parallel to fat-muscle interface, as well as normal to it, were obtained to study maximum heating and depth of penetration of microwave energy in muscle tissue. The temperature profile produced in a planar phantom by an applicator, consisting of an open WR(430) rectangular waveguide partially filled with teflon slabs to excite the transverse electromagnetic mode in the unloaded middle portion, has a broad uniform center region. A birefringent crystal optical ther-

mometer was placed in the mid-plane of each phantom to obtain temperature readings and cooling rates in the region of heating. It was found that leakage radiation levels could be maintained below 5 mW/cm^2 (equivalent plane wave power density), if the applicator aperture size was considerably smaller than the phantom size. (No refs.)

4972 DUAL BEAM TEM APPLICATOR FOR DIRECT CONTACT HEATING OF DIELECTRICALLY ENCAPSULATED MALIGNANT MOUSE TUMOR (MEETING ABSTRACT). (Eng.) Cheung, A. Y.; Dao, T.; Robinson, J. E. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 140; 1976.

A microwave heating technique that employs a direct parallel to parallel opposed treatment field for use in ionizing radiation therapy is described. The sources of irradiation are two opposite-directed "TEM" applicators operating at 2,450 MHz. The applicator design consists of an open-ended rectangular waveguide, partially loaded with low loss dielectric slabs. Such a structure can support a TEM mode of propagation. The impedance mismatch generated from the TE to TEM transition and from the aperture-tissue boundary are compensated by a properly designed taper and a quarter-wave transformer. On direct contact with a tissue-equivalent slab, the TEM applicator heats uniformly in the transverse plane (± .2°C at 45°C). To test the apparatus, exposed C3H mouse tumors, 1 cm in diameter and transplanted to grow on the flank of mice, were encapsulated within simulated phantom materials with dielectric properties similar to that of the tumor to form a rectangular slab. The thickness of the slab along the direction of propagation was designed so that the super-position of two exponentially decreasing heating fields from opposite directions would generate a uniform temperature distribution. Two TEM applicators in direct contact with the slab were used to heat from opposite sides at alternate time intervals of 5-50 sec. Alternating at 30 sec, two applicators operating at 30 W for 10 min, produced a temperature of 42 ± .1°C over the entire tumor volume, compared with a 2°C front to back drop when a single applicator was used alone under the same condition. (No refs.)

4973 THE USE OF SPONTANEOUSLY OCCURRING ANIMAL TUMORS FOR PRECLINICAL TESTING OF HYPERTHERMIA TREATMENTS (MEETING ABSTRACT). (Eng.) Connor, W. G.; Roth, H. B.; McKelvie, D. H.; Wilson, S. E.; Cetas, T. C. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 141; 1976.

Tumor systems occurring spontaneously in animals are being used as experimental models for the development of heating and thermal dosimetric techniques to be used in hyperthermia treatments of human tumors. The animals, mostly dogs and cats, are referred by local veterinarians. Treatments consist of heat alone, e.g., 43°C for 30 min; x-irradiation alone, e.g., 4,000 rads/4 wk; or a combination of the two. Localized heating is induced by radio-frequency current fields (500 KHz), microwave diathermy (2,450 and 915 MHz), or shortwave (27.1 MHz) diathermy. Temperatures are monitored with a non-perturbing fiber optic thermometer incorporating a birefringent crystal as a sensor and with thermistor probes. Thermographic techniques both in phantoms and, when possible, on the actual subjects are used to determine the thermal pattern. All thermometry is tied to a laboratory standards facility, which is accurate to better than 0.01°C. The biologic aspects are supported by cell culture and laboratory animal studies in adjacent laboratories. Radiation oncologists consult regularly on the treatments. (No refs.)

4974 WHOLE BODY DOSIMETRY OF ANIMALS: THE EFFECT OF WEIGHT AND EXPOSURE GEOMETRY (MEETING ABSTRACT). (Eng.) Kinn, J. B. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 42; 1976.

Whole body energy absorption of 2,450 MHz radiation was measured in rats over a weight range of 9-440 g and in mice ranging from 30-50 g to determine the effect of weight and exposure geometry on such absorption. Simultaneous exposures of groups of animals in various configurations were made in a free field condition in an anechoic chamber. Measurements of whole body absorption were made with twin-cell calorimeters. Preliminary results indicated that the range of energy absorption may vary by a factor of 2-7 within specific weight groups. The implication of this spread on the choice of incident power levels used in dose-effect studies is discussed. Comparison of the measured dose of theoretic values produced by a spherical shell model showed considerable variations of the observed from the predicted. Specific relationships of absorbed dose to power density and size are presented. (No refs.)

4975 COMBINED EFFECT OF MICROWAVE HYPERTHERMIA AND PURIFIED BACTERIAL TOXINS ON DEVELOPMENT OF SARCOMA-180 AND GUERIN TUMORS (MEETING ABSTRACT). (Eng.) Szmigielski, S.; Bielec, M.; Janiak, M. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 141-142; 1976.

Mice with transplantable Sarcoma 180 or rats with transplantable Guerin tumor were exposed to microwave hyperthermia (40 mW/cm^2, 3 hr daily) at various periods after transplantation of the tumor to study the combined effect of microwave hyperthermia and

bacterial toxins on tumor development. Rectal temperature was measured during irradiation (liquid crystall probe), and distribution of temperatures on the body surface was observed. The animals were treated with highly purified Streptolysin O, staphylococcal phospholipase C (beta-hemolysin), or with cyclophosphamide (positive controls). The toxins were administered daily and given alone or in combination with microwave hyperthermia. Survival rate, weight and size of tumors, and incorporation rate of ^{3}H-thymidine, ^{3}H-uridine, and ^{3}H-glycine into tumor tissue were studied. Microwave hyperthermia resulted in inhibition of tumor growth in about 25-30% of animals. The combined treatment with microwave hyperthermia and Streptolysin O resulted in regression of tumors in 50-70% of animals, depending on the time schedule of the treatment. The best results were obtained in animals treated in the phase of logarithmic growth of the tumors. (No refs.)

4976 ELECTROMAGNETIC POWER DEPOSITION IN MAN AND ANIMALS WITH AND WITHOUT GROUND AND REFLECTOR EFFECTS (MEETING ABSTRACT). (Eng.) Gandhi, O. P.; Hunt, E. L.; D'Andrea, J. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 42; 1976.

Experimental results are given for electromagnetic power deposition in man models and rats in the presence of flat and 90°-corner reflectors. Whole body absorptions 5-20 times that at resonance values were observed for spacings to the reflecting surfaces accurately predicted from antenna theory. Projected energy deposition rates for man and animals subjected to incident fields of 10 mW/cm^2 are presented with and without ground and reflector effects. Resonance values as high as 3000-6000 W for adult humans are predicted. The times to convulsion of 100 and 400 g rats for incident field intensities of 5-20 mW/cm^2 confirmed some of the highest projections in the presence of reflecting surfaces. (No refs.)

4977 USE OF HEATING AND COOLING CURVES TO MEASURE MICROWAVE ENERGY ABSORPTION IN BIOLOGICAL SAMPLES (MEETING ABSTRACT). (Eng.) Allis, J. W.; Blackman, C. F.; Fromme, M. L.; Benane, S. G. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 43; 1976.

A method is described that uses the entire heating or cooling curve to measure rate of microwave energy absorption in biologic samples rather than relying on the estimation of the initial slope. The cooling constant and temperature rise of the sample due to irradiation can be obtained directly from either a heating or a cooling curve. The method does not require the determination of the heating curve constant, which contains the absorption cross-section of the sample. The latter constant is not necessary for calculation of the rate of energy absorption. Data are presented demonstrating the use of the method for far field exposure of samples contained in tissue culture flasks and petri dishes as well as for exposure of a sample at the end of a waveguide transmission line. (No refs.)

4978 MICROWAVE IRRADIATION OF ISOLATED RAT HEARTS TREATED WITH ANS BLOCKING DRUGS (MEETING ABSTRACT). (Eng.) Reed, J. R., III; Lords, J. L.; Durney, C. H. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 115-116; 1976.

In the work reported here rat hearts in which both systems, parasympathetic and sympathetic, are blocked by the respective drugs showed no significant effect upon irradiation. With respect to these data, it is hypothesized that the microwave energy interacts with the autonomic nerve remnants present in the excised hearts. Although the mechanism is as yet undetermined, it is believed that neurotransmitter is likely to be involved in the process. The dose rate (absorbed power density) in the heart was calculated from the rate of temperature rise during irradiation. The temperature was measured by the liquid crystal optical fiber probe, which being nonmetalic, is not disruptive to the microwave field. (No refs.)

4979 BEHAVIORAL AND PHYSIOLOGICAL EFFECTS OF CHRONIC PULSE-MODULATED MICROWAVE RADIATION IN RATS (MEETING ABSTRACT). (Eng.) Lovely, R. H.; Myers, D. E.; Johnson, R. B.; Guy, A. W. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 92; 1976.

To determine the behavioral and physiologic effects of chronic microwave exposure, eight male rats were irradiated for 3 mo with 918 MHz microwaves pulse-modulated at 11 Hz, for 10 hr/night, and at an average power density of 2.5 mW/cm^2 (spatially averaged over the cross-section of the exposure chamber). The exposure apparatus consisted of cylindrical waveguide capable of delivering circularly polarized guided waves (TE_{11} mode) and a living chamber designed to be compatible with laboratory conditions required by rodents. The cylindrical waveguide allowed for easy quantification of the fields in terms of incident power, total absorption, and specific absorption rate for each exposed animal, independent of other rodents being simultaneously exposed. Physiologic and behavioral comparisons between the eight irradiated and eight sham-irradiated control rats included daily food and saccharin/water intake. In addition, aperiodic assessments were made of deep colonic temperatures, behavioral repertoire during

radiation, and serum chemistry (i.e., calcium, sodium, potassium, chlorine, blood-urea-nitrogen, CO_2, ion gap, glucose, as well as basal and ether-stress-induced levels of corticosterone). The results of these assessments are discussed in terms of the biologic effects of equivalent continuous wave average power density, as well as in terms of the existing literature. (No refs.)

4980 DRUG-INDUCED ECTOTHERMIA IN SMALL MAMMALS: THE QUEST FOR A BIOLOGICAL DOSIMETER (MEETING ABSTRACT). (Eng.) Putthoff, D. L.; Justesen, D. R.; Levinson, D. M.; Ward, L. B. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 43; 1976.

The use of chemical agents to render mammals ectothermic, thus enabling the conversion of pre- and post-radiation temperatures of the animal into estimates of quantities of absorbed energy, is reported. Sodium salicylate and cortisone acetate were administered to mice, rats, guinea pigs, and rabbits of both sexes and of pigmented and albino strains, and their effects on colonic and rectal temperature were studied. While the salicylate produced a marked hypothermal response in mice and rats, it was less effective in guinea pigs and rabbits and was otherwise variable with respect to strain. Cortisone produced a more uniform hypothermal response; studies of mice and rats revealed that increments of colonic temperature from short periods of moderately thermalizing microwave radiation yielded estimates of energy dosing that were accurate within ± 10%. It is concluded that cortisone is useful in microwave dosimetry studies in the free field where an empirical fit between measures of incident and absorbed energy is the objective. (No refs.)

4981 EFFECTS OF CHRONIC ATHERMAL MICROWAVE RADIATION ON INNATE AND LEARNED BEHAVIORS IN RATS (MEETING ABSTRACT). (Eng.) Mitchell, D. S.; Switzer, W. G.; Bronaugh, E. L. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 92; 1976.

A multimode microwave exposure chamber was designed, calibrated, and employed to investigate the effects of chronic 2.45 GHz continuous-wave radiation at an equivalent plane-wave power density of 5 mW/cm^2 on innate and learned behaviors in rats. Relative to sham-irradiated controls, irradiated subjects displayed statistically significant increases in locomotor activity, reliable evidence of disrupted differential responding during asymptotic discriminative operant reward conditioning, but no significant differences in Sidman avoidance conditioning performance . Comparisons with pre-irradiation baseline data revealed that the observed effects emerged almost immediately following the initiation of microwave exposures and persisted throughout the course of a 5-hr per day, 22-wk irradiation sequence. Daily core temperature sampling produced no evidence of whole-body heating in irradiated rats. It was concluded that the observed behavioral effects are consistent with a general activation hypothesis, suggesting the possibility of microwave-induced alterations in central nervous system activity, although the exact mechanism remains unclear. Evaluation of the present findings in conjunction with those reported by other investigators suggests that a given behavioral outcome may depend in complex ways upon specific combinations of irradiation parameters. The need for increased standardization in laboratory techniques and paradigms was stressed, with particular emphasis on modes and procedures of irradiation. (No refs.)

4982 RADIATORS FOR MICROWAVE BIOLOGICAL EFFECTS RESEARCH--WAVEGUIDE SLOT ARRAY WITH CONSTANT RADIATION INTENSITY (MEETING ABSTRACT). (Eng.) Hagmann, M. J.; Gandhi, O. P. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 66; 1976.

A longitudinal shunt slot array having a pattern with nearly constant radiation intensity over the beamwidth and zero intensity outside was designed for use in microwave biologic studies with large or multiple targets. A beamwidth of 12.5° was chosen as being small enough for a radiated beam to approximate a plane wave yet give enough divergence for convenient chamber dimensions. Discontinuities in the desired pattern force the Fourier-synthesized pattern to have significant errors due to overshoot and ripple. Solutions developed on the basis of Fejer sums and Lanczos' σ factors gave patterns with objectionable rounding. A new procedure based on weighted least squares was developed for optimum characteristics. The test design at 10.4 GHz used 9 slots and had a calculated variation of ± 5% in radiation intensity over the 12.5° beamwidth with 80% of the total radiated power contained within the beamwidth. Experimental results on this antenna are presented. (No refs.)

4983 A MICROWAVE EXPOSURE SYSTEM FOR PRIMATES (MEETING ABSTRACT). (Eng.) Heynick, L. N.; Polson, P.; Karp, A. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 66; 1976.

A set of cavity/cage units for chronic irradiation of macaques and smaller animals at 2.45 GHz was developed. Each cavity was a three-foot, multimode, mode-stirred cube excited by a magnetron. Forward and reflected powers were measured by calibrated diode detectors in a bidirectional coupler between the magnetron and cavity. Power values were set by phase-angle selection and maintained constant by

detector-output feedback to a thyristor control circuit. The cage was of low radiofrequency-loss-tangent materials. Calorimetry with saline-filled bottles and dolls was used to determine energy absorption values as related to net input power and time. Calorimetric measurements were taken with plane-wave irradiation in an anechoic chamber to establish total absorbed power equivalence between the two irradiation methods. Scanning infrared thermography was also performed on macaque carcasses irradiated in the cavity/cage unit. Twelve units are currently in use for investigating behavioral effects on squirrel monkeys subjected to chronic irradiation. (No refs.)

4984 INTERNAL EM FIELD AND ABSORBED POWER DENSITY IN HUMAN TORSOS INDUCED BY 1 TO 500 MHz EM WAVES (MEETING ABSTRACT). (Eng.) Guru, B. S.; Chen, K. M. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 39; 1976.

Numeric results are presented on the internal electromagnetic (EM) field and absorbed power density inside a human torso induced by EM waves of frequencies ranging from 1 to 500 MHz with vertical and horizontal polarizations. The induced fields inside the torso were dependent on the frequency and the torso geometry. Resonance phenomena at particular frequencies were evaluated. Theoretic results were obtained based on the tensor integral equation method, and some of the theoretic predictions were compared with existing experimental results. (No refs.)

4985 MEASUREMENT OF THE DIELECTRIC CONSTANT AND CONDUCTIVITY OF BIOLOGICAL MATERIALS BY MICROWAVE CAVITY PERTURBATION METHOD (MEETING ABSTRACT). (Eng.) Ma, C. H.; Deaton, D. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 47; 1976.

The electrical properties of blood and solid biologic materials were determined from the measurements of the resonant frequency and Q of the resonance curve of microwave cavities with and without samples inside the cavities. Unlike the commonly used transmission line and waveguide methods in which the accuracy and repeatibility are critically dependent upon the accurate measurement of the sample dimensions, the smoothness of the sample surfaces, slicing and packing techniques, it was found that the accuracy of the cavity perturbation method relied only on the accuracy of mass measurement of the sample, if the sample was small compared with the cavity and was placed in the region with approximately uniform field. Circularly cylindrical cavities with sample filled glass tube as a central rod were used in the experiments. Initially, measurements to verify the accuracy of the technique were performed, resulting in accurate determination of the dielectric constant and conductivity in dielectric materials of known properties. The electrical properties of blood and various solid biologic materials were determined, and the properties of the white blood cells were measured as a function of temperature. The results were summarized in the plots of the electrical properties of the biologic materials with temperature and quantities of the samples as parameters, and good repeatibility was observed throughout the range of investigation. (No refs.)

4986 MICROWAVE DOSIMETRY VIA ELECTRIC FIELD MAPPING WITHIN FULL-SIZE AND SCALED PHANTOM MODELS (MEETING ABSTRACT). (Eng.) Herchenroeder, P.; Cheung, A. Y.; Swicord, M.; Bassen, H. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 40; 1976.

Electric field strengths and patterns induced by plane wave irradiation within various tissue structures were examined using a calibrated, nonperturbing, isotropic electric field probe. The probe was implanted inside simulated tissue phantoms of various shapes and sizes. To establish the reliability of the probe for implantation measurement, the values of the electric field detected by the probe inside plane wave irradiated phantoms of simple geometry (planar slabs and spheres) were compared with theoretic predictions at 915 MHz and 2,450 MHz. Under all conditions, the magnitude and relative pattern of electric field distributions agreed closely with existing theoretic predictions. Using the same probe, absolute electric field intensity at various locations were made within half-sized and quarter-sized human phantoms (with properly adjusted electrical properties) developed for simulated total body exposure studies at 915 MHz and 2,450 MHz. One-dimensional and two-dimensional E-field distributions throughout the body were mapped using data generated from continuous single-axis probe-scans and sectional thermographic presentation at various locations. The simultaneous use of the E-field probe, together with thermography, gave a complete detailed, quantitative evaluation of induced internal electromagnetic field under various exposure conditions. (No refs.)

4987 BIOLOGICAL PHANTOM MATERIALS FOR SIMULATING MAN AT DIFFERENT FREQUENCIES (MEETING ABSTRACT). (Eng.) Gandhi, O. P.; Sedigh, K. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 40; 1976.

Compositions of biologic phantom materials for simulating man over the frequency range 13-570 MHz (including the important resonance regions of 33 and 65 MHz) are given. These materials were developed to fill eight proportionately scaled man-shaped cavi-

ties of height 7.6-40.6 cm for dosimetric measurements at 300, 400, 600, 915, 985, and 2,450 MHz. Complex permittivity (ε_c) measurements at the irradiation frequencies were made using a modified version of the coaxial line method. Models reduced by 8 in all dimensions allowed simulation of man at frequencies given by (experimentation frequency)/8, provided materials with ε_c at (lower) simulated frequencies were used. Whole-body average values of ε_c at simulated frequencies were first calculated on the basis of 65% muscle and tissues of high water content and 35% fat, bone, and tissues of low water content on the basis of tissue values extrapolated from published data. Several compositions of salt, polyethylene powder, Superstuff, and water were first measured for ε_c's at the six experimental frequencies. Interpolated compositions were then measured and modified, if necessary, for desired permittivities. To simulate man at still higher frequencies, compositions are being developed for average electrical properties to the depth of penetration for individual parts of the body. Also, dosimetric measurements will be compared for correct and incorrect phantom materials. (No refs.)

4988 ELECTROMAGNETIC ENERGY EXPOSURE EFFECTS ON MOTOR COORDINATION OR BALANCE (MEETING ABSTRACT). (Eng.) Frey, A. H.; Gendelman, S. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 19; 1976.

The effect of pulse-modulated electromagnetic (EM) energy on motor coordination or balance was evaluated in Sprague-Dawley rats. A horizontal rod was set to rotate at an increasing rate of speed until a predetermined speed was reached. The subjects were divided into two groups: sham exposed and EM energy exposed. The EM energy exposed occurred during their time on the rotating rod. In a series of experiments, different EM energy parameters were used. The animals were exposed individually on the rotating rod until they fell off the apparatus. The time scores of the animals on the rod were recorded for evaluation. The results of this evaluation are not currently available. (No refs.)

4989 LYMPHOCYTE TRANSFORMATION INDUCED BY MICROWAVE RADIATION (MEETING ABSTRACT). (Eng.) Huang, A. T.; Engle, M. E.; Elder, J. A. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 21; 1976.

The effects of microwave radiation at power densities below 30 mW/cm^2 were examined in blood lymphocytes from Chinese hamsters. Animals were irradiated for 15 min on 5 consecutive days at 2,450 MHz (continuous wave) with power densities from 5 to 30 mW/cm^2 and at 9,000 MHz (pulse) with density 10 mW/cm^2. Absorbed dose measurements were determined by twin-well calorimetry. One hour after irradiation, blood lymphocytes were obtained from orbital hemorrhage. Cells were cultured for 1 day if unstimulated or for 3 days if stimulated with phytohemagglutinin (PHA) to induce mitosis. After termination, lymphocytes were processed for morphologic and cytogenetic analyses with a brief colchicine treatment to arrest cells in metaphase. Microwave radiation caused a dose-related (5-30 mW/cm^2) increase in blastic transformation (increase in nuclear size by three fold in area) of unstimulated lymphocytes. However, frequency of cell division from PHA-stimulation decreased in irradiated samples. Both effects were evident at 5 mW/cm^2. Autoradiography of cells labelled with [^{3}H]-thymidine and [^{3}H]-uridine suggested that the increased blastic transformation was associated with an enhancement of RNA synthesis, probably due to changes in chromatin structure. There was no evidence of radiation-related DNA repair. Cytogenic analysis of the irradiated samples showed no significant chromosomal aberration within these power densities. (No refs.)

4990 TEMPERATURE DEPENDENCE OF MICROWAVE AVOIDANCE (MEETING ABSTRACT). (Eng.) Monahan, J. C.; Ho, H. S. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 4-5; 1976.

The effect of ambient temperature on avoidance behavior induced by 2,450 MHz continuous wave radiation was investigated in CFI male mice (30-34 g). The animals were irradiated in an environmentally controlled waveguide assembly at temperatures of 20, 24, 30 or 35°C and a relative humidity of 50 ± 1.5%. Incident power levels ranged from 0.04 W to 4 W resulting in average absorbed dose rates of 0.06 to 55 mW/g. In those groups that exhibited avoidance behavior, the percentage of absorption decreased after the initial 5 min and remained lower for the duration of the exposure. The threshold incident power level at which avoidance behavior was observed decreased with an increase in the environmental temperature. The data suggest that the subjects were capable of detecting average absorbed dose rates of as little as 0.5 mW/g. Furthermore, this level of irradiation, while producing no core temperature increase, was aversive and caused the animal to actively avoid the microwave radiation when the environmental temperature was 35°C. (No refs.)

4991 EFFECTS OF PULSED MICROWAVES ON THE HEMATOPOIETIC SYSTEM OF MICE (MEETING ABSTRACT). (Eng.) Ragan, H. A.; Phillips, R. D. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 22; 1976.

To investigate the effects of pulsed microwaves on the hematopoietic system, female mice were exposed

approximately 8 hr daily for 10 days to 2.88 GHz pulsed microwaves (2.3 μsec pulses at 100/sec) in an anechoic chamber at an average power density of 5 mW/cm^2. Female littermates were sham-exposed and served as controls. All mice were killed 92 hr after the last exposure. No statistically significant effects were observed on red cell parameters, total white cell counts, or the leukocyte differential counts. Platelet counts were lower ($p<0.05$) in exposed mice. This was compatible with the relative paucity of megakaryocytes in bone marrow and spleen. Cellularity of femoral bone marrow was higher ($p<0.001$) in the exposed group. Cytologic examination revealed a decrease in megakaryocytes, but a slight increase in the myeloid-erythroid ratio of exposed mice. More nonheme iron was present in the marrow from exposed mice, suggesting an interference with iron metabolism. Splenic erythropoietic and leukopoietic activity were greater, and megakaryocytopoiesis was less in exposed than control mice. Microwave exposure did not influence serum protein concentrations or the protein electrophoretic patterns. Serum triglyceride levels were higher ($p<0.05$) in the microwave exposed group. A future experiment will compare hematologic changes observed in these mice with changes in a group exposed to continuous wave microwaves. (No refs.)

4992 MICROWAVE CONTROL OF BEHAVIOR: AN AUDITORY PHENOMENON (MEETING ABSTRACT). (Eng.) Johnson, R. B.; Lovely, R. H.; Guy, A. W.; Galambos, R. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 2; 1976.

To elucidate the behavioral effect of microwaves, rats trained to make a food reinforced "nose-poke" response while held in a plexiglas restrainer were irradiated during alternating 5-min periods with 918 MHz pulsed microwaves. Three animals were trained to respond only during irradiation, and three were trained to respond during nonirradiation. Six additional animals were similarly trained with alternating periods of acoustic stimulation. All twelve animals acquired the discrimination at comparable rates, learning to inhibit responding during inappropriate stimulus conditions. The results are discussed in terms of the motivational properties of pulsed microwave irradiation and its effect on inhibitory processes. During continued training, the performance of some animals gradually deteriorated. Auditory-evoked potentials could not be recorded from these animals at the stimulus intensities employed. Examination revealed profound middle ear infections rendering these animals deaf. However, these animals demonstrated continued ability to perform when extremely intense acoustic stimulation or visual stimulation was provided. Six animals were adapted to perform the discrimination using acoustic stimulation, as well as 918 MHz and 2,450 MHz pulsed microwaves on a variable interval schedule of stimulus presentation. Comparisons were obtained for each animal between behavioral and auditory-potential thresholds for each form of stimulation. The comparisons support the conclusion that performance on the discrimination task requires adequate auditory stimulation, whether from acoustic or microwave origins. Finally, cochlear microphonic recordings from pulsed microwave irradiated rats, in addition to behavioral and physiologic threshold comparisons in a "microwave avoidance" task, are discussed. (No refs.)

4993 MICROWAVE EFFECTS ON THE BLOOD-BRAIN BARRIER OF HAMSTERS (MEETING ABSTRACT). (Eng.) Albert, E. N.; Grau, L.; Kerns, J. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 18; 1976.

To investigate the effects of microwave irradiation on the blood-brain barrier, Chinese hamsters were exposed to continuous wave microwave energy at 2,450 MHz for 1-2 hr at 10, 50, and 70 mW/cm^2 power densities. The exposed and sham-irradiated animals were anesthetized and injected with various electron dense tracers, fixed by perfusion, and prepared for gross, light, and electron microscopic examination. A positive reaction was present in the pineal body, pituitary gland, supraoptic crest, and choroid plexus at the gross and light microscopic levels in sham-irradiated animals exposed to 50 and 70 mW/cm^2. However, brains of irradiated animals displayed a positive reaction in the cerebral and cerebellar cortices, medulla, thalamus, and hypothalamus, as well as the above mentioned areas. Brains of exposed animals had lesions that varied in location and intensity. Closer observations with the electron microscope showed the tracer material present in the extracellular space of the neuropil. Furthermore, tracers appeared to have crossed capillary walls via the endothelial intercellular clefts and by increased pinocytotic activity. Preliminary observations on animals exposed to 10 mW/cm^2 appear to be consistent with those in animals exposed to 50 and 70 mW/cm^2. (No refs.)

4994 PREDICTED FREQUENCY AND THRESHOLD OF MICROWAVE-INDUCED AUDITORY SENSATION (MEETING ABSTRACT). (Eng.) Lin, J. C. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 3; 1976.

A spherical model of the head was used to analyze microwave-induced auditory sensation. The problem was formulated in terms of thermoelasticity theory in which the absorbed microwave energy represents the volume heat source, which depends on both space and time. The inhomogeneous thermoelastic motion equation was solved for the acoustic wave parameters under both stress-free and constrained surface conditions using boundary value technique and Duhamel's theorem. Numeric results showed that the predicted frequencies of vibration and threshold pressure amplitude agree well with experimental findings

over a wide range of incident microwave characteristics. It is concluded that the good agreement demonstrates the validity of the thermoelastic stress-production mechanism for microwave-induced hearing in man. (No refs.)

4995 MICROWAVE HEARING: THE RESPONSE OF SINGLE AUDITORY NEURONS IN THE CAT TO PULSED MICROWAVE RADIATION (MEETING ABSTRACT). (Eng.) Lebovitz, R. M.; Seaman, R. L. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 1; 1976.

The response of single auditory neurons in the cat to pulsed microwave radiation (MWR) at 915 MHz was studied. The response to acoustic click stimuli of primary auditory fibers and of cell bodies in brain stem cochlear nuclei were recorded via NaCl-filled glass micropipettes. The effect of pulsed MWR on the neuronal discharge properties was then similarly determined. Threshold effects were observed at absorbed energies of 5 μJ/g per pulse; the response was independent of the MWR pulse parameters and independent of the average imposed MWR power density (less than 1 mW/cm^2). Of the more than 200 neurons studied, most demonstrated a response to acoustic clicks similar to that of pulsed MWR stimuli. Units most sensitive to acoustic frequencies below about 3 KHz were more likely to be responsive to microwave pulses than were units with higher best frequencies. It is concluded that the results refine and partially support the suggestion that microwave hearing is mediated by a thermoelastic absorption of the microwave pulse. (No refs.)

4996 LOW FREQUENCY HEARING AND SEEING (MEETING ABSTRACT). (Eng.) Adrian, D. J. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 1; 1976.

Auditory and visual (phosphenes) effects generated by transcranial stimulation with low frequency electric currents were studied to aid the understanding of sensory processes. Frequency response characteristics for both effects were measured. The sensory channels were found to behave much like frequency selective filters but with a number of important nonlinearities. Several types of stimulus currents were used including sinewave, periodic bursts of sinewave, and two simultaneous sinewaves of differing frequency. Habituation to both the phosphene and auditory sensation were noted. The minimum current threshold for the phosphene and auditory effect occurred at 20-25 Hz and 60-90 Hz, respectively. The effects were also generated by the application of two simultaneous sinewaves well above the cutoff frequency when the difference frequency was near the minimum threshold frequency. A decrease in sensory "noise" was noted following some experiments. Possible application of this effect as a therapy for tinnitus is briefly discussed. (No refs.)

4997 CHARACTERISTICS OF MICROWAVE-INDUCED COCHLEAR MICROPHONICS (MEETING ABSTRACT). (Eng.) Chung-Kwang Chou; Guy, A. W.; Galambos, R. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 2; 1976.

Cochlear microphonics (CM) of guinea pigs and cats during irradiation by 918 and 2,450 MHz pulsed microwaves were characterized. Both horn applicators and a cylindrical waveguide exposure system were used to radiate the animals. As the body weight of the guinea pigs varied from 0.5 to 1.0 kg, the frequency of microwave-induced CM decreased from 50 to 42 kHz. Similarly, for cats with body weights of 0.9 to 3 kg, the frequency of microwave-induced CM decreased from 38 to 29 kHz. In addition, as the body weight of the test animals was increased, the number of cycles of CM oscillation varied from 11 to 7 cycles in guinea pigs and 10 to 4 cycles in cats. The characteristics of the microwave-induced CM depended on the size of the animal head, i.e., the smaller the head, the higher the frequency of CM, and the thicker the skull, the less the oscillation of CM. For each animal, the same frequency and duration of CM were induced at both 918 and 2,450 MHz with either horn applicator or the waveguide exposure system. The measured parameters were also independent of electrical field orientation with respect to body axis. The thresholds of evoked response (CM or N_1 nerve response) were 10 mJ/kg maximum in adult cats, 2.5 mJ/kg in kittens, and 7.5 mJ/kg average in adult guinea pigs. The results indicate that the microwave auditory effect is mechanical in nature. (No refs.)

4998 AUDIOGENIC SEIZURE SENSITIVITY OF MICE AFTER REPEATED EXPOSURES TO 2.88 GHz PULSED MICROWAVES (MEETING ABSTRACT). (Eng.) Phillips, R. D.; Hjersen, D. L.; Sheldon, R. L. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 19; 1976.

Female SJL/J mice were exposed 2 hr daily to 2.88 GHz pulsed microwaves (2.3 μsec pulse width, 100 pulses/sec) in an anechoic chamber at an average power density of 10 mW/cm^2 to investigate audiogenic seizure sensitivity. Sensitivity to audiogenic-induced seizures was determined at 1 and 2 wk after daily exposures (5 days/wk) by subjecting the animals to white noise (110-114 dB) and measuring the latencies to running fits and full tonic-clonic seizures. All mice were primed at 21 days of age by subjecting them to 110-114 dB of white noise for 60 sec. The mice were then pretested at 28 days of age to score seizure sensitivity for distribution of animals into control and experimental groups on the basis of

equivalent means and variencies in seizure latencies. The latency to a full tonic-clonic seizure was significantly increased ($p<0.05$) in exposed mice compared with controls after 1 wk of exposure. The animals were retested after an additional week of exposure and treated mice continued to have longer latencies than controls ($p<0.01$). Latencies to running fits were not affected by microwave exposure for 1 or 2 wk. A parallel investigation using continuous wave microwaves is in progress. (No refs.)

4999 PAVLOVIAN CONDITIONING OF MICROWAVE-INDUCED HYPERTHERMIA (MEETING ABSTRACT). (Eng.) Bermant, R. I.; Justesen, D. R. *In: Proceedings of the Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 4; 1976.

Rats were subjected to a trace-conditioning procedure in which an auditory signal (conditional stimulus [CS]) preceded by ≥ 30 sec and then overlapped a shorter period (≤ 5 sec) of microwave radiation at 2,450 MHz in a multimode cavity. The radiation served as the unconditional stimulus (US) and was sufficiently intense to produce a 2-3°C rise in colonic temperature. Repeated pairings of CS and US resulted in small increments (~ 0.2°C) of colonic temperature; whether these increments are true conditional response or are an artifact of sensitization or pseudo-conditioning will not be known until completion of control experiments. Preliminary data reconfirm earlier observations that microwave radiation can elicit a rise of body temperature of endogenous origin, presumably through activation of sympathetic pathways via sensory stimulation. (No refs.)

5000 COMPARISON OF THE AVERAGE SPECIFIC ABSORBED POWER IN THE ELLIPSOIDAL CONDUCTOR AND DIELECTRIC MODELS OF HUMANS AND MONKEYS AT RADIO FREQUENCIES (MEETING ABSTRACT). (Eng.) Massoudi, H.; Durney, C. H.; Johnson, C. C. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 39; 1976.

The results of the perturbation theory applied to a lossy dielectric ellipsoidal model are described. The average specific absorbed power in dielectric ellipsoidal models of man and rhesus monkey were calculated and compared with those of the conductor models for the six standard polarizations. The average specific absorbed power in the two models was found to be the same, if the conduction current in the body was much larger than the displacement current. Although the conductor model is inaccurate for low values of conductivity, the equations are simpler than the ones for the dielectric model, and the conductor model is, therefore, advantageous when it is valid. Since it was found necessary to use tissue conductivity values below the range of validity of the conductor model, it is concluded that the dielectric model is essential for accurate theoretic modeling. (No refs.)

5001 EFFECTS OF LOW POWER DENSITY MICROWAVES ON MACROMOLECULAR CONSTITUENTS OF THE BRAIN OF RATS (MEETING ABSTRACT). (Eng.) Catravas, G. N.; Takenaga, J.; Katz, J. B.; Abbott, J. R. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 18; 1976.

Experiments were conducted to determine the biochemical changes that occur in discrete regions of the brain of rats exposed to low power density microwave radiation. Groups of rats were exposed to continuous wave microwaves of 2,450 MHz frequency and 15 mW/cm^2, 8 hr per day for 3 wk. During exposure, the animals were confined to styrofoam cages; the inner walls of which were coated with quinine to prevent the rats from chewing through the walls of the cages. The microwave-induced changes in the PGE_1-stimulated brain adenyl cyclase and serotonergic systems were investigated in this series of experiments. Preliminary results indicated an increased sensitivity of brain adenyl cyclase to PGE_1. Marginal increases in the activity of tryptophan hydroxylase and levels of serotonin in the hypothalamic-thalamic region were also observed. (No refs.)

5002 THERMAL AND NEUROENDOCRINE EFFECTS OF LONG TERM, LOW LEVEL MICROWAVE (2450 MHz, CW) IRRADIATION (MEETING ABSTRACT). (Eng.) Lu, S. T.; Lebda, N.; Michaelson, S. M.; Pettit, S.; Rivera, D. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 90-91; 1976.

To determine the thermal and neuroendocrine effects of long-term low level microwave irradiation, Long-Evans rats were irradiated with 2,450 MHz microwave (continuous wave) at 1, 5, 10 and 20 mW/cm^2 for 1, 2, 4 and 8 hr. The animals had been acclimated to the laboratory environment and procedures for 2 wk and preconditioned three times to the equilibration and exposure procedures. Before exposure, a 3-hr equilibration period was utilized for control and irradiated rats. Post-irradiation, rectal temperature varied with incident power densities and duration of exposure. None of the average group rectal temperatures exceeded that of circadian rhythmicity of the sham-irradiated except the groups that were exposed to 20 mW/cm^2 for 4 to 8 hr. Again, a consistent elevation in individual rectal temperature exceeding the confident limits for each duration of exposure could only be found in rats exposed to 20 mW/cm^2 for 4 to 8 hr. Weight loss did not exceed the fiducial limits of sham exposures, although it tended to vary from group to group. The adrenal and thyroid gland weight varied between groups without a consistent change in rats exposed to different

incident power densities and duration; pituitary weight did not vary significantly. Serum thyroxine was found to be transiently elevated at 1 mW/cm^2 for 5 hr. Consistent and significant depression of serum thyroxine was observed in rats exposed to 20 mW/cm^2 for 4 to 8 hr. Serum corticosterone levels did not vary significantly from control. It is concluded that 20 mW/cm^2 incident power density (absorption rate approximately 5 W/kg) exceeded the thermoregulatory capacity of rats. The changes in the thyroid function were a result of thermoregulation. (No refs.)

5003 EXPERIMENTAL HEATING PATTERNS IN BI-LAYERED BIOLOGICAL TISSUE CIRCULAR APERTURE SOURCES (MEETING ABSTRACT). (Eng.) Wallace, J. E.; Guy, A. W. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 41; 1976.

Three circularly cylindrical waveguide apertures, developed to heat biologic tissues, were evaluated. Each applicator was dielectrically loaded to maintain a small aperture diameter and still permit propagation of the TE_{11} mode at 918 MHz. The applicator diameters were 8.9 cm (ε_r = 6.0), 11.1 cm (ε_r = 4.0), and 11.1 cm (ringed dielectric configuration). Testing of the applicators was performed on a planar bi-layered (fat and muscle) phantom model that simulates human tissue. The heating patterns induced in the tissue were measured using an established thermographic technique. This technique uses a high power microwave source (500 W) to heat the tissue for a short period of time (10 to 20 sec). The desired tissue surface is then scanned with an infrared sensitive camera. The significant parameters that were measured included the ratio of peak heating in the fat to peak heating in the muscle, the peak specific absorption rate in both fat and muscle tissue, the uniformity of heating at a given depth into the tissue, and the depth of penetration of energy into the muscle tissue. Each applicator was compared to a 13 x 13 cm square bifurcated aperture, which is currently used clinically for diathermy purposes. This applicator also operates at 918 MHz. (No refs.)

5004 EFFECTS OF SINGLE EXPOSURES TO 2450 MHz MICROWAVE IRRADIATION ON RAT BEHAVIOR (MEETING ABSTRACT). (Eng.) Gage, M. I. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 90; 1976.

The effects of single exposures to microwave radiation on rat behavior were studied. Eight male Sprague-Dawley albino rats (Charles River CD) were trained to alternately press each of two bars in an operant conditioning task for food pellet reinforcement. After the animals learned this task and stable baseline performance was achieved, changes in this operant behavior during daily sessions immediately following exposure to 2,450 MHz microwave irradiation were observed. The rats were tested after single 1 or 15 hr exposures to 2,450 MHz continuous wave irradiation at incident power levels of 0.5, 1, 5, 10, 15 and 20 mW/cm^2. Exposures to 15 and 20 mW/cm^2 for 15 hr suppressed the rate of bar press alternations, but exposures to the same levels of microwaves for only 1 hr did not suppress the behavior. After exposure to 20 mW/cm^2, rats displayed a minimum of 40% decrease in rate of task performance, and 30% of the rats did not perform at all on this task. The results indicate that microwave power densities just above the allowable occupational exposure levels can adversely alter animal behavior. In addition, exposure duration, even in an environment where temperature and humidity are well controlled, is an important variable in determining microwave hazards. (No refs.)

5005 THE EFFECT OF MICROWAVE (2450 MHz) ON THE RESPONSE OF MICE TO T LYMPHOID CELL DEPENDENT AND T LYMPHOID CELL INDEPENDENT ANTIGENS: PRELIMINARY RESULTS (MEETING ABSTRACT). (Eng.) Wiktor-Jedrzejczak, W.; Ahmed, A.; Czerski, P.; Leach, W. M.; Sell, K. W. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 20-21; 1976.

The effect of microwaves on the response to T lymphoid cell dependent and T lymphoid cell independent antigens was studied in CBA/J adult male mice. Groups of mice were injected on day "0" with 0.5 ml of saline, or 0.2 ml of T lymphoid cell dependent antigen (i.e., requiring the cooperation of T cells for the production of antibody)-sheep red blood cells (SRBC) or 100 µg of synthetic T cell independent antigen (i.e., B cells produce antibody without cooperation of T cells)-DNP-lysine-Ficoll. On days 1, 2, and 3 the experimental groups consisting of four animals each were exposed to 2,450 MHz microwaves. Sham-exposed mice served as controls. Exposures were performed in an environmentally controlled waveguide facility with a forward power of 0.6 W to the average absorbed dose rate about 12 mW/g body weight for each exposure. On day 4, mice were sacrificed, and their spleen cells were assayed for antibody. Cells from SRBC immunized animals were assayed using SRBC as indicator cells, while cells from DNP-lys-Ficoll immunized mice were plaqued against SRBC coated with appropriate antigenic determinant—trinitrobenzene sulfonic acid. Cells from saline injected animals were assayed against these indicators. While the number of immunoglobin antibody secreting cells increased in nonimmunized (saline) microwave-exposed mice as compared with nonimmunized sham animals, the ability to form specific antibody against both T-dependent and T-independent antigen decreased in microwave-exposed animals. The difference was, however, statistically significant only in the case of their response to the T-independent antigen. The results suggest that while microwaves stimulate nonspecific reactivity of B lymphoid cells, they simultaneously decrease

the number of antigen reactive cells specific for both thymus dependent and independent antigens. The exposure conditions of microwaves *in vivo* seem to be weakly immunosuppressive. Further studies on the mechanism of this reaction are in progress. (No refs.)

5006 EFFECTS OF A 60-Hz ELECTROMAGNETIC FIELD ON LOCOMOTIVE & AGGRESSIVE BEHAVIORS OF MICE (MEETING ABSTRACT). (Eng.) Smith, R. F.; Justesen, D. R. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 146; 1976.

Mice in small groups were observed for 24 to 48 hr for locomotor activity and for aggression-related vocalizations during short (120-sec) but recurrent and aperiodic exposures to a 60-Hz field. The field was sinusoidal with a dominant magnetic component that was measured at 1.7 mWb/m, root-mean-square, and its effects were analyzed in terms of strain of mouse (DBA-2J, pigmented versus CD-1 Albinos), circadian periodicity, and trend. Highly reliable and persistent increases of activity of a time-locked sort were observed during exposures of mice to the field. Both the strain of mouse and circadian period were reliable sources of variation. The influence of the field on the measure of aggressive behavior was less significant, although the data suggest a two-fold reaction: inhibition during exposure followed by a rebound. Data from control experiments with anesthetized or sham-exposed animals excluded an artifactual basis of the observed alterations of activity. (No refs.)

5007 MICROWAVE INTERROGATION OF DIELECTRIC TARGETS (I) BY SCATTERING PARAMETERS (MEETING ABSTRACT). (Eng.) Larsen, L. E.; Jacobi, J. H. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 47; 1976.

Incident microwave radiation was used to interrogate the physical structure and radiofrequency electrical properties of dielectric objects. Single and multiple dielectric discontinuities of various geometries and magnitudes were investigated in a medium of dionized water. Mechanical scanning permitted the investigation of spatial resolution and aperture effects. The scattering parameters measured were the amplitude and phase of S_{11} and S_{21} for a phase locked 3,243 MHz source. These were studied as functions of space for the various dielectric discontinuities presented. Dielectrically loaded matched antennas were incorporated into a digitally controlled scanner, which was interfaced to an automatic network analyzer. The resulting complex functions of space were further processed to create a real valued function of space for intensity presentation of the data. The real valued spatial series' were also inverse filtered by digital methods to compensate for antenna patterns. Use of this system allowed the detection of single and multiple dielectric discontinuities of dimensions well below one wavelength in water. The results were sensitive to aperture size, wavelength, and antenna separation. (No refs.)

5008 IRRADIATION OF RATS BY LOW LEVEL 918 MHz MICROWAVES: DELINEATING THE DOSE-RESPONSE RELATIONSHIP (MEETING ABSTRACT). (Eng.) Myers, D. E.; Lovely, R. H.; Guy, A. W. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 91; 1976

To delineate the dose-response relationship, eight male rats were exposed for 13 wk to 918 MHz continuous wave microwaves at an average incident field strength of 2.5 mW/cm^2. The animals were irradiated 10 hr every night for a total of 910 hr. The exposure system consisted of cylindrical waveguides capable of delivering circularly polarized guided waves (TE_{11} mode) and Plexiglas living chambers, which provided standard laboratory conditions for the rodents. The waveguides allowed easy quantification of the fields for each chamber, independent of other rodents being simultaneously exposed. Daily recordings of body weight and food and water intake demonstrated no significant differences between the eight irradiated and eight sham-irradiated controls. Four-, eight-, and twelve-wk blood samples showed no differences in serum chemistry (i.e., Ca, Na, K, Cl, BUN, CO_2, ion gap, and glucose). Corticosterone levels sampled at the end of the radiation period gave no indication of stress. During the 11th wk, serial assessments were made of rectal temperatures and behavioral repertoire; neither of which demonstrated a significant effect to the microwave exposure. Finally, neither one- nor two-bottle saccharin preference tests suggested the presence of malaise. The significance of these results with respect to chronic exposure of rats to mW/cm^2 (which does influence several of the parameters assessed) are discussed. (No refs.)

5009 AN ELECTRON MICROSCOPIC AND HEMATOLOGIC INVESTIGATION OF RATS CHRONICALLY EXPOSED TO LOW-INTENSITY 2.45 GHz MICROWAVE RADIATION (MEETING ABSTRACT). (Eng.) Switzer, W. G.; Mitchell, D. S. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 22; 1976.

An attempt was made to discover permanent changes in the fine structure of the cerebral cortex of microwave-irradiated rats that could be associated with microwave-induced behavioral changes (increased locomotor activity and disrupted operant discriminative conditioning performance) observed in the same animals. Fifteen mature female Sprague-Dawley rats were exposed to 2.45 GHz continuous-wave microwaves at an equivalent plane-wave power density of 5 mW/cm^2

for 5 hr a day, 5 days a wk, for 22 wk in a multimode chamber designed and calibrated for this purpose. Six to 12 wk after cessation of radiation, irradiated and sham-irradiated control animals were perfused with a variation of Karnovsky's fixative, and cerebral cortex tissues were examined with an electron microscope. No changes in ultrastructure that could definitely be attributed to the prior action of microwaves were observed. Hematologic analyses revealed a significant increase in erythrocytes in irradiated subjects compared with controls. No other statistically significant differences in hematologic parameters were observed. Daily core temperature sampling indicated that no whole-body heating took place in irradiated subjects. (No refs.)

5010 MICROWAVES (2450 MHz) STIMULATE MATURATION OF B LYMPHOID CELLS IN SPLEENS OF EXPOSED MICE (MEETING ABSTRACT). (Eng.) Wiktor-Jedrzejczak, W.; Ahmed, A.; Czerski, P.; Leach, W. M.; Sell, K. W. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 20; 1976.

To evaluate microwave-stimulated maturation of B lymphoid cells in spleens, CBA/J male adult mice were exposed to 2450 MHz microwaves (amplitude modulated 12 Hz) at a forward power of 0.6 W for 30 min in an environmentally controlled waveguide facility. The absorbed dose rate was computed from measurements of forward, reflected, and transmitted power and was about 14 mW/g body weight of the animal for each exposure. The experiments were carried out with two groups of mice. One group received a single exposure for 30 min; the other group received a total of three exposures of 30 min, each at 3-day intervals. Sham-exposed animals served as controls. A single exposure to microwaves in such conditions produced a significant increase in the frequency of a subpopulation of B lymphoid cells bearing a receptor for complement (CR^+). Triple exposures not only enhanced this effect but significantly increased the total frequency of immunoglobulin (Ig) B cells in spleens of exposed mice. The effect was most pronounced 7 days after exposure and was independent of cell proliferation since the total number of spleen cells and the incorporation of ^{3}H-TdR (DNA-precursor), ^{3}H-uridine (RNA-precursor) and ^{3}H-leucine (protein precursor) by spleen bone marrow, and peripheral blood lymphoid cells of the exposed mice remained unchanged. This effect could not be related to the arrest of further maturation of B cells in Cr^+ stage, since 7 days after a single exposure the number of cells spontaneously forming IgM antibody also increased as evaluated by the plaque assay. Moreover, the functional immune capacity of these mice was evaluated by the response of their spleen cells *in vitro* to B cell-specific mitogens: dextran sulphate lipopolysaccharide, polyinosinic:polycytidylic acid, and PPD-tuberculin. While there was no significant increase in their ability to respond to dextran sulphate (which stimulates neonatal B cells), there was a significant increase in their ability to respond to the other B cell mitogens used. The proportion of T lymphoid cells (theta-positive) remained unaltered as did their functional capacity (as evaluated by response of spleen cells *in vitro)* to the T cell specific mitogens-phytohemagglutinin and concanavalin A and to allogenetic stimulator cells in mixed lymphocyte cultures. (No refs.)

5011 MICROWAVE-INDUCED TERATOLOGY IN THE RAT (MEETING ABSTRACT). (Eng.) Chernovetz, M. E.; Oke, A. F.; Justesen, D. R. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 143; 1976.

Primigravid rats were exposed in a multimode cavity for 20 min to microwave radiation (2,450 MHz, ~30 mW/g) or to infrared radiation during 1 of 7 days of gestation, the 10th through the 16th, to investigate microwave-induced teratology. Increments of colonic temperatures were equated for microwave and infrared treatments. Animals from a third group of dams were given a sham-exposure during 1 of the 7 days. On the 19th day of gestation, fetuses were taken by cesarean section, and after weighing, were examined for structural abnormalities and signs of insult. Brains of fetuses that were sampled from each of the three treatment groups were analyzed for levels of norepinephrine and dopamine. It was found that (1) extensive hemorrhagic signs were present in fetuses after infrared and microwave radiation; (2) averaged fetal mass was slightly but reliably lower in infrared- and microwave-radiated subjects compared with the averaged mass of controls; (3) averaged number of fetal resorptions did not differ for the control and infrared treatments but was highly elevated in association with the microwave treatment; and (4) while the averaged whole-brain dopamine levels did not differ greatly over the three conditions of treatment, the averaged level of whole-brain norepinephrine was lower in microwave-treated fetuses than in controls or infrared-treated rats. It is concluded that highly intense microwave irradiation (LD~10) is a stressor but one with sequelae that differ somewhat from those produced by conventional sources of thermal stress. (No refs.)

5012 CAN ELECTROMAGNETIC WAVES CAUSE CONGENITAL ANOMALIES? (MEETING ABSTRACT) (Eng.) Rugh, R.; McManaway, M. *In: Proceedings of the 1976 Annual Meeting of the International Union of Radio Science Held at the University of Massachusetts, Amherst, Massachusetts, 11-15 October, 1976.* USNC/URSI. (Washington, D.C.): 143; 1976.

To determine whether electromagnetic waves can cause congenital anomalies, 145 CFI white mice with timed pregnancies were used either as unirradiated controls or were exposed individually for 4 min to 2,450 MHz microwave radiation in a waveguide mean of 99.12 to 114.6 mW/g average absorbed dose rate (23.79 to 27.5 J/g average absorbed dose). The temperature was controlled at 25°C and humidity at 50%. A minimum of 10 pregnant mice were exposed on each gestation