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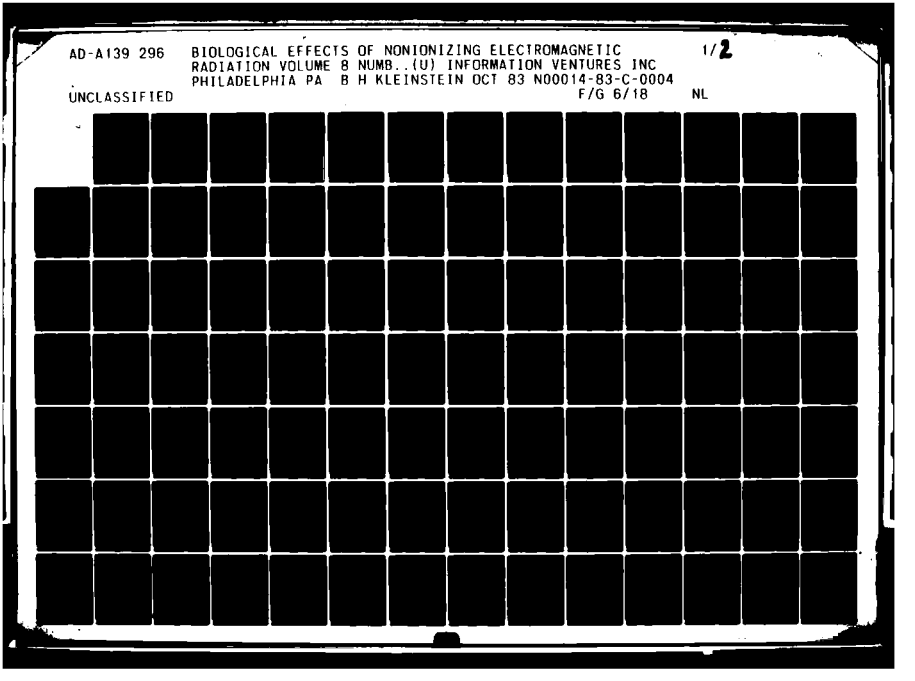

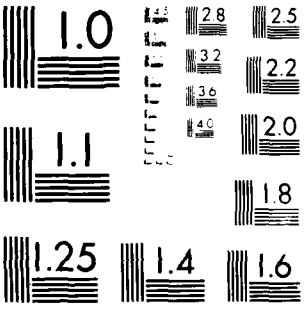

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Biological Effects of Nonionizing Electromagnetic Radiation

Volume VIII, Number 1

October 1983

A Digest of Current Literature

A Quarterly Publication Produced for
Office of Naval Research

INFORMATION VENTURES, INC.

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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Nonionizing radiation, electromagnetic fields, literature digest, bibliography, electric fields, magnetic fields, microwaves, radiofrequency radiation

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The literature digest contains original abstracts of English and foreign-language research literature, current research summaries, news items and announcements and information on relevant meetings and conferences. Subject and author indices are provided for all literature abstracts. Original abstracts are prepared based on data presented in the text, tables, and figures in the document. Where appropriate, quantitative data such as wavelength or frequency modulation, pulse width, duty cycle, incident

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Block 6. Performing Organization Report Number. Only numbers other than the official report number shown in Block 1, such as series numbers for in-house reports or a contractor/grantee number assigned by him, will be placed in this space. If no such numbers are used, leave this space blank.

Block 7. Author(s). Include corresponding information from the report cover. Give the name(s) of the author(s) in conventional order *(for example, John R. Doe or, if author prefers, J. Robert Doe)*. In addition, list the affiliation of an author if it differs from that of the performing organization.

Block 8. Contract or Grant Number(s). For a contractor or grantee report, enter the complete contract or grant number(s) under which the work reported was accomplished. Leave blank in in-house reports.

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Block 10. Program Element, Project, Task Area, and Work Unit Numbers. Enter here the number code from the applicable Department of Defense form, such as the DD Form 1498, "Research and Technology Work Unit Summary" or the DD Form 1634, "Research and Development Planning Summary," which identifies the program element, project, task area, and work unit or equivalent under which the work was authorized.

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Block 12. Report Date. Enter here the day, month, and year or month and year as shown on the cover.

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Block 19. Key Words. Select terms or short phrases that identify the principal subjects covered in the report, and are sufficiently specific and precise to be used as index entries for cataloging, conforming to standard terminology. The DoD "Thesaurus of Engineering and Scientific Terms" *(TEST)*, AD-672 000, can be helpful.

Block 20. Abstract. The abstract should be a brief *(not to exceed 200 words)* factual summary of the most significant information contained in the report. If possible, the abstract of a classified report should be unclassified and the abstract to an unclassified report should consist of publicly- releasable information. If the report contains a significant bibliography or literature survey, mention it here. For information on preparing abstracts see "Abstracting Scientific and Technical Reports of Defense-Sponsored RDT&E," AD-667 000.

☆U.S. Government Printing Office 1981—699-106/7128

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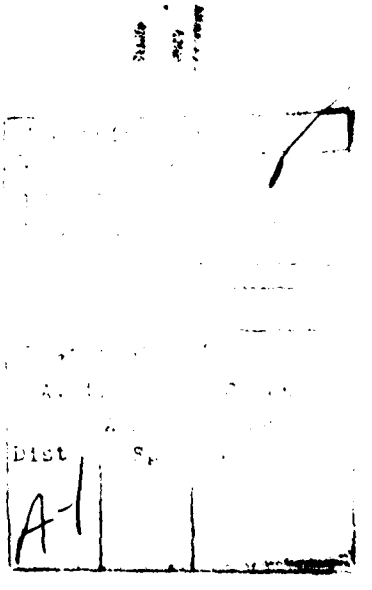
of Nonionizing Electromagnetic Radiation

A Digest of Current Literature

A Quarterly Publication Produced for
Office of Naval Research

Literature Selected and Abstracted
by
Information Ventures, Inc.
1500 Locust Street
Philadelphia, Pa 19102

Bruce H. Kleinstein, Ph.D., J.D., Project Manager



Biological Effects of Nonionizing Electromagnetic Radiation

October, 1983 *Volume VIII, Number 1*

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Preface

Biological Effects of Nonionizing Electromagnetic Radiation is a publication researched and prepared by Information Ventures, Inc. under contract to the Office of Naval Research.

This digest serves as a vehicle through which current documentation of research highlights on the biological effects and health implications of nonionizing electromagnetic radiation (microwave and other radio frequency radiation) is compiled, condensed, and disseminated on a regular basis. The effects of electric and magnetic fields (static and alternating) and research on medical applications of these nonionizing electromagnetic radiations are also included.

Biological Effects of Nonionizing Electromagnetic Radiation is intended to be a highly useful current awareness tool for scientists engaged in research or related activities. The great number and diversity of relevant publications make imperative the availability of the service to persons whose work requires that they keep abreast of current developments in the field.

Biological Effects of Nonionizing Electromagnetic Radiation is published quarterly. The issues of Volume VII and future volumes will include materials received during the preceding three months. Each issue contains abstracts of current English and foreign-language research literature, current research summaries, news items and announcements, and information on relevant meetings and conferences. Subject and author indices are provided for all literature abstracts to facilitate specific search and reference use. Journals, books and conference proceedings are used as sources for this publication. Materials for which full text is not available will be included as summary abstracts. Announcements and other materials submitted for publication should be addressed to: Dr. Bruce H. Kleinstein, Information Ventures, Inc., 1500 Locust Street, Philadelphia, PA 19102.

The digest was first published in 1974 under the title "Biological Effects of Electromagnetic Radiation." Since 1976 it has been published under the present title. Previous issues can be obtained from the National Technical Information Service.

Abbreviations and Acronyms

A, amp - ampere
C - centigrade
cm - centimeter(s)
cps - cycles per second
dB - decibel(s)
EPA - Environmental Protection Agency
eV - electron volt
F - fahrenheit
FAA - Federal Aviation Administration
FDA - Food and Drug Administration
g - gram(s)
G - gauss
GHz - gigahertz
HHS - Department of Health and Human Services
hr - hour(s)
Hz - hertz
ip - intraperitoneal
ISM - industrial, scientific, medical
IU - international unit(s)
iv - intravenous
J - joule(s)
k - kilo-
l - liter(s)
m - meter(s)
m - milli-
M - mega-
u - micro-
min - minute(s)
mo - month(s)
n - nano-
NIH - National Institutes of Health
NIOSH - National Institute for Occupational Safety and Health
NTIA - National Telecommunications and Information Administration
NTIS - National Technical Information Service
Oe - oersted(s)
OSHA - Occupational Safety and Health Administration
rad - radiation absorbed dose(s)
R - roentgen(s)
rpm - revolutions per minute
sec - second(s)
sc - subcutaneous
USAF/SAM - U. S. Air Force School of Aerospace Medicine
V - volts
VA - Veterans Adminstration
W - watt(s)
WHO - World Health Organization
wk - week(s)
wt - weight
x - times
yr - year(s)

NEWS ITEMS

EPA RF/MW BIOEFFECTS REPORT

The FPA's draft report on the biological effects of radiofrequency/microwave radiation will undergo revision with respect to its assessment of thermal risk. The Science Advisory Board Subcommittee met on September 22-23, 1983, at EPA Headquarters in Washington, DC to discuss the draft report. Revisions are expected to be completed by December 83. Copies of the draft report may be obtained from David Janes, Office of Radiation Programs, EPA Headquarters, 401 M Street, SW, Washington, DC; (703)557-8217. Minutes for this meeting can be obtained by contacting Dr. Terry F. Yosie, Director, Science Advisory Board (202)382-4126 or Dr. Douglas Seba, Executive Secretary, Science Advisory Board (202)382-2552. A transcript of the entire proceedings is available for $0.40 per page from the Executive Court Reporters, 8525 Colesville Road, Silver Spring, MD 20910; (301)565-0054. The transcript is approximately 300 pages.

CRITICAL APPRAISAL OF THE BIOLOGICAL EFFECTS DUE TO EXPOSURE TO ELECTRIC AND MAGNETIC FIELDS AT LOW FREQUENCIES

Contract 68-02-3845. The Environmental Protection Agency, Research Triangle Park, NC has contracted with the National Council on Radiation and Measurements, 7910 Woodmont Avenue, Suite 1016, Bethesda, MD 20814 for the above study.
Commerce Business Daily, October 18, 1983

COMPUTER MODELLING OF 60 HZ ELECTRIC FIELD COUPLING TO BIOLOGICAL TISSUE

Sol DE-RP01-84CE76236. The U.S. Dept. of Energy is seeking proposals from qualified organizations for the above study. Proposals are due by 11/16/83.
Commerce Business Daily, October 14, 1983

THEORETICAL AND NUMERICAL STUDIES OF AN INTENSE MICROWAVE SOURCE

The Naval Research Laboratory, Washington, DC, is negotiating with Science Applications, Inc. McLean, VA 22102 for the above study.
Commerce Business Daily, July 29, 1983

HYPERTHERMIA QUALITY ASSURANCE PROGRAM

Contract N01-CM-37512. The National Cancer Institute has contracted with Allegheny-Singer Research Corp., 320 East North Ave., Pittsburgh, PA 15212 for the above five year incrementally funded study.
Commerce Business Daily, July 7, 1983

NEW BOOKS:
NUCLEAR MAGNETIC RESONANCE IMAGING: BASIC PRINCIPLES. Young, Stuart W.
176 p., 80 figures, $19.00 (November 1983) ISBN 0-89004-998-X. Published by Raven Press, NY, NY

ALL-UNION SYMPOSIUM IN PUSHCHINO

An All-Union Symposium on the "Biological Effects of Electromagnetic Fields" was held in Puschino, USSR, in 1982. One hundred sixty eight papers were presented in the following areas: I. Biological Effects of Radio Frequency Electromagnetic Radiation (40); II. Biological Effects of Millimeter-Band Electromagnetic Radiation (14); III. Biological Effects of Low-Intensity Electromagnetic Fields (20); IV. Biological Effects of Constant Magnetic Fields (30); V. Biological Effects of Electric Fields (11); VI. Clinico-Hygienic Aspects of Electromagnetic Radiation (29); VII. Effects of Combined Exosures (10); and VIII. Physical Fields of Biological Materials (14). Figures in parentheses indicate the number of papers presented in each category. Translated titles and author names will appear in the next issue of the Digest. Author affiliations include:

DUBNA
- Joint Inst. Nuclear Research

IVANO-FRANKOVSK
- Medical Inst.

KARAGANDA
- State Medical Institute

KAZAN
- Res. Inst. Traumatology and Orthopedics

KHARKOV
- Res. Inst. Industrial Hygiene and Occupational Diseases

KIEV
- P. M. Buiko Res. Inst. Pediatrics, Obstetrics and Gynecology
- A. N. Marzeev Inst. General and Communal Hygiene
- Inst. Molecular Biology and Genetics, Ukrainian

SSR Acad. Sciences
- A. V. Palladin Inst. Biochemistry, Ukrainian SSR Acad. Sciences
- Inst. Microbiology, Virology, Parasitology
- T. G. Shevchenko Kiev State Univ.

KUPAVNA
- Res. Inst. Biological Testing of Chemical Compounds

LENINGRAD
- A. A. Ukhtomskii Physiological Inst.
- Sanitary-Hygienic Medical Inst.
- B. P. Konstantinov Inst. Nuclear Physics
- Res. Inst. Industrial Hygiene and Occupational Diseases
- Res. Inst. Radiation Hygiene

MAKHACHKALA
- Dagestan Polytechnical Inst

MINSK
- Belorussian State Inst. Advanced Medical Training

MOSCOW
- All Union Res. Inst. Cable Industry
- All Union Res. Inst. Electric Current Sources
- A. N. Sysin Res. Inst. General and Community Hygiene
- Inst. Higher Nervous Activity and Neurophysiology
- Inst. Medico-Biological Problems
- Central Res. Inst. Balneology and Physical Therapy
- Inst. Radio Engineering and Electronics
- All Union Cancer Res. Center
- Inst. Biophysics, USSR Ministry Public Health
- Inst. Chemical Physics, USSR Acad. Sciences
- Inst. Biological Physics Pushchino, Moscow Region

OBNINSK
- Res. Inst. Medical Radiology

ROSTOV-ON-DON
- Res. Onkological Inst.

SARATOV
- State Univ.

SIMFEROPOL
- M. V. Frunze State Univ.

TOMSK
- Res. Inst. Biology and Biophysics, State Univ.
- Polytechnical Inst.

VLADIVOSTOK
- Medical Inst.

[illegible] October 1983

WORKSHOP ON [illegible] ELECTROMAGNETIC [illegible]

On November [illegible], 1983 a workshop was held at the University of Maryland, College Park Campus. The Workshop was sponsored by the U.S. Office of Naval Research and the Bureau of Radiological Health of the U.S. Food and Drug Administration. The purpose of the meeting was to foster exchanges between researchers in this field and those in other closely related disciplines, provide a forum for critical assessment of theoretical ideas, and to identify problem areas and research priorities. The two and one-half day program included a dozen invited tutorial lectures from leading authorities in their fields, a poster session for contributed papers, and a general review and discussion session. Although the proceedings of the meeting will not be published, it is expected that a short report will be prepared which will attempt to summarize the principal ideas presented at the Workshop and will include the abstracts of the poster papers.

MEETINGS AND CONFERENCES

5th COURSE
BIOLOGICAL EFFECTS AND DOSIMETRY OF NON-IONIZING RADIATION: STATIC AND ELF ELECTROMAGNETIC FIELDS

Date: November 15-25, 1983
Place: Erice, Italy
Requests for Information: Persons from Europe wishing to attend the course should write to Professor Martino Grandolfo, Instituto Superiore di Sanita, Viale Regina Elena 299, 00161 Rome, Italy; persons from other continents should write to Professor Sol M. Michaelson, The University of Rochester, Medical Center, 601 Elmwood Avenue, Rochester, NY 14642. Closing date for application is September 15, 1983
Fee: $500 (covers full board and lodging)
Content: Part of the course will be devoted to studies, both of a theoretical and experimental nature, relating to potential mechanisms of interaction of static and ELF electromagnetic fields with biological systems. After a detailed review of the fundamentals of physics and biology connected with the interaction of these fields with living matter, the lectures will provide an updating of the techniques developed for the detection and the dosimetry of these energies and a critical analysis of their biological effects in relation to the establishment of safety standards.

RADIATION AND ENERGY: CONFRONTING THE CHALLENGES OF THE EIGHTIES - LAW, REGULATION, RISK LIABILITY, LITIGATION AND COMPENSATION

Date: December 8-9, 1983
Place: New York, NY
Requests for Information: James Lawrence, Lloyd's of London Press, 817 Broadway, New York, NY 10003; (212)673-4700

8TH ANNUAL IEEE INTERNATIONAL CONFERENCE ON INFRARED AND MILLIMETER WAVES

Date: December 12-17, 1983
Place: Carillon Hotel, Miami Beach, FL
Requests for Information: Dr. K. J. Button, National Magnet Laboratory, Building NW-14, MIT, Cambridge, MA 02139; (617)253-5561

MICROWAVE SIGNATURES IN REMOTE SENSING

Date: January 16-20, 1984
Place: Toulouse, France
Requests for Information: Dr. Richard Moore, Remote Sensing Laboratory, Univ. of Kansas, Center for Research, 2291 Irving Hill Drive, Lawrence, KS 66045; (913)864-4836.

SYMPOSIUM ON NMR IMAGING

Date: January 27-29, 1984
Place: Fontainebleau Hotel, Miami Beach, FL
Requests for Information: American College of Radiology, 6900 Wisconsin Ave., Chevy Chase, MD 20815; (301)654-6900.

28TH ANNUAL MEETING OF THE B YSICAL SOCIETY

Date: February 19-23, 1984
Place: San Antonio Convention San Antonio, TX
Requests for Information: Biop c Society, 9650 Rockville Pike, Bethesda, MD 20 (301)493-6114

BIOLOGICAL EFFECTS OF ELF ELECTROMAGNETIC FIELDS AND THERAPEUTIC APPLICATIONS

Date: February 23-25, 1984
Place: Venice, Italy
Requests for Information: Dr. Luigi Zecca, Associations for Biomedical Applications of Electromagnetism, Via Gentilino, 9/A, 20136 Milano, Italy; Tel. 02-8321655 or 8391867
Content: Topics of the meeting will be the physical aspects, the biological effects, the medical implications and the therapeutic applications of extremely low frequency (ELF) electromagnetic fields. Attention will be focused on the following items: Physics: field generation devices, field characterization, dosimetry; Biology: cellular effects, developmental effects, physiology, hematology, immunology, neurology, tissue-vascular relationships; and Therapeutics: rheumatology, traumatology, angiology, dermatology, neurology. Abstracts in English must be submitted by December 31, 1983. Invited lectures by W. R. Adey, V. M. Bogoliubov, G. Cheng, J. M. R. Delgado, R. W. Farndale, F. Lechner, A. R. Liboff, V. V. Poltoranov, and L. Zecca
Fee: Registration will be $150 up to December 31, 1983. Late registration will be $180.
Publications: An abstract book will be provided to all registered participants. The proceedings will be published by an International Publishing House.

SIXTH INTERNATIONAL CONGRESS OF THE RADIATION PROTECTION ASSOCIATION

[illegible], 198-
[illegible]ternational Congress Center, Berlin, [illegible]
[illegible]. Int. Radiation Protection Assn. (IRPA)
[illegible] for Information: R. Neider, Secretariat, Bundesanstalt für Materialprüfung, Unter den [illegible], 87, D-1000 Berlin 45, Germany (DFR)
[illegible]: The scientific sessions of the congress [illegible] exhibit cover all aspects of radiation [illegible] from basic research to practical applications with special emphasis on the risk assessment [illegible] ionizing and non-ionizing radiation as [illegible] risks derived from all other man-made [illegible] Papers in English, French, and German

4TH INTERNATIONAL SYMPOSIUM ON HYPERTHERMIC ONCOLOGY

Date: July 2-6, 1984
Place: Aarhus, Denmark
Requests for Information: Jens Overgaard, M.D., Symposium Chairman, The Institute of Cancer Research, Forskningsstationen, DK-8000 Aarhus C, Denmark

BIOELECTROMAGNETICS SOCIETY SIXTH ANNUAL MEETING

Date: July 12-17, 1984
Place: [illegible]mont Hotel, Atlanta, GA
Sponsor: Bioelectromagnetics Society
Requests for Information: BEMS Headquarters, 1 Bank Street, Gaithersburg, MD [illegible]

EIGHTH INTERNATIONAL BIOPHYSICS [illegible]

Date: July 29 - August [illegible], 198[illegible]
Place: Bristol, United Kingdom
Sponsor: Int. Union of Pure & Appl[illegible]
Requests for Information: Dr. B. G. [illegible] of Biochemistry, The University, Bristol, United Kingdom

URSI SYMPOSIUM

Date: August 29 - September 7, 198[illegible]
Place: Florence, Italy
Sponsor: URSI
Requests for Information: Contact [illegible] Rosenthal, Polytechnic Institute of [illegible] 1[illegible], Farmingdale, NY 11735
Note: A joint meeting with the Bio[illegible] Society is tentatively scheduled [illegible]

MEETING OF THE EUROPEAN SOCIETY THERAPEUTIC RADIOLOGY AND [illegible]

Date: September 9-15, 1984
Place: Jerusalem Hilton, Jerusalem, [illegible]
Sponsor: KENES
Requests for Information: Prof. Z. [illegible], Dept. of Radiation and Oncology, Hadassah [illegible] Center, Jerusalem, Israel

TRANSLATIONS FROM FOREIGN LITERATURE

From time to time, Information Ventures, Inc. will prepare full-text translations of foreign research efforts on the biological effects of nonionizing electromagnetic fields for publication in this Digest. The second of these translations is presented below. It is an excerpt from the following article:

BIOLOGICAL EFFECTS OF MICROWAVE RADIATION. (Hun.) Almássy, Gy. (Scientific Council, TKI - Telecommunications Research Inst. - Hungary); Szabó, L.; Ballai, L. *A Távközlesi Kutato Intezet Kozlemenyei*, Vol. 27(1-2):15-45; 1982 (46 refs).

Literature data on the biological effects of microwave radiation are reviewed. The discussion covers the physical properties of microwave radiation, its absorption by living organisms, and systemic effects of microwave radiation. Microwave thermography for medical diagnostic purposes is described and apparatus for centimeter- and millimeter-wave thermographic examinations is illustrated. The draft of a new Hungarian microwave radiation safety standard is presented.

..... "In the draft of the new Hungarian standard, different safety regulations are specified for the general population and for persons who are occupationally exposed to microwave radiation. The permissible exposure level for occupationally exposed persons can be higher by 10 dB than that for the general population. Occupationally exposed personnel must undergo periodic medical check examinations.

In the draft of the standard, occupationally exposed persons are defined as follows:

- persons operating, repairing, and measuring equipment emitting electromagnetic energy, who are adequately trained;
- persons using and operating energy-generating equipment who are adequately trained for these tasks;
- persons who are at the site of equipment radiating electromagnetic energy during performance of their jobs, regardless of professional training.

Permissible radiation levels in the draft of the Hungarian radiation safety standard are summarized in Table I, below. The safety levels shown in the table are averages. No distinction is made between exposure to continuous wave or pulse modulated signals. The levels in the table are illustrated in Figures 13, 14, 15, and 16 (from the article).

During extraordinary work conditons, occupationally exposed persons can stay in areas with a high-frequency radiation hazard for a short time period (maximum of 20 minutes) and can perform work. Protective apparatus to be used is specified in separate regulations. To reduce the harmful effects of the microwave field, protective goggles absorbing microwave energy must be worn.

Radiation safety regulations of the socialist countries are summarized in Table II. "

The measurement of microwave radiation is discussed.

Table I.

Frequency range		0.03-30 MHz	30-300 MHz	0.3-300 GHz
Lower limit values of hazardous radiation	General population	20 V/m	10 V/m	0.01 mW/cm^2
	Occupational exposure	50 V/m	20 V/m	1.0 mW/cm^2
Upper limit values of harmless radiation	General population	480/t	240/t	0.24/t mW/cm^2
	Occupational exposure	1200/t	480/t	2.4/t mW/cm^2
Forbidden areas: general population + occupational exposure		1000 V/m	500 V/m	10 mW/cm^2

Note: t = exposure time in hours (t > 1 hour).

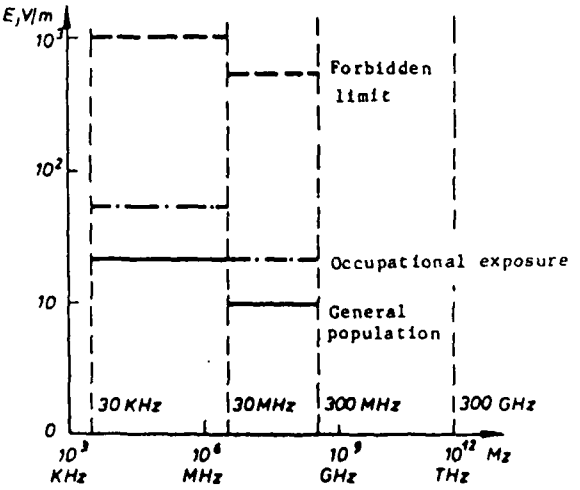

Figure 13.
Safe limits of electric field intensity for continuous exposure (Hungarian draft standard).

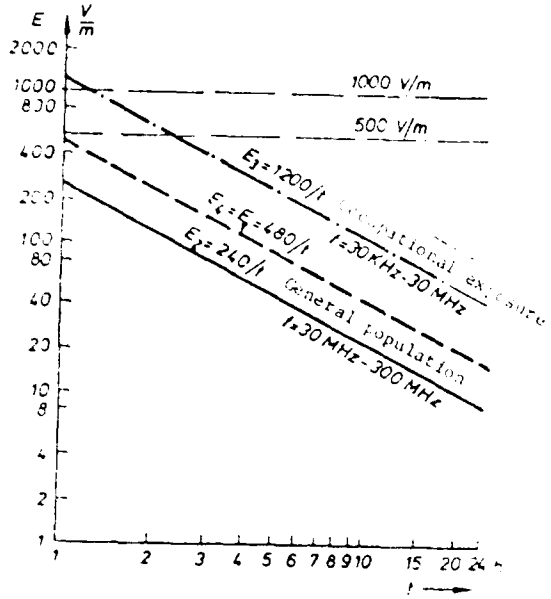

Figure 14.
Safe limits of electric field intensity for intermittent exposure (Hungarian draft standard).

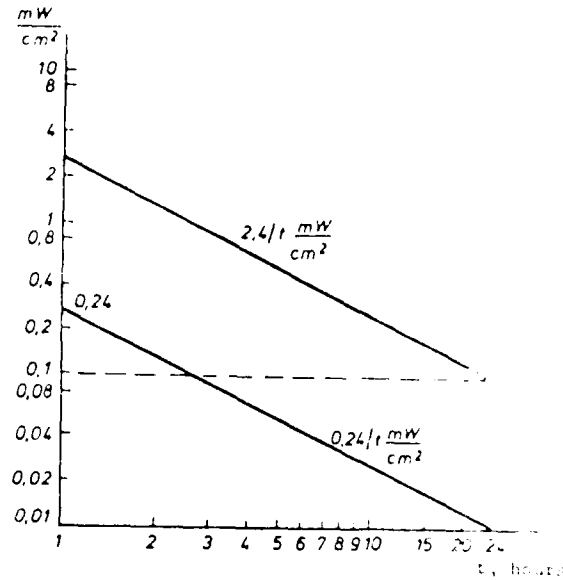

Figure 16.
Permissible values of microwave power density for intermittent exposure (Hungarian draft standard).

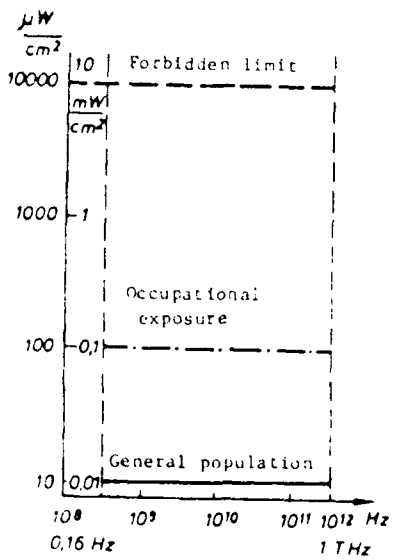

Figure 15.
Permissible values of microwave power density for continuous exposure (Hungarian draft standard).

Table 11.

Standard	Scope	Frequency	Exposure limit	Exposure duration	Continous/ pulsed mode	Fixed/rotary antenna
Soviet standard 1974	Occupational Exposure	10-30 MHz	20 V/m	Work day	Both	Both
		30-50 MHz	10 V/m	Work day	Both	Both
			0.3 A/m	Work day	Both	Both
		50-300 MHz	5 V/m	Work day	Both	Both
		0.3-300 MHz	10 uW/cm^2	Work day	Both	Fixed
			100 uW/cm^2	Work day	Both	Rotary
			100 uW/cm^2	2 hours	Both	Fixed
			1 mW/cm^2	2 hours	Both	Rotary
			1 mW/cm^2	20 minutes	Both	Fixed
Soviet standard 1978	General Population	0.3-300 MHz	1 uW/cm^2	24 hours	Both	Both
Polish standard 1972	Occupational Exposure	0.3-300 MHz	0.2 mW/cm^2	10 hours	Both	Fixed
			0.2-10 mW/cm^2	32/P^2/hour/	Both	Fixed
			1 mW/cm^2	10 hours	Both	Rotary
			1-10 mW/cm^2	800/P^2/hour/	Both	Rotary
	General Population	0.3-300 MHz	10 uW/cm^2	24 hours	Both	Fixed
			0.1 mW/cm^2	24 hours	Both	Rotary
Polish recommended standard 1975	Occupational Exposure	10-300 MHz	20 V/m	Work day	Both	Both
			20-300 V/m	3200/E^2/hour	Both	Both
	General Population	10-300 MHz	7 V/m	24 hours	Both	Both
Czech standard 1970	Occupational Exposure	10-30 MHz	50 V/m	Work day	Both	Both
		30-300 MHz	10 V/m	Work day	Both	Both
			25 uW/cm^2	Work day	Continuous	Both
			10 uW/cm^2	Work day	Pulsed	Both
		0.3-300 GHz	1.6 mW/cm^2	1 hour	Continuous	Both
			0.64 mW/cm^2	1 hour	Pulsed	Both
		30-300 MHz	1 V/m	24 hours	Both	Both
		0.3-300 GHz	2.5 uW/cm^2	24 hours	Continuous	Both
			1 uW/cm^2	24 hours	Pulsed	Both
	General Population	30-300 MHz	1 V/m	24 hours	Both	Both
		10-30 MHz	2.5 V/m	24 hours	Both	Both

P = Power density W/m^2 E = Electric field density V/m

BIOLOGICAL EFFECTS OF NONIONIZING ELECTROMAGNETIC RADIATION DIGEST welcomes contributions from its readers. Information on meetings, news, current research and current literature is actively sought for publication in the DIGEST. Forms for submission of notices of current research projects are included at the back of this issue.

0655 TECHNIQUE FOR MICROWAVE-INDUCED HYPERTHERMIA IN SUPERFICIAL HUMAN TUMORS. (Eng.) Nilsson, P. (Dept. Radiation Physics, Univ. Hosp., S-22185 Lund, Sweden); Persson, B.; Kjellen, E.; Lindholm, C.-E.; Landberg, T. Acta Radiol Oncol 21(4):235-239; 1982 (16 refs).

A hyperthermia system consisting of a microcomputer-controlled 2450 MHz microwave (MW) generator is described. MW power is delivered via a circular direct contact applicator. Up to 8 thermistor probes connected to a temperature registration unit can be used simultaneously to measure tumor and skin surface temperature; digitized temperature signals are sent to the microcomputer for calculation of temperature and for control of the heating. One of the thermistors (usually the one inserted in the center of the tumor) is chosen as the master probe, and the temperature recorded at this probe is compared with a preset temperature value. Heating is started via a signal from the computer to the MW generator when temperature at the master thermistor is at least 0.2 C lower than the preset temperature. The power of the generator (maximum output power of 200 W) is selected manually to achieve a temperature increase of approximately 0.5 C during a 15-sec MW pulse. All probes are read 2 sec after MW energy is shut off by the computer, eliminating the problem of incorrect temperature measurement during MW irradiation due to interaction between the metallic wires of the probes and the electric field. When the preset temperature value is reached, the length of the pulse is adjusted by the control program so that temperature at the master thermistor does not fluctuate more than ± 0.5 C. This automatic control system has proven to be very reliable in clinical work.

0656 MICROWAVE-INDUCED HYPERTHERMIA AND IONIZING RADIATION. PRELIMINARY CLINICAL RESULTS. (Eng.) Lindholm, C.-E. (Dept. Oncology, Malmo Allmanna Sjukhus, S-21401 Malmo, Sweden); Kjellen, E.; Landberg, T.; Nillson, P.; Persson, B. Acta Radiol Oncol 21(4):241-254; 1982 (70 refs).

Local hyperthermia induced by a computer controlled 2450 MHz microwave (MW) system was used alone or in combination with ionizing radiation to treat superficial tumors that were refractory to other therapy. Thermistor probes were placed within the tumor and on the skin surface; temperature of the probe designated as the master probe was maintained at 42.5 ± 0.5 C via the computer control system. The effects of hyperthermia alone, ionizing radiation alone (30 Gray in 10 fractions over 12 days), or hyperthermia (45 min 1/wk or 2/wk for 2 wk) with radiation were compared. Of 8 evaluable tumors given combined hyperthermia and radiation, 5 showed a complete and 3 showed a partial response while no response was seen in 3 tumors treated with ionizing radiation alone or in 1 tumor treated with heat alone. Combined therapy was effective even in sites that had been irradiated previously. The MW applicator allowed heating of lesions less than 7 cm in diameter and 3 cm deep. The preset temperature at the master probe could be maintained at ± 0.5 C but differences of up to 3.5 C were observed between the different thermistors at a given treatment session. Side effects of hyperthermia included pain and skin burns.

0657 USE OF RADIO-FREQUENCY PULSED ENERGY IN THE CONTROL OF POSTOPERATIVE REACTION IN BLEPHAROPLASTY. (Eng.) Nicolle, F. V. (30 Harley St., London W1N 1AB, England); Bentall, R. M. Aesthetic Plast Surg 6(3):169-171; 1982 (9 refs).

Clinical results obtained with a portable device used to apply small pulses of radiofrequency (RF) energy to surgical wounds are reported. The device consists of a small oscillator tuned to 27.12 MHz with a timer switching the oscillator so that small pulses of RF energy (square, 100-usec long pulses; 1000 pulses/sec) are emitted from the single turn coaxial coil. The unit is powered by a small nickel-cadmium battery that can be used for 5 days without recharging. The area of the coil is approximately 6 cm in diameter. In order to adapt the device to fit over the eyelid region, two wire loops were designed in the shape of an eyeglasses frame and held in place with light padding and a bandage. Only one loop was electrically active; the other provided a control. The device was applied for 24 hr to one eye in 21 consecutive patients after bilateral blepharoplasty. No device-related complications were observed. Improvement was apparent in 11/13 cases where sufficient ecchymosis and edema existed for comparison; ecchymosis and swelling were so slight in 6 cases that no difference was visible between treated and untreated sides. Two cases were judged to be worse on the treated side and 2 were excluded because of displacement of the dressings by the patients. A similar device with larger loops to cover the neck and sides of the face is being used in face and neck lifts.

0658 REACTION OF NORMAL EQUINE EYES TO RADIO-FREQUENCY CURRENT-INDUCED HYPERTHERMIA. (Eng.) Neumann, S. M. (Dept. Clinical Sciences, Coll. Veterinary Medicine and Biomedical Sciences, Colorado State Univ., Fort Collins, CO 80523); Kainer, R. A.; Severin, G. A. Am J Vet Res 43(11): 1938-1944; 1982 (4 refs).

The long-term effects of treatment of equine ocular tumors with radiofrequency (RF) current-induced hyperthermia were studied. The eyes of 13 horses and 8 ponies were subjected to a 30-sec application of RF current (2 MHz, 7 or 10 W); the eyes of 3 horses were sham-treated. The electrodes of a localized

current field device were applied horizontally to the central cornea in the right eye and horizontally and vertically to 2 separate limbal sites in the left eye. Mean temperatures at the 2 corneal sites was 48.7 C; at the 4 limbal sites, 56.0 C. In eyes observed from 1 to 6 mo after treatment, scars persisted at 1 central corneal site (4.5%) and 6 limbal sites (27.3%) where electrodes were positioned vertically. Pathologic changes observed up to 1 wk after treatment included transient ulcerative keratitis and anterior uveitis. Vision was not compromised in any of the animals permitted to live beyond 1 wk.

0659 ACCELERATION OF THE DEVELOPMENT OF BENZOPYRENE-INDUCED SKIN CANCER IN MICE BY MICROWAVE RADIATION. (Eng.) Szudzinski, A. (Dept. Dermatology, Postgraduate Centre, Military Medical Acad., Szaserow 128, PL-00-909 Warsaw, Poland); Pietraszek, A.; Janiak, M.; Wrembel, J.; Kalczak, M.; Szmigielski, S. Arch Derm Res 274(3-4):303-312; 1982 (20 refs).

The possible co-carcinogenic activity of long-term low-level microwave (MW) radiation was studied in Balb/c mice. Skin cancer was induced in the mice by chronic exposure to 3,4-benzopyrene painted on the dorsal skin every 2 days for up to 6 mo. Mice were exposed to 2450 MHz MW energy (from a Lucz 58 generator with maximum output power at 150 W) in a temperature and humidity controlled anechoic chamber at incident power levels of 5, 10, or 15 mW/cm^2 (specific absorption rates of 2, 4, and 6 mW/g, respectively) for 2 hr/day, 6 days/wk, for up to 6 mo. Mice were divided into six experimental groups of 100 animals each. Mice in groups 1 and 2 were simultaneously exposed to benzopyrene treatment and MW energy (5 mW/ cm^2 or 15 mW/cm^2) for 6 mo. Mice in groups 3-5 were irradiated for 1, 2, or 3 mo before the beginning of benzopyrene treatment. Control animals were exposed to benzopyrene treatment for 6 mo and sham-irradiated for 2 hr/day for 1, 2, 3 or 6 mo. All MW irradiation protocols resulted in significant stimulation of the development of benzopyrene-induced skin cancer and in shortening of the life span of the tumor bearing hosts. The effect was more pronounced both after exposure to higher power densities and after longer exposure periods. When benzopyrene treatment was preceded by or concomitant with MW irradiation, skin reactivity to dinitrofluorbenzene was markedly inhibited, suggesting that long-term exposure to low-dose 2450 MHz MW radiation may suppress cellular immune reactions.

0660 INTERRELATIONSHIPS BETWEEN WATER AND CELL METABOLISM IN ARTEMIA CYSTS. X. MICROWAVE DIELECTRIC STUDIES. (Eng.) Clegg, J. S. (Lab. Quantitative Biology, Univ. Miami, Coral Gables, FL 33124); Szwarnowski, S.; McClean, V. E. R.; Sheppard, R. J.; Grant, E. H. Biochim Biophys Acta (745):458-468; 1982 (50 refs).

The dielectric properties of cysts of Artemia, a primitive crustacean known as the brine shrimp, were measured over the frequency range 0.8-70 GHz. Artemia cysts are composed of about 4 000 closely-packed cells surrounded by an acellular shell and can undergo cycles of hydration-dehydration without loss of viability. Measurements were performed on cysts with various water contents, primarily 1 g H_2O to 1 g dried cysts. Complex permittivity measurements were made at 0.8, 2, and 4 GHz with a coaxial line apparatus; those at 15, 35, and 70 GHz were made with a waveguide apparatus. At each frequency except 70 GHz, the permittivity showed an increase as the water content of the cyst was increased. At the high hydration values, the permittivity leveled off. At 70 GHz, permittivity was linearly dependent on cyst water content. The permittivity of the intracellular water at 35 GHz was estimated as 16 which is 30% below that for pure water at 34 GHz. The authors assumed that water exists as bulk and nonbulk fractions in the cysts and calculated that 43% of the cellular water had a permittivity equal to that of pure water.

0661 MICROWAVE MODULATION OF NEURAL ACTIVITY. (Eng.) Wachtel, H. (Dept. Electrical Engineering, Univ. Colorado, Boulder, CO). Biomed Sci Instrumen 18:45-50, 1982 (6 refs).

A mathematical model is presented which can be used to predict optimal microwave (MW) pulse parameters for perturbing neural activity with minimal risk of damage due to temperature rise or excessive current density. The model, which is based on the observation that low levels of MW power can rapidly produce changes in the firing patterns of isolated Aplysia pacemaker neurons and that MW pulses may be equivalent to injected transmembrane DC pulses, suggests that a distinct minimum pulse energy exists when pulse duration (in sec) equals 1.2 x the membrane time constant. Noninvasive modulation of neurenal activity by MW pulses could have numerous biomedical applications.

0662 MICROWAVE ABSORPTION OF DNA BETWEEN 8 AND 12 GHz. (Eng.) Swicord, M. L. (Bureau of Radiological Health, 12721 Twinbrook Parkway, Rockville, MD 20857); Davis, C. C. Biopolymers 21(12):2453-2460; 1982 (11 refs).

The microwave (MW) absorption coefficients of aqueous solutions of DNA extracted from Escherichia coli were measured over the frequency range 8-12 GHz. The phase fluctuation optical heterodyne technique

was used to monitor the temperature rise induced in a sample by pulsed MW irradiation. In this technique, a single frequency He-Ne laser beam traverses the sample while the sample is heated with 10 mJ pulses of MW energy. The heating of the liquid sample when it absorbs MW energy induces a phase chirp in the laser beam. The absorption coefficient of the sample is determined from a plot of optical heterodyne signal as a function of the distance of the laser beam from the surface of the liquid. The maximum random error in the system was less than 2% as determined from measurements on deionized water and other media such as saline solutions and methanol. The attenuation coefficient of the DNA solution was greater than that of water and saline solution. The absorption coefficient of the DNA solution was 40% higher than water at 8 GHz, decreasing to 10% higher at 12 GHz. At 6 GHz, the absorption coefficient of the sample, which had a measured dc conductance of 0.67 mmhos/cm, was 25% higher than that of a saline solution of 20 times greater dc conductance. Thus, the absorption in the DNA solution does not arise from ionic behavior but is in agreement with absorption by the longitudinal acoustic mode of the double helix.

0663 FALSE CLAIMS FOR MAGNETOTHERAPY (LETTER TO EDITOR). (Eng.) Orpin, J. A. (Bureau Medical Devices, Health Protection Branch, Dept. National Health and Welfare, Ottawa, Ont., Canada). Can Med Assoc J 126(12):1375; 1982 (no refs).

In response to many requests from physicians regarding medical applications of magnetic fields, the author states that there is no scientific evidence of any usefulness of magnetotherapy. The units used for this therapy consist of a coil through which direct current passes and may be pulsed 1 to 50 times per sec. The magnetic field, which can reach a value of 10 mT, approximates that found near a small 100-W transformer. He further states that findings in the literature concerning magnetotherapy often conflict and that no properly controlled trial has been conducted.

0664 CLAIMS FOR MAGNETOTHERAPY (TWO LETTERS TO EDITOR). (Eng.) Bassett, C. A. L. (Orthopaedic Res. Labs., Coll. Physicians and Surgeons, Columbia Univ., New York, NY); Orpin, J. A. Can Med Assoc J 127(11):1079-1080; 1982 (no refs).

Regarding Orpin's letter to the editor in Can Med Assoc J 126:1375, 1982 [see Abstract No. 0663], it is necessary to differentiate between electromagnetic devices for which unfounded claims have been made and those which have been thorougly investigated in controlled laboratory and clinical conditions such as the use of highly specific pulsed electromagnetic fields in fractures that fail to heal, failed arthrodeses and congenital pseudarthroses. Orpin responds that his letter referred to magnetic equipment currently advertised in Canada and not to devices used in research that are not yet available for clinical use. A more precise terminology and a classification system for devices that deliver diagnostic or therapeutic energy based on their levels of acceptance and authenticity are proposed.

0665 NEUROPHYSIOLOGICAL EFFECTS OF ELECTROMAGNETIC FIELDS. A CRITICAL REVIEW. (Eng.) Hansson Mild, K. (National Board Occupational Safety and Health, Dept. Occupational Health, Box 6104, S-900 06 Umea, Sweden); Oberg, P. A. Electroencephalgr Clin Neurophysiol [Suppl] 36:715-729; 1982 (58 refs).

The neurophysiological effects produced by exposure to 0-300 GHz electromagnetic (EM) fields at levels considered to be non-thermal are reviewed. Occupational exposure to near- and far-field radiation is discussed. The effects of constant and alternating magnetic fields at the cellular level of the nervous system have been studied in giant axons of lobsters, frog nerve-muscle preparations, frog retina and sciatic nerves, cat saphenous nerves, rabbit vagus nerves and superior cervical ganglia, and the abdominal ganglia of aplysia californica. At the organ level, calcium fluxes in cat and chick brain tissue exposed to modulated EM fields and heart rate changes in isolated perfused rat hearts exposed to microwave (MW) irradiation have been reported. The results of studies of EM field effects on different mammals are reviewed. Effects observed in humans exposed to EM fields include deep heating in tissue during shortwave and MW diathermy, a faint flickering visual sensation when the head is exposed to electric currents or magnetic fields, and auditory perceptions when the head is exposed to pulse-modulated MW energy above a certain intensity level. The neurasthenic syndrome (headache, irritability, dizziness, loss of appetite, sleeplessness, sweating, difficulties in concentration or memory, depression, emotional instability, dermographism, thyroid gland enlargement, and tremor of extended fingers) has been reported in epidemiological studies of workers exposed to radiofrequency (RF) and MW radiation. There appears to be a general consensus that the majority of biological effects of RF and MW fields can be explained by thermal energy conversion. For frequencies in the kHz range the possibility exists of direct nerve excitation by induced eddy currents at very high magnetic field strengths. Modulated fields appear to have a greater ability for interfering with biological material than do continuous waves. Both amplitude modulated ultra high frequency fields and extremely low frequency fields with frequencies in the range 6-30 Hz have been shown to affect brain tissue and bioelectrical activity. However, the level of

knowledge of the mechanisms behind EM field effects on biological systems is still low.

0666 RADIOFREQUENCY AND MICROWAVE RADIATION. (Eng.) Hileman, B. (No affiliation given). Environ Sci Technol 16(8):442A-444A; 1982 (no refs).

The environmental effects of radiofrequency and microwave radiation are reviewed. Results of animal studies are outlined briefly. Standards and guidelines for exposure to microwave radiation vary by 3 orders of magnitude (up to 100, 1000, or 10,000 uW/cm^2). The U.S. has no federal standards adopted by the government through the regulatory process for the protection of workers or the general population from either microwave or radiofrequency radiation.

0667 AN INCREASE IN COLONY-FORMING CAPACITY OF THE BONE MARROW STEM CELLS AFTER MICROWAVE IRRADIATION IN VITRO. (Eng.) Rotkovska, D. (Inst. Biophysics, Czechoslovak Acad. Sciences, 612 65 Brno, Czeckoslovakia): Vacek, A. Folia Biol (Praha) 28(2): 138-141; 1982 (7 refs).

The effect of microwave (MW) radiation on bone marrow cell suspensions in vitro was investigated in mice. Bone marrow cell suspensions in Hanks' solution were irradiated for 5 min (2450 MHz, 65 mW/cm^2, temperature increase of 6 C) and injected iv into x-irradiated isogenic recipients 10, 30, or 45 min after MW exposure. On day 10 after transplantation, a significant increase in the number of colony forming units was observed for the bone marrow cell suspension transplanted within 10 min of MW exposure but no difference was observed for the suspension transplanted 45 min after MW irradiation. In a control experiment, the colony forming capacity of bone marrow heated in a water bath was not affected by a rise in temperature comparable to that reached during MW irradiation. The repopulation activity of bone marrow cells added to MW-irradiated Hank's solution and transplanted after 20 min incubation at room temperature was almost equal to that of MW-irradiated bone marrow suspensions. The results suggest that the effect of MW radiation on the colony forming capacity of the bone marrow may be indirect and may be mediated by alterations in the MW-irradiated solution.

0668 CHANGES IN CARDIAC-CELL MEMBRANE NOISE DURING MICROWAVE EXPOSURE. (Eng.) Sea[illegible], R. L. (Biomedical Res. Div., Georgia Tech Engineering Experiment Station, Atlanta, GA 30332); [illegible]r, R. K.; DeHaan, R. L. 1982 IEEE MTT-S Digest: 436-438; 1982 (11 refs).

The membrane voltage noise of cardiac-cell aggregates was studied during microwave (MW) irradiation as a probe of the molecular mechanism of interaction between electromagnetic (EM) energy and an excitable cell membrane. Aggregates of embryonic white leghorn chicken heart cells in culture were placed in an open-ended coaxial exposure device connected to a source of continuous wave, 2450 MHz MW energy. Temperature of the medium was maintained at 2[illegible] ± [illegible]. During irradiation at specific absorption rates of 122 to 237 mW/g, the local temperature of the aggregates increased by no more than 0.8 C. Membrane voltage noise was recorded from 5 different aggregates in a total of 8 exposures. Average pre-exposure value of power for the 8 exposures was -8[illegible] ± 3.12 dB; during the beginning of exposure, it was -82.36 ± 4.25 dB. Average powers for the first 5 exposures were -83.39 ± 3.87 dB and -81.44 ± 2.[illegible] dB for pre-exposure and beginning epochs, respectively. The average increase in power during the beginning of exposure was 0.99 ± 3.93 dB over all 8 exposures and 1.94 ± 3.81 dB for the first 5 exposures. Because of the large variability, this result is inconclusive and further experiments are in progress.

0669 A SELF-BALANCING MICROWAVE RADIOMETER FOR NON-INVASIVELY MEASURING THE TEMPERATURE OF SUBCUTANEOUS TISSUES DURING LOCALIZED HYPERTHERMIA TREATMENTS OF CANCER. (Eng.) Sterzer, F. [illegible] Labs., Princeton, NJ 08540); Paglione, R.; [illegible] F.; Mendecki, J.; Friedenthal, E.; Botstein, [illegible] IEEE MTT-S Digest:438-440; 1982 (6 refs).

The use of a self-balancing radiometer operating from 2350 to 2550 MHz to non-invasively measure subcutaneous tissue temperature during localized radiofrequency (RF, 27 MHz) and microwave (MW: 2450 MHz) hyperthermia treatments for cancer is described. With 2450 MHz contact applicators are used for treating cutaneous and subcutaneous tumors, the applicator serves as the antenna of the radiometer and receives the thermal radiation from the heated tissues. [illegible] 27 MHz applicators are used to heat deep-seated tumors, tissue temperatures are measured by removing the applicator after heating and then measuring the thermal noise power emitted by the heated tissues. A ceramic filled waveguide applicator usually serves as the antenna of the radiometer. Current limitations of radiometers of this type are that only average rather than point temperatures are measured by this method, and the depths at which tissue temperatures are measured are relatively shallow.

0670 THERMAL DRIFT IN MICROWAVE THERMOGRAPHY. (Eng.) Shaeffer, J. (Dept. Radiat[illegible]

Oncology and Biophysics, Eastern Virginia Medical Sch., Norfolk, VA 23507); El-Mahdi, A. M.; Bielawa, R.; Regan, J. F.; Carr, K. L. 1982 IEEE MTT-S Digest:441-443; 1982 (3 refs).

During microwave (MW) thermography for the measurement of subcutaneous tissue temperature, prolonged contact between the MW antenna at one temperature and a subject at a different temperature results in thermal drift, the apparent change in the subject's temperature. Thermal drift may be positive or negative depending on the nature of the thermal mismatch between antenna and subject. It can be eliminated or minimized by appropriate thermal matching of subject and antenna and improvement in antenna design.

0671 DYNAMIC IN VIVO PERFORMANCE OF TEMPERATURE CONTROLLED LOCAL MICROWAVE HYPERTHERMIA AT 2.45 GHz. (Eng.) Knochel, R. (Philips Res. Lab., Vogt-Kolln-Strasse 30, D-2000 hamburg, W. Germany); Mever, W.; Zywietz, F. 1982 IEEE MTT-S Digest:444-447; 1982 (4 refs).

A temperature-controlled 2.45 GHz microwave (MW) system for local heating of small animal tumors is described which consists of a Philips MW 127 generator (25 or 200 W maximum output power) operating in a pulsed power mode, micro-thermocouple temperature monitoring equipment and three different applicators: commercially available non-contact spiral antenna, ceramic-filled waveguide and cross-fire arrangement of two ceramic-filled ante nas in cophase. It was capable of inducing an intratumor temperature of 43 C within 3 min and maintaining it within ± 0.1 C during 15-min treatment sessions. Comparison of the control-loop response in phantom tissue and in solid tumors (rhabdomyosarcoma R1H) in anesthetized rats showed significantly different heat distributions during both transient and stationary phases of heat control. Interference between thermocouples and electromagnetic fields was reduced by orthogonal positioning of the thermocouples and by at least a 1 sec interval between turning off MW power and temperature sampling. The ceramic-filled waveguide antennas exhibited better coupling between the tumor and the antenna than the spiral antenna. Although *positioning* of the rat was not as easy as with a single applicator, the crossfire arrangement of applicators was the most efficient: less power per applicator was applied and faster heating to the final temperature was obtained.

0672 BIOLOGICAL EFFECTS AND MEDICAL APPLICATIONS OF RF ELECTROMAGNETIC FIELDS. (Eng.) Gandhi, O. P. (Dept. Electrical Engineering, *Univ. Utah, Salt Lake City*, UT 84112). IEEE Trans Microwave Theor Tech 30(11):1831-1847; 1982 (113 refs).

Current knowledge about the biological a[illegible] al effects of exposure to radiofrequen[illegible] tromagnetic fields is summarized. Ocular, [illegible] and behavioral effects, enhanced efflux [illegible] ions from chick and cat cortex tissues, a[illegible] gistic effects between microwave radiati[illegible] choactive drugs have been reported. A te[illegible] with exposures lasting up to 16 wk have [illegible] ducted. *Results of the first* 15 mo of a two-y[illegible] simulating human exposure to the Air Force [illegible] system are discussed. Factors affecting [illegible] absorption of electromagnetic radiation [illegible] rized. A lower, frequency-dependent safety standard has been recommended by the ANSI C95 committee. The allowed power densities are calculated to [illegible] whole-body averaged specific absorption rate [illegible] than or equal to 0.42 W/kg over the frequency [illegible] 3-100,000 MHz. Medical applications of [illegible] netic fields include hyperthermia as an [illegible] cancer therapy, biomedical imaging, and r[illegible] wave heating of the animal head as a [illegible] sacrificing animals and inactivating brai[illegible] Areas that need further investigation ar[illegible]

0673 UN-UNITED FRACTURES. PART I. [illegible] ELECTROMAGNETIC FIELDS: A NON-[illegible] WAY TO PRODUCE BONY UNION. (Eng.) [illegible] L. (Dept. Orthopaedic Surgery, Columbia [illegible] Physicians & Surgeons, 630 W. 168 St., New [illegible] 10032). Instr Course Lect 31:88-94; 198[illegible]

The first article of a three-part series [illegible] ed fractures describes the use of pulse[illegible] magnetic fields (PEMFs) to stimulate the [illegible] un-united fractures. A study of 1[illegible]7 [illegible] patients with un-united fractures or failed [illegible] deses treated with PEMFs revealed a success [illegible] 77% for the first attempt to produce union [illegible] method [see Abstract No. 0068]. A success [illegible] 92% was seen in a series of 53 un-united [illegible] of the tibial diaphysis treated at Colora[illegible] terian Center in 1979. Contraindications [illegible] method and procedures that are important [illegible] the success are outlined. PEMFs and bone [illegible] pear to work synergistically to assure [illegible] PEMFs are used in clinical evaluations of [illegible] vascular necrosis, looosened prostheses, [illegible] osteoporosis, and Paget's disease, and, [illegible] oratory, they have proved effective in [illegible] repair of peripeheral nerve lesions.

0674 UN-UNITED FRACTURES. PART II. [illegible] CONSTANT DIRECT CURRENT IN THE [illegible] OF NONUNION. (Eng.) Brighton, C. T. (Dept. [illegible] paedic Surgery, Sch. Medicine, Univ. Penn[illegible] Philadelphia, PA 19104). Instr Course [illegible] 103; 1982 (36 refs).

The second part of a three-part series on un-united fractures describes the use of a semiinvasive percutaneous constant direct current method to treat bony nonunions. In clinical studies, 316 patients with [illegible] well-established nonunions secondary to trauma were treated with constant direct current delivered by a power pack consisting of field-effect transistors and resistors in circuit with a 7.5 V battery such that a constant current was delivered regardless of changing resistance. During the course of the study, the current was increased from 10 to 20 [illegible], the number of cathodes from one to four, and the duration of the electrical treatment from 9 to 12 wks. Stainless steel cathodes were inserted in the operating room. In most cases, the patients were discharged from the hospital 1 day post-operatively. Of the 324 nonunions treated with constant direct current 238 (73.4%) healed. Inadequate electricity accounted for 11/86 failures, synovial pseudarthrosis for 10, and the presence of a large gap (greater than half the diameter of the bone at the level of the nonunion) for 8. Thus of 295 nonunions treated properly, bony union was achieved by 80.7%. The most common nonunion in the series, the tibia ([illegible]), achieved an 86% heal rate; the worst results were seen in the humerus (24/29[illegible]) with a heal rate of [illegible]%. The advantages of this method include: portability of the apparatus; a low risk benefit ratio; presence of a metallic fixation device at the nonunion site does not compromise the use of direct current; even when the procedure fails to achieve solid bony union, usually some bone is formed in the vicinity of the cathode.

[illegible] UN-UNITED FRACTURES. PART III. CLINICAL USE OF THE OSTEOSTIM, AN IMPLANTED BONE GROWTH STIMULATOR, FOR IMPAIRED BONE HEALING. (Eng.) Paterson, D. (Dept. Orthopaedic Surgery, Adelaide Childrens' Hosp., 72 King William Rd., N. Adelaide [illegible], South Australia). Instr Course Lect 31:103-[illegible], 1982 (2[illegible] refs).

The final part of a three-part series on un-united fractures describes the use of the Osteostim, a surgically implanted bone growth stimulator, which has been used to achieve union of long bones in > 250 cases in Australia with an overall success rate of [illegible]. The unit consists of a hermetically sealed titanium casing incorporating the power source, the anode in the platinized hemispherical end of the [illegible] and a silicone-insulated stainless steel lead connected to the titanium cathode. The surgical procedure for implantation of the unit [illegible] described; the generator and the detachable cathode are removed [illegible] approximately 6 mo [illegible]. The efficacy of this method of electrical stimulation is illustrated in [illegible] case reports. The [illegible] time for union is 16 wk. [illegible] has been successfully used in all [illegible] of both upper and lower limbs and has stimulated [illegible] in cases where other techniques have failed. [illegible] treatment has been used [illegible]

cases of [illegible] to 5[illegible] [illegible] be attributed [illegible] technique, [illegible] existing [illegible]

[illegible] NEAR [illegible] (Dept. [illegible] Preventative Medicine [illegible] C-245, Univ. Medical Center, [illegible] Denver, CO 8[illegible] (4): 345-3[illegible]; 198[illegible]

The association between [illegible] adults and the presence of [illegible] wiring was studied [illegible] comprised [illegible] adult [illegible] who had died of [illegible] life-threatening form of [illegible] without known [illegible] age, age at [illegible] economic level [illegible] could be traced [illegible] yr prior to cancer diagnosis [illegible] study; the address [illegible] of the [illegible] dress coded and [illegible] configurations around the addresses [illegible] according to the number of current [illegible] near the house, [illegible] the wires [illegible] house. The results [illegible] incidence of cancer in adults [illegible] addresses with high current [illegible] suggest a possible dose-relationship [illegible] the proportion of homes with [illegible] the majority of the cases studied, there [illegible] nificant difference between males and [illegible] degree of association [illegible] under [illegible] yr of age exhibited a greater [illegible] sociation between HCCs and cancer [illegible] The [illegible] subjects with [illegible] environments. [illegible] level [illegible] members of [illegible] [illegible]

[illegible] RESPONSES [illegible] MICROWAVES. [illegible] Naval Aerospace Medical Res. Lab., Naval Air [illegible], R. F. [illegible] refs).

[illegible] microwave [illegible] similar in magnitude to that ob[illegible] mammalian species, rectal temperature, levels of cortisol, thyroxine (T_4), [illegible] (GH) were measured in 6 rhesus [illegible] pulsed MW power (1.29 GHz; pulse [illegible], pulse repetition rate, 347/sec) produced by [illegible] type AN/TPS-1G radar. Whole-[illegible] of the chair-restrained monkeys [illegible] under [illegible] conditions. Irradiations [illegible], 28, and 38 mW/cm^2 [illegible] corresponding specific absorption [illegible] and 2.1 W/kg. Blood samples [illegible] indwelling jugular venous [illegible] period before, during, and [illegible] exposure. Rectal temperature [illegible] average of [illegible], and 1.7 C [illegible] for the three intensities used. [illegible] or GH were observed. Only the 38 [illegible] resulted in raised increases in [illegible]. The results indicate that whole-[illegible] rhesus monkeys to 1.29 GHz pulsed [illegible] increase in circulating cortisol [illegible] at a threshold intensity of exposure [illegible] 28 and 38 mW/cm^2. It was concluded [illegible] temperature and thermoregulatory responses to [illegible] the rhesus monkey are comparable to [illegible] responses in other animal models.

[illegible] RADIATION [illegible] REPAIR WITH SE[illegible] [illegible] ELECTROMAGNETIC FIELDS. [illegible], C. A. [illegible], Electronic Res. Labs., [illegible], Physicians and Surgeons, 630 [illegible], New York, NY [illegible]); Valdes, M. G.; [illegible] Plast Surg [Am] 69(6): 888-[illegible]

[illegible] chromatic [illegible] and histological [illegible] of the radius [illegible] male Sprague-Dawley rats. [illegible] with [illegible] microtomes were [illegible] for [illegible] final re[illegible] [illegible] part found, [illegible] exposed to [illegible] day for 2 wk. [illegible] artery, [illegible] width, [illegible] repetition rate was [illegible], or 15 Hz. [illegible] with PEMF were killed on Day 14; [illegible] were [illegible] 8 wk. [illegible] testing was [illegible] histo-

0679 STUDIES OF LONG-TERM EXPOSURE OF THE PORCINE BRAIN TO RADIATION FROM TWO-WAY PORTABLE RADIOS (MEETING PAPER). (Eng.) Sutton, C. H. (Div. Neurosurgery, Univ. South Florida Coll. Medicine, Tampa, FL 33612); Balzano, Q.; Garay, O.; Carroll, F. B. J Microwave Power 17(4):280-281; 1982 (2 refs).

To assess the effect of prolonged exposure to intermittent microwave (MW) energy on the brain, 15 200-lb pigs were fitted with a leather harness holding a standard two-way portable radio (Motorola, Model MX350, 452 MHz, 6.4 W) so that the antenna remained at a distance of 1.5 cm from the frontal midline of the scalp. After a 1-mo training period to habituate the pigs to the headgear, 8 (5 pigs were irradiated for 8 h/day for 90 days. To simulate intensive use of a radio by a human operator, MW exposure was composed of repeated 10-min cycles (1 min continuous-wave radiation, 9 min pause). After 90 days, all animals were sacrificed. Each animal was injected with Evans Blue 1 hr prior to sacrifice. No areas of blood brain barrier disruption were encountered and there was no evidence of brain edema. In addition to routine processing of brain tissue for hematoxylin and eosin stains, neurohistological special stains were prepared and several enzyme histochemical incubations were carried out. There was no evidence of injury to brain tissue in either the 8 irradiated pigs or the 7 nonirradiated pigs. The results indicate that repeated daily exposure to 452 MHz MW energy does not produce detectable brain injury in pigs and that it is unlikely that similar usage of two-way portable radios in humans will produce any brain injury or blood-brain barrier disruption.

0680 SYNERGISTIC EFFECTS OF MICROWAVES AND PENTOBARBITAL IN LABORATORY RATS (MEETING PAPER). (Eng.) De Witt, J. R. (Dept. Electrical Engineering, Univ. Utah, Salt Lake City, UT 84112); D'Andrea, J. A. J Microwave Power 17(4): [illegible]; 1982 (5 refs).

...effects of combined doses of pulsed microwave MW radiation and sodium pentobarbital on the acquisition of shuttle-box avoidance responses were studied in 24 male Long-Evans rats. Six groups of rats were given different combinations of sodium pentobarbital (0, 10, or 15 mg/kg, ip) followed by MW radiation (0 or 1 mW/cm^2, 3-GHz carrier wave, 500 pulses/sec, 2-usec pulse width, for 30 min). After sham or MW radiation, rats were removed to a shuttle box and given 10 min to explore and adapt before training was begun. The conditioning stimulus (CS) was a combination of sound from a speaker and illumination from the 24-V lamp in the chamber that the rat happened to occupy at the onset of the CS. During the training trials, the CS preceded the unconditioned stimulus (US: 0.73 mA pulsed shock of constant current delivered to the grid floor of the shuttle-box) by 10 sec and stayed on until the rat made an avoidance, escaped from the shock, or 120 sec of footshock had been given. A training session consisted of 50 trials with an average 30-sec intertrial interval. The effects of drug dose and the interaction between drug dose and radiation treatment were statistically significant. Increases in drug dose were associated with increased latencies to escape or avoid for both irradiated and nonradiated rats. There was no difference between radiated and nonradiated rats receiving saline. However, radiated rats given either 10 or 15 mg/kg were slower than nonradiated rats given the same dose suggesting that there was a synergism between pulsed MW radiation and drug doses of 10 and 15 mg/kg pentobarbital.

...RF HYPERTHERMIA APPLICATOR WITH MOVING ELECTRODES (MEETING PAPER). (Eng.) Cur... T. C. (Dept. Electrical Engineering, Univ. ...berta, Edmonton, Alberta, *Canada T6G 2G7*); Voss, ... S. ... Microwave Power 17(4):284-285; 1982 (2 ...

...ated agar phantoms and capacitive electrodes ...ing through an 80 degree arc were submerged ...eated in a saline water bath to 22.1 C. Small ...plated electrodes provided 200 W at a fre... ...3.75 MHz for 10 min. Temperature gradi... ...the wear cylinder are illustrated. Extra... ...of the data suggests that this technique ... achieve a tumor temperature of 45... ...maintaining all other body temperatures ...

...A SIMPLE PRECISE METHOD TO MEASURE PD AND ... FOR BIOLOGICAL SAMPLES (MEETING PA... ... Shen, Z.-Y. (Microwave Res. Inst., ... Inst. New York, 333 Jay St., Brooklyn, ... Chi, A. I Microwave Power 17(4):287-289; ...

The transmitted power method for measuring power density (PD) on the surface of biological samples is presented. The method uses a liquid sample in a quartz ... power behind a sample, which is ... disturbing the field at the ... proportional to the PD at the ... To determine the proportionality ... ple is placed in a TEM cell ... cross section as the sample ... the sample is used to measure ... The PD is determined by measuring ... er with the same small ... keeping the surface of the ... the incident wave. In a ... ident power and reflected ... the input waveguide of a ... for calculating the specific ... gives the value of the SAR ... electrical conductivity, dielectric ... loss tangent of the sample.

...0683 EFFECT OF LOW ... ON THE DUODENAL ... UNANESTHETIZED RAT. (Eng.) ... ...ologie-Pharmacologie, Bat. ... ...ert Einstein, 69621 Villeurbanne ... Microwave Power 17(4):329 ...

...chrome-nickel insulated electrodes ... in the duodenal wall of ... male wistar ... The effects of 2.45 GHz microwave ... smooth muscle. Rats ... were irradiated in a multimode ... mW/cm^2 or 1-4 hr. Specific absorption ... measured by readings of forward and ... at 5, 7.5, and 10 mW/cm^2 were 5.3, ... mW/g, respectively. During ... slow-wave frequencies accelerate ... MW exposure began (by 9% at 5 mW ... ...ases and by 19% at 7.5 mW/cm^2 in 9 ... and disappeared 10-15 min after ter... ...posure. Duodenal action potentials ... by radiation; the effect was more ... at 5 mW/cm^2. The results show ... trical activity is affected by ... accelerating effect on duodenal ... dependent on thermal activity ... effect on action potentials is ... ...ific MW effect.

...0684 LACK OF MUTAGENIC ... ASPERGILLUS AMSTELDAM ... 8.7175-GHz CW MICROWAVES. ... (Dept. Biology, Coll. Science, ... Habash, R. W. Y.; Al-Hafid, H. ... er 17(4):345-351; 1982 (3) ...

The mutagenic effects of 8.7175 GHz continuous wave (CW) microwave (MW) radiation were studied in conidia of Aspergillus amstelodami. Conidia were exposed in the near field of a horn antenna for 3 or 6 hr at an estimated incident power density of 2.09 mW/cm^2. Exposures were carried out in the dark at temperatures ranging between 28 and 30 C. During irradiation, the suspension was continuously stirred by a rotating magnetic stirrer (rate of rotation, 14 Hz; a 16.87×10^{-3} tesla magnetic field was induced by the stirring device). The frequencies of conidial color variants and of 8-azaguanine resistant mutants in treated and untreated populations were compared. Both treated and untreated conidial populations gave similar frequencies in morphological and in drug-resistant mutants. The response was not affected by exposure duration or by temperature elevation (2.2 C and 2.4 C higher than controls after 3- and 6-hr exposures, respectively). The results demonstrate a lack of genetic response of conidia of A. amstelodami to 8.7175 GHz CW MW radiation.

0685 PSYCHOLOGICAL SYMPTOMS AND INTERMITTENT HYPERTENSION FOLLOWING ACUTE MICROWAVE EXPOSURE. (Eng.) Forman, S. A. (Navy Environmental Health Center, Norfolk, VA 23511); Holmes, C. K.; McManamon, T. V.; Wedding, W. R. J Occup Med 24 (11):932-934 (11 refs).

Psychological symptoms and hypertension following accidental, acute, high-level exposure to X-band microwave (MW) radiation are reported in two healthy men operating a portable high-power MW radar tracking system during military field maneuvers. The exposures occurred in the radiating near field and were from a continuous wave beam from a uniformly illuminated circular aperture antenna. The worst case, a 54 yr old man who was exposed continuously for 80 sec, showed an electric field strength of 475-580 V/m (corresponding to an equivalent plane wave power density of 60-90 mW/cm^2). Immediate effects were severe chest pain, vertigo, and a heating sensation of the chest and head. Rapid onset of recurrent, severe headaches, insomnia, irritability, and emotional lability were also experienced. Peak severity of the subjective complaints occurred 3 mo after the exposure, coincident with a diagnosis of arterial hypertension in the range of 160/105 which was controlled with medication. After 1 yr of follow-up, blood pressure readings were normal but psychological problems of varying severity persisted. A 21-yr-old man sustained intermittent exposure to the MW beam over a period of 5 min (total time of irradiation, approx. 75 sec). Immediate effects included a heating sensation of the head and chest and a headache. Irritability, insomnia, headaches, photophobia, and visual blurring were experienced subsequently. Hypertension of 140/105 was detected 4 mo after the incident; it was controlled with medication. Blood pressure was normal at the 12-mo follow-up; emotional lability and insomnia persisted. No organic basis was discovered for the psychological problems or the hypertension experienced by the men; a diagnosis of acute post-traumatic [illegible] order was given in both cases. The other affected men, aged 30 and 39 yr, were exposed [illegible] power density for 5-10 sec. They reported vertigo, and a heating sensation, but these symptoms did not persist beyond 3 wk after [illegible]

0686 DEVELOPMENT AND USE OF A NONRESTRAINING WAVEGUIDE CHAMBER FOR RAPID MICROWAVE IRRADIATION KILLING OF THE MOUSE AND NEONATE RAT. (Eng.) Schneider, D. R. (Dept. Pharmacology, Sch. Med. Res., Wayne State Univ., 540 East Canfield, Detroit, MI 48201); Felt, B. T.; Rappaport, M. [illegible] J Pharmacol Methods 8(4):295-[illegible]

A nonrestraining waveguide chamber designed to irradiate with focussed 2450 MHz microwave (MW) radiation to kill small rodents rapidly and without stress to the animals is described. The design is based on the observation that a rodent will preferentially enter a darkened hole (e.g., in the broad face of the waveguide chamber device) with a delay time of 1-2 sec after being placed on a lighted platform adjacent to the chamber. The MW generator to which the waveguide chamber is attached must have a minimum 3.5 kW output power to properly heat the mass of the small rodent head within the time limit of 1.5 msec required for the accurate measurement of basal concentrations of rapidly modulated brain neurochemical indices. For maximum coupling of MW energy to the rodent brain, animal placement must be at a distance of 1/4 wavelength from the closed end of the waveguide. To insure accurate positioning of a standing wave of MW radiation at this location, a triple screw tuner waveguide section is inserted into the waveguide system between the magnetron and the chamber. A positioning cup, consisting of a plastic cylindrical tube with a rounded end, is placed through the waveguide to optimally position the animal head within the energy field. Two versions of the waveguide have been extensively tested: a small WR-284 chamber suitable for either the neonate mouse or rat (up to 10 g), and a WR-430 chamber for use with the adult mouse and small rats (to 50 g). The center of the entrance hole is positioned at distances of 2.5 and 3.69 in from the terminal end of the WR-284 and the WR-430 chambers, respectively.

0687 PULSING ELECTROMAGNETIC FIELDS IN THE TREATMENT OF NON-UNION OF [illegible] (Eng.) Caullay, J. M. (Orthopaedic and [illegible] Unit, Royal Infirmary, Glasgow, Scotland); Mann, S. S. J R Coll Surg Edinb 27(2):102-[illegible] refs).

Four cases of non-union of the tibia treated successfully with pulsing electromagnetic fields [illegible]

A model of the cell surface is developed to determine the effect of an externally applied electric field on the interaction between negative charges embedded in the cell membrane and positive ions (counter-ions) trapped near the surface. The cell is assumed to be an immovable hemisphere with a continuous distribution of charges on the surface. A homogeneous electric field is applied parallel to the surface on which the hemisphere is affixed. At a time period after the application of an external electric field that is long compared to the relaxation time of the surrounding ions but short compared to the time needed for movement of the charged molecules within the surface, the electric field due to counter-ion polarization can be estimated at any point on the cell surface. The electric field was evaluated at each point on the surface under the assumption that $qaE_0 \ll kT$ where q is the charge of the ion near the surface, a is the radius of the cell, E_0 is the external electric field, k is Boltzman's constant, and T is the absolute temperature. Plots of the electric field are given as a function of cell surface potentials from 10 to 80 mV, temperatures from 5 to 37 C, and electrolytes. The solution for the electric field due to ion polarization is independent of the cell radius for small applied fields (approx. 1 V/cm); if $qaE_0 < kT$, it will depend on the cell radius and polar spherical coordinate. A more refined model would include distributions of discrete charges on the cell surface instead of a continuous distribution, allowance for redistribution of surface charges with the field, and the effects of bound water. The model presented does predict a force due to counter-ion distribution polarization that could significantly affect the charges that are embedded in the membrane.

0691 LEUKEMIA IN WORKERS EXPOSED TO ELECTRIC AND MAGNETIC FIELDS (LETTER TO EDITOR). (Eng.) Wright, W. E. (Dept. Family and Preventive Medicine, Univ. Southern California Sch. Medicine, Los Angeles, CA 90033); Peters, J. M.; Mack, T. M. Lancet 2(8308):1160-1161; 1982 (11 refs).

Leukemia incidence in Los Angeles County from 1972 to 1979 in white males occupationally exposed to electrical and magnetic fields was studied following reports suggesting an increased risk for leukemia with exposure to electrical and magnetic fields. There were 35 cases of all leukemias among occupationally exposed men; the proportional incidence ratio (PIR=observed/expected x 100) was 128.6. For acute leukemias, the number of cases was 23 and the PIR 172.6. For acute myelogenous leukemias (AML), the number of cases was 22, and the PIR 207.1. The data indicate that there is a trend toward increased PIRs in occupationally exposed males and that the risk is greatest for AML. AML in power linemen and telephone linemen and the cumulative PIRs for all electrical jobs for acute leukemia and AML are significant.

0692 EFFECTS OF LOW-LEVEL MICROWAVE [illegible] ON THE EYE OF THE CRAYFISH. (Eng.) Munemori, J. (Dept. Electrical Engineering, Nagaoka Inst. Technology, Gokisho, Nagaoka, Niigata 940-21, Japan); Ikeda, T. Med Biol Eng Comput 20(4):[illegible] 1982 (4 refs).

The biological effects of low-level microwave radiation were investigated in the optic nerves of crayfish (procambarus clarkii). Optic nerves were inserted into a waveguide and irradiated at a power of 1 mW for 1 min. MW power was provided by an HP Model 8620C sweep oscillator operating at 9.4 GHz (continuous wave). Electrodes were inserted into the optic nerve from the side of the waveguide to measure the spontaneous discharge without disturbing the electromagnetic field. The spontaneous discharge was recorded for 1 min before irradiation, during 1 min of irradiation, and after the power was turned off. Although the amplitude of the waves and the mean value of the interspike intervals were not significantly changed by irradiation, the distribution of the intervals (variance) changed gradually at the beginning of exposure and then increased and approached pre-irradiation values. The calculated power density at the crayfish eye irradiated under these conditions was [illegible] and the calculated temperature increase in the eye for 1 min of irradiation was 0.01 C. This threshold response, which was obtained at a power level lower than Japanese maxiumum permissible exposure levels, was not due to a thermal effect.

0693 MORTALITY FROM LEUKEMIA IN WORKERS EXPOSED TO ELECTRICAL AND MAGNETIC FIELDS (LETTER TO EDITOR). (Eng.) Milham, S. (Washington State Dept. Social and Health Services, Olympia, WA 98504). N Eng J Med 307(4):[illegible] 1982.

When proportionate mortality ratios (PMRs=observed/expected x 100) standardized by age and year of death were calculated for 158 cause-of-death groups in 21 occupational classes in Washington state for [illegible] through 1979, leukemia mortality [illegible] was found to be greater than expected among men 20 yr old whose occupations required them to work with electric or magnetic fields. The PMR for leukemia ranged from 67 (welders and flame cutters) to 176 (power station operators) in the [illegible] presumed exposure to electric and magnetic fields and averaged 137. The PMR was elevated in [illegible] pations. For acute leukemia, the PMR [illegible] (streetcar and subway motormen [illegible] and radio repairmen) and averaged [illegible] of expected total and acute [illegible] ranged from 1.7 to 37 and from [illegible] The author states that the available literature on occupational exposure to electrical and magnetic fields has not mentioned carcinogenesis. However, these findings suggest a causal relationship between electric and magnetic fields and leukemia.

time of the mice to MW radiation was assessed by measuring the interval between the onset of exposure and the time for EHL to reach a point corresponding to (1-1/e) of the total change (approx. 63% above baseline). The response time decreased as a power function with increasing SAR, from 9 min at 19 W/kg to 3.9 and 3.4 min at 68 and 194 W/kg, respectively. When deep-body temperature was measured in restrained mice during exposure to MW radiation (incident power of 1 to 10 W), a direct correlation between the rate of increase in deep body temperature and SAR was observed: the temperature increased by 0.0004 C/sec for each W/kg elevation in SAR. The results suggest that control of EHL in the mouse is highly sensitive to the rate of heat absorption and support the hypothesis that the mammalian heat-dissipating system is highly affected by the rate of temperature increase (i.e., temperature regulation as opposed to thermoregulation).

0699 EFFECTS OF ELECTROMAGNETIC STIMULI ON BONE AND BONE CELLS IN VITRO: INHIBITION OF RESPONSES TO PARATHYROID HORMONE BY LOW-ENERGY LOW-FREQUENCY FIELDS. (Eng.) Luben, R. A. (Div. Biomedical Sciences and Dept. Biochemistry, Univ. California, Riverside, CA 92521); Cain, C. D.; Chen, M. C.-Y.; Rosen, D. M., Adey, W. R. Proc Natl Acad Sci USA 79:4180-4184; 1982 (35 refs).

The effects of clinically useful pulsed electromagnetic fields (PEMF) on cultures of the osteoblast-like mouse cell line MMB-1 were studied and the responses of the cells to hormones that either do or do not appear to act primarily via plasma membrane receptors were examined. PEMFs were produced by the paired square Helmholtz coils of the Bi-Osteogen clinical field generator. In one configuration, a continuous train of single pulses was produced at a frequency of 72 Hz. The second system consisted of bursts of 4-kHz pulses lasting 5 msec and repeated at a 15 Hz rate. Both fields generated an electrical gradient of 1.0 mV/cm. Exposure to both PEMFs inhibited accumulation of cAMP stimulated by parathyroid hormone (PTH) or osteoclast-activating factor (OAF) by decreasing the hormonal effects on adenylate cyclase in the cell membrane. Inhibition of PHT and OAF responsiveness persisted after the cells were removed from the fields. The catalytic activity of adenylate cyclase, as determined by fluoride activation, was not changed by exposing cell cultures to either PEMF. The inhibition of cAMP levels was attributed to field effects on cell surface receptors for the hormones. Neither field altered the effects on collagen synthesis of 1,25-dihydroxyvitamin D_3, a hormone with a cytoplasmic receptor. Another cell surface effect was the blocking of PTH inhibition of collagen synthesis by the fields. No significant difference was seen in the effects of the two PEMFS. These experiments substantiated the hypothesis that field effects are mediated through the osteoblast cell membrane by interferences with hormone-receptor binding or receptor coupling with adenylate cyclase.

0700 LOCAL HYPERTHERMIA FOR TREATMENT OF CARCINOMA OF THE PROSTATE: A PRELIMINARY REPORT. (Eng.) Yerushalmi, A. (Radiation Unit, Weizmann Inst. Science, Rehovot 76100, Israel); Servadio, C.; Leib, Z.; Fishelovitz, Y.; Robowsky, E.; Stein, J. A. Prostate 3:623-630; 1982 (28 refs.)

After extensive animal experiments, 15 patients with prostatic carcinoma received a total of 146 treatments of local deep microwave hyperthermia (LDMWH, 2.45 GHz) either alone or in combination with radiotherapy (6,200 rads) or hormonal therapy (DES, 3 mg/day). LDMWH was delivered from a probe inserted into the rectal cavity. Tumors were heated to 42-45 C while non-invaded tissues were maintained at a temperature below 32 C. A total of 6 to 9 60-min LDMWH treatments were given at 2-3 day intervals. Treatments were well tolerated by all of the patients and subjective and objective improvements were recorded in all cases.

0701 INTERACTION OF MICROWAVE RADIATION WITH TURKEY SPERM. (Eng.) Hall, C. A. (Lab. Environmental Biophysics, Natl. Inst. Environmental Health Sciences, Research Triangle Park, NC 27709); Galvin, M. J.; Thaxton, J. P.; McRee, D. I. Radiat Environ Biophys 20(2):145-152; 1982 (17 refs).

Mature turkey sperm were exposed in vitro to 2.45 GHz continuous wave microwave (MW) radiation in a temperature controlled waveguide apparatus. Temperature was maintained at 40.0 ± 0.5 C in suspensions were exposed for 30 min at an average specific absorption rate (SAR) of either 1, 10, or 50 mW/g. Samples were stirred during exposure by magnetic stirrers mounted below the waveguide to eliminate variation in intrasample temperatures. The following parameters were examined before and after MW exposure: percentage viability, percentage abnormal sperm, and release of the enzymes lactate dehydrogenase (LDH) and glutamic oxalic transaminase (GOT). Removal of the seminal plasma had no effect on spermatocyte viability; thus, the results are from washed spermatocytes only. The time to perform the experiments and the stirring of the samples produced no observed changes in viability of the sperm or enzyme release. Viability was 90% or above for all exposed and control groups and was not significantly affected by in vitro exposures at SARs of 1, 10, or 50 mW/g. There were no significant differences between treatment groups in the percentage of abnormal sperm. Release of the cytoplasmic enzymes LDH and GOT was not significantly altered by MW radiation.

[illegible]ERATION OF MALIGNANT TUMORS AFTER LOCALIZED MICROWAVE HYPERTHERMIA. (Eng.) [illegible]. F.W. [illegible]Physiologisches Inst. Univ. Mainz, [illegible]sse 21, D-6500 Mainz, W. Germany); Otte, [illegible]. Radiat Environ Biophys 21(4):289-[illegible]; [illegible] of refs).

[illegible]ges in the oxygenation of tumor tissue during localized microwave (MW) hyperthermia treatment of rhabdomyosarcoma tumors in rats were studied. Tumors were grown on the hind feet of 270-300 g inbred Sprague-Dawley rats of both sexes until tumor volumes reached 1.5-5.0 ml (10-17 days after implantation). Observations were performed on a total of 41 tumor-bearing rats anesthetized by ip injection of sodium pentobarbital. Tumors were heated to 40, 43, and 45 C for 30 min by application of 2450 MHz MW radiation produced by a Radarmed type 12 S 20 generator. Tumor temperatures were monitored with miniaturized thermocouples and the power of the generator was adjusted as required to maintain tumor temperatures constant to within 0.1 C. Core temperatures, mean arterial blood pressure, and blood gases of the left carotid artery were also monitored. After heating, tumor tissue biopsies were taken to measure the oxygenation state which was determined by the oxyhemoglobin (HbO_2) saturation of single red blood cells within tumor microvessels with diameters up to 12 um using a cryophotometric method. HbO_2 saturation varied from 0 to 100% saturation percent with a mean value of 51 sat.% in 13 control tumors. After 43 C-hyperthermia, mean saturation increased to 56 sat.% (11 tumors). However, mean tumor oxygenation decreased to 47 and 24 sat.% after 43 and 45 C hyperthermia, respectively. No changes in core temperature, blood pressure, or blood gases were recorded. Lower HbO_2 saturation values at 45 C were attributed to decreased nutritive blood flow. Metabolic needs of the tumor tissue such as oxygen consumption seem to have a minor effect on the intercapillary HbO_2 saturation distribution.

0703 SCIENTIFIC AND HYGIENIC ISSUES IN BIOLOGICAL RESEARCH ON MICROWAVES: TOWARD RAPPROCHEMENT BETWEEN EAST AND WEST. (Eng.) Justesen, D. R. (Dept. Psychiatry, Univ. Kansas Sch. Medicine, Kansas City, Kansas 66103). Radio Science 17(5S):1S-12S; 1982 (74 refs).

Many issues and controversies separate the experimental radiobiologist and the hygienist from the goal of attaining a concordant view of biological effects of exposure to microwaves and other radiofrequency electromagnetic (RFEM) fields. Although the strongest notes of discord are struck by East-West differences (e.g., recommended limits with respect to exposure of human populations to RFEM fields are generally orders of magnitude more stringent in the USSR than in the U.S.), there are dissonant notes as well within national boundaries. Selected problems are addressed in terms of semantic, tactical, logistic, and strategic [illegible] of which in some measure have impeded [illegible] community of radio scientists. Semantic [illegible] clude the false agreement or disagreement [illegible] from failure to achieve common definition [illegible] The tactical issues are those of [illegible] ment: field strength, densitometry, and [illegible] The pitfalls of interdisciplinary research [illegible] the logistical burden and problems of [illegible] two or more disciplines. Strategic issues [illegible] deserving of study on a global level are [illegible]

0704 COHERENT OSCILLATIONS IN BIOLOGICAL SYSTEMS: INTERACTION WITH EXTREMELY LOW FREQUENCY FIELDS. (Eng.) Kaiser, F. (Inst. Theoretical Physics, Univ. Stuttgart, Pfaffenwaldring 57, D-7000 Stuttgart 80, W. Germany). Radio Science 17(5S):17S-22S; 1982 (27 refs).

Frohlich's concept of coherently excited [illegible] length electric vibrations in the [illegible] region associated with metastable states with a [illegible] high dipole moment in biological membranes has been the basis for explaining the extraordinary high sensitivity of certain biological systems to extremely weak electromagnetic signals. In this model, long-range collective interactions within the membrane may lead to oscillatory biochemical reactions. The resulting slow chemical oscillation is connected to a corresponding electric vibration by means of the large dipole moments of reaction-activated enzymes. Thus a macroscopic oscillating polarization is built up, causing large regions to oscillate coherently in the 10 to 100-Hz region (e.g., EEG activity). The remaining (unscreened) polarization causes the system to exhibit a ferroelectric instability. The nonlinear kinetic equations describing the system are discussed. Extremely low frequency fields interact with the limit cycle oscillation, which is caused to collapse for certain frequencies and intensities of the stimulation. This leads to the set of propagating pulses even for an extremely weak stimulation. There is increasing experimental support for the rather speculative model and the existence of biological effects when systems are exposed to electromagnetic waves. Furthermore, a correspondence between this model and nerve [illegible] generating models has been established.

0705 QUANTUM SOLID STATE MECHANISMS [illegible] ICAL EFFECTS OF ELECTROMAGNETIC RADIATION WITH EMPHASIS ON LOCAL SUPERCONDUCTIVITY. [illegible] Achimowicz, J. (Military Inst. Aviation Med[illegible], Warsaw, Poland). Radio Science 17(5S):[illegible] (36 refs).

Quantum solid state mechanisms of nonthermal effects of nonionizing electromagneti[illegible]

reviewed, and an hypothesis concerning mechanisms based on biological superconductivity is presented. Classical and quantum mechanisms of bioeffects are compared, stressing the necessity of not only considering quantum absorption, transfer, and conversion of radiant energy in biological systems, but also of appropriate systems modeling. There is a need for developing quantum models of the biological solid state on the supramolecular level to fill the gap between molecular and cell biology. The supramolecular models of macromolecules and enzyme complexes are reviewed. The high-temperature superconductivity problem in organic systems is discussed, with stress on the importance of system structure and the excitation quasi-particle (phonon and electron) spectra relationship. New mechanisms of enzymatic activity assuming enzyme-substrate complex electron spectrum instability induced by electron-and phonon mediated electron-electron interaction are proposed. Since this quantum cooperative phenomenon is the possible origin of specificity and efficiency of enzyme action, it is extremely sensitive to system-generated electromagnetic fields, which gives the possibility of enzymatic regulation and also may explain some nonthermal resonant bioeffects. In systems containing superconducting regions, the processes of electron transport depend strongly on magnetic and electromagnetic fields which can be the origin of biological effects of nonionizing radiation. Local superconductivity coherent electron states) and the Josephson effects are discussed as the possible mechanisms of bioeffect, such as the observed sensitivity of small animals to very weak magnetic fields.

0706 MEASUREMENTS OF ELECTRIC AND MAGNETIC STRAY FIELDS PRODUCED BY VARIOUS ELECTRODES OF 27-MHz DIATHERMY EQUIPMENT. (Eng.) Kalliomaki, P. L. (Inst. Occupational Health, SF-00290 Helsinki 29, Finland); Hietanen, M.; Kalliomaki, K.; Koistinen, O.; Valtonen, E. Radio Science 17(5S):29S-34S; 1982 (5 refs).

To investigate the exposure of the physiotherapist and to unprescribed tissues, electric and magnetic stray fields were measured around 3 types of commercially available diathermy units (3 Siemens Ultratherm 608 units, 3 Curapulse Curamed 418 units, and 1 Diapulse D 401 unit) with 4 typical electrodes in 6 routine therapeutic treatments. The subjects were 2 men and 2 women. Field strengths were determined at the point of treatment and at 14 locations close to the patient's body, and as a function of distance from the electrodes. The radiation dose setting was at position 1 for continuous wave power and at positions 5-7 for pulsed power. At a distance of 0.6 m from the diathermy units, the power density was less than 10 W/m^2. The results showed that the diathermy devices are very similar with respect to stray fields, but there are great differences between the electrodes during specific treatments. When the unit was well tuned, the relative output power of the equipment [illegible] rational to the dose scale readings. [illegible] cles were found to be only [illegible] the respective instruction manuals. The measured values of electric [illegible] strengths are tabulated. The [illegible] used to select proper electrodes for [illegible] treatments, as they indicate which [illegible] have minimum stray fields.

0707 ELF MAGNETIC FIELDS IN ELECTROSTEEL AND WELDING INDUSTRIES. (Eng.) Lovsund, P. (Dept. Biomedical Engineering, Linkoping Univ., S-581 85 Linkoping, Sweden); Oberg, P. A., Nilsson, S. E. G. Radio Science 17(5S):35S-38S; 1982 (5 refs).

In order to obtain a realistic basis for laboratory studies of the bioeffects of low-frequency magnetic fields present in industrial environments, magnetic fields were mapped for a number of welding and steel processes. All of the measurements were performed at points selected to obtain the closest possible impressions of the fields to which the workers are exposed. Measurements were carried out with the aid of a F W Bell 610Z gaussmeter operating within [illegible] kHz and the dynamic region 0.1 mT-[illegible] mT = 10^4 G. The industrial measurements comprised only the magnetic component of the field as the processes studied require high currents even though low voltage is used. Field flux densities in the range of 10 mT at mostly 50 Hz were found in both the electric welding and electric steel industries. Both the magnetic flux density and the frequency may be very high (up to 10 kHz) near induction heaters, and a study which will include electric field measurements is planned. In order to improve knowledge on how low-frequency magnetic fields affect man in industrial environments, it is important to simulate the flux density data measured in industry in the laboratory. As understanding of how the magnetic field influences biological structures at the cellular level increaes, it will be possible to predict effects at higher levels and to establish more reliable threshold values.

0708 POPULATION EXPOSURE TO VHF AND UHF BROADCAST RADIATION IN THE UNITED STATES. (Eng.) Tell, R. A. (Office of Radiation Programs, Electromagnetic Radiation Analysis Branch, EPA, Las Vegas, NV 89114); Mantiply, E. D. Radio Science 17(5S):39S-47S; 1982 (13 refs).

Nearly 11,000 individual broadcast [illegible] intensities were determined at 871 measurement sites distributed throughout 12 large cities (Boston, Atlanta, Miami, New York, Philadelphia, Chicago, Las Vegas, Washington, San Diego, Portland, Houston, and Los Angeles) to estimate population exposure to

...frequency (RF) and microwave radiation. The cumulative population of the 12 cities represents 18% of the total U.S. population. It included 38,548 census enumeration districts (CED) with an mean population per CED of 99± persons. The 373 sites comprised 293 FM radio stations, 26 low VHF and 31 high VHF TV stations, and 31 UHF stations. VHF and UHF broadcast service is the main source of ambient RF exposure in the U.S. A computer algorithm using the measurement data to estimate the broadcast exposure at the CEDs within the metropolitan boundaries of the 12 cities was developed. The results provide information on the fraction of the population that is potentially exposed to various intensities of RF radiation. A median exposure level of 0.005 uW/cm^2 time-averaged power density was determined for the population of the 12 cities. Approximately 1% of the population studied, or about 380,000 persons, is potentially exposed to levels greater than 1 uW/cm^2, the suggested safety guide for the population of the USSR. Alternative techniques of using the measurement data to estimate population exposure are examined and future extensions of this work are discussed.

0709 MEASUREMENT OF INDUCED ELECTRIC FIELDS IN A PHANTOM MODEL OF MAN. (Eng.) Chen, K.-M. (Dept. Electrical Engineering & Systems Science, Michigan State Univ., East Lansing, MI 48824); Ruksputsuang, S.; Nyquist, D. P. Radio Science 17(5S): 49S-59S; 1982 (8 refs).

An inexpensive and rugged implantable electric field probe with an interference-free lead wire system was constructed to measure the induced electric fields in a phantom model model of man irradiated by waves of various frequencies. The probe consisted of a short dipole loaded with a zero-bias microwave (MW) diode, and the interference-free lead wires were constructed with two series of lumped resistors of 3 kohm. Characteristics of the probe were checked by measuring the induced electric fields in irradiated, electrically small cubes filled with phantom material. The measured results agreed well with theoretical results obtained from the tensor integral equation method. A phantom model of man scaled to 1/5 dimensions of a typical man made of thin Plexiglas was filled with phantom material of appropriate conductivity and permittivity and placed in a large MW anechoic chamber and exposed to 500-3000 MHz traveling electromagnetic waves incident normally from front to back. Induced electric fields were probed over 28 locations in one side of the model and the distribution of the measured electric fields was compared with the distribution of theoretical results obtained numerically from the tensor integral equation methods. While a qualitative agreement was obtained between experiment and theory, the agreement tended to deteriorate at lower frequencies. This may be due to the fact that the magnetic mode of induced electric field starts to dominate the electric mode as the frequency becomes lower than 1000 MHz, and ... cal convergence with the ...

0710 ... FIELDS ... U.S. ... Lee, J.-H. (Dept. Electrical ... Science, Michigan State ...) M. Radio Science ...

A theoretical method ... eddy currents induced by ... magnetic fields ... up to ... in biological ... bodies of ... sented. The body ... circular rings of various ... areas. The induced electric ... in each ring ... numerically ... of the theory ... vector ... method. A computer program ... calculate induced eddy ... cal bodies yielded numerical ... significantly from ... utions. A series of experiments ... measure the electric field ... frequency magnetic fields ... models constructed with ... phantom biological material ... fied by the experimental ... results.

0711 IRRADIATION OF ... OF HUMANS AND ANIMALS ... OF A SMALL LOOP ANTENNA. ... (Dept. Electrical Engineering, ... Lake City, UT 84112); Iskander, M. F.; ... H.; Massoudi, H. Radio Science ... 1982 (23 refs).

Absorption characteristics ... els of humans and animals ... of a small coaxial loop antenna ... near fields of the antenna ... used to identify the suitable ... volved in the spherical model. ... mulated in terms of an ... transverse loads ... diated by the current ... the vector spherical harmonic ... ue problem is solved by the ... tion method. The specific ... distribution and the average ... lated as a function ... different frequencies ... of an average ... medium rat. ... the average SAR ... value. ...

an increase in the average SAR values was generally observed. In spite of the complicated nature of the near fields, the absorption characteristics can be explained in terms of the incident radiation. At all frequencies, excessive heating occurs at the surface of the spheroid while a limited absorption occurs in the central region around the major axis. This result is of particular importance in hyperthermia, where efforts are being directed towards achieving deep-tissue heating by a coaxial coil carrying radiofrequency power at about 27 MHz.

0712 STUDIES OF MICROWAVE ABSORPTION IN LIQUIDS BY OPTICAL HETERODYNE DETECTION OF THERMALLY INDUCED REFRACTIVE INDEX FLUCTUATIONS. (Eng.) Davis, C. C. (Electrical Engineering Dept., Univ. Maryland, College Park, MD 20742); Swicord, M. L. Radio Science 17(5S):85S-94S; 1982 (6 refs).

A new technique is described for performing microwave (MW) absorption spectroscopy of transparent or translucent media, particularly liquids, which directly measures the frequency dependence of power absorbed in the sample. In this technique, called phase fluctuation optical heterodyne spectroscopy, the refractive index fluctuation produced in a sample when its temperature rises as a result of absorption of MW radiation is measured. This refractive index fluctuation produces a phase fluctuation in a single-frequency laser beam passing through the sample. For a small temperature increase, the magnitude of the induced phase fluctuation is directly proportional to the temperature increase, and is a direct measure of the amount of absorbed power. The phase fluctuation is measured by heterodyning the laser beam which traverses the sample with a reference beam derived from the same single-frequency laser. Preliminary experiments on water and ethanediol yield absorption spectra that are consistent with those obtained in previous investigations using conventional techniques.

0713 THERMOGRAPHIC ANALYSIS OF WAVEGUIDE-IRRADIATED INSECT PUPAE. (Eng.) Olsen, R. G. (Naval Aerospace Medical Res. Lab., Pensacola, FL 32508); Hammer, W. C. Radio Science 17(5S):95S-104S; 1982 (8 refs).

A high-resolution thermographic imaging system was used to study radiofrequency (RF) absorption patterns in the yellow mealworm, Tenebrio molitor L., for waveguide irradiation situations. Early-stage pupae (1-3 days old) of the yellow mealworm without visible defects were mounted inside a right-angle, waveguide E bend and irradiated through longitudinal slots cut in the broad wall of the E bends. Use of the E bends was required by the addition of a closeup lens assembly mounted on the front of the thermographic imaging device, a Spectotherm Model 900, which was used to obtain the magnitude and spatial distribution of absorbed microwave energy at three frequencies. At 1.3 and 5.95 GHz, the MW source was a sweeper/oscillator (Anritsu) that was used to drive traveling wave tube amplifiers (Semidyne); at 10 GHz, a Gunn oscillator (Spectral Microwave CMF-420AE) supplied the power. Measured power levels were 25 W, 1.0 W, and 2.5 mW, respectively, at 1.3, 5.95, and 10 GHz. The thermographic images show good resolution of the irradiated pupae; many of the thermograms clearly show the head, legs, and other features. Distinct differences in electrical properties exist between the various sections of the insect, particularly between the abdomen and the other two sections. These thermographic measurements suggest that more theoretical work is needed to properly model the nonhomogeneous nature of the actual pupa.

0714 MILLIMETER WAVE IRRADIATION AND MEASUREMENT SYSTEM FOR CELL SUSPENSIONS. (Eng.) Tamburello, C. C. (Inst. Elettrotecnica & Elettronica, 90128 Palermo, Italy); Zantorlin, L. Radio Science 17(5S):105S-110S; 1982 (6 refs).

The high water content of cell suspensions, which is necessary for cell survival, creates certain problems in the measurement of electric parameters in the millimeter wave band. By feeding microwave energy through the sample holder bottom, it has been possible to make accurate measurements of the sample mismatch using a highly sensitive null interferometer. Two measurement systems have been developed; the first, which utilizes a tunable klystron in the 65-73 GHz range, allows precise measurements at fixed frequencies; the second, which utilizes two swept impact avalanche transit time (IMPATT) sources covering the 66-85 GHz range, allows rapid parameter measurements over a wide frequency range but with reduced precision. Reflection characteristics of a cell sediment can be accurately derived in the 60-90 GHz frequency band. These results may then be utilized in cooperation with biologists for analyses of correlations between electrical and biological effects, in an effort to better understand the mechanism of microwave interaction at the cellular level and to help define a physical model of these phenomena.

0715 A MICROWAVE METHOD FOR ESTIMATING ABSOLUTE VALUE OF AVERAGE LUNG WATER. (Eng.) Iskander, M. F. (Dept. Electrical Engineering, Univ. Utah, Salt Lake City, Utah 84112); Durney, C. H.; Bragg, D. G.; Ovard, B. H. Radio Science 17(5S): 111S-117S; 1982 (21 refs).

The ability to measure lung water is an essential diagnostic technique for the diagnosis of virtually all lung diseases. A microwave (MW) transmission method for calculating the absolute value of the water content of the lung has been developed, using computerized axial tomography to obtain a transverse cross-sectional image of the thorax showing the dimensions and the relative positions of the organs and the MW applicators. The electromagnetic field problem is then solved numerically using the method of moments. The numerical procedure was evaluated by carrying out detailed calculations for a human cross-section, and the cross-section of a dog's thorax. The transmission coefficient can be directly related to the average amount of total water content in the lung since the mismatch between the MW applicators and the patient's skin is found to be highly insensitive to the changes in the underlying lung parenchyma.

0717 A CLASS OF NEW MICROWAVE THERAPEUTIC APPLICATORS. (Eng.) Lin, J. C. (Bioengineering Program, Univ. Illinois, Chicago, IL 60680); Fantor, G.; Ghods, A. Radio Science 17(5S):119S-[illegible]; 1982 (11 refs).

A class of new direct-contact microwave (MW) applicators for hyperthermia and diathermia applications is described. The applicators consist of three concentric, circular, cylindrical tubes. The inner cylinder may serve as a port for circulating coolant to reduce surface temperature, as a port for introducing ionizing radiation in combination therapy for cancer, or to insert a temperature or field sensor for monitoring purposes. The coaxial waveguides formed by the inner and middle cylinders and by the middle and outer cylinders can be used to propagate TE_{11} and TE_{21} modes, respectively, for dual-beam, single frequency operation, or may be designed to permit two frequencies to propagate with the same TE_{11} mode. The dual-beam 2450 ± 50-MHz applicator has an an overall diameter of 10.4 cm at the output aperture. The annular regions formed by the middle and outer cylinders are loaded with high-density polyfoam to give added structural support. Dielectric loading may be used to maintain a small aperture diameter and still permit the propagation of TE_{11} and TE_{21} modes at lower frequencies. The applicator has a measured voltage standing wave ratio of 1.25. At the therapeutically effective specific absorption rate of 235 W/kg, the net forward power required is only 26 W; the maximum leakage at distances of 5 cm from the applicator surface in contact with a fat-muscle phantom is 4 mW/cm^2. These results compare favorably with the best designs available and are superior to the noncontact applicators currently in clinical usage. Thus the new applicator may be a good candidate for safe and efficacious use in diathermy and in hyperthermia for combination cancer therapy.

0717 IMPLANTABLE MICROWAVE [illegible] ICAL HYPERTHERMIA. [illegible] (Dept. Radiation Oncology & Electr[illegible] Univ. Maryland Sch. Medicine, Balti[illegible] Samaras, G. M.; Cheung, A. Y.; [illegible] P. M. Radio Science 17(5S):[illegible] refs).

Microwave (MW) induced hyperthermia [illegible] nally located radiators promises a significant improvement in therapy for neoplasia in the [illegible] brain and other organs which are accessible [illegible] body orifices. Coaxial MW radiators [illegible] to pass through standard bronchoscopes [illegible] scopes have been constructed, permitting direct visual control of radiator position. A [illegible] is combined with an antenna consisting [illegible] array of half-wave dipoles which, instead [illegible] connected by an external line that would interfere with the radiation pattern, are connected by an internal cable whose outer conductor is similarly used as the radiating element. The [illegible] formed by cross-connecting the inner and [illegible] conductors of the cable at intervals, terminated in the needle antenna. When the radiator is [illegible] in a phantom material with the same dielectric permittivity and loss tangent as human muscle at [illegible] MHz, test results show more than 75% of the power at the radiator is absorbed by the phantom. In order to obtain realistic estimates of the temperature distributions induced by the coaxial radiators in live tissues, steady state in vivo heating patterns were measured in feline esophagus and brain. The heating and cooling times were short. The MW radiation was confined to the target volumes with no detectable leakage.

0718 BIOLOGICAL AND BEHAVIORAL EFFECTS OF [illegible] NATAL AND POSTNATAL EXPOSURE TO [illegible] MHz ELECTROMAGNETIC RADIATION IN THE SQUIRREL MONKEY. (Eng.) Kaplan, J. (SRI International, Menlo Park, CA 94025); Polson, P.; Rebert, C.; Luman, K. [illegible] M. Radio Science 17(5S):135S-144S; 1982 [illegible]

The effect of chronic microwave (MW) irradiation at or below the ANSI-recommended radiation protection guide for human exposure on prenatal and postnatal development of the squirrel monkey (Saimiri sciureus) was studied. Pregnant squirrel monkeys [illegible] were exposed to 2450 MHz radiation in a resonant cavity at whole-body average specific absorption rates equivalent to those resulting from exposure to plane wave irradiation at 0, 0.034, [illegible] W/kg (8, 5, 6, and 4 monkeys, respectively). [illegible] births occurred, exposed animals were randomly assigned to groups for which exposures were either terminated or continued. In both cases, infants were treated together with their mothers [illegible] and then alone for an additional 6 mo. Exposure occurred 3 hr/day, 5 days/wk throughout the study. No differences were found between irradiated [illegible]

control adult monkeys with respect to the number of live births produced, or to measures of locomotor activity, maternal care, urinary catecholamines, plasma cortisol, phytohemagglutinin-stimulated response of peripheral blood lymphocytes, or electroencephalographic (EEG) activity. Offspring exposed at 3.4 W/kg both before and after birth had a high mortality rate (4/5) before 6 mo of postpartum age. These results suggest that MW radiation at power densities to 3.4 W/kg might have little direct effect on the monkey fetus when exposures occur in utero during the latter half to two-thirds of pregnancy but that continued exposure after birth may be harmful. No differences were found between exposed and nonexposed offspring in the same blood, urine, and EEG parameters; growth rate and most aspects of behavioral development were not altered by exposure. In a follow-up study, pregnancy outcome and offspring survival were compared between a group of 31 monkeys irradiated at 2450 MHz beginning in the first trimester of pregnancy and a group of 34 sham-treated controls. After parturition dams and their offspring were treated under the same conditions; then offspring were treated alone through 9 mo of age. The results of the latter study did not support those obtained in the initial experiment: no differences were found between irradiated and sham-exposed monkeys in the number of abortions, stillbirths, or livebirths that occurred or in the number of offspring that died.

0719 CONSTANT-DOSE MICROWAVE IRRADIATION OF INSECT PUPAE. (Eng.) Olsen, R. G. (Naval Aerospace Medical Res. Lab., Pensacola, FL 32508). Radio Science 17(5S):145S-148S; 1982 (4 refs).

The effects of a constant total dose of 5.95 GHz microwave (MW) energy on pupae of the yellow mealworm Tenebrio molitor L. were investigated. Pupae were irradiated in the standing wave of a continuous MW beam. The standing wave configuration produced alternating planes of electric field (E) and magnetic field (H) intensities, and the pupae were mounted in either the E field or the H field plane. Exposure duration was 1.5, 3.0, 6.0, 12, or 24 hr with specific absorption rates (SAR) of 208, 104, 52, 26, and 13 W/kg, respectively. Irradiations were conducted both with and without a ventilating fan that limited the rise in chamber temperature to less than 4.5 C for all irradiations; without ventilation, the temperature increased about 11 C at the highest power level. Abnormal development as a result of the MW exposure was seen only in the high-power, short-duration experiment without chamber ventilation. It is proposed that a predominately thermal interaction mechanism operates in abnormal insect development, which hypothesis necessarily precludes the existence of cumulative effects. For this configuration and frequency, 40 C appears to be the threshold for effects.

0720 [illegible]
VIEW. (Eng.) [illegible]
California, [illegible]
Radio Science [illegible]

Studies of brain tissue [illegible] tromagnetic fields are reviewed [illegible] experiments testing the [illegible] ence of lanthanum may [illegible] lated chick brain exposed [illegible] tromagnetic fields are reported. [illegible] rebral hemispheres were [illegible] solutions of different [illegible] posed to a 450 MHz field [illegible] ulated at 16 Hz to a depth [illegible] 0.75, 0.375, and 2.[illegible] ation was verified. [illegible] efflux was compared for [illegible] bonate, increased levels [illegible] bonate, without calcium, [illegible] solution containing lanthanum [illegible] hemisphere was tested against [illegible] brain with left and right sides [illegible] and test samples. Efflux [illegible] solution was the control [illegible] ing calcium concentration, [illegible] solutions. Efflux in the [illegible] medium served as reference [illegible] lanthanum. The results of the [illegible] previous findings that radiofrequency fields amplitude-modulated at brain wave frequencies increase calcium efflux from isolated chick cerebral tissue. New observations include an absence of sensitivity of the response to variations [illegible] tion (0 to 4.16 mM) in the bathing [illegible] hancement by addition of hydrogen [illegible] hibition in the absence of normal [illegible] els. Addition of lanthanum [illegible] solution restored field sensitivity [illegible] ulus decreased calcium efflux. It is proposed that weak extracellular electric [illegible] ating at low frequencies or exhibiting [illegible] quency modulation on a radiofrequency [illegible] may be transduced in a specific class [illegible] lar negative binding sites, normally [illegible] calcium ions and susceptible to [illegible] gen ion binding. The transduction [illegible] so far defined for field interactions [illegible] calcium binding strongly suggest [illegible] interaction based on long-range interactions [illegible] length of a coherently organized charge system. The cooperative aspects of the interaction, as tuned in frequency and power windows may arise in a quite different role for hydrogen ions, with proton tunneling occurring between energy wells that [illegible] across the boundary between solvent and [illegible] charge zones.

0721 COMPARISON OF MEASURED AND PREDICTED CHARACTERISTICS OF MICROWAVE-INDUCED SOUND. (Eng.) Lin, J. C. [illegible]

puter Engineering and Neurology, Wayne State Univ., Detroit, MI 48202); Meltzer, R. J.; Redding, F. K. Radio Science 17(5S):159S-163S; 1982 (16 refs).

The thermoelastic theory of microwave (MW) auditory effect was compared with new measurements obtained in cats and with previously available measurements. The theory describes the acoustic waves generated in the head as functions of the size of brain spheres, and characteristics of impinging and absorbed MW energies. Anesthetized cats were placed in a stereotaxic head holder using hollow ear bars. During the experiments, the animals' body temperature was maintained between 36 and 39 C. The dorsal aspect of the skull was exposed and insulated stainless steel electrodes were advanced to various brain stem nuclei and fixed to the skull. The reference gold pin electrode was always located near the lowest part of the right pinna. A small direct contact applicator (Flmed 15) was used to deliver short rectangular 2.5-25 usec-wide pulses produced by an Applied Microwave Lab. MW pulsed signal source (2450 MHz) at a rate of 10-100/sec. Peak incident power varied from 0 to 10 kW. Biolelectric activity extracted from the vertex and from each depth electrode was amplified by Grass (RM 122) amplifiers with a band pass of 80 Hz to 10 kHz and summated online using a Nucelar Chicago computer of average transient. The first 10 msec of the averaged response were displayed on the cathode-ray tube and also photographed. The thermoelastic theory correlated well with experimental measurements regarding the frequency of sound and threshold of sensation, width of impinging MW pulses, independence from MW frequency, and specific absorption rate distribution.

0722 THE EFFECT OF MICROWAVE RADIATION (1.0 GHz) ON THE BLOOD-BRAIN BARRIER IN DOGS. (Eng.) Chang, B. K. (Div. Hematology & Oncology, Dept. Medicine, Electrical Engineering & Neurosurgery, Duke Univ. Medical Center, Durham, NC 27710); Huang, A. T.; Joines, W. T.; Kramer, R. S. Radio Science 17(5S):165S-168S; 1982 (10 refs).

The integrity of the blood-brain barrier (BBB) was evaluated in dogs following exposure to continuous wave microwave (MW) radiation at 1.0-GHz (20 min at power densities ranging from 2 to 200 mW/cm^2). The MW source was an AIL 125 generator. A Plexiglas apparatus for suspension of a double-ridged waveguide horn antenna was used to deliver near-field MW radiation directly onto the top of the head of anesthetized 15-20 kg mongrel dogs. Control (11) and exposed (21) dogs were injected with 25-30 uCi/kg of ^{131}I albumin as a tracer. Cannulation of the cisterna magna and the femoral vein permitted simultaneous sampling of cerebrospinal fluid (CSF) and plasma every 20 min for 5 hr. Measurement of the CSF/plasma distribution ratio of ^{131}I revealed no effect on the BBB at power densities of 2, 4, 10, 50, or 200 mW [illegible]. However, 4/11 dogs exposed at [illegible] increased penetration of the BBB [illegible] compared to control [illegible] in 2 dogs, and 2-4x greater [illegible]. Two patterns were observed [illegible] the CSF:plasma ratio for the [illegible] rise with subsequent [illegible] standard deviation [illegible] rise to a level well outside the [illegible]. A possible explanation for the [illegible] 30 mW/cm^2 is that a MW [illegible] ing very near this value.

0723 EFFECTS OF [illegible] EXPOSURE OF RAT BRAIN. (Bioelectromagnetics [illegible] Lab., [illegible] tion Medicine, Univ. [illegible] Seattle, WA 98195); Cress, [illegible] (5S):169S-178S; 1982 [illegible].

The heads of female Wistar [illegible] to 915-MHz microwave (MW) [illegible] (1 usec-360 msec) and power [illegible] the threshold for the [illegible] sciousness. The exposure [illegible] lindrical waveguide with [illegible] in a region of high magnetic [illegible] field. The threshold [illegible] correspond to a constant [illegible] regardless of the pulse width [illegible]. Based on thermographic data, [illegible] to a change in temperature [illegible] brain temperature of 4° or [illegible] el) or a peak specific absorption [illegible]. Rats exposed to pulses with [illegible] sponding to energy levels [illegible] appeared to be normal [illegible] to pulses with energies at [illegible] generally displayed postictal [illegible] lasting for 1 min after exposure [illegible] min of unconsciousness. When [illegible] els corresponding to the [illegible] the threshold curve, the rats were [illegible] stunned, but displayed a letharg[illegible] The period of unconsciousness was [illegible] with the amount of exposure over [illegible] old level. The temperature [illegible] to the baseline level within [illegible], rats began to move when the temperature [illegible] within 1 C of their normal temperature [illegible] ical examination was performed [illegible] the rats: 1 control; 1 exposed [illegible] pulses (below the threshold [illegible] to 10-kW, 0.1-sec pulses were above [illegible] level). Macroscopically, there was [illegible] difference among the 3 groups [illegible] (10 kW at 100 msec and [illegible] ation indicated some cellular [illegible] and microfocal [illegible] to demyelination of neurons [illegible] bral cortex [illegible] after [illegible]

pathological findings in 2 exposed rats 1 mo after exposure were that the brains appeared swollen and microfocal glial nodules were present in the brain.

0724 INTERACTION OF AMBIENT TEMPERATURE AND MICROWAVE POWER DENSITY ON SCHEDULE-CONTROLLED BEHAVIOR IN THE RAT. (Eng.) Gage, M. I. (Neurotoxicology Div., MD-74B, Health Effects Res. Lab., EPA, Research Triangle Park, NC 27711); Guyer, W. M. Radio Science 17(5S):179S-184S; 1982 (15 refs).

The interactive effects of microwave (MW) power density and temperature on behavioral changes measured immediately after termination of exposure were investigated in 64 adult male Long-Evans rats trained to insert their heads into a food cup to obtain a 45 mg food pellet on a 1-min variable-interval schedule of reinforcement. Exposure to 2450 MHz continuous wave MW energy took place in an anechoic chamber under far field conditions; relative humidity was 50% during all exposures, and air velocity was 0.07 m^3/sec. Two groups of 4 rats each were exposed for the 15.5 hr period from 1630 to 0800 hr under one of the following combinations of power density and air temperature: 8 or 14 mW/cm^2 at 22 C; 0, 8, or 14 mW/cm^2 at 26 C; or 14 mW/cm^2 at 30 C. Before MW exposure, 3 daily behavioral testing sessions followed a sham exposure at 22 C to acclimate the rats to the housing conditions during exposure. The last sham exposure also served as the 0 mW/cm^2 at 22 C exposure. The night following exposure, each group was given a sham exposure at the ambient temperature of the previous night. Rectal temperature was measured in 1 rat of each group before and after each MW or sham exposure. Behavioral testing occurred approximately 10 min after termination of exposure. MW irradiation was found to reduce rates of responding in direct proportion to the power density at each ambient temperature. This decrease of rate was most pronounced after exposures at 30 C. During sessions 1 day after MW exposure many rats showed behavioral overcompensation as response rates exceeded those measured the day before irradiation. When response duration was measured, increases in response duration were seen after exposures at 14 mW/cm^2 and 26 C and after exposure at both 8 and 14 mW/cm^2 when the temperature was 30 C. There were no significant increases in response duration after any exposures at 22 C. The results indicate that the intensity of MW irradiation and ambient temperature interact to increase decrements in rates of behavioral responding measured at the termination of irradiation.

0725 EFFECTS OF CONTINUOUS AND PULSED CHRONIC MICROWAVE EXPOSURE ON RABBITS. (Eng.) Chou, C.-K. (Bioelectromagnetics Res. Lab., Dept. Rehabilitation Medicine, Univ. Washington Sch. Medicine, Seattle, WA 98195); Guy, A. W.; McDougall, J. A.; Han, L.-F. Radio Science 17(5S):185S-[illegible] (18 refs).

The effects of exposure to continuous wave [illegible] pulsed microwave (MW) fields for a 3-mo period [illegible] investigated and compared in 18 New Zealand [illegible] (3 mo old; 9 male, 9 female). Animals were [illegible] in Plexiglas cages and exposed singly in [illegible] anechoic chambers to CW, pulsed, or sham [illegible] plane wave fields for 2 hr/day, 5 days/wk [illegible] days. An S band standard-gain horn was located [illegible] above the animal. Because of the limited [illegible] erage power output (10 kW peak power) of the [illegible] generator (Applied MW Lab. PH40K), maximum average power density at the animal location was 1.5 mW/cm^2. To maximize the animal exposure, rabbits were exposed singly to 1.5 mW/cm^2 pulsed fields [illegible] width, 10 usec; repetition rate, 100 pulses sec[illegible]. The same average power density was used for [illegible] posure. Sagittal specific absorption rate (SAR) patterns were obtained thermographically; the [illegible] sagittal SAR for 1.5-mW/cm^2 incident power density was 2.1 W/kg in a rabbit's back and 1.6 W/kg [illegible] head region. Carbon loaded Teflon wires were used for the electroencephalogram (EEG) recording. To control for possible effect of circadian rhythms, the schedule of exposure for each group of animals was rotated. No significant differences were observed between the exposed and sham rabbits in body wt (measured every other day); EEG and evoked potentials (recorded 1/wk); blood tests (hematological, chemical, and morphological studies, 1 mo); or cataract examination before and after the 3-mo exposure. At the end of the 3-mo period, all the rabbits were injected with various dosages (1, 2, [illegible] mg/kg) of apomorphine to study drug induced hyperthermia and behavioral hyperactivity. However, 7 (1 exposed to CW, 3 pulse-exposed, and 3 sham-exposed) animals died during the experiment indicating that the animals were very sensitive to the apomorphine (normal young rabbits can tolerate up to [illegible] kg dosage). The remaining rabbits (5 each exposed to CW or sham-exposed, 3 pulse-exposed) were sacrificed and detailed histopathological examinations were carried out. No consistent, significant differences in tissue damage were seen [illegible] pathological study.

0726 THE RESPONSE OF MOUSE MAMMARY [illegible] MICROWAVE HEATING AT 2450 MHz. [illegible] Robinson, J. E. (Div. Radiation Therapy, Univ. Maryland Sch. Medicine, Baltimore, MD 21201); Chaffey, J. Y.; Harrison, G. H.; Samaras, [illegible] Radio Science 17(5S):195S-199S; 1982 (8 refs).

The response of mammary carcinomas implanted in the flanks of female C3H mice to microwave (MW) induced hyperthermia was studied and compared with water bath heating. Tumor regrowth time, i.e., the time for the treated tumors to regress to a vol twice that at the time of treatment [illegible]

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a criterion of tumor response to treatment. In order to minimize the size and shape dependence of the 2.45 GHz MW heating, the tumors were immersed in a bath of tissue equivalent bolus. Two types of bolus were used: a semisolid gel and a temperature controlled liquid bolus made up of 20% ethanol in isotonic saline. In order to reduce energy deposition gradients, two parallel opposed MW applicators dielectrically loaded to support a simulated transverse electromagnetic wave were energized alternately at a rate which was fast in comparison to that of tumor cooling. During heating in the gel, the temperature was monitored immediately adjacent to but not inside the tumor. Target temperatures were 42, 43, 43.5, and 44 C, together with an ambient temperature control. During heating in the liquid bolus, tumor temperatures were monitored for one of six animals per data point. Target temperatures were 42, 43, and 44 C; thermal controls were MW-heated to 37.5 C. The liquid bolus was kept at 0.1 C below target temperature for the tumors and sufficient MW power used to elevate tumor temperature to a level equal to or in excess of the target temperature. Data from tumors treated in the gel bolus yielded lower regrowth slopes and higher intercepts (greater regrowth times) than those of the control and the water bath-heated tumors. This may be due to nonuniform heating by MW energy with some small fraction of the tumor vol about 1 C below the target temperature. Regrowth curves that were consistent with homogeneous heating were obtained for tumors heated in liquid bolus. Slopes were steeper than for the semisolid bolus and there was little or no indication of the biphasic nature of the response curves seen after heating in the gel. A plot of thermal sensitivity vs. temperature suggested that all parts of the tumor were at or slightly above (0.4 C) target temperature. Thus, any difference in the effect of MW and water bath heating on the regrowth time of the tumors studied in this experiment was very small. Regrowth time of tumors with thermal probes left in place during the treatment was significantly greater than that of tumors in which no probe was present during MW irradiation.

0727 TREATMENT OF NON-UNION OF FRACTURES BY PULSING ELECTRO-MAGNETIC FIELDS. (Eng.) Hutchings, J. (Royal Hospital, Chesterfield, England). Radiography 48(566):25-32; 1982 (5 refs).

Results of treament of non-uniting fractures with the ElectroBiology International Bi-Osteogen System 304 unit are reported. The unit consists of a 250 s time-operated, quasi-square wave generator powering an 8-shaped treatment coil and a plastic positioning block which is centered over the fracture site and attached to the external surface of a plaster of Paris cast moulded to the contours of the limb. The procedure for prescribing the system is outlined. Of 52 patients treated during the period 1976-1980, 38 fractures were proved to be radiographically and clinically united, representing a success rate of 73.07%. The 14 failures were [illegible] difficulty in immobilization with a minimum gap of 5 mm or more, and a case with a fixation screw [illegible] in the gap, possibly causing and alteration of the induced field or the cell population in that area.

0728 MODEL FOR THE GROWTH OF BACTERIA UNDER ELECTROMAGNETIC RADIATION. (Eng.) Arsac, C. (Sect. d'Electromagnetisme & d'Hyperfrequences, Dept. Genie Electrique, Ecole Polytechnique, P.O. Box 6079, station "A", Montreal, Quebec, H3C 3A7, Canada); Bosisio, R. G. Speculations Sci Technol 5(1):15-22; 1982 (10 refs).

A multi-resonant interaction (MRI) model is proposed for the growth of cells in the presence of electromagnetic (EM) radiation. The cell growth cycle of Escherichia coli predicted by the MRI model is in good agreement with experimental data obtained since 1969 on the growth of E. coli subjected to EM radiation of variable frequency in the millimeter wavelengths. The MRI phenomenon is probably due to a difference in the dielectric properties of the cell colony and the adjacent medium. The hypothesis conceives that the retardation or stimulation of cellular growth is directly linked to the applied frequency of low power EM waves. An electro-mechanical resonance phenomenon may be the interacting agent which defines a given length of cellular colony at a given stage of development. According to the model, it should be possible to stimulate or retard cell growth by suitably programming the EM radiation periods regardless of the chosen operating frequency point.

0729 EFFECT OF MICROWAVE HEATING ON THE RADIATION RESPONSE OF RHABDOMYOSARCOMA. (Eng.) Zywietz, F. (Inst. Biophysics & Radiobiology, Univ. Hamburg, D-2000 Hamburg, W. Germany). Strahlentherapie 158(4):255-257; 1982 (12 refs).

The response of rat rhabdomyosarcoma R1H to single doses of X-rays (15 and 30 Gray) applied alone or in combination with hyperthermia (43 C) induced by 2450 MHz microwave (MW) radiation was investigated. Heat was delivered to the 2.3 cm^3 tumors by a 4 cm contact applicator 4.0 cm in diameter. MW heating of the tumors was performed 20 min after x-irradiation in 3 steps: (1) the tumors were heated for 5 min with the Radarmed 12T202 generator's maximum output power of 25 W, which led to a fast temperature rise; (2) the power was reduced to 8 W for 15 min; and (3) by applying 7 to 9 W, a constant tumor temperature of 43.0 ± 0.3 C was maintained. The temperature of the rat did not exceed 39 C during treatment. Heating the tumors at 43 C caused a tumor growth delay that increased linearly with the heating time, up to 120 min. However, the animals [illegible]

always tolerate 2-hr treatments. RIH tumors showed enhanced volume regression and tumor growth delay after combined treatment as compared to irradiation alone. After a single dose of 15 Gray, postirradiation hyperthermia treatments for 30 and 60 min led to thermal enhancement ratio (TER) values of 1.3 and 1.6, respectively. After a dose of 30 Gray combined with 30 or 60 min of hyperthermia, TER values were 1.5 and 1.7.

0730 MODELLING OF THE PERTURBATION INDUCED BY LOW-FREQUENCY ELECTROMAGNETIC FIELDS ON THE MEMBRANE RECEPTORS OF STIMULATED HUMAN LYMPHOCYTES (MEETING PAPER). (Eng.) Chiabrera, A. (Electrical Engineering Dept., Univ. Genoa, Viale Causa 13, 1-161 45 Genoa, Italy); Grattarola, M.; Viviani, R.; Braccini, C. Studia Biophysica 90:77-78; 1982 (1 ref).

Lectins are known to induce the in vitro reactivation of human lymphocytes by acting as ligands of membrane receptors. Since most of the molecules involved are electrically charged, an effect on the parameters of the process due to electromagnetic (EM) perturbation can be anticipated. Two differential non-linear equations are proposed as a model of the interactions between receptors and lectins which give the time evolutions of the concentrations of couples of receptors (encounters) and complexes, respectively. Computer simulations of the time evolutions of receptors and complexes do not agree with experimental results and do not take into account the time spent by receptors together. Therefore, a gain function is introduced which is the ratio between the fraction of couples that, in the presence of lectins, remain together longer than a given time and the same expression in the absence of lectins. In principle, sinusoidal perturbations will always inhibit the process by lowering the value of the gain factor. This concept is in qualitative agreement with available experimental data.

0731 MOLECULAR BIOLOGICAL IMPLICATIONS OF ELECTRIC-FIELD EFFECTS (MEETING PAPER). (Eng.) Berg, H. (Central Inst. Microbiology and Experimental Therapy, Dept. Biophysical Chemistry, Acad. Sciences GDR, Beutenbergstrasse 11, DDR-6900 Jena, E. Germany) Studia Biophysica 90:169-176; 1982 (34 refs).

The interactions between biopolymers and biological membranes and electric fields produced by high single pulses with different electrodes or pulsed electromagnetic fields are reviewed. Single pulses can orient biopolymers and their complexes in solution, increase the permeability of membranes and disrupt cell walls, and fuse animal cells and protoplasts. In contrast to the single pulse technique, low pul-

sating fields [illegible] over a longer period [illegible] logical and metabolic [illegible] other investigators and [illegible] ticle. Normally, bursts [illegible] gular pulses [illegible] 1/ msec are used in biomedical [illegible]

0732 ELECTRIC-FIELD-IND[illegible] (MEETING PAPER). [illegible] (Arbeitsgruppe Membrane [illegible] Kernforsch. Anlage, [illegible] D-5170 Julich 1, W. [illegible] G. Studia Biophysica [illegible]

The use of electric fields [illegible] cells is described. Membrane [illegible] is achieved by dielectrophoresis [illegible] ac field resulting in the formation of pearl-chains. Suitable field strength [illegible] of pearl-chains are in the range [illegible] To initiate cell fusion, closer membrane [illegible] to be established by increasing the field strength for a very short time [illegible] the breakdown pulse. The frequency range [illegible] electrophoretic collection should be between 10 kHz and 1 MHz. Reversible electrical breakdown in the zone of membrane contact is the primary process responsible for the initiation of fusion. Electrical breakdown is achieved by the application of a field pulse of short duration and of sufficient strength (0.5 to 7 kV/cm). Breakdown causes a few pores to be generated in the cell membranes so that a bridge is formed between the two cells, through which mass transport can take place. Fusion is generally observed between cells within a pearl chain when a field pulse of 2 to 50 usec is applied and when the field strength is 1.5- to [illegible] times the critical field strength normally required for breakdown in the membrane sites. The [illegible] can be used for the [illegible]

0733 MODELLING OF THE [illegible] BY LOW-FREQUENCY ELECTR[illegible] MA[illegible] THE MEMBRANE RECEPTORS OF STIMULAT[illegible] HUMAN LYMPHOCYTES. I. INFLUENCE OF THE FIELDS ON THE [illegible] FREE ENERGY. (Eng.) Grattarola, M. [illegible] troteenica, Univ. Genoa, Viale Causa [illegible] Genoa, Italy); Viviani, R. [illegible] Biophysica 90(2):117-12[illegible]

An attempt is made to model the [illegible] onstrated inhibitory effect of [illegible] electromagnetic (EM) [illegible] reactivation of human [illegible] reactivate human lymphocyte [illegible] complexes with membrane [illegible] or more [illegible]

[illegible] the [illegible] and after distance is shorter than a [illegible] critical distance R_A. Several possible field effects on the interactive kinetics between membrane receptors and lectins are postulated. Three EM signals are considered: 2Hz sinusoidal, a kHz sinusoidal, and a repetition of a burst of rectangular positive and negative pulses of about 250 usec followed by a zero signal period, the signal time average being zero, and the period 2 msec. The low field EM exposures considered in this paper have a small influence on the values of the numbers of encounters and aggregates per unit surface area so that the small-signal linear approximation holds. The model does not predict any inhibition induced by the EM field.

[illegible] MODELING OF THE PERTURBATION INDUCED BY LOW-FREQUENCY ELECTROMAGNETIC FIELDS ON THE MEMBRANE RECEPTORS OF STIMULATED HUMAN LYMPHOCYTES. II. INFLUENCE OF THE FIELDS ON THE MEAN LIFE-TIMES OF THE AGGREGATION PROCESS. (*Eng.*) Chiabrera, A. (Inst. Elettrotecnica, Univ. Genoa, Viale Causa 13, 16145 Genoa, Italy); Grattarola, M.; Viviani, R.; Bracchi, C. Studia Biophysica 91(2): 127-133; 1982 (2 refs).

In order to model the interaction of electromagnetic (EM) exposure and lectin-induced reactivation of human lymphocytes in vitro, a reactivation gain function G is introduced which is the ratio between the fraction of receptors that remain together longer than a given time in the presence of lectins (encounters and aggregates), and the same expression in the absence of lectins (encounters *alone*). Such a mitotic gain takes into the account the clustering life-times of lymphocyte surface receptors and allows a more appropriate measure of reactivation effectiveness. The introduction of an electrical perturbation decreases the value of G, thus inhibiting the reactivation process, in agreement with the experimentally observed effects of weak low-frequency EM fields on lectin-stimulated lymphocytes.

[illegible] REVERSIBLE CHANGES IN DIELECTRIC PARAMETERS OF SELECTED RAT TISSUES CAUSED BY [illegible] EXPOSURE TO PULSE MICROWAVE RADIATION. I. EXPERIMENTAL RESULTS. (Eng.) Stanisławska, M. [illegible] (Dept. Physical Hazards, Inst. Occupational Medicine, Teresy Str. 8, 90-950 Lodz, Poland); Terlecki, [illegible] Studia Biophysica 91(2):155-161; 1982 (no refs).

[illegible] investigate the effects of exposure to microwave [illegible] radiation on the dielectric properties of rat tissues, [illegible] adult male Wistar rats were exposed to [illegible] pulsed MW energy (pulse width, 1.5 usec, [illegible] pulses per sec) at a specific absorption rate [illegible] 1.5 W/kg for 30 min. The rats were decapitated 0, 2, 6, 17, 2[illegible], and 48 hr after MW exposure. After [illegible] irradiation, temperature in the abdominal ca-

[illegible] Subcutaneously [illegible] rabbit. [illegible] tissue samples [illegible] tance meter [illegible] cavity and [illegible] function [illegible] MW radiation. [illegible] damped harmonic [illegible] pretty phenolic, [illegible] the temperature [illegible] weight-defined [illegible] glands and [illegible] function [illegible]

[illegible] RECESSION OF CHANGES IN DIELECTRIC PARAMETERS OF SELECTED RAT TISSUES CAUSED BY SINGLE EXPOSURE TO PULSE MICROWAVE RADIATION. II. [illegible] (Dept. Physical Hazards, Inst. Occupational Medicine, Teresy Str. 8, 90-950 Lodz, Poland); Stanisławska, M. Studia Biophysica 91(2):163-169; 1982 (no refs).

A mathematical model is [illegible] changes in the dielectric [illegible] submaxillary saliva glands [illegible] single exposures to pulsed [illegible] (2949 MHz, 1.5 usec pulse width, [illegible] for 30 min). The complex dielectric [illegible] tissue samples was measured [illegible] a frequency of 3 GHz. [illegible] data on the real and imaginary parts [illegible] permittivity as a function [illegible] MW exposure, the short-term [illegible] recessional process [illegible] meters is some kind of damped [illegible] ter content in the tissues and [illegible] the abdominal cavity [illegible]

[illegible] EFFECTS OF [illegible] ON THE [illegible] EXPOSURE. (Eng.) [illegible] Biophysics, NIEHS, [illegible] Park, NC 27709); [illegible] tol 2*(1):113-1[illegible]; [illegible]

The morphologic [illegible] the developing [illegible] quail after [illegible] of weak MW [illegible] fields [illegible] pound [illegible] an extra- [illegible] effect [illegible] MW of [illegible] for one [illegible] irradiation [illegible] treated [illegible]

[illegible] histologically. To [illegible] effect of MW irradiation [illegible] cerebellum. [illegible] were [illegible] cerebella from 22 exposed [illegible], and the extent [illegible] of the stem of the [illegible] the perikaryon of [illegible] was [illegible] Slight developmental retardation [illegible] the cerebellar cortices of the irradiated rats. The arrest and subsequent decline of the external germinal layer, the arrest of the molecular layer, the [illegible] and the alignment of Purkinje cells, and the accumulation of [illegible] beneath the Purkinje cell layer were [illegible] the MW-exposed embryos. The mean body [illegible] were also reduced in the exposed [illegible]. However, these effects were temporary with [illegible] and the cytoarchitecture appeared normal at 8 wk of age. In the 8-wk-old quail, no significant differences were noted between irradiated and control cerebella for the morphological measurements of Purkinje cells. These findings suggest that the developmental retardation in the external germinal layer following MW irradiation had no effect on the later development of the cerebellum.

[illegible] TERATOGENIC EFFECTS OF 27.12-MHz RADIO-[illegible] RADIATION IN RATS. (Eng.) [illegible] Carpenter, R. L. (Biological Agents Effects Branch, NIOSH, Cincinnati, Ohio 45226); Conover, D. L.; Foley, E. J.; Weaver, R. L. Teratology 26(3):299-309; 1982 (47 refs).

Pregnant Sprague-Dawley rats were exposed to hyperthermic levels of 27.12 MHz radiofrequency (RF) radiation to study the teratogenic and embryolethal effects of exposure to relatively high levels of RF radiation. Awake rats were irradiated separately in a near-field synthesizer operating in the dominant magnetic field mode under continuous wave conditions at an ambient temperature of 23 ± 2 C. Eight groups, each consisting of 16 to 28 pregnant rats, were exposed to a magnetic field strength of 75 A/m and an electric field strength of 200 V/m on gestation days 1, 3, 5, 7, 9, 11, 13, or 15. The rats were irradiated to a colonic temperature of 43 C rather than for a constant time period; the average irradiation period was 26-32 min. The specific absorption rate for the RF-irradiated animals averaged from 11.1 to 12.5 mW/g. Eight matching control groups were sham irradiated for 30 min (their colonic temperature rose an average of 0.5 C during the exposure period from an initial 38.6 C), and an untreated group of 29 pregnant rats was left in the animal quarters throughout their gestation. RF exposure caused a significant incidence of fetal malformations throughout the postimplantation period (days 7-15). It also caused a low but significant incidence of preimplantation malformations. Fetal [illegible] and crown-rump length were reduced in the postimplantation exposure groups [illegible] by preimplantation exposure. [illegible] or resorbed fetuses was significant [illegible] rats exposed on days 7 or 9. [illegible] appeared to be caused by RF induced [illegible] the treated dams. A number of industrial, [illegible] fic, and medical devices operating at [illegible] MHz can cause hyperthermia in humans, [illegible] sults suggest that women of childbearing [illegible] avoid exposure to RF-radiation levels [illegible] current US occupational standards. [illegible] that maximum permissible exposure levels [illegible] nant workers in Czechoslovakia and West [illegible] from 2 to 50 V/m, much below the ANSI [illegible] 200 V/m.

0739 LOCAL MICROWAVE HYPERTHERMIA [illegible] THERAPY. PRELIMINARY REPORT. [illegible] Valdagni, R. (Centro Oncologico, Inst. [illegible] 38100 Trento, Italy); Amichetti, M.; [illegible] G. Tumori 68(3):247-251; 1982 (23 refs).

Microwave (MW) hyperthermia was used in [illegible] with radiotherapy (15 patients) or [illegible] patient) to treat 19 histologically [illegible] perficially seated malignancies (7 [illegible] noma, 4 melanoma, 1 adenocarcinoma, and [illegible] refractory to other therapeutic measures. [illegible] patients (5 females and 11 males; [illegible] average age, 65 yr) 15 had a Karnofsky [illegible] Local MW hyperthermia to a preselected [illegible] ature (42.5, 43, 43.5, and 44 C) was applied [illegible] for 20-55 min by a BSD-1000 computer-controlled [illegible] perthermia unit operating at frequencies [illegible] MHz. Thermometry was performed by [illegible] probes placed on the skin and intratumoral [illegible] serted catheters. After radiotherapy [illegible] hyperthermia (< 20 min), a complete response was observed in 9/18 treatment fields [illegible] partial response > 50% in 5 and [illegible] tient was not evaluable. Tumor regression usually began about 2 wk after the first treatment. No tumor progression was observed during therapy or in mo 1 of follow-up. The only [illegible] fects directly attributable to hyperthermia were skin burns in 147 treatment sessions. The patient receiving chemotherapy 3 hr before hyperthermia exhibited no response.

0740 STUDY OF THE EFFECT OF PULSED [illegible] NETIC WAVES ON THE BLOOD [illegible] LIMB. (Eng.) Mollan, R. A. B. (Orthopaedic Surgery, Queen's Univ., Belfast, N. Ireland); Allen, J. D.; Orr, J. F.; McGrath, S. Injury 13(1):67-70; 1982 (13 refs).

Pulsed electromagnetic (EM) energy was [illegible] the calf of eight healthy [illegible]

tests to investigate the effect of electrical stimulation on blood flow. An electronic device was constructed to deliver a train of pulses 200 msec wide in bursts every 5 msec, with a repetition frequency of 10-15 Hz. Three separate signal generators were used to produce a composite signal which was magnified and fed into a set of coils wired in series. The induced field between the coils was 1.5-4.5 mT/cm. In four experiments, the coils were applied to the left thigh and right and left calf blood flow was measured by venous occlusion plethysmography. In a second series of four experiments, the coils were incorporated in a water-filled plethysmograph made of polycarbonate and the EM filed was applied to the calf at the level at which blood flow was being measured. In all eight experiments, calf blood flow was recorded for a 3-min control period before the coils were switched on, then for 3-min periods when the coils had been on for 15, 20, and 27 min, and finally for 3 min after they were switched off. No significant difference was detected between right and left calf blood flow in either series of experiments. These findings suggest that the reported osteogenic effect of electrical stimulation on bone is not produced by variations in blood flow to the stimulated limb.

0742 ELECTROMAGNETIC AND ACOUSTIC PROPERTIES OF TISSUES. (Eng.) Burdette, E. C. (Biomedical Res. Div., Engineering Experiment Station, Georgia Inst. Technology, Atlanta, GA 30332). In: Physical Aspects of Hyperthermia. Nussbaum, G. H., ed. (American Inst. of Physics: New York); American Assoc. of Physicists in Medicine, Medical Physics Monograph 8:105-150; 1982 (87 refs).

In beneficial applications of electromagnetic (EM) and ultrasonic energy, an accurate knowledge of tissue dielectric and acoustic properties is essential. A brief discussion of the basic principles underlying EM and ultrasonic absorption and dispersion in tissues is presented, tissue property measurement techniques are reviewed, and results of dielectric and acoustic tissue property investigations are described. A brief description of in situ tissue property measurement techniques is given and in situ properties of living normal and tumor tissues are presented. Substantial differences have been found between the dielectric properties of tumors and normal host tissues. Accurate dielectric or acoustic property information that reflects in vivo characteristics is necessary for successful application of EM or ultrasonic diagnostic and treatment techniques in medicine and for accurately determining absorption in tissues. The capability for accurate in situ measurements of tissue dielectric and acoustic properties could be used in dosimetry determinations and in treatment planning for cancer patients using EM or ultrasonic-induced hyperthermia.

0742 PHYSICAL ASPECTS AND MEDICAL APPLICATIONS OF HYPERTHERMIA PRODUCTION BY RF CURRENTS AND MICROWAVES. (Eng.) Iskander, M. F. (Univ. of Utah, Salt Lake City, UT 84112). In: Physical Aspects of Hyperthermia. Nussbaum, G. H., ed. (American Inst. of Physics: New York); American Assoc. of Physicists in Medicine, Medical Physics Monograph 8:151-196, 1982 (22 refs).

The noninvasive production of hyperthermia for cancer therapy by electromagnetic (EM) techniques is described. The basic aspects of EM absorption in tissue are reviewed, with emphasis on the laws that decribe the propagation of EM waves and the mechanisms involved in their interaction with materials such as tissue. The interaction of EM fields with tissue produces two basic types of effects which are reflected in the dielectric behavior, one related to the drift and oscillation of free charges and the other the polarization both through the alignment of the already existing electric dipoles or the production of new ones. The fundamental differences between heating mechanisms in short-wave (conduction current type) and microwave (radiation type) diathermy are discussed. Examples of specific practical systems are used to illustrate the advantages and limitations of both procedures. Factors affecting the optimum frequency range for short wave diathermy are discussed. EM and ultrasound applications in hyperthermia are compared.

0743 POWER DEPOSITION WITH MICROWAVES. (Eng.) Paglione, R. W. (RCA Labs., Princeton, NJ 08540). In: Physical Aspects of Hyperthermia. Nussbaum, G. H., ed. (American Inst. of Physics: New York); American Assoc. of Physicists in Medicine, Medical Physics Monograph 8:197-[illegible]; 1982 (10 refs).

A short review of the dielectric and thermal properties of tissues is presented. The success of hyperthermic treatment for cancer appears to be related to the ability to deliver uniform heat to specific volumes of tissues and to maintain the optimum temperature for the required period of time. The depth to which radiofrequency waves can penetrate into tissues and produce heating is primarily a function of the dielelectric properties of the tissues and of the frequency. The designs and uses of waveguide, printed-circuit antenna, and coaxial applicators at microwave and radio frequencies are described and illustrated.

0744 CLINICAL HYPERTHERMIA WITH RF CURRENTS. (Eng.) Oleson, J. R. (Div. Radiation Oncology, Arizona Health Sciences Center, Tucson, AZ 85724); Cetas, T. C. In: Physical Aspects of

Hyperthermia. Nussbaum, G. H., ed. (American Inst. of Physics: New York); American Assoc. of Physicists in Medicine, Medical Physics Monograph 8:289-328; 1982 (35 refs).

Mechanisms of interaction between radiofrequency (RF) radiation and biological tissue are reviewed briefly. RF fields are coupled to biological matter either in a capacitive mode in which RF current passes from one electrode to another through through tissue interposed between electrodes, or in an inductive mode in which current flow results in tissue placed within an alternating RF magnetic field. Examples are presented illustrating each of these modes of RF heating as used for clinical hyperthermia. Phantoms are used to illustrate power deposition patterns in heterogenous materials. Temperature distributions observed in clinical situations are qualitatively compared to these power density distributions. Work is in progress in the laboratory and clinical evaluation of newer techniques using magnetic induction. These include the following: 1) A coaxial pair of coils (Helmholtz pair) for heating by magnetic induction. Careful positioning of the coils is necessary to result in a maximum eddy current density passing through the tumor; 2) Ferromagnetic implants used in conjunction with the magnetic induction technique to preferentially absorb energy from an applied RF field. The tissue in the vicinity of the implant is heated by thermal conduction from the hot seed rather than by direct absorption of energy from the magnetic field; and 3) Curie point seed heating. These newer techniques may extend the usefulness of RF heating in clinical applcations.

0745 CLINICAL APPLICATIONS OF HIGH FREQUENCY METHODS FOR LOCAL TUMOR HYPERTHERMIA. (Eng.) Corry, P. M. (Dept. Physics & Developmental Therapeutics, Univ. Texas System Cancer Center, Houston, TX 77030); Barlogie, B. In: Physical Aspects of Hyperthermia. Nussbaum, G. H., ed. (American Inst. of Physics: New York); American Assoc. of Physicists in Medicine, Medical Physics Monograph 8: 307-328; 1982 (10 refs).

Methods operating at frequencies in the high frequency (HF) spectrum (3-100 MHz) to induce local or regional temperature elevation in human tumors are reviewed. Criteria for an ideal system are presented and compared with methods that have been or can be used, including capacitive dielectric heating, magnetic induction heating, HF currents from implanted electrodes, ferromagnetic induction and hysteresis, as well as the use of phased annular arrays of radiators and folded dipole antennae driven at 433 MHz. Although there is no single method available which is ideal or which will facilitate hyperthermia induction in a wide range of tumor sizes, histologies, and anatomic locations, the work to date has provided guidelines for systems of the future. The ability t[illegible] at least 45 C is essential, [illegible]. Toxicity information indicat[illegible] attention must be focused [illegible] interface to make the system [illegible] observation of deep seated [illegible] visceral lesions suggests that th[illegible] localized to the vicinity of th[illegible]

0746 CLINICAL HYPERTHERMIA [illegible] (Eng.) Sandhu, T. S. [illegible] Lake City, UT 84132). In: [illegible] perthermia. Nussbaum, G. H., [illegible] of Physics: New York); American A[illegible] in Medicine, Medical Physi[illegible] 1982 (61 refs).

Instrumentation required to treat [illegible] crowave (MW) induced hyperthermia [illegible] hyperthermia equipment includes a MW [illegible] circulator or isolator, power [illegible] stub tuners, and MW applicators. [illegible] cators include the external waveguide, [illegible] slot, and intracavitary antenna [illegible] Invasive methods include the use [illegible] coaxial antenna applicators and [illegible] cators. Static tissue equivalent phant[illegible] heating studies allow the selection [illegible] applicator, the aperture size, and the MW frequency to be used to treat a prescribed target tissue volume. A dynamic phantom is described which can be used to study the effects of blood flow on the thermal field size produced by an applicator. The system is designed for use with noninvasive heat transducers and consists of a chamber divided into compartments, with liquid (e.g., saline solution) in the top and bottom ones, and foam in the middle. The flow in this system is simulated in only one direction, but the data obtained can be manipulated to account for counter current blood flow.

0747 MICROWAVE TECHNIQUES FOR CLINICAL [illegible] THERMIA. (Eng.) Cheung, A. Y. (Dept. Radiation Therapy, Univ. Maryland [illegible], Baltimore, MD 21201). In: Physical [illegible] thermia. Nussbaum, G. H., ed. (Amer[illegible] Physics: New York); American Asso[illegible] in Medicine, Medical Physics Mon[illegible] 1982 (15 refs).

The rationale behind systems [illegible] to microwave (MW) hyperthermia for cancer [illegible] and innovative engineering [illegible] ing to the implementation of clinical [illegible] MW hyperthermia systems are presented. A MW [illegible] for the induction of localized hyperthermia [illegible] divided into six subunits: inductive [illegible], temperature measurement, power and [illegible]

[illegible] data acquisition and storage; operator interface; and failure/error-checking. The induction subsystem consists of the power source, power monitoring and impedance matching network, and the applicators. At MW frequencies, the two types of applicator commonly used are direct contact external applicators and implantable internal radiators. The clinical system developed at the University of Maryland Hospital is described as an example of an integrated, safe and reliable unit for MW-induced hyperthermia for cancer treatment.

[illegible] UNITED STATES RADIATION SAFETY AND REGULATORY CONSIDERATIONS AND PROCEDURES FOR RADIOFREQUENCY HYPERTHERMIA SYSTEMS. (Eng.) Bassen, H. I. (Bureau Radiological Health, FDA, Rockville, MD 20852); Coakley, R. F., Jr. In: Physical Aspects of Hyperthermia. Nussbaum, G. H., ed. (American Inst. of Physics: New York); American Assoc. of Physicists in Medicine, Medical Physics Monograph 8:372-392; 1982 (15 refs).

Radiofrequency (RF) radiation may be effectively utilized to produce therapeutic heating in human tissues, but stray radiation emissions from devices using this modality may expose clinical personnel and the patient's non-prescribed tissue to relatively high field strengths. Studies of RF emissions from shortwave and microwave (MW) diathermy devices by the Bureau of Radiological Health (BRH) have lead to a proposed standard for MW diathermy devices operating above 900 MHz. The provisions of the proposed standard involve four basic concepts: leakage of MW radiation beyond the intended treatment area is limited to 10 mW/cm^2 at a distance of 5 cm from the diathermy unit, except in the treatment beam; required controls, indicators, RF power stabilizers and controls, and safety interlocks; heating effectiveness is required to be quantified through tests using standard phantoms; and a requirement to provide the operator with sufficient information to treat a patient with maximum efficiency and minimum leakage. Present U.S. radiation safety standards allow much higher unintentional human exposures than do those in several East European countries, but a trend to lower permissible exposures is underway.

[illegible] THE PHILOSOPHY AND USE OF TISSUE-EQUIVALENT ELECTROMAGNETIC PHANTOMS. (Eng.) Cetas, T. C. (Div. Radiation Oncology, Univ. Arizona Health Sciences Center, Tucson, AZ 85724). In: Physical Aspects of Hyperthermia. Nussbaum, G. H., ed. (American Inst. of Physics: New York); American Assoc. of Physicists in Medicine, Medical Physics Monograph 8:441-461; 1982 (44 refs).

The use of tissue equivalent phantoms for studies of

[illegible]

[illegible] AND PHANTOM MEASUREMENTS [illegible] (Univ. Utah, Salt Lake [illegible] cal Aspects of Hyperthermia. [illegible] (American Inst. of Physics: [illegible] Assoc. of Physicists in Medicine, Monograph 8:[illegible]; 1982.

[illegible] because of the problem [illegible] urement of electromagnetic [illegible] scale phantoms, which [illegible] The mathematical basis [illegible] ented. Mathematical [illegible] tive procedure [illegible] hence the temperature [illegible] models exposed to external [illegible] internal fields and the [illegible] in a two-dimensional [illegible] human subjects can be calculated [illegible] procedure. This amendment [illegible] larly useful for hyperthermia applications [illegible] takes into account the specific [illegible] different tissues in the [illegible] field characteristics [illegible]

[illegible] ANALYSIS OF [illegible] DOSIMETRIC EFFECTS [illegible] HEAT, RADIATION AND HEAT [illegible] OF A PHASE III RANDOMIZED [illegible] ANIMALS. (Eng.) Dewhirst, M. [illegible] Oncology, Univ. Arizona [illegible] Tucson, AZ 85724); Myers, L. [illegible] cal Aspect of Hyperthermia. [illegible] (American Inst. of Physics: [illegible] Soc. of Physicists in Medicine, [illegible] Monograph 8:[illegible]; 1982.

the results of a randomized Phase III trial to compare the relative efficacies of heat alone, radiation alone, and radiation plus heat to treat tumors in pets are reported. A total of 77 dogs and cats with a variety of spontaneous malignancies were stratified by tumor type and randomized to receive therapy. The heat prescription was 44 ± 2 C for 30 min 1/wk, while the radiation dose was 460 rad/fraction 2/wk for 8 fractions. When the treatments were combined, heat preceeded one radiation treatment each week by no more than 10 min. All but 3 of the heated patients were treated with 500-kHz radiofrequency current using parallel plates, needles, or a plate plus needles; 3 patients with superficial tumors received 2450 MHz microwaves. A comparison of overall response rates showed that the fraction of patients with no response was significantly higher for heat alone than with either of the other two treatment arms. The complete response rates for heat alone and radiation alone were significantly lower than that for heat plus radiation. Analysis of potential therapeutic gain factors based on moist desquamination as a normal tissue endpoint indicates that larger values are possible for large tumors (> 10^3 cm^3) than for small ones. In the heat plus radiation group, response rates and durations were dependent on minimum temperature monitored in the tumor. Temperature measurements should be made during each treatment, since predictable heating patterns were not seen except in a few cases. In patients treated with heat alone, there was no correlation between minimum heat dose and prognosis.

0752 BIOELECTROCHEMISTRY - ELECTROPHYSIOLOGY - ELECTROBIOLOGY. (Eng.) Findl, E. (Bio Research, Inc., 315 Smith St., Farmingdale, NY 11735). In: Modern Aspects of Electrochemistry, Bockris, J. O., Conway, B.E., White, R.E. eds. (Plenum Publishing Co:New York) Vol 14:509-555; 1982 (127 refs).

A review is presented of interactions between electric fields and biological matter, with emphasis on transmembrane potentials, bioelectrokinetic phenomena, and surface charges of biomaterials. Topics discussed include electric fields and ion transport, cellular transmembrane potentials, potentials that are generated in vivo by motion between biofluids and cellular materials in the cardiovascular system, and potentials generated in bone and cartilage. The author presents results from in vivo and in vitro experiments to support the hypothesis that electrocardiogram waveforms are largely due to electrokinetic potentials. Medical and biological applications include the use of electric fields to stimulate bone growth and limb regeneration, and electric currents to induce electroanesthesia and to relieve chronic pain and eliminate pain during surgical procedures (e.g., in dentistry, gynecology, surgery, neurology, and psychiatry). The surface charge and surface energy of a material have been shown to affect the ability of the material to absorb blood components and to be critical to the [illegible]. Electric currents or electric fields [illegible] to facilitate passage of substances [illegible] blood-brain barrier, to influence [illegible] and cellular differentiation, [illegible] brane breakdown, and to promote [illegible].

0753 RISK/BENEFIT ANALYSIS [illegible] CASE. (Eng.) Stenek, [illegible] Francisco Press: San Francisco, [illegible]

A conference sponsored and [illegible] Michigan Collegiate Inst. for [illegible] and the National Science Foundation [illegible] ues in Science and Technology [illegible] 1981 was the basis of this [illegible] the problem of setting safety standards [illegible] to radiofrequency (RF) and microwave [illegible] through risk/benefit analysis. [illegible] papers in the volume cover the [illegible] origins and present state of the [illegible] fication of critical cost/benefit [illegible] cations of RF and MW energy; [illegible] ty practices in the USSR and [illegible] tions; results of an inquiry by the [illegible] nications Commission on potential [illegible] radiation; the costs of perceived [illegible] of MW radiation; a suggested use [illegible] analysis in the MW debate; cost, risk, [illegible] the military; the importance of the [illegible] environment; cost/benefit analysis, risk [illegible] analysis in the formulation of [illegible] nonionizing electromagnetic standards and [illegible] plementation; the effect of extrasensory [illegible] on MW research; science, objectivity and [illegible]. While individually, the papers in this [illegible] vide no simple, correct resolution [illegible] debate, as a group, they cover the [illegible] view that must be considered seriously [illegible] making, if consensus is to be achieved. [illegible] agreement and disagreement among the [illegible] ticipants are summarized in an appendix.

0754 MICROWAVE AND RADIOFREQUENCY [illegible] (Eng.) Michaelson, S. M. (Dept. of [illegible] Biology and Biophysics, Sch. Medicine & Dentistry, Univ. Rochester, Rochester, NY). [illegible] Radiation Protection. Suess, M. J., ed. (World Health Organization Regional Office for Europe, Copenhagen, Denmark). WHO Regional Publications, European Series [illegible] 174; 1982 (375 refs).

The frequency ranges considered are [illegible] MHz for radio frequency radiant energy, [illegible] 300 MHz-300 GHz for microwaves (MW). [illegible] has been made to delineate areas of uncertainty with respect to biological effects and gaps in the state of knowledge. The review covers [illegible]

...ical principles; biological effects and health ...ts; instrumentation and measurement; MW/RF ...ces and devices; protection measures and techniques; protection guides and standards; and health ...ations. It is recommended that the development ... and additional sources of MW/RF exposure be controls followed and monitored. Consistent efforts should be made to minimize the impact of these sources on man and the environment. Continued attention should be given to the development of dosimetry and to the standardization of measurement techniques; greater attention should be given to the investigation of fundamental interactions of MW as energy with biological systems.

0755 ELECTRIC AND MAGNETIC FIELDS AT POWER FREQUENCIES, WITH PARTICULAR REFERENCE ... AND 60 Hz. (Eng.) Hauf, R. (Res. Inst. Electr...thology, Freiburg, W. Germany). In: Nonionizing Radiation Protection. Suess, M. J., ed. (WHO, Regional Office for Europe, Copenhagen, Denmark); Regional Publications, European Series No. 10: ...; 1982 (68 refs).

Electric (E) and magnetic (H) fields are generated by power transmission systems and wherever electric energy is used, whether in domestic activities, in transportation, or in industry. Future power transmission network voltages are expected to exceed the present level of 800 kV, and a transmission voltage of 1,200 kV is projected for the near future. In the interest of health protection, the effects that the E and H fields may have on man are reviewed. It is concluded that many observed phenomena, particularly changes in behavior, attributed to the effects of E and H fields can easily be explained by secondary effects which are not field-specific. Experimental studies show that E fields of intensity up to 20 kV/m and H fields of intensity up to 240 A/m, whether individually or in combination, do not constitute a danger to health. Epidemiological studies of exposure to E fields in workers in high-voltage substations and on power lines have failed to show any adverse health effects. No mechanism of action is known whereby power frequency fields can produce direct effects on living organisms, and no specific symptoms have been detected in humans as a consequence of exposure to these fields. E and H fields caused by transmission systems up to 420 kV are not considered to constitute a danger to human health; it can be assumed that this is also true for 800 kV systems.

0756 MEDICAL APPLICATIONS OF RADIOFREQUENCY-RADIATION HYPERTHERMIA (FINAL REPORT Jan...). (Eng.) Kiel, J. L. (USAF/SAM, Brooks AFB, TX). Report No. SAM-TR-82-38, Oct 82. Contract No. ...; 21 p. (Available through NTIS, Springfield, VA 22161, Document No. ... 1982.

This report provides a ... plications of radiofrequency ... thermia. RFH has limitations ... tration but can heat tissue ... sis of water content and ... Nonionizing electromagnetic ... the out several mechanisms, ... the amount of energy deposited ... type of tissue irradiated. These ... great versatility in the ... RFH. Furthermore, the synergy ... with ionizing radiation and ... treatment increases their effectiveness ... wet doses. Lowered toxicity is ... a lower effective dose in the ... With improved therapeutic instrumentation ... dosimetry and a better understanding ... anisms, the number of medical applications ... effectiveness of RFH should ...

0757 EFFECTS OF 200, ... AND ... WAVES ON CEREBRAL ENZYMES. ... (Eng.) Sanders, A. P. (Duke Univ. Medical Center, Durham, NC); Joines, W. T. Sponsored by Health Effects Research Lab., Research Triangle Park, NC. Report No. EPA-600/182-014, Oct 82. Prepared in cooperation with Duke Univ., Durham, NC. Dept. of Electrical Engineering. Contract No. EPA-...; ... (Available through NTIS, Springfield, VA, ... No. PB83-116913]:72 p.; 1982.

Previous work has shown that levels of key biochemicals in the energy production system of rat brain are affected by exposure to 591 MHz microwave radiation at 13.8 mW/cm^2. The objectives of this study were to determine whether there are direct microwave effects on the biological system or whether they are secondary to the hyperthermia produced in the tissue, to establish dose-response relationships for the effects, and to investigate different frequencies of exposure and modulation of the carrier signal. The fluorescence of reduced nicotinamide adenine dinucleotide (NADH) in the rat brain was measured in vivo during exposure to the microwave radiation, and adenosine triphosphate (ATP) and creatine phosphate (CP) levels were measured chemically after exposure.

0758 MICROWAVE TESTING ON MICE YIELDS ... TIVE EFFECTS (NTIS TECH NOTE). ... Dept. of the Navy (Washington, DC). ... information about Tech Notes subscriptions ... issue packages available. (Available ... Springfield, VA 22161, Document No. PB8... p.; 1982.

This citation summarizes a one-page announcement of technology available for utilization. A single, 15-min exposure to 2450-MHz microwave radiation is sufficient to reach a threshold that stimulates a significant increase in mouse splenic B lymphocytes bearing cell surface receptors for the third component of complement, according to recent tests. They also showed that the effect of absorption of multiple subthreshold quantities of energy was cumulative, provided the exposures occurred within 1 hr of each other. For additional information, contact: Navy Technology Transfer Fact Sheet, Code E411, Naval Surface Weapons Center, Dahlgren, VA 22448; reference No. 79504/TN.

0759 HYPERTHERMIA IN RHESUS MONKEYS EXPOSED TO A FREQUENCY (225 MHz) NEAR WHOLE-BODY RESONANCE. (Eng.) Lotz, W. G. (Naval Aerospace Medical Res. Lab., Pensacola, FL 32508). Report No. NAMRL-1284, 1 Jun 82. Contract No. F58524; MF5852-+020. Available through NTIS, Springfield, VA 22161, Document No. AD-A118 364]:13 p.; 1982.

Exposure of Rhesus monkeys to 225 MHz radiation caused severe hyperthermia at power densities > 5 mW/cm^2 (2.3 W/kg). A comparison of body temperature responses to exposure at two frequencies, 225 and 1290 MHz, indicated that the resonant frequency (225 MHz) is at least 2-x more effective in causing hyperthermia than the higher frequency, even after considerations of specific absorption rate (SAR) are included in the analysis. It was concluded therefore, that the effects on Rhesus monkeys of exposure to a resonant frequency (225 MHz) were substantially greater than what could be predicted based upon straightforward comparisons of dosimetric information (SAR) and the effects of exposures to a much higher frequency (1290 MHz).

0760 BIOLOGICAL EFFECTS OF STATIC MAGNETIC FIELDS: A SELECTIVE REVIEW WITH EMPHASIS N RISK ASSESSMENT. (Eng.) Easterly, C. E. (Oak Ridge Natl. Lab., TN). Contract No. W-7405-ENG-26. Available through NTIS, Springfield, VA 22161, Document No. DE82-013350]:78 p.; 1982.

Rather than focusing on literature per se, the current study determines the status of magnetic field information that is applicable to risk assessment. Hence, an attempt is made to identify both the literature that is useful to the goal of risk assessment and a framework within which risk assessment methodologies can be derived. From this selected review, it is concluded that three areas exist for which adequate information can be found to begin modelling: disease induction, reproduction and development, and cardiovascular response. The first two are supported by a combination of positive and negative findings and the last by a technique which utilizes the principle of flow retardation of fluid moving through a magnetic field.

0761 MECHANISM OF ELECTROMAGNETIC [illegible] EFFECTS OF THE NERVOUS SYSTEM. (PROGRESS REPORT AND PRELIMINARY RESULTS). (Eng.) Campbell, N. L. (Naval Ocean Systems Center, San Diego, CA 92152); Brandt, C. L. Report No. NOSC-TR-[illegible], July 82. Contract No. ZR00001; [illegible]. Available through NTIS, Springfield, VA 22161, Document No. AD-A117 527]:68 p.; 1982.

Effects of high-level electromagnetic (EM) energy on living nerve tissue were assessed by subjecting individual nerve cells of the marine gastropod Aplysia californica to microwave radiation levels of 10-300 mW/cm^2. Of the 84 exposed cells, 7 showed inhibitory responses and 1 showed excitatory response that required 6-82 min to develop. In each case, the cell returned to normal activity within 70 min of removing the EM field. It was concluded from the data collected that interaction of EM energy with the electrical activity of nerve cells does exist, and that this interaction is not heat-related. Understanding the mechanism of this interaction will provide a valuable tool in determining the standards of nonionizing EM energy and the ultimate safety limits of exposure.

0762 ANNUAL REPORT, DIVISION OF BIOLOGICAL EFFECTS, BUREAU OF RADIOLOGICAL HEALTH (FISCAL YEAR 1980). (Eng.) Bureau of Radiological Health (FDA, Rockville, MD). Report No. [illegible], DHHS-PUB, Mar 82. Available from NTIS, Springfield, VA 22161, Document No. [illegible], 1982.

The Division of Biological Effects, Bureau of Radiological Health, plans, conducts, and supports epidemiological and experimental studies of the effects of both ionizing and nonionizing radiation, including x-rays, radiopharmaceuticals, microwaves, ultraviolet light and ultrasound. The intramural and extramural epidemiological studies, laboratory investigations and contracts are described. In addition to the literature, the division evaluates research to assess the health effects resulting from exposure to radiation. This report gives the status of projects completed and in progress for the period 1 October 1979 through 30 September 1980. It supports radiation related radiation research and evaluation, particularly as it concerns the biological effects of exposure to electronic products.

0763 INTERACTIONS OF RADIOFREQUENCY RADIATION WITH NITELLA: ELECTRICAL EXCITATION AND PERTURBATION OF THE CONTROL OF CYTOPLASMIC STREAMING (MASTER'S THESIS). (Eng.) Wong, L. S. (Air Force Inst. Technology, Wright-Patterson AFB, OH). Report No. AFIT-NR, Mar 82. [available through NTIS, Springfield, VA 22161, Document No. AD-A116 713]:94 p.; 1982.

Radiofrequency radiation (RFR) of 0.5 Hz - 2.5 GHz at field strengths on the order of 10 V/cm has been shown to interact with isolated Nitella internodal cells in two separate and frequency dependent manners. At frequencies up to approximately 10 KHz, RFR acts to directly excite the cell membrane, eliciting an action potential and halting cytoplasmic streaming. There is no reason to believe the RF induced action potentials and accompanying streaming cessations occur through a mechanism different from that which results from conventionally applied excitatory stimuli. Microscopic observations of the streaming in cells exposed to RFR gave no evidence of direct action by RFR upon the mechanism which generates the motive force. Streaming alterations, however, did indirectly indicate the existence of a field induced disruption of the calcium ion release which normally occurs upon membrane excitation. On the basis of these observations and previously reported theoretical models of RF interactions with biological systems, a molecular mechanism for the electrically mediated release of calcium ion is presented.

0764 OPEN-ENDED COAXIAL EXPOSURE DEVICES (PATENT APPLICATION). (Eng.) Burdette, E. C. (Dept. of the Air Force, Washington, DC). Report No. PAT-APPL-6-357 442; filed Mar 82. [available through NTIS, Springfield, VA 22161, Document No. AD-D009 487];24 p.; 1982.

A device for, and a method of, delivering a known amount (i.e., a dose) of electromagnetic energy radiation in the radiofrequency/microwave frequency range to a specimen of organic material (e.g., a cell and/or a tissue culture), and thereby exposing the specimen to the delivered energy. The device comprises a source of the desired electromagnetic energy to which is electrically connected a coaxial cable having an open end which terminates in a centrally located aperture of a circular brass ground plane plate to which, in turn, is electrically and mechanically connected to a metallic ring which is positioned such that it is equidistant from the aperture to which the energy-radiating open end of the coaxial cable is located. A circular culture dish which is positioned over the aperture, within the metallic ring, and on the ground plane plate holds the specimen of organic material which is exposed to the energy radiated from the open end of the coaxial cable.

0765 REVIEW OF HEALTH AND SAFETY [illegible] VIDEO DISPLAY TERMINALS. [illegible] niet, W. C. (Communications [illegible], Ont., Canada). Sponsored by NSSA, [illegible] Report No. CRC-TN-712-[illegible], [illegible] NTIS, Springfield, VA [illegible], [illegible] 19816]:39 p.; 1982.

The factors that contribute to [illegible] when video display terminals (VDT) are [illegible] into the workplace are investigated. [illegible] from field experiments indicate that [illegible] ergonomic factors and job characteristics [illegible] tribute to reports of discomfort [illegible] Specifically, reports of visual discomfort [illegible] lated to improper ambient lighting (which is [illegible] bothersome reflections and contrast ratio), display quality, and ophthalmological defects. [illegible] Reports of muscle pain and fatigue are [illegible] poor work-station design such as improper [illegible] of chair, keyboard, and display screen, [illegible] of source document holder, and no support [illegible] forearms and wrists. It is noted that the frequency of such complaints is influenced by the [illegible] attitude regarding the job. A negative [illegible] arising from perceived monotonous [illegible] task, or from having no opportunities [illegible] advancement, will result in more complaints [illegible] ergonomic shortcomings. The issue of electromagnetic emissions from television displays is [illegible] considered.

0766 MECHANISMS OF MICROWAVE NEURAL INTERACTION (FINAL REPORT). (Eng.) [illegible] L. (Dept. Biology, Utah Univ., Salt Lake [illegible] 84112); Durney, C. H. Contract No. [illegible] 0932. [available through NTIS, Springfield, VA 22161, Document No. AD-A[illegible] [illegible] p.; [illegible]

Examination of the binding characteristics [illegible] tylcholine receptor (AchR) and either [illegible] beled acetylcholine (^{3}H-Ach) or calcium [illegible] via a modified Hill plot revealed a [illegible] synergistic binding for both agonist [illegible] and calcium (Ca++) in low concentrations. [illegible] crease was observed at a power density [illegible] (SAR) of 1.5 - 2.5 mW/g [illegible] W/g, [illegible] continuous wave or 2 Hz square wave [illegible] cal in both cases). Cooperativity [illegible] was not changed at physiological concentrations [illegible] Experiments performed at [illegible] distinguished from those at [illegible]

0767 MICROWAVE INDUCED [illegible] IN THE [illegible] (FINAL REPORT). A DECADE OF [illegible] Olsen, R. G. (Naval Aerospace Medical [illegible] Pensacola, FL [illegible] [illegible]

81. Contract No. MR04108; MR0410801. [available through NTIS, Springfield, VA 22161, Document No. AD-A118 821]:15 p.; 1982.

Microwave-induced developmental effects in insects have been studied at several laboratories during the past decade. Results of the initial experiments were interpreted to show a so-called nonthermal microwave effect, but as more studies were conducted by various investigators, a predominantly thermal effect appeared to be the best explanation. This report presents the results of a comprehensive series of insect irradiation experiments including a rigorous statistical analysis of the data. Statistical analysis shows no microwave-induced effects for exposure of up to 4 hr at dose rates of 63 W/kg. Irradiation at higher intensities (102-126 W kg) did produce statistically significant effects when applied over a 2-4 hr period.

0768 THE EFFECT OF PULSED MICROWAVES ON THE BREATHING OF MICE. (Swe.) Criborn, C. O. (Foersvarets Forskningsanstalt, Stockholm, Sweden); Henriksson, C. I.; Clemedson, C. J. Sponsored by NASA, Washington, DC. Report No. FOA-C-54032-H2 H3, Apr 81. [available through NTIS, Springfield, VA 22161, Document No. N82-22873]:20 p.; 1981.

With the use of a specially constructed microwave generator, mice were exposed to microwaves synchronized to the different stages of respiration. Frequencies other than the respiratory rate affect the volume and rate of respiration in shorter intervals of exposure. Even though the animals were not heated at the low average effect, approximately 1mW/cm^2 during exposure, a change in body wt was measurable. These results indicate that the thermal energy balance in mice is somehow affected.

0769 DOSIMETRIC AND BEHAVIORAL ANALYSIS OF MICROWAVE-DRUG SYNERGISTIC EFFECTS ON OPERANT BEHAVIOR IN THE RAT. (FINAL REPT. Sep 79-Dec 81). (Eng.) Lovely, R. H. (Battelle Memorial Inst., Pacific Northwest Lab., Richland, WA); Lundstrom, D. L.; Phillips, R. D. Contract No. N00014-79-C-0819. [available through NTIS, Springfield, VA 22161, Document No. AD-A115 115]:26 p.; 1981.

Five male Long-Evans rats maintained at 80% of their free-feeding wt, were trained to bar press for food reward on a 1-min fixed-interval (FI1) schedule of reinforcement. Once stable FI1 baseline response rates were established dose-response functions were generated for Chlordiazepoxide HCl (CDZ). Subsequent treatments with CDZ were followed by 30 min pulsed microwave radiation (MWR) and FI1 behavioral assessment. Pulsed MWR exposures were [illegible] zone of an anechoic chamber at an average power density of 1 mW/cm^2 (PRF=3[illegible] width). After 2 replications of the combined treatments another CDZ dose-response function was generated. This was followed by 3 more [illegible] MWR applications the first of which was carried [illegible] averaged incident power density of 1 mW/cm^2. Increased rates of response for the CDZ and [illegible] MWR treatment were demonstrated relative to control CDZ dose-response functions in 4 of 5 rats tested. However, the dose-response functions for CDZ alone that were generated following this apparent synergy showed the same shift in response rate. Further, 8 mW/cm^2 pulsed MWR combined with CDZ also produced data similar to the 1 mW/cm^2 post-MWR exposure CDZ dose-response functions for the animals tested. Thus, an earlier demonstration of synergism between CDZ and MWR could not be replicated.

0770 SUBTLE CONSEQUENCES OF EXPOSURE TO WEAK MICROWAVE FIELDS: ARE THERE NON-THERMAL EFFECTS. (Eng.) Lovely, R. H. (Biophysics and Physics Res. Lab., Univ. Hosp., Seattle, WA [illegible]; Mizumori, S. J. Y.; Johnson, R. B.; Guy, A. W. Prepared in cooperation with Battelle Pacific Northwest Labs., Richland, WA, Biology Dept., and California Univ., Berkeley, Dept. of Psychology. Contract No. N00014-75-C-0464. [available through NTIS, Springfield, VA 22161, Report No. AD-A[illegible] 169/3]:53 p.; 1983.

When we speak of subtle consequences of exposure we mean only that the effects were observed in the absence of changes in core temperature due to microwave exposure. When we measure the difference in core temperature consequent to microwave exposure, we are witnessing a breakdown of thermoregulatory mechanisms. Short of this event, the exposed subject makes a number of thermoregulatory and metabolic accommodations to maintain a constant body temperature and to deal effectively with the energy being deposited in its tissues. These latter changes should interest us for they are the subtle consequences of exposure to weak microwave fields. The long-term accommodations, which a[illegible] chronic exposure, can lead to a number of [illegible] ing effects some of which are described [illegible]. Two fundamentally different types of experimental protocol were employed. In Experiment IA, independent groups of male rats were either exposed [illegible] posed to 915 MHz microwaves for 10 hr/night [illegible] to 4 mo. In Experiment IB, independent [illegible] rats were similarly exposed, or sham-exposed, to 2450-MHz microwaves for 10 hr/night for [illegible] mo. In Experiment II, using a different [illegible] pregnant female rats were exposed for [illegible] 19 days of gestation. Control groups were either sham-exposed or served as caged controls. The major focus of the study attended to assessment of [illegible] functions and the developmental status of the offspring rats' progeny.

[illegible] REVIEW OF THE CURRENT STAT[illegible] [illegible] RESEARCH [illegible] AND KNOWLEDGE CONCERNING THE [illegible] RADIOWAVES AND [illegible] WAVES. [illegible] Physics, [illegible] [illegible] New York [illegible] Sep 82. Contract No. AF[illegible] [available through NTIS, Springfield, VA [illegible] Document No. AD-A[illegible]

[illegible] being carried [illegible] vari[illegible] concerning the possible [illegible] of radiowaves and microwaves. [illegible] the safety limits [illegible] exposure to [illegible] in various [illegible] countries.

[illegible] WAVES AND HUMAN [illegible] Medicine [illegible] S.-F.; [illegible] Aerospace Medicine, Brooks [illegible] Contract [illegible] [available through [illegible] VA 22161. Document No. [illegible]

[illegible] exposure [illegible] even exceed[illegible] safety [illegible] No effects [illegible] function of human [illegible] from exposure to micro[illegible] absorption rate [illegible] contrast to the results of similar st[illegible] the results were highly [illegible] provided no evidence that current [illegible] inappropriate [illegible]

[illegible] EFFECTS [illegible] WAVES ON [illegible] [illegible] Aero[illegible] Administration, Washington, DC. [illegible] available through NTIS, Springfield, VA [illegible] Document No. [illegible]

[illegible] thermal [illegible] using [illegible]

[illegible] being determined from [illegible] evaluation values of water in a plast[illegible] In [illegible] rats the body temper[illegible] [illegible] higher [illegible] heat or microwave radiation. No [illegible] rise in the brain, compared with the [illegible] ture, was observed. Anesthetized [illegible] animals showed an accelerat[illegible] tory rate as the body temperature increased. At microwave intensites over 3[illegible] mw [illegible] temperature rose.

[illegible] ANNUAL REPORT OF THE [illegible] CAL EFFECTS, BUREAU [illegible] HEALTH, FISCAL YEAR 198[illegible], October [illegible], 198[illegible] [illegible] 30, 1981. (Eng.) National Center [illegible] [illegible] health (Rockville, MD). [illegible] FDA [illegible]; FDA/NCDRH-[illegible] [illegible] through NTIS, Springfield, VA [illegible] No. [illegible]; see also PB8[illegible]

The Division of Biological Effects [illegible] Risk Assessment [illegible] epidemiologic and experimental [illegible] biological effects of exposure [illegible] radiation, magnetic fields, and [illegible] emphasis [illegible] This report [illegible] progress during Fiscal Year 198[illegible] [illegible] mural and extramural epidemiological studies, [illegible] tory investigations, and critical reviews [illegible] erature, the Division studies [illegible] health effects resulting from exposure to [illegible] and studies and develops techniques for [illegible] ment of energy distribution in biological tissues in order to provide quantitative dose-effect [illegible] mation. The responsibility for risk assessment [illegible] the development of scientifically-based biological criteria in support of exposure standards, perform[illegible] ance standards, and voluntary guidelines [illegible] radiation emission and radiati[illegible] [illegible] marily within the Division.

[illegible] POTENTIAL HUMAN [illegible] NON-IONIZING (RADIOFRE[illegible] RADIATION [illegible] EFFECTS. (Eng.) [illegible] ociates, Inc., McLean, VA [illegible] by Health Effects Research Lab., EPA, R[illegible] angle Park, NC. Report No. [illegible] 82. Contract No. EPA-[illegible] through NTIS, Springfield, VA [illegible] PB83-1[illegible] p., 1982.

[illegible] particular [illegible] the health [illegible] [illegible] lations of [illegible]

occupations and applications of radio frequency radiation (RFR) were identified and evaluated for their suitability for further study. Three populations were eliminated early in the study because adequate exposure to RFR was not evident or data necessary for epidemiological research were unavailable. Eight populations were evaluated in detail and appear to satisfy many of the criteria for epidemiological research and could be useful study groups in an investigation of the health effects of nonionizing radiation. The eight potential study populations are: RF heat sealer operators, high frequency tube welder operators, medical diathermy operators in Veterans Administration hospitals, medical diathermy operators in rehabilitation facilities, school children located near broadcasting towers, state policemen, security guards, and radar technicians.

077o EFFECTS OF ELECTROMAGNETIC RADIATION ON CALCIUM IN THE BRAIN (TECHNICAL REPORT). (Eng.) Greengard, P. (Southeastern Center for Electrical Engineering Education, Inc., St. Cloud, FL); Douglas, W. W.; Nairn, A. C.; Nestler, E. J.; Ritchie, J. M. Prepared in cooperation with Yale Univ. New Haven, CT, Dept. of Pharmacology. Report No. SAM-REVIEW-2-82, Jul 82. Contract No. F33615-78-D-0617; 7757; 01. [available through NTIS, Springfield, VA 22161, Document No. AD-B066 872/3]; 117 p.; 1982.

Electromagnetic radiation has been reported to alter several aspects of nervous system function. Authors have claimed effects of radiation on calcium efflux from nervous tissue, on thermoregulation, on the blood-brain barrier, and on several other aspects of brain function, including behavioral, electrophysiological, and neurochemical processes. In most cases, either the results of these studies cannot be confirmed by other investigators or the biological significance of the results is unclear. Most (but not all) investigators accept that radiation alters the efflux of calcium from nervous tissue. But even accepting the validity of these findings, one is left with little indication as to what the results mean for the overall role of the central nervous system. Despite the plethora of studies that demonstrate radiation effects on the blood-brain barrier, the available evidence, together, indicates that permeability of the barrier remains intact except when the exposure involves very high power densities which cause thermal damage.

077z PRELIMINARY STUDY OF [illegible] BEHAVIORAL AND BIOLOGICAL EFFECTS OF HIGH INTENSITY 60 Hz ELECTRIC FIELDS (INTERIM TECHNICAL REPORT). (Eng.) Frankenhaeuser, G. S.; Southwest Research Inst., San Antonio, TX; [illegible], J. [illegible]; Smith, W. [illegible], [illegible], [illegible]. Sponsored by Dept. Energy, Washington, DC. Report No. AFRL-[illegible]; [illegible]. Contract No. AC04-[illegible]. [available through NTIS, Springfield, VA 22161, [illegible]; [illegible] p., 19[illegible].

Increasingly higher voltages for [illegible] and transmission lines are currently [illegible]. The increased efficiency of such lines, [illegible] with increases in the cost of electric, will [illegible] ultra-high voltage lines a necessity. The serious question arises of what effects the high intensity electric fields will have on living organisms. The objective of the preliminary study (Phase I) is to develop and thoroughly test the apparatus and experimental procedures which are planned for a second study (Phase II) which will begin when the preliminary study is complete. The experiments in Phase I were not intended to produce scientifically valid results. The results should be considered preliminary and potentially useful in planning Phase II. In Phase I a group of six individual subjects and a group of four social subjects were placed in the exposure facility. An initial pre-exposure period was allowed data to be gathered for [illegible] before any electric fields were turned [illegible] similar (post-exposure) period followed the exposure period. For the first experimental group, the exposure period was a 5-wk period during which data were gathered on 23 days. The exposures in [illegible] the preliminary study were to 30 kV/m [illegible] fields.

077s EFFECTS OF MAGNETIC FIELDS ON STEELHEAD TROUT (SALMO GAIRDNERI (CONFERENCE PROCEEDING). (Eng.) Strand, J. A. (Battelle Pacific Northwest Labs., Richland, WA); Abernethy, C. S.; Seaman, J. A.; Genoway, R. G. Sponsored by Dept. Energy, Washington, DC. Report No. PNL-SA-9[illegible]; CONF-[illegible], Jul 81. Contract No. AC06-[illegible]. [available through NTIS, Springfield, VA 22161, [illegible] PNL-[illegible] p.; 1981.

Initial studies conducted at this laboratory (Strand et al., 1981) suggested that fertility of trout eggs would be affected by magnetic fields of 1 Tesla. Additional studies were performed to confirm these results and to examine the relative susceptibility of egg and sperm to magnetic fields. Preliminary results and their interpretation are presented. [illegible] additional information [illegible] Wash. Acad., Volume 51, Number 1, Abstract No. [illegible]

[illegible] BIOLOGICAL EFFECTS [illegible] FIELDS. (Eng.) Seitz-Stein, E. [illegible] Lawrence Berkeley Lab., Univ. California, Berkeley, [illegible] Sponsored by Dept. Energy, Washington, [illegible]

1978.

Research conducted during the contracting period has involved a continuation of an investigation of the in vivo effects of exposure of Dutch rabbits to electromagnetic pulsed (EMP) fields and an in vitro study of the effects of transient electrical and electromagnetic fields on biomembranes. Phenomenological studies of the effects of EMP exposure of Dutch rabbits have been undertaken in an attempt to characterize the nature of the alterations induced by such fields, whereas the biomembrane studies have been directed toward a mechanistic understanding of field-induced alterations in biological model systems.

0783 INVESTIGATION OF THE BIOLOGICAL EFFECTS OF PULSED ELECTRICAL FIELDS (ANNUAL PROGRESS REPT. NO. 2, 1 Feb 76 - 30 Jan 77). (Eng.) Cleary, S. F. (Dept. Biophysics, Virginia Commonwealth Univ., Richmond, VA 23298); Hoffman, R.; Liu, L. Contract No. N00014-75-C-0334. [available through NTIS, Springfield, VA 22161, Document No. AD-A091 813/6]:74p.; 1977.

The investigation of the effects of pulsed electrical fields on mammalian erythrocytes indicates that such fields produce transient pores or channels in the cell membrane as evidenced by the release of intercellular potassium ions and hemoglobin (and perhaps other intracellular protein molecules). The release has been found to be strongly dependent upon the duration of the electric field pulse as well as the amplitude of the electric field. Significant intracellular potassium release occurs under exposure conditions that do not result in release of protein molecules, suggesting that the size of the induced pore is dependent upon the induced field strength and the duration of the field. The mechanism of dielectric breakdown of cell membranes does not adequately account for these results. The results of studies of the relationship of field strength and pulse duration for the rupture of an artificial bilayer lipid membrane (oxidized cholesterol) indicate a dependency on the pulse duration that is consistent with the effects upon cell membrane permeability. The in vivo studies have involved the exposure to Dutch rabbits to repetitively pulsed electromagnetic fields in an EMP simulator. Such exposure has not been found to result in significant alterations in a number of physiological response variables including the duration of drug induced sleeping time and serum chemistry changes, although there is some suggestion (nonstatistically significant) of a post-exposure increase in certain serum enzymes.

0784 THE EFFECTS OF C[illegible]AMINE AND M[illegible] THE ECG DURING AC[illegible]E MICROWAV[illegible] TION. (Rus.) Koldaev, V. M. (Medical [illegible] divostok, USSR). Farm Toksikol [illegible] (12 refs).

The protective effects of analeptic and nitrogen[illegible] ic drugs during acute microwave (MW) [illegible] length) irradiation were studied in random-[illegible] bino mice. The animals were subjected to [illegible] MW exposure at 37.2 J/cm^2 (for 10 min), [illegible] (for 12 min), or 75 J/cm^2 (for 20 min). Immediately after irradiation, the animals received [illegible] injection of cordiamine (25, 50, 100, or [illegible] or mesatone (5, 10, 25, 50 or 100 mg/kg). [illegible] mals were follwed up for 3 wk. The optimal [illegible] of cordiamine and mesatone that provided a [illegible] increase in the survival of MW-irradiated [illegible] 100 and 10 mg/kg, respectively. MW irradiation [illegible] duced a transient dose-dependent increase in [illegible] temperature and decrease in pulse rate of the [illegible] ECG examination showed marked elongation of the [illegible] and PQ segments in mice irradiated at 55.8 and [illegible] J/cm^2. Administration of the drugs enhanced [illegible] ization of the ECG changes induced by MW radiation.

0785 WEATHER RADARS AS A SOURCE OF [illegible] FREQUENCY ELECTROMAGNETIC FIELDS AS PROBLEMS OF ENVIRONMENTAL HYGIENE. (Rus.) [illegible] skii, Iu. D. (A. N. Marzeev Res. Inst. [illegible] Community Hygiene, A. I. Voeikov Chief Geo[illegible] Observatory, Central Aerological Observatory, [illegible] USSR); Nikitina, N. G.; Tomashevskaia, I. A.; [illegible] iavko, F. R.; Zhupakhin, K. S.; Iurmazov, [illegible] Gig Sanit (2):7-11; 1982 (7 refs).

To evaluate the potential environmental and [illegible] hazards of weather radar generating superhigh [illegible] quency (SHF) electromagnetic fields (wavelengths of 0.8, 3, 10 and 17 cm, power flux density 1-4,000uW/cm^2), random-bred albino rats were subjected to chronic 4-mo exposure to SHF fields at 115, 60, 40, 25, 10, and 5 uW/cm^2. Biological effects were estimated by behavior reactions, physical endurance, biochemical and immunological parameters. Exposure to SHF fields at [illegible] uW/cm^2 resulted in a 1.5- to 1.1-fold increase in the threshold of galvanic skin response and [illegible] decrease in physical endurance. At power densities of 40 and 25 uW/cm^2, the animals' changes in the reflex latency. Exposure to SHF fields at 115 and 60 uW/cm^2 caused inhibition of cholinesterase activity, increase in serum plasmin activity, a significant increase in urea and nitrogen levels, and a decrease in glycogen levels. SHF fields at 40 and [illegible] resulted in the increase in adrenaline [illegible] the brain and in the adrenal glands.

0787 HYGIENIC EVALUATION OF 8-mm ELECTROMAGNETIC FIELDS. (Rus.) Dumanskii, Iu. D. A. N. Marzeev Res. Inst. General and Community Hygiene, Kiev, USSR); Tomashevskaia, L. A. Gig Sanit (6):1-3; 1982 (4 refs).

The potential health hazards of 8-mm electromagnetic fields generated by weather radars were studied in albino rats. Daily exposures to EM fields were carried out at power densities (PD) of 140, 100 and 60 uW/cm^2 (12 hr/day for 4 mo). The biochemical effects of exposure were estimated by blood urea and residual nitrogen concentration, liver glycogen levels, blood cholinesterase activity, serum ceruloplasmin and transferin concentrations, and succinate dehydrogenase and cytochrome oxidase activity in liver and brain mitochondria. Exposure to PDs of 140 and 100 uW/cm^2 caused an increase in blood urea levels, inhibition of succinate dehydrogenase and cytochrome oxidase in liver mitochondria, and inhibition of blood cholinesterase. Exposure to a PD of 140 uW/cm^2 increased the residual blood nitrogen level, decreased the liver glycogen level, and increased ceruloplasmin activity. The most marked changes in biochemical parameters were observed after exposure to 140 and 100 uW/cm^2 fields for 3 and 4 mo. Exposure to the 60 uW/cm^2 field failed to induce any changes in rat metabolism.

0788 HYGIENIC EVALUTATION OF THE BIOLOGICAL EFFECTS OF NONIONIZING MICROWAVE RADIATION. (Rus.) Belokrinitskii, V. S. (A. N. Marzeev Res. Inst. General and Community Hygiene, Kiev, USSR). Gig Sanit (6):32-34; 1982 (7 refs).

The results of studies on the biological effects of centimeter-band electromagnetic (EM) radiation are summarized. A Luch-58 generator (wavelength, 12.6 cm) was used to irradiate experimental animals in an anechoic shielded chamber, at power densities ranging from 1-5 uW/cm^2 to 500 mW/cm^2. Rats exposed to low power density EM radiation (1-50 uW/cm^2) exhibited a mild increase in succinate dehydrogenase and glucose-6-phosphate dehydrogenase activity. Chronic exposure to EM radiation at 10, 25, and 50 uW/cm^2 (3 hr/day for 2 mo) resulted in dose-dependent changes in the ultrastructure of brain cells. Single exposure to EM radiation at 500 uW/cm^2 caused damage of mitochondria, endoplasmic reticulum, cell nuclei and nucleoli; the structural damage was associated with an increase in enzyme activity and enhanced synthesis of glycogen, DNA, and RNA. Single exposure of cats and dogs to EM radiation at 10 or 400-500 mW/cm^2 resulted in marked dilatation of blood arterioles, enlargement of intercellular space, marked decrease in collagen level, demyelination and vacuolization of nerve fibers, and changes in the size and shape of various cells. These findings indicate that histochemical and ultrastructural parameters are highly sensitive to EM radiation and that changes in these parameters can be used in hygienic estimation of maximum permissible levels of exposure to microwave radiation.

0788 INCIDENCE OF DIGESTIVE SYSTEM DISEASES IN WORKERS EXPOSED TO LEAD IN COMBINATION WITH SHF ELECTROMAGNETIC FIELDS. (Rus.) Titova, M. S. (Res. Inst. Industrial Hygiene & Occupational Diseases, Ukranian SSR Ministry Public Health, Kiev, USSR). Gig Sanit (9):93-94; 1982 (4 refs).

The health hazards of combined exposure to lead and superhigh frequency (SHF) electromagnetic fields were studied in workers in the electronics industry. Analysis of the incidence of digestive system disorders in workers exposed to lead vapors alone or in combination with SHF fields (dosages within or slightly greater than maximum permissible exposure levels) showed frequent lead intolerance, loss of appetite, and epigastric pain. The incidence of chronic gastritis, chronic cholecystitis, stomach ulcer, and duodenal ulcer in workers exposed to lead vapors alone was significantly greater than that in workers exposed to SHF fields alone or in combination with lead vapors. The characteristic feature of exposure to SHF fields alone was hyperacid gastric secretion, compared with hyperacidity after exposure to lead vapors alone.

0789 GENETIC HAZARDS OF MICROWAVES OF NONTHERMAL INTENSITY AND THEIR HYGIENIC ASPECTS. (Rus.) Shandala, M. G. (A. N. Marzeev Res. Inst. General and Community Hygiene, Kiev, USSR); Antipenko, E. N.; Koveshnikova, I. V.; Timchenko, O. I. Gig Sanit (10):38-41; 1982 (17 refs).

To evaluate potential genetic hazards of microwave (MW) radiation of nonthermal intensities, male random-bred albino rats were irradiated with MW generated by a Luch-58 apparatus (2,375 MHz) at power flux densities (PFD) of 10 uW/cm^2 (7 hr/day for 45 days), 50 uW/cm^2 (7 hr/day for 45 days), and 500 uW/cm^2 (single 7 hr exposure). One day after termination of exposures at 10 uW/cm^2, the animals were subjected to x-irradiation (12.9 mC/kg). On day 7 after MW and x-irradiations, the rats underwent partial hepatectomy, and the liver specimens were subjected to cytogenetic analysis. A single exposure to MW at PFD of 500 uW/cm^2 did not increase the number of cells with chromosome aberrations (16.4%, compared with 17.0% in controls). The incidence of chromosome aberrations in rats subjected to chronic MW irradiation at 10 uW/cm^2 was 2x lower than that in the controls (7.1% and 14.4%, respectively). Preliminary exposure to MW at 10 uW/cm^2 reduced the incidence of chromosome aberrations induced by x-rays. The rats subjected to chronic exposure at a PFD of 50 uW/cm^2 showed a bimodal distribution of chromosome aberrations.

radiation is characterized by deep penetration to tissues at depths of up to 9 cm; the method is used in patients with chronic inflammatory diseases of peripheral origin.

0794 EXPERIMENTAL EVALUATION OF THE USE OF LOW FREQUENCY PULSED ELECTRIC CURRENT FOR STIMULATION OF BONE REGENERATION. (Rus.) Landa, V. A. (N. N. Priorov Central Inst. Traumatology and Orthopaedics, Moscow, USSR). Ortop Travmatol Protez (2):52-57; 1982 (21 refs).

The potential use of weak electric currents to stimulate bone regeneration was studied in rabbits. An 0.5-cm segment of the radius was resected and platinum wire electrodes inserted between the bone fragments. Electric stimulation (8-10 uA, 1-sec pulses with intervals of 3 to 8 sec between the pulses) enhanced formation of the bone callus. Mineralization of the bone callus reached levels comparable to intact bone 75 days after the fracture compared with 3 mo in control animals. Radionuclide studies indicated that electric stimulation increased accumulation of [illegible] in the region of bone wound. Electron microscope examination of the callus tissue indicated enhanced cell proliferation and predominance of osteoblasts. Blood flow determinations showed enhanced blood flow velocity due to revascularization of the bone wound region. Improved blood supply was associated with increased ATP concentration, pyruvic acid levels, and redox potential.

0795 EFFECT OF WIDE-BAND MODULATED ELECTROMAGNETIC FIELDS ON WORKERS OF HIGH-FREQUENCY TELEPHONE EXCHANGES. (Bul.) Dimitrova, M. (no affiliation given); Dobrev, B.; Kirlakov, K.; Kirkov, V.; Panova, Z.; Nakova, L.; Izrael, M.; Khadzieva, L.; Todorova, L.; Kostova, M. Probl Khig (7):21-29; 1982 (3 refs).

Health hazards of radio-frequency electromagnetic fields (RF EMF) were studied in 82 workers (60.25% women, average age 35.1 yr) at an international telephone exchange. The workers were exposed to amplitude modulated or pulsed EMF with frequencies of 4 KHz to 12 MHz; the average intensities of the electric and magnetic components at the workplace were 1.6-7.7 V/m and 0.5 A/m, respectively. The maximum intensities were 29.6 V/m for the electric component and 5 A/m for the magnetic component. The workers who had an occupational exposure to RF EMF showed elevated blood pressure, headache, fatigue, irritability, hyperesthesia, neurasthenia, menstruation disorders, inhibition of neutrophil phagocytosis, a decrease in the erythrocyte count, and a decrease in serum albumin concentrations.

0796 [illegible] IN ANIMALS [illegible] Rabotnova, [illegible] (Rus.) [illegible] Biofizika, [illegible] refs).

Biological effects of short-term exposure to low-frequency low-intensity pulsed electromagnetic fields (EMF) were studied in adult and 21-mo male rabbits. The animals were irradiated with sine-modulated EMF generated by the NGPK-3m apparatus for a field intensity of 2.5-5.0 V/m, 3-msec pulses, and a total durations of exposure of 15-12 min. The effects of EMF were estimated by the changes in electrical activity of the cerebral cortex and by changes in heart rate. Electroencephalography (EEG) showed that adult rabbits assumed the 5-8-Hz modulation rhythm of EMF; the effect was less pronounced for a 1-2-Hz modulation. In contrast with adult rabbits, the EEG biopotentials in old animals did not assume the EMF modulation rhythm. Electrocardiographic [illegible] analysis showed that 1-hr exposure to 5-8-Hz EMF at intensities of 2.5-5.0 V/m resulted in a mild decrease in the heart rate. Exposure of old rabbits to 8-Hz EMF at 2.5-5.0 V/m induced extrasystoles.

0797 ANALYSIS OF FREQUENCY RELATIONS OF BIOLOGICAL EFFECTIVENESS OF A MAGNETIC FIELD IN A RANGE OF MICROPULSATION OF A GEOMAGNETIC FIELD (0.01-100 Hz). (Rus.) Makeev, V. B. (no affiliation given); Temur'iants, N. A. Probl Kosm Biol 43:116-128; 1982 (42 refs).

To evaluate biological activity of short-period oscillations of a geomagnetic field, random-bred male rats were exposed to an alternating magnetic field (AMF) generated by a NGPK-3m apparatus (intensity of 5,100, 51 and 5.1 gamma, rectangular or sine-modulated pulsed with duty factor of 0.5). Biological effects of AMF were estimated by blood cell count and the functional characteristics of peripheral blood neutrophils. The biological activity of AMF depended upon its frequency and type of modulation. Exposure to AMF at 0.02 Hz resulted a marked increase in peroxidase, alkaline phosphatase, and cationic protein concentrations, an increase in the phagocytic index, and an increase in serum gamma-globulin levels indicative of enhanced nonspecific resistance. Exposure to AMF at 8 Hz was associated with a decrease in all histochemical indices, a decrease in the phagocyte index, and a decrease in blood complement and lysozyme levels. Exposure to AMF at 0.5 Hz resulted in an increase in peroxidase activity in peripheral blood neutrophils and a concomitant decrease in cationic proteins and alkaline phosphatase levels. Opposite effects on the indices of nonspecific resistance were also observed after exposure to AMF at 9-10 Hz. The biological activity of rectangularly-modulated AMF was more pronounced

[illegible] that of sine-modulated AMF.

0798 BIOLOGICAL EFFECTIVENESS OF WEAK INFRA-LOW-FREQUENCY ELECTROMAGNETIC FIELDS. (Rus.) Temur'iants, N. A. (no affiliation given). Probl Kosm Biol 44:128-139; 1982 (20 refs).

Biological effects of infralow-frequency weak electromagnetic fields (EMF) were studied in young (3-4 mo old) and adult rabbits, in 3-wk-old puppies, and in adult dogs. The animals were exposed to 8 Hz EMF with intensities of 7, 0.7, and 0.07 V/m for a single 3-hr exposure, or for 7 x for 3 hr/day, every 3 days. Intensities of EMF corresponded to the intensity of the geomagnetic field during the period of high solar activity. The biological activity of EMF was estimated by changes in the functional state of peripheral blood neutrophils. Single exposures to EMF resulted in an increase in neutrophil size, a marked decrease in the activities of oxidases and alkaline phosphatase, and a mild decrease in glycogen levels. Analysis of the effects of chronic exposure showed two-phase changes in the cytochemical indices: a marked decrease in enzyme activities and glycogen levels after the first 3 irradiations, followed by progressive normalization of the cytochemical indices during the last 4 exposures. Puppies and young rabbits were more sensitive to EMF exposure than adult dogs and rabbits. The decrease in enzyme activity and glycogen level was more pronounced in rabbits than in dogs.

0799 PATHOLOGICAL CHARACTERISTICS OF EXPERIMENTAL MYOCARDIAL INFARCTION AFTER EXPOSURE TO LOW-FREQUENCY LOW-INTENSITY ELECTROMAGNETIC FIELDS. (Rus.) Artishchenko, V. A. (no affiliation given); Vinogradov, S. A.; Volynskii, A. M.; Perederii, V. G. Probl Kosm Biol 43:139-147; 1982 (14 refs).

The effects of low-frequency low-intensity electromagnetic fields (EMF) on pathogenesis, clinical manifestations, and healing of myocardial infarctions were studied in rabbits and guinea pigs. Myocardial infarction was induced by ligation of the left coronary artery. The animals were subjected to whole-body continuous irradiation with EMF (8 Hz, 0.8 V/m) generated by the NGPE-3m apparatus. Within 2-10 days after exposure, the animals were sacrificed, and myocardium specimens were examined histologically and histochemically. Exposure of animals with myocardial infarction to EMF resulted in more pronounced hyperemia of the perivascular and interstitial connective tissue, development of dystrophic processes in the myocardium tissue adjacent to the infarction zone, and development of fresh microcirculation foci.

0800 REACTIONS OF A BIOLOGICAL SYSTEM TO ADEQUATE WEAK LOW-FREQUENCY ELECTROMAGNETIC FIELDS. (Rus.) Kislovskii, L. D. (no affiliation given). Probl Kosm Biol [illegible]; 1982. [illegible] refs.

The mechanism of response of a biological system to weak low-frequency electromagnetic fields (EMF) are discussed. A characteristic feature of any living biological system is a highly nonlinear response to stimulus. Specific effects of weak magnetic and electric fields are associated with changes in the spatial orientation of atoms and a decrease in orientation entropy of water as a critical reaction. Weak magnetic fields have a specific effect on an excited unstable system if their intensity does not exceed a certain critical value. Cooperative effects provide for significant elongation of the duration of the excited state. Weak stimuli affect cluster structures of water, and the transition to metastable structures. These structural changes create the conditions conducive to kinetic isolation of a calcium ion with several water molecules for a time sufficient for the rearrangement of electron orbits.

0801 EFFECT OF MAGNETIC FIELDS ON RADIOSENSITIVITY OF MICE. I. EFFECT OF INFRALOW-FREQUENCY LOW INTENSITY MAGNETIC FIELDS ON SURVIVAL OF ANIMALS SUBJECTED TO WHOLE BODY X-IRRADIATION. (Rus.) Kopylov, A. N. (Life Science Faculty, M. V. Frunze State Univ., Simferopol, USSR); Zaitsev, M. A. Radiobiologiia 22(5):687-[illegible]; 1982. [illegible] refs.

The modifying effect of low-frequency magnetic fields was studied in random-bred male mice subjected to whole-body x-irradiation (5% rad/min, total dose of 750 rad). Before or after irradiation, the animals were exposed to an alternating magnetic field (AMF) at frequencies of [illegible] and 8 Hz, and intensities of 4.0% and [illegible] A/m for 3 hr. A 30-day survival rate in the animals subjected to x-ray irradiation alone was 24.8%. Exposure to AMF had a significant effect on the survival of irradiated mice. Preirradiation exposure to [illegible] Hz AMF had a radioprotective effect at both intensities (57.3% and 69.4% respectively), while 8 Hz AMF had a radioprotective effect only at [illegible] A/m (47.5%, compared with 36.0% at [illegible] A/m). Postirradiation exposure to AMF failed to provide a radioprotective effect.

0802 USE OF MATHEMATICAL MODELS FOR ANALYSIS OF ADAPTATION PROCESSES IN PERIPHERAL BLOOD. (Rus.) Antomonov, M. Iu. (A. N. Marzeev Res. Inst. General and Community Hygiene, Kiev, USSR); Gonchar, N. M. Radiobiologiia 22(4):[illegible]; 1982 (9 refs).

[illegible] low [illegible] EMF [illegible] repeated exposures [illegible] days) [illegible] effects [illegible] alkaline phos- [illegible] peripheral blood [illegible] after expo- sure. [illegible] after [illegible] expo- sures indicated that the response of peripheral blood to EMF irradiation consisted of cumulative and adaptation components. The adaptation component could be described by a differential equation of the first order.

[illegible] STANDARDIZATION OF PHYSICAL CONDITIONS IN ANALYSIS OF BIOLOGICAL EFFECTS OF ELECTROMAGNETIC FIELDS. (Rus.) Pfutzner, H. (Inst. Applied [illegible] Electrical Engineering, Technical Univ., [illegible], Austria). Soobsh Akad Nauk Gruz SSR [illegible]; 1982 (5 refs).

To improve the reproducibility of the results of experiments on biological effects of electromagnetic fields (EMF), a system of standardization of physical properties of EMF is described. Significant variability of the values of threshold intensity of an electric field (F) can be explained by measuring F as the intensity of the field of the condenser. Placing the biological material with significant conductivity and dielectric permeability in the field results in a significant decrease in the intensity of the field inside the material and a concomitant increase of the intensity of the field on its surface. For comparison of the results of different experiments, it is recommended that the following data should be included: the potential on the electrodes instead of F; the distance between the electrodes, and the size and geometrical localization of the material (for estimation of the edge effect). In the case of magnetic fields, the intensity can be assumed to be equal to that in a vacuum. The data on the magnetic fields should include their gradients, effective parameters (for sine-modulated fields), and Fourier series spectra (for nonsine-modulated fields).

[illegible] MAGNETOTHERAPY IN VARIOUS DISEASES AND INJURIES IN SPORTSMEN. (Rus.) Shepeleva, I. S. (N. N. Priorov Central Res. Inst. Traumatology and Orthopedics, USSR); Kameev, Iu. F.; Demetskaia, N. A.; Bogdanov, Iu. V.; Sliusarenko, V. G.; [illegible], V. Sh. Teor Prakt Fiz Kul't 1:56-58; 198[illegible] ([illegible] refs).

[illegible] patients [illegible] with [illegible] 20 [illegible] per [illegible]. Magnetotherapy resulted in complete [illegible] 82[illegible] patients [illegible] restoration of the [illegible]. Analysis of the [illegible] reduced [illegible]. Applications of elastic magnets resulted in normalization of the leukocyte count and erythrocyte sedimentation rate [illegible] days [illegible] after the onset of the treatment.

0805 IRRADIATION OF THE THYROID GLAND WITH DECIMETER-BAND ELECTROMAGNETIC WAVES IN THE TREATMENT OF PATIENTS WITH STOMACH AND DUODENAL ULCER. (Rus.) [illegible], V. M. (Central Inst. Balneology and Physical Therapy, Moscow, USSR); Vyrodner, F. R.; Frenkel', I. D.; [illegible], Iu. [illegible]; Ponomarev, Iu. I.; Gukhar', L. G.; [illegible]. Ter Arkh 54(10):98-10[illegible]; 1982 ([illegible] refs).

The therapeutic efficacy of irradiation of the thyroid gland with decimeter-band waves (DBW) was studied in 1[illegible] patients ([illegible]-5[illegible] yr [illegible]) with stomach or duodenal ulcers. DBW were generated by a "Romashka" apparatus (460 MHz, wave length [illegible] cm, power flux density of 12[illegible] mW/cm², [illegible] min/day, for a total of 15-20 irradiations per course). Complete healing of the ulcer was observed in 71.[illegible]% of the patients, compared with [illegible]% after conventional therapy. Remissions of [illegible] and 1.5 yr were observed in 71.5% and 4[illegible]% of the patients, respectively. DBW irradiations stimulated secretion of thyrotropin and thyroid hormones, reduced gastric juice secretion, reduced gastric acidity, increased blood lysozyme and complement levels, decreased titers of circulating antibodies against stomach and duodenal tissues, and improved gastric motility. These findings indicated that the therapeutic effect of DBW in patients with stomach and duodenal ulcers is associated with stimulation of the [illegible] system.

0806 ORGANISMS AND MAGNETIC FIELDS. (Rus.) Kholodov, Iu. A. (Inst. Higher Nervous Activity and Neurophysiology, USSR Acad. Medical Sciences, Moscow, USSR). Usp Fiziol Nauk 1[illegible]; 1982 (1[illegible] refs).

Current literature data on the biological effects of magnetic fields (MF) and on methods of [illegible] biomagnetic fields are reviewed. The [illegible] parameters of MF depend upon its [illegible].

pulse type, vector, gradient, localization, and duration of exposure. The sensitivity of an organism to MF is associated with its age, sex, and individual characteristics. Response to MF is characterized by a prolonged latent period; changes in the biological parameters of MF produce insignificant changes in response latency. Both slow and fast systems of initial sensory response were observed after exposure to superhigh frequency electromagnetic fields. The initial response to MF is followed by an overall rearrangement reaction and an adaptation reaction. An adaptation response which involved the endocrine system was observed after daily exposures of > 20 min in duration. MF-induced adaptation reactions were associated with changes in erythropoiesis, redox potentials, and cell membrane permeability. Therapeutic applications of MF are associated with increased resistance to infection, temperature exposure, and ionizing radiation. Prolonged exposure to MF induced various pathological changes. The biophysical mechanisms of MF activity can be described by changes in sodium-potassium gradient, orientation of RNA and DNA macromolecules, and polarization of the side-chains of protein molecules.

0807 AUTOALLERGIC EFFECTS OF EXPOSURE OF RATS TO SUPERHIGH FREQUENCY ELECTROMAGNETIC FIELDS AND THEIR ACTION ON THE FETUS AND OFFSPRING. (Rus.) Shandala, M. G. (A. N. Marzeev Res. Inst. General & Community Hygiene, Kiev, USSR); Vinogradov, G. I. Vestn Akad Med Nauk SSSR (10):13-16; 1982 (11 refs).

The role of immunological factors in the mechanism of hazardous effects of superhigh frequency (SHF) electromagnetic fields (EMF) was studied in pregnant Wistar rats. The animals were exposed to SHF EMF generated by a Luch-2 apparatus (500 uW/cm^2) for 7 hr/day during the entire 20-day gestation period. To evaluate the effect of autoantibodies on embryogenesis, pregnant intact rats were immunized with serum from irradiated or intact donor rats. Donor rats were irradiated at 500 uW/cm^2 for 7 hr/day for 30 days. Exposure to SHF EMF resulted in marked stimulation of autoimmune reactions; the average number of plaque-forming cells at the end of the gestation period was 7.3% compared with 1.1% in intact controls. Irradiation of pregnant females caused inhibition of immunogenesis estimated by phytohemagglutinin-induced lymphocyte blast transformation (24.6% compared with 41.7% in controls). Immunization with serum from intact rats did not affect the course of pregnancy, while immunization with serum from irradiated rats resulted in increased embryolethality and decreased viability of the offspring.

0808 CLINICAL ASPECTS OF THE EFFECT OF ALTERNATING MAGNETIC FIELDS ON POSTOPERATIVE COMPLICATIONS. (Rus.) Verzin, A. A. (Dept. Eye Diseases, Eye Microsurgery Res. Lab., N. I. Pirogov Second Medical Inst., Moscow, USSR); Kolesnikova, L. N. Vestn Oftalmol (3):56-57; 1982 (2 refs).

The therapeutic efficacy of alternating magnetic fields (AMF) was studied in 33 patients with postoperative complications following eye surgery. The patients were divided into three groups: 18 patients with hypema follwing intracapsular cataract extraction (Group 1); 11 with partial postoperative hemophthalmos(Group 2); 4 with postoperative inhibition of the cornea with blood (Group 3). Patients from Group 1 were exposed to AMF (50-80 Oe) for 5 min/session for 10 sessions while patients from Groups 2 and 3 were exposed to AMF (80-100 Oe) for 5-8 min/session. After 2 to 3 AMF applications, > 75% of the patients in Group 1 exhibited resorption of hyphema compared with 50% of the control group. All Group 2 patients showed complete restoration of corneal transparency. In Group 3, half of the patients showed resorption of the hemorrahage after 10 AFM applications versus 36.3% of the controls. AMF applications enhanced the normalization of visual acuity in patients in all 3 groups.

0809 MICROWAVE THERAPY. (Rus.) Kulesbova, Z. S. (Dept. Physical Therapy, Central Inst. Advanced Training Physicians, Moscow, USSR). Vopr Kurortol Fizioter Lech Fiz Kult 2:63-67; 1982 (no refs).

Indications for therapy with microwave (MW) radiation are outlined. Centimeter-band MW (2375 MHz, 12.6 cm) is generated by Luch-2 (20 W output power) and Luch-58-1 (150 W output power) units. Decimeter band MW (65 cm, 460 MHz) is generated by Romashka (20 W) and Volna-2 units. The duration of a single irradiation ranges from 5-10 min for Luch-2 and Romashka units to 10-20 min for Luch-58 and Volna-2 units. Patients are subjected to daily irradiations; the total number of applications per course ranges from 5 to 20. The therapeutic effect of MW radiation is associated with thermal and nonthermal actions. MW therapy is indicated for parodontosis, arthritis of the maxillo-temporal joint, inflammation of the paranasal sinuses, furunculosis, tonsilitis, chronic dermatoses, prostatitis, endocervicitis, chronic and recurrent nonspecific bronchopulmonary diseases in children, pyelonephritis in children, arthritis of the shoulder joint, osteoarthritis of the ankle joint, coxarthrosis, osteochondrosis, rheumatoid arthritis, bronchial asthma, chronic pneumonia, peptic ulcer, chronic gastritis with hyposecretion, chronic colitis, chronic adnexitis, lactation mastitis, hypertension, renovascular hypertension, vibration disease, chronic pyelonephritis, and atherosclerosis of cerebral vessels. MW therapy is contraindicated in patients with cancer, active tuberculosis, fever, hemorrhages, thyrotoxicosis, and cardiovascular insufficiency.

[illegible] EFFECT OF A CONSTANT MAGNETIC FIELD ON [illegible] OF THE CAROTID ARTERIES IN [illegible] EXPERIMENTAL STUDY. (Rus.) [illegible] Gruzinskii Nauch. Inst. Balneology and [illegible], Tbilisi, USSR). Vopr Kurortol Fizioter Lech Fiz Kult (3):15-18; 1982 (no refs).

The effects of constant magnetic fields (CMF) on resistance to asphyxia and brain anoxia were studied in 150 white rats. The head of a rat was placed between the poles of a heterogenous CMF; induction at the pole surface was 12 mTesla. In the first series of the experiment, animals were subjected to CMF exposure for 120 min/day for 4 days, followed by constriction of the carotid arteries. Brain function and its recovery were estimated by development of conditioned reflex (avoidance learning). In the second series, the animals were exposed to CMF for 4 or 10 days; the rats were placed in air-tight chambers on days 4 and 10 after exposure, and resistance to asphyxia was estimated by duration of survival. It was found that CMF improved the reproductibility of conditioned reflex in rats with cerebral anoxia. CMF also increased resistance to oxygen deficiency; duration of survival in an air-tight chamber increased significantly, after 4- and 10-day exposure, by [illegible].

[illegible] LOW-FREQUENCY PULSED MAGNETIC FIELDS IN [illegible] DISEASES. (Rus.) Pikulina, A. G.; [illegible] Kutaisskii Res. Inst. Balneology & Physical Therapy, Tbilisi, USSR); Abuladze, L. A.; Glonti, L. [illegible]; Mgeliashvili, M. N.; Urpanishvili, L. S. Vopr Kurortol Fizioter Lech Fiz Kult (3):18-21; 1982 (no refs).

The therapeutic efficacy of low-frequency alternating magnetic fields (AMF) was studied in 60 patients with arteriosclerosis obliterans and in 30 patients with osteoarthrosis deformans. A 10 kHz, [illegible] was generated by a therapeutic apparatus. The course consisted of daily irradiations of the [illegible] for 15 days. The treatment was [illegible] of the patients with arteriosclerosis obliterans. The patients showed the following [illegible]: elevation of skin temperature by 0.8-1.6 degrees; increase in the rheographic index; normalization of blood concentrations of total lipids, [illegible] and beta-lipoprotein cholesterol; improvement in the bicycle ergometry test. Examination results [illegible] clinical improvement in the patients with osteoarthrosis deformans, [illegible] pain, increased movement [illegible], and normalization of [illegible] sulfate [illegible]. The treatment was ineffective [illegible] in the [illegible] of the hip joint.

[illegible] CURRENT APPARATUS [illegible] MAGNETIC FIELDS. (Rus.) [illegible] Tbilisi Res. Inst. [illegible] Ministry of [illegible] USSR). Vopr Kurortol Fizioter Lech Fiz Kult (2):67; 1982 (no refs).

Various therapeutic apparatuses [illegible] magnetic field sources are [illegible]. The field parameters in the body depend on the magnetic field frequency, the type of [illegible], its size and shape. A magnetic field is characterized by the vector of magnetic induction, [illegible] heterogeneity of magnetic fields is characterized by the gradient of magnetic induction. The nature of the source (inductor or magnet) is the chief criterion in all devices for magnetotherapy. The Soviet industrial apparatus for low-frequency magnetotherapy, the Polius-1, consists of 1-2 inductors operated by sine-modulated or pulsed 50-Hz current. The Bulgarian apparatus, the Magnetodiaflux, consists of two solenoids operated by pulsed 50-Hz and 1 kHz currents. The Soviet portable apparatus, the Polius-1-1, consists of two solenoids generating sine-modulated 1-50 Hz magnetic fields; maximal induction at a distance of 5 cm from the center of the solenoid is at least 1 mTesla. The most widely used of permanent magnetic object applications (magnets) include the treatment of [illegible] various proctological and gynecological [illegible]. The maximum magnetic induction at the working [illegible] applicator is 35 mTesla.

[illegible] A DEVICE FOR [illegible] MATERIALS TO CONSTANT MAGNETIC [illegible]. (Rus.) Golinskaia, M. S. (Experimental [illegible], Central Inst. Balneology & Physical Therapy, Moscow, USSR); Kozlov, G. D. Vopr Kurortol Fizioter Lech Fiz Kult (3):65-66; 1982 (no refs).

A special apparatus was developed to provide [illegible] exact localization of constant magnetic fields [illegible] given body areas of small [illegible]. The device consists of 2 ferrite magnets [illegible] concentrators for the magnetic flux. The [illegible] of the magnetic field between the [illegible] changed by insertion of paper liners. Each [illegible] was in the shape of a [illegible] plate. The magnets were placed in plexiglas [illegible] attached to vertical stands. The area of the [illegible] plate of the concentrator was equal to the area of the magnet. Changes in the orientation of the field by 180 degrees affected the magnetic field distribution between the [illegible].

[illegible] REMOVAL OF [illegible] PHYSICAL [illegible] USSR Academy of Medical Sciences, Moscow. FIELD OF MECHANISM OF ACTION AND [illegible]

TIONS OF MAGNETIC FIELDS. (Rus.) Balneology & Physical Therapy Res. Council (USSR Acad. Medical Sciences). Vopr Kurortol Fizioter Lech Fiz Kult (3):68-69; 1982 (no refs).

Methodological guidelines for experimental and clinical studies have been developed to coordinate research on the biological effects of magnetic fields (MF). Reports should include the following: type of apparatus, type of MF (constant or alternating), pulse duration and frequency, applicator type and size, inductivity in mTesla, location of the applicator, duration of exposures and total number of exposures. The effects of MF should be recorded after the 1st, 5th, and 10th exposures, and following completion of the treatment. Recommendations include the use of MF with inductivity of 3-30 mTesla, a distance of 0-5 cm between the constant magnet or the inductor and the body surface, exposure duration of 10-30 min, and a total of 10-30 exposures. The biological effects studied should include hemodynamic indices, blood coagulation, hematocrit, erythrocyte sedimentation rate, cell membrane permeability for inorganic ions, free radical oxidation, membrane potential, electron paramagnetic resonance, and water structure. Therapeutic efficacy of MF should be tested in patients with acute and chronic aseptic and infectious inflammations of the locomotor apparatus, peripheral nerve diseases, vascular diseases and dystrophic skin diseases.

0815 ALL-UNION SYMPOSIUM ON PHYSICO-CHEMICAL MECHANISMS OF THE BIOLOGICAL ACTIVITY OF STATIC AND LOW-FREQUENCY ELECTROMAGNETIC FIELDS. (Rus.) Kuznetsov, A. N. (Moscow, USSR); Shtemler, V. M. Vopr Kurortol Fizioter Lech Fiz Kult (3):70; 1982 (no refs).

The agenda of the First All-Union Symposium on Physico-Chemical Mechanisms of the Biological Activity of Static and Low-Frequency Electromagnetic Fields is outlined. The symposium was held 19-20 October 1981 in Pushchino, USSR. Six reports and 18 communications were presented. The reports summarized the results of studies of the effects of electromagnetic fields on free radical biochemical reactions, liquid crystal structure of cell membranes, and ferromagnetic inclusions in biological materials. The symposium emphasized the need for further evaluation of maximum permissible levels of exposure to electromagnetic radiation.

0816 EFFICACY OF DECIMETER-BAND WAVES AND MAGNETOPHORE THERAPY IN PATIENTS WITH HYPERTENSION. (Rus.) Orzheshkovskii, V. V. (Dept. of Physical Therapy, Inst. Advanced Training for Physicians, Kiev, USSR); Chepchik, D. I.; Fastykovskii, A. S. Vrach Delo (6):[illegible]; 1982 (no refs).

Comparative therapeutic effects of [illegible] therapy and decimeter band waves [illegible] applied to [illegible] MHz, field intensity [illegible] W, 5-15 min each, 10 daily exposures per course] were studied in [illegible] hypertensive patients. [illegible] resulted in [illegible] hypotensive effect, [illegible] of beats, decrease in [illegible] pressure, improvement [illegible] therapy, [illegible] circulation [illegible] patients. [illegible] of both applicators, [illegible] therapy was [illegible] effective. Magnetophore therapy [illegible] short periods [illegible] the adverse [illegible] in [illegible] were observed shortly [illegible] of the [illegible] patients; [illegible] therapy [illegible] to [illegible] the [illegible] It was concluded that [illegible] was [illegible] effective in the treatment [illegible] the [illegible] before application.

0817 THE EFFECT OF AN ELECTRIC FIELD OF INDUSTRIAL FREQUENCY ON THE INDICES OF NATURAL IMMUNITY. (Rus.) Lobachevskii, S. A. (A. N. Marzeev Res. Inst. General & Community Hygiene, Kiev, USSR). Vrach Delo (6):[illegible]; 1982 (no refs).

The results of comprehensive studies of the effects of electromagnetic (EM) fields of industrial frequency (50 Hz) on natural immunity are reported. Chronic exposure of rabbits (10 V/m, 2 hr/day, for 2 mo) resulted in a transient decrease in blood bactericidal activity and beta-lysine levels. Exposure of male albino rats for 2 hr/day to 50 Hz EM fields with intensities of 1, 2, 5, 7, and 15 kV/m caused a transient increase in blood complement activity in animals exposed to 7 and 15 kV/m, while blood bactericidal activity in rats exposed to 5 Hz EM fields did not differ from that in controls. Exposure of human volunteers at 5 kV/m for 2 hr/day for 1 mo did not change complement and lysozyme titers. Exposures to EM fields with intensities of 10 and 15 kV/m (30 min/day with 1 hr intervals between the exposures for 10 days) resulted in slight and transient elevation of the complement titer; complement titer and blood bactericidal activity did not differ from those in controls. These findings can be used for the establishment of maximum permissible levels of exposure to 50 Hz EM fields for residential areas.

0818 MORPHOLOGICAL CHANGES IN CENTRAL NERVOUS SYSTEM NEURONS AFTER EXPERIMENTAL EXPOSURE TO CENTIMETER BAND ELECTROMAGNETIC WAVES. (Rus.) Belorfeitskii, V. S. (A. N. Marzeev Res. Inst. General & Community Hygiene, Kiev, USSR).

Vrach Delo (8):95-99; 1982 (13 refs).

The effects of centimeter band (CB) electromagnetic fields (EMF) on the morphology of central nervous system neurons were studied in dogs and cats. CBEMF were generated by a Luch-58 apparatus. The animals were exposed to CBEMF of thermal intensities (400-500 mW/cm^2); dogs were irradiated for 4 hr and cats for 1 hr. Morphological changes in the central nervous system included swelling of the neurons, displacement of the nucleus, irregular contours of cell and nuclear membranes, redistribution of chromatin, and the appearance of vacuoles. The most pronounced changes were observed in neurons from the hypothalamus, limbic area, and temporal lobe. The neurons from the sensorimotor cortex, reticular formation, brain stem, and cerebellum were least affected by CBEMF. Exposure to CBEMF caused morphological changes in the neurons from all regions of the spinal cord.

[illegible] IN RATS AFTER COMBINED EXPOSURE TO [illegible] ELECTROMAGNETIC FIELDS. [illegible], M. P. [illegible]. Functional Diagnosis, Proc. 1st. Industrial Hygiene and Occupational Diseases, Dept. Medical Radiology, Inst. for Advanced Training of Physicians, Kiev, USSR); Oderfil, F. A.; Vrach Delo (8):[illegible]; 1982 (6 refs).

The state of liver circulation was studied in 218 workers who had an occupational exposure to lead vapors and or super-high frequency electromagnetic (EM) fields. The lead levels and EM field exposures were within the maximum permissible exposure limits. The workers exposed to the EM fields alone showed a significant decrease in liver clearance, inhibition of liver excretory function, and a decrease in the accumulation capacity of liver cells. The changes in liver circulation after combined exposure to lead and EM fields were similar to those after exposure to EM alone.

0820 BRAIN AND LIVER METABOLISM AFTER EXPERIMENTAL EXPOSURE TO SHF-FIELDS OF NONTHERMAL INTENSITIES. (Rus.) Bolokrinitskii, V. S. (A. N. Marzeev Res. Inst. General & Community Hygiene, Kiev, USSR); Tomashevskaia, L. A. Vrach Delo (10): [illegible]; 1982 (20 refs).

The effects of superhigh frequency (SHF) electromagnetic fields on brain and liver metabolism were studied in albino rats. The SHF fields were generated by a Luch-58 apparatus (12.6 cm wavelength). The animals were irradiated at 50 uW/cm^2 (6 hr/day for 10 days). On day 30 after the last exposure, the rats were subjected to a single irradiation at 500 uW/cm^2. The metabolic activity of the brain and liver was estimated by [illegible] concentrations and by activities of [illegible] dehydrogenase (SDH), malate dehydrogenase (MDH), [illegible] dehydrogenase (GPDH), [illegible] SHF fields (50 uW/cm^2) [illegible] vation of SDH, MDH, GPDH, and [illegible] and hepatocytes, marked inhibition of the oxidative phosphorylation in brain and liver mitochondria, and a mild increase in DNA and RNA levels. Normalization of the histochemical and biochemical indices was observed 1-2 mo after termination of irradiation. Preliminary exposures to low intensity SHF fields increased resistance of animals to irradiation at 500 uW/cm^2.

0821 EFFECT OF LOW-INTENSITY SHF-ENERGY ON RESPIRATION AND OXIDATIVE PHOSPHORYLATION IN MITOCHONDRIA AND ACTIVITIES OF CARBON BLOOD ENZYMES. (Rus.) Rudnev, M. I. (A. N. Marzeev Res. Inst. General and Community Hygiene, Kiev, USSR); Tarasius, N. F.; Kulikova, A. P. Vrach Delo (12): 93-95, 1982 (7 refs).

The effect of a superhigh-frequency (SHF) electromagnetic field (EMF) on energy metabolism was studied in random-bred albino rats. The animals were exposed to SHF EMF generated by a Luch-58 apparatus (wavelength of 12.6 cm) at a power flux density (PFD) of 50 uW/cm^2 (6 hr/day, for 5, 10, 20, or 30 days) or of 500 uW/cm^2 (single 2-hr exposure). The metabolic changes were estimated by respiration and oxidative phosphorylation in liver and brain mitochondria and by activities of serum transaminases and alkaline phosphatase. Repeated irradiations at 50 uW/cm^2 resulted in temporary inhibition of respiration, an increase in serum aspartate aminotransferase and marked inhibition of alanine aminotransferase and alkaline transferase activities. The significant decrease in blood glucose levels on days 1 and 5 after exposure to 50 uW/cm^2 was indicative of enhanced glycolysis. Single irradiation at 500 uW/cm^2 failed to induce significant changes in liver and brain mitochondria.

0822 THE EFFECT OF A CONSTANT MAGNETIC FIELD ON EPILEPTOGENIC FOCI IN RABBIT HIPPOCAMPUS. (Rus.) Tsvin, I. I. (Medical Pediatric Inst., Leningrad, USSR). Zh Vyssh Nerv Delat [illegible]; 1982 (19 refs).

The effects of heterogeneous magnetic fields (MF) on the functional activity of the hippocampus were studied in rabbits. The animals were subjected to administration of [illegible] ml of penicillin solution into the left or right hippocampus. Penicillin injection produced marked changes in electroencephalogram activity and development of epileptogenic

discharges. Immediately after development of the epileptogenic foci, the elastic magnets were placed above the right and/or left hippocampus. The maximum induction of MF at the magnet surface was 18 or 28 mTesla, the gradient was 30 or 45 mTesla/cm, and the average induction in the area of the epileptogenic focus was 0.3 or 0.5 mTesla. Exposure to a weak heterogeneous MF produced marked stimulation of epileptogenic activity. MF enhanced the epileptogenic activity of the left hippocampus. The mechanisms of the stimulating effects of MF were associated with MF-induced hyperplasia of the glial cells, hypoxic state of brain structures, changes in glycogen metabolism, and changes in neuronal membrane permeability.

0823 ELECTRICAL AND ELECTROMAGNETIC EFFECTS ON OSTEOGENESIS AND BONE GROWTH (EDITORIAL). (Ger.) Ungethum, M. (Aeskulapwerk, Postfach 40, D-7200 Tuttlingen). Munch Med Wschr 124(26):621-622; 1982 (6 refs).

Methods of therapeutic electric osteostimulation and their evaluation are discussed. Current commercial electrical osteostimulation methods are so different in principle and design that it is impossible to evaluate them relative to one another. Electric osteostimulation seems to be indicated in the case of fractures in which repeated surgical interventions were unsuccessful. Ultrasound absorption measurement, x-raying after venography, transcutaneous measurement of the fracture potential, and double-blind methods are available for evaluating the effectiveness of electrical osteostimulation. The problem of quantitative evaluation of therapeutic effects is illustrated by the treatment of loosened total endoprostheses with purely magnetic fields, in which no radiological changes are apparent, even though subjective results suggest the effectiveness of this method. Surgery combined with electrodynamic field therapy was successful in more than 93% of 351 patients with mostly atrophic pseudarthroses of low reactivity after several unsuccessful operations. Electrical osteostimulation improves the retention of autologous spongiosa transplants.

0824 APPLICATION OF PHARMACOLOGICAL METHODS TO THE STUDY OF BIOLOGICAL EFFECTS OF MICROWAVE RADIATION DURING LOW-LEVEL IRRADIATION. (Fre.) Klein, M. J. (Div. neurophysiologie appliquee, Centre d'etudes et de recherches de medicine aerospatiale, 26, blvd. Victor, 75996 Paris Armees); Steru, L.; Milhaud, G. L.; Rosolen, S. G. Radioprotection 17(4):225-241; 1982 (34 refs).

Synergistic effects between microwave (MW) radiation and psychopharmacologic agents were investigated in 813 mice and 120 rats. Charles River mice and Wistar rats were exposed to MW power [illegible], continuous wave, 12.2 cm wave length [illegible] an industrial generator (Thomson CSF [illegible], output power) for 30 min at power densities of and 5 mW/cm². No significant difference was observed in motor activity between irradiated and control mice injected with various dosages of d-l-amphetamine sulfate or d-amphetamine sulfate immediately before exposure. MW irradiation had no effect on the incidence or severity of stereotypic events in rats receiving d-l-amphetamine sulfate or apomorphine chlorhydrate before exposure. MW irradiation either before or after administration of the convulsant agents bicuculline and cardiazol to mice had no effect on the chronology of convulsions or their average duration; thus exposure to MW did not interfere with the metabolism of the convulsants in mice. There was no evidence of blood brain barrier permeability in mice receiving oxotremorine plus methylatropine before MW irradiation. In motor activty tests in mice, irradiation at 2 mW/cm² significantly potentiated the sedating effects of a 5 mg/kg dose of chlordiazepoxide; the effect was not statistically significant at other dose levels. Although the rectal temperature of control mice was not affected by irradiation at either power level, mice with hypothermia induced by injection of oxotremorine and apomorphine had significantly higher rectal temperatures after irradiation than nonirradiated mice.

0825 IMPACT OF LOCALIZED MICROWAVE HYPERTHERMIA ON THE PH-DISTRIBUTION IN MALIGNANT TUMORS. (Ger.) Vaupel, P. (Physiologisches Inst., Univ. Mainz, Saarstrasse 21, D-6500 Mainz, W. Germany). Strahlentherapie 158(3): 168-173; 1982 (15 refs).

The effect of localized microwave (MW) hyperthermia (2.45 GHz, 43 C for 1 hr) on pH distribution in mammary adenocarcinoma was studied in 12 female C3H-SED-BH mice 10-20 days after sc tumor implantation into the lateral femoral region. Treatment was performed with a special MW applicator connected to a Raytheon magnetron (model CMD-10). Glass pH microelectrodes were used to measure pH values. The mean pH value measured in small tumors weighing [illegible] without appreciable necrosis was 6.75 (6.2-7.2) immediately before hyperthermia. Immediately after tissue temperature returned to the initial value after hyperthermia, the mean pH was 6.21 (5.7-6.9). The reduction in pH value was statistically highly significant ($2p < 0.0005$). The mean pH was 7.21 in large tumors (1.1-1.5 g) in which more than 50% of the tumor mass was necrotic. The pH values were significantly higher than in small, non-necrotic tumors, but showed inhomogeneous distribution. Hyperthermia caused no significant changes in pH in the large tumors. The findings indicate that MW hyperthermia markedly intensifies preexisting tissue acidosis, but causes no significant changes in the pH value in the case of more alkaline values.

0826 COMBINATION OF 2450 MHz-MEA AND RADIATION IN CANCER THERAPY. PART I. CLINICAL RESULTS WITH MICROWAVE-INDUCED HYPERTHERMIA. Carlo Abe, S. Sugo, Kyoto, Japan). Hiraoka, M., Jo Strahlentherapie 158(5):312-318, 1982 (11 refs).

Radiotherapy followed by 2,450 MHz mi r wave (MW) hyperthermia was used to treat 26 patients with malignant tumors refractory to radiotherapy (squamous epithelial carcinomas, adenocarcinomas, malignant melanomas, and myoblastomas). External hyperthermia using tunnel-shaped applicators was used for 22 of these: 8 had recurrent tumors after radiotherapy with total doses exceeding 5,000 rad. The radiation dose administered during the combination therapy was 2,100-4,000 rad. Each MW treatment was 2'-3' min, and the total number of fractions was 3-14 (2-5/wk). The temperature reached in the target area was 42.5-43 C. Complete remissions (CR) were achieved in 5/8 patients, partial remissions (PR) in 2/8 and no response occurred in 1/8. Total radiation doses of 1,200-7,000 rad along with 3-26 MW thermal sessions at 25-30 min each (1-5 sessions/ were given to 14 patients who were not pretreated. The temperature in the target area was also 42.5 C. CR was achieved in 7/14 patients, PR in 4/14, and 3 showed no response. Four of the 26 patients underwent radiotherapy (total dose 1,200-) with MW hyperthermia generated by intracavitary applicators. The number of MW therapy sessions was 3-11 (1-2 wk), at 30 min/session. The temperature reached in the target area was 43-46 C. CR was achieved in 1 patient and PR in 3 others.

0827 NONSURGICAL TREATMENT OF UNUNITED FRACTURES BY SPECIFIC PULSED ELECTROMAGNETIC FIELDS. (Germ.) Bassett, C. A. L. (Orthopaedic Res. Lab., Columbia Presbyterian Medical Center, Columbia Univ., New York, NY). Z Orthop 120(4):439-496; 1982 (16 refs).

Clinical and experimental results obtained by specific pulsed electromagnetic (EM) field treatment of fracture non-unions with the EBI Bi-Osteogen System are reviewed. A current of 1-1.5 mV/cm is induced in tissues and cells by the specific pulsed EM fields generated by the coils placed on the cast. The fields are applied by the patient every day for 10 hr. Interfaces and the presence of metals do not influence the results. A success rate of 77% was achieved by this treatment in 1,007 patients with fracture non-unions, including 322 with an average duration of disability of 4.7 yr. The same success rate was achieved in 126 patients with fracture non-unions after internal fixation. A success rate of 4.2 was recorded in a group of 24 cases with non-essential arthrodeses after re- [illegible] pt theses, including 18 with infec- [illegible]. A 90% success rate was also achieved in patients with [illegible] genic pseudarthroses, and the [illegible] results [illegible] [illegible] tests are also [illegible] [illegible] re- tion during [illegible] fracture site and after [illegible] months. Clinical studies [illegible] healing of large fractures [illegible] treatment. No treatment had [illegible] osteotomies in dogs treated [illegible] Female beagles with [illegible] ey were treated with specific pulsed EM fields. [illegible] diologically earliest [illegible] phatase activity in the region [illegible] mineralization of the fibrous [illegible] vascularization were observed after [illegible] days.

0828 ON THE PROBLEM OF THE HAZARDS OF NONIONIZING RADIATION - MICROWAVES, LASERS. [illegible] Florian, H. J. (Inn. Medizin & Arbeitsmedizin, Bundeswehrkrankenhaus [illegible] Munchen 22, W. [illegible] Arbeitsmedizin [illegible] beitsschutz [illegible]

The health hazards of microwave (MW) radiation and related safety standards are reviewed. The depth of penetration and absorption rate of MW are frequency-dependent. The absorption rate is nearly 100% in the 1-3 GHz range in which most radar equipment operates. The safety standard established on the basis of the thermal effect of MW radiation is 10 mW/cm^2, which corresponds to an increase in body temperature during exposure [illegible] of a body surface of [illegible] cm^2 with [illegible]. Experiments of the crystalline lens and of the testicles are most relevant medically in connection with [illegible] body irradiation. Transient infertility was observed after exposure of testicular tissue to MW energy at densities above [illegible] mW/cm^2. Development of cataract was observed in persons exposed occupationally to MW periodically for several hours at levels exceeding [illegible] mW/cm^2. However, extensive [illegible] studies on exposed military and civilian personnel failed to show any increase in the [illegible] cataracts whose age and sex as well as systemic risk factors (metabolic disorders, [illegible], drugs) were taken into account. At [illegible] > 10 mW/cm^2 at an exposure [illegible] can be considered to be the [illegible] cataract formation in the frequency range [illegible] 10 GHz, as determined in rabbits. The [illegible] temperature of the media of the eye can be considered to be ≥ 45 C. The [illegible] psychovegetative effects [illegible] blood pressure and blood picture, and decrease in performance. However, there is no justification for lowering the safety standard on the [illegible] of such long-term, low-level effects, even if [illegible] studies are [illegible]. The energy flux density of 10 mW/cm^2 [illegible] for 1-3 hr should not exceed [illegible], according to [illegible].

829 TECHNICAL ASPECTS OF HEAT DELIVERY (MEETING ABSTRACT). (Eng.) Hand, J. W. (MRC Cyclotron Unit, Hammersmith Hosp., London W12, England). Br J Radiol 55(660):941; 1982.

The use of non-ionizing electromagnetic waves (microwaves and radiofrequency) and ultrasound to induce hyperthermia in patients was briefly reviewed. The advantages and disadvantages of a number of techniques were explained through reference to simple physical considerations. The techniques discussed included aperture microwave (MW) sources, interstitial and intracavitary MW sources, localized current fields, interstitial ferromagnetic seeds, capacitive coupling of radiofrequency (RF), inductive coupling of RF and focused ultrasound. The problems associated with heating deep tissues were also addressed, with an emphasis on those techniques commercially available. The availability of non-perturbing thermometers was discussed. Until the advent of suitable non-invasive thermometry, information concerning temperature distributions achieved during therapy will be acquired through a necessarily small number of invasive thermometers. The implications of this limitation in thermal dosimetry for the effectiveness of hyperthermal treatments were outlined.

830 MICROWAVE RADIATION EXPOSURE INDUCES TRANSLOCATIONS AND UNIVALENTS DURING *SPERMATOGENESIS IN MICE (MEETING ABSTRACT).* (Eng.) Mankowska-Czerski, E. (Bureau Radiological Health, FDA, HHS, 5600 Fishers Lane, Rockville, MD). J Cell Biol 95(2):A301; 1982 (1 ref).

In attempts to clarify inconsistent and contradictory results from dominant lethal testing of microwave exposed rodents, cells were examined from testes of mice. For examination, cells were prepared with a modified Meredith technique. Irradiations were at frequencies of 0.915, 2.45, and 9.4 GHz, continuous wave, and 9.4 GHz pulsed, with whole body average absorbed dose rates of 0.35, 0.5, 1, 5, 10, and 20 mW/g. Spermatogonial and spermatocyte I and II metaphases were counted and examined for chromosomal abnormalities. Metaphase numbers decreased below control values at low dose rates, and increased at high dose rates. A dose rate dependent increase in translocations was observed. The incidence of unfivalency increased at 10 and 20 mW/g. The findings are interpreted to indicate interference with normal spermatogenesis during late spermatogonial and spermatocyte prophase I stages. Further, inheritance of the chromosomal changes seems a possibility.

831 PULSING ELECTROMAGNETIC FIELDS ALTER CELLULAR REGULATORY PROCESSES (MEETING ABSTRACT). (Eng.) Goodman, R. (Dept. Path., Col. P&S, Columbia Univ., College of Physicians & Surgeons, 630 W. 168th St., New York, NY); Bassett, C. A. L. (Research Corp., 1 Bridge St., Irvington, NY). J Cell Biol 95(2):A474; 1982.

The functional and temporal pattern of general cellular metabolism can be altered by changes in the electrical environment. It was hypothesized that exogenously administered pulsed electromagnetic fields (PEMFs) can be used to trigger prescribed cellular responses. This has been tested in a study of pattern alterations in specific cellular events in the polytene salivary gland chromosomes of the dipteran Sciara coprophila. The experimental design uses both cytological and biochemical methods to follow alterations in the pattern of genetic activity resulting from the use of PEMFs alone or in combination with hormonal induction of puffs, heat shock and variation in the ionic environment. Alterations in transcription and translation were monitored by sucrose gradient centrifugation, gel electrophoresis, cytological nick-translation and transcription autoradiogram. Specifically, both repetitive single pulse (RSP) and repetitive pulse burst (RPB) induced alterations in transcriptional events up to 60 min. The effect of RPB is an increase in RNA synthesis in all size classes following 45 min of pulse. RSP, however, induced a biphasic increase in the specific activity of mRNA at 15 and 45 min of pulse. This is reflected in the protein synthetic pattern. The results suggest that the two signals evoke distinctly different cellular responses. Induction is influenced by the type of pulse as well as the cellular environment. The recognition of mediating factors in the use of PEMFs should allow us to define more specifically the role of electrical fields in the normal function of the cell.

832 RADIOFREQUENCY HAZARDS IN THE VLF TO MF BAND (MEETING ABSTRACT). (Eng.) Gandhi, O. P. (Dept. Electrical Engineering, Univ. Utah, Salt Lake City, UT 84112); Chatterjee, I. J Microwave Power 17(4):323; 1982.

The paper gives the currents that can flow through a human body for conditions of conductive contact with ungrounded metallic objects such as cars, trucks, fences, etc. These are then compared to the threshold currents for perception and let go, for frequencies in the 10 KHz - 10 MHz range, deriving thereby the incident electric field intensities for these phenomena to occur. It is shown that the ANSI proposed guideline of 100 mW/cm² (approximately 615 V/m) in the frequency band 3 KHz - 3 MHz may result in a potential for radiofrequency burns for conditions of conductive contact with these commonly encountered metallic objects.

[illegible] Electrical Protection, Paris, [illegible]. Microwave Power [illegible].

Many of the diagnostic EMF techniques have recently been applied to fetal medical diagnosis, and efforts are underway to develop them for clinical use. These include impedance plethysmography, microwave (MW) methods for lung water measurements, radioactive techniques, and EM flow meters. Other methods such as the use of MW Doppler radar to monitor arterial wall movements, and EM imaging are in preliminary research stages and still need to be developed. In this paper, we describe the principles underlying the operation of each method and present important results illustrating the advantages and limitations of each method. In most cases it will be noted that, while the EM diagnostic are attractive and promising, much more work still needs to be done before these method become suitable for [illegible] clinical use.

0836 SOME COMMENTS ON THE SAFE LIMITS OF EXPOSURE TO 60-Hz ELECTRIC FIELDS (MEETING ABSTRACT). (Eng.) Bridges, J. E. (EIT Res. Inst., 1 West 35th St., Chicago, IL 60616). IEEE Microwave Power [illegible]:323-324; 1982.

The thrust of programs to determine the safe limits of exposure to electric fields, principally 60-Hz fields, is examined. The major difficulty has been that the effects of 60-Hz electric field exposure are weak and very likely to be overshadowed by other competing factors which are reviewed. Elimination of these factors can lead to long and costly experiments. Since definitive answers to many biological effects may be some time off, some useful interim conclusions can be drawn by comparing human exposures to fields which are routinely experienced in the home and in industrial settings. This approach could be strengthened by making extensive measurements of the household and industrial electric field environments and resulting body currents. Computer aided studies, followed by laboratory verification in animal models, to develop the spatial distribution of body current could also be used to determine comparative exposure levels arising from power-line or household environments.

0835 PULSATING ELECTROMAGNETICALLY INDUCED CURRENTS HAVE ANTI-TUMOR ACTIVITY IN VIVO (MEETING ABSTRACT). (Eng.) Norton, L. (Mount Sinai Sch. Medicine, New York, NY 10029); Tansman, L. S.; Popelsou, W.; Geller, S.; Pilla, A. A. IEEE Electron Dev. Soc. 12(93):132C; 1982.

[illegible] cell membrane, [illegible] tion chemotherapy. [illegible] of PEMC with [illegible] Mice were treated [illegible] tween 60 and 70 Hertz. The results showed that the median survival time [illegible] creased by PEMC or PEMC and PEAN as compared to controls. However, a synergistic response, i.e. prolonged survival time to [illegible] mice treated with PEMC and PEAN. These results provide evidence for an effective and nontoxic anticancer modality. Histological characteristics for PEMC exposed tumors, suggesting a mechanism of synergy with the macrophage and NK-cell stimulating PEAN.

0836 EFFECTS OF MODULATED AND PULSED ELECTROMAGNETIC RADIATION ON THE EFFLUX OF CALCIUM IONS WITH BRAIN TISSUE IN VITRO (MEETING ABSTRACT). (Eng.) Blackman, C. F. (Experimental Biology Div., MD-74, Health Effects Res. Lab., EPA, Research Triangle Park, NC 27711). [illegible] Chem Soc [illegible]:420; 1982.

Radiofrequency radiation at [illegible] MHz, [illegible] ulated at brain-like [illegible] caused changes in the rate of efflux [illegible] ed calcium ions from [illegible] However, only specific [illegible] radiation are effective. Experiments [illegible] lated 50-MHz radiation produce similar [illegible] identical findings. The results at different carrier frequencies can be reconciled if the fundamental variable is taken to be the intensity of the electric field within the tissue rather than the intensity of the electric field in free space.

0837 AN ELECTROMAGNETIC FIELDS ANALYSIS OF THE HELMHOLTZ COIL DELIVERY FOR BIOLOGICAL STUDIES (MEETING ABSTRACT). (Eng.) McLeod, B. R. (Dept. Electrical Engineering & Computer Science, Montana State Univ., Bozeman, MT 59717); Sances, A., Jr.; Pilla, A. A. IEEE Electrochemical Soc. [illegible] 1982; 104-2.

Helmholtz coils that are being used to induce currents in biological systems are examined. The well-known but complex fields and the associated graphical term for easy reference. An analysis is also done on an in vitro system in the near-field region of the coils. Associated experimental data are presented and compared. Special attention directed at the [illegible]

perturbation given to a living cell by the Helmholtz coils.

0838 EFFECTS OF ELECTROMAGNETIC FIELDS ON THE CELL SURFACE (MEETING ABSTRACT). (Eng.) Marron, M. T. (Biomedical Res. Inst., Univ. Wisconsin-Parkside, Kenosha, WI 53141); Goodman, E. M.; Greenebaum, B.; Luzander, S. J Electrochem Soc 129(3):133C; 1982.

Effects on the cell surface of Physarum polycephalum amoebae grown in 60 Hz sinusoidal field of 1.0 V m and 1.0 G can be detected using aqueous two-phase partition chromatography. We report the first direct observation of cell surface effects due to weak, low frequency electromagnetic fields.

0839 THE EFFECT OF PULSING ELECTROMAGNETIC FIELDS (PEMFs) ON RNA TRANSCRIPTION IN POLYTENE CHROMOSOMES (MEETING ABSTRACT). (Eng.) Goodman, R. (Dept. Pathology, Columbia Univ., New York, NY 10032); Henderson, A. S.; Bassett, C. A. L. J Electrochem Soc 129(3):133C; 1982.

Using tritiated uridine incorporation to monitor transcription, RNA was extracted from control and PEMF-treated (single pulse and pulse train) salivary gland cells at 15 min intervals up to 2 hr. Cytologically transcription was monitored by transcription autoradiographically. Biochemically PEMFs induced a marked increase in the specific activity of RNA: (i) the single pulse induces increased specific activity of presumptive messenger RNA (6S-17S) at 15 and 45 min; (ii) the pulse train induces one peak of activity at 45 min in the 18S region; (iii) following peaks in RNA activity induced by PEMFs, fall-off in transcription is sharp and after 60 min, and more prolonged PEMF treatment, specific activities fall below control levels; (iv) the effect of sudden elevated temperature (heat shock) and PEMF together produce a synergistic effect; and (v) by taking the cells in and out of the field, it is apparent that the reduced rate of transcription resulting from long time periods in PEMFs can be reversed. Studies on this rebound effect are discussed.

0840 THE EFFECT OF PULSATING ELECTROMAGNETIC FIELDS (PEMF) ON OSTEOBLAST-LIKE CELLS IN CULTURE (MEETING ABSTRACT). (Eng.) Rodan, G. A. (Dept. Oral Biology, Univ. Connecticut Sch. Dental Medicine, Farmington, CT 06032); Johnson, D. E. J Electrochem Soc 129(3):133C; 1982.

The object of this investigation was to study the mechanism through which PEMF promotes fracture healing. In this study we report the establishment of an experimental system in which PEMF elicits reproducible effects on osteoblast-like cells in culture. Under growth restrictive conditions (in early cultures and at confluence), PEMF stimulates proliferation. This effect is associated with a postponement of phenotypic maturation, as measured by alkaline phosphatase levels. The PEMF effects were proportional to the repetition rate of PEMF in the range of 5-25 Hz. The time course and the pleiotypic nature of PEMF effects are similar to hormone effects in this system.

0841 EFFECTS OF INDUCED ELECTROMAGNETIC FIELDS ON THE HORMONAL RESPONSES OF BONE AND BONE CELLS IN VITRO (MEETING ABSTRACT). (Eng.) Luben, R. A. (Div. Biomedical Sciences, Univ. California, Riverside, CA 92521); Cain, C. D. J Electrochem Soc 129(3):133C; 1982.

The effects of pulsed electromagnetic fields on bone healing are well known. However, the molecular and cellular actions of these fields remain obscure. The current study examined the effects of clinically useful fields on bone and bone cells in tissue culture. Exposure of cells to Bio-stim gen™ fields produced significant inhibition of several biochemical responses to parathyroid hormone (PTH), suggestion that some or all of the in vivo actions of the fields may be mediated by blocking the osteolytic effects of PTH in localized areas. Studies were also performed to examine the role of the fields in stimulating differentiation of precursor cells into osteoblasts. Further results are discussed.

0842 PULSED ELECTROMAGNETIC FIELD EFFECTS CHONDROBLAST CULTURE (MEETING ABSTRACT). (Eng.) Norton, L. A. (Univ. Connecticut Health Center, Sch. Dental Medicine, Farmington, CT 06032). J Electrochem Soc 129(3):133C; 1982.

Changes in products of differentiation were measured in cultured chondroblasts exposed to a pulsed electromagnetic field (PEMF) for 48 hr. Relative to control groups, PEMF cultures had a decreased glycosaminoglycan, and increased DNA and a changed hydroxyproline content per dish. The lysozyme activity increased 2x, the hyaluronic acid in the medium increased, while the total protein in the cultures decreased. Chitotriose, a specific lysozyme inhibitor, abolished the PEMF effects. Addition of exogenous lysozyme augments the effects. Increase in lysozyme activity in the presence of PEMF was seen when cycloheximide was added to the culture. Thus, lysozyme appears to be

at 2, 5, 7, and 15 Hz, and depressed at 1 Hz with respect to the controls.

0848 ALTERED BIOLOGICAL RESPONSES IN PARAMECIUM INDUCED BY 60-Hz PULSATING CURRENT (MEETING ABSTRACT). (Eng.) Smith-Sonneborn, J. (Dept. Zool. & Physiol., Univ. Wyoming, Laramie, WY 82071); Pilla, A. A. J Electrochem Soc 129(6):1420; 1982.

The biological response of the single-celled organism Paramecium to specific pulsating current was monitored with respect to longevity and length of cell cycle. Paramecium are eukaryotic protozoan cells which can be viewed as excitable cells capable of generating receptor and action potentials in response to proper electrical, mechanical, or chemical stimuli. Clonal aging in Paramecium provides a model system of cellular senescence which exhibits a species-specific number of cell divisions since the previous fertilization. Cells cultivated continuously in pulsating currents showed significantly ($P < 0.05$) increased survival relative to controls in response to current signals. The induced voltage was obtained using air-gap coils driven by a programmable power supply (Electro-biology Corp., Fairfield, NJ). The length of the cell cycle was found to be modulated in response to specific pulsating current and was a function of current density.

0849 A CELL ELECTRICAL SIMULATION ACCOUNTING FOR IONS TRANSPORT AND ABSORPTION PROCESSES (MEETING ABSTRACT). (Eng.) Drago, G. P. (Istituto Circuiti Elettronici-C.N.R. No. 5 Genoa, Italy); Marchesi, M.; Ridella, S. J Electrochem Soc 129(3):1320; 1982.

A multilayer spherical structure, simulating a cell, is studied under the influence of an alternate electric field. Refining previous works, the cell membrane and the cell nucleus are simulated accounting for ion fluxes and binding processes under linear hypothesis. The parameters of the model are obtained from data of experimental origin. The main quantities of physical and biological interest and their transfer functions, with respect to the external electric field, are computed within each layer. Many of these quantities present multimodal behaviors against the frequency, sometimes with strong maxima of particular interest (e.g. ion concentrations and fluxes).

0850 ELECTRIC FIELD MEDIATED ION TRANSPORT (MEETING ABSTRACT). (Eng.) Seto, Y. I. (Electrochem. & Biophysics Res. Lab., Nat. Electrical Engineering, Tulane Univ., New Orleans, LA [illegible]; Osteryoung, R. A. J Electrochem Soc 129(6):1320; 1982.

The effect of electric field perturbation on the transcellular transport of ions has been analyzed. The analysis reveals that periodic step carrier electric field may enhance or retard the ion transport depending on the intrinsic system parameters such as the diffusion resistance and ion turnover rate. The theoretical results also present some potential applications of electric fields in the kinetics of pharmacokinetic and localized enzyme systems.

0851 ON-LINE SYSTEM IDENTIFICATION AND EQUIVALENT CIRCUIT MODELING OF BIOELECTROCHEMICAL KINETIC PARAMETERS (MEETING ABSTRACT). (Eng.) Cerri, G. (Dept. Physiology, Coll. Physicians and Surgeons, Columbia Univ., New York, NY 10032); Pilla, A. A. J Electrochem Soc 129(6):1320; 1982.

The identification and estimation of the functional parameters in biological cell response to applied electrochemical stimuli has figured significantly in optimizing electromagnetically induced pulsed signals for clinical use. As it has been demonstrated that biological systems respond to stimuli of specific frequencies and amplitude, it is critical to accurately determine the time constants of cellular transient response. An on-line measurement and analysis technique has therefore been developed to resolve impedance data from 0-10 MHz. The existing frequency domain technique based on the Laplace transform has been replaced by a nonlinear optimization algorithm and results have been obtained for amphibian epithelium and the human red blood cell.

0852 OCULAR CHANGES INDUCED BY MICROWAVE DIATHERMY IN THE RABBIT (MEETING ABSTRACT). (Eng.) Miki, H. (Dept. Ophthalmology, Kansai Medical Univ., Japan); Doi, H.; Miki, K.; Okada, H. Jpn J Ophthalmol 26(1):135; 1982.

An apparatus for microwave (MW) coagulation was developed that emits pulse radiation with 2450 ± 50 Hz and 0-300 W. The rabbit eye was irradiated under various conditions and the ocular changes were studied clinically and histologically. After irradiation with 30 W for 5-30 min, no particular change was noted. After irradiation with 50 W for 6-10 min, a slight cataract developed, and about 1 mo later the cataract was absorbed; subsequently the eye became shrunken. Destructive effects were mainly on the iris, ciliary body and lens, and the

[illegible] normal tissues. [illegible] the eye was [illegible], the [illegible] and the whole ocular tissue [illegible]. The MW scattering method may be useful for [illegible] ocular disease if appropriate energy [illegible] rate of use.

[illegible] IMMUNITY OF JUVENILE AND ADULT JAPANESE [illegible] EXPOSED TO MICROWAVE RADIATION DURING EMBRYOGENY (MEETING ABSTRACT). (Eng.) Thaxton, J. P. (Dept. Poultry Science, North Carolina State Univ., Raleigh, NC 27650); Galvin, M. J.; McRee, D. I. Poult Sci [illegible]; 1982.

Fertile Japanese quail eggs were exposed to 2.45 GHz continuous wave microwave radiation for the first [illegible] days of embryonation. Exposed and non-exposed quail of both sexes were reared to either 8-, 12-, or 20-wk of age. At these times quail were evaluated for humoral immune responsiveness to sheep red blood cells, delayed hypersensitivity to phytohemagglutinin, and total and absolute circulating levels of leukocytes. All parameters were equivalent in exposed and non-exposed controls at [illegible] wk of age. However, at 12- and 20-wk of age, delayed hypersensitivity was reduced in exposed quail, and total and absolute leukocyte numbers were increased in exposed females. Possible sex hormone and age dependent influences on immune responsiveness are feasible explanations of these results.

[illegible]52 EFFECTS OF MICROWAVE HYPERTHERMIA ON THE UPTAKE OF MISONIDAZOLE BY TUMOR TISSUE IN VIVO (MEETING ABSTRACT). (Eng.) Neubert, S. (New York Univ., New York, NY 10003); Goldfeder, A. Proc Annu Meet Am Assoc Cancer Res 23:3; 1982 (1 ref.).

A previous report from this laboratory has demonstrated that the greatest potentiation of x-ray induced tumor regression and cure by the radiosensitizer misonidazole (MIS) was achieved when the tumors were [illegible] previously treated with [illegible] MW hyperthermia (HT). The present studies were undertaken to assay the uptake of MIS into tumor tissue under both ambient and HT conditions. Three transplantable tumor lines were used, all carried in [illegible] mouse hosts: [illegible] mammary carcinomas designated [illegible]AH and MI2 and a spindle-cell sarcoma designated TEC. Tumor tissue was transplanted s.c. by trocar, and the tumors were studied when they reached a volume of [illegible] ± [illegible] cc. MIS was injected i.p. at 1 mg/g body weight. For HT, mice were placed in lead shields with only the tumor exposed, and MW (2450 MHz) were directed at the tumor with the intratumor temperature regulated at 42.5 ± 0.5. The tissue was removed and extracted with methanol and water and extracts were analyzed by reversed-phase HPLC. [illegible] There was [illegible] significant difference [illegible] concentration of MIS at [illegible] temperature [illegible] tissue. When HT was given [illegible] prior to MIS there was a significant reduction [illegible] uptake in all 3 tumor types: TEC [illegible], M[illegible], LBAH [illegible]. When HT was given after MIS, there was no significant effect on MIS uptake in TEC or MI2, while in LBAH there was a slight decrease. The results indicate that the potentiating effects of HT are probably not due to increased permeability of the tissue to the drugs, and the HT is [illegible] best given after drug [illegible].

[illegible] RADIOFREQUENCY HYPERTHERMIA IN MALIGNANCY: A PHASE I-II STUDY (MEETING ABSTRACT). (Eng.) Khandekar, J. D. (Evanston Hosp., Evanston, IL 60201); Scanlon, E. F.; Jarvis, R. M.; Lawrence, [illegible]. Proc Annu Meet Am Assoc Cancer Res [illegible]; 1982 (1 ref.).

Hyperthermia (HT) either alone or in combination with radiation (RT) and/or chemotherapy (CT) can induce tumor (T) regression. Local HT can be delivered with a variety of techniques. Magnetrode®, a radiofrequency (RF) [illegible] unit, [illegible] through magnetic [illegible]. In Jan. 19[illegible] we initiated a phase I-II trial with magnetrode HT, given as a [illegible] course of either [illegible] or [illegible] treatments, given over a [illegible] wk period. HT [illegible] either immediately preceding, or [illegible] following RT. In selected cases, CT was given [illegible] RT or HT. In each patient [illegible] temperature and in selected cases intra-T temperature were measured with thermistor [illegible] or with [illegible] system. Sixty [illegible] patients unlikely to benefit from conventional Rx entered the trial [illegible]. [illegible] were treated. [illegible] at this time, while [illegible] was [illegible] disease [illegible]. There were no treatment related deaths. [illegible] therapy. Following conclusions are drawn: [illegible]

seeds at 4 C.

0856 SYNERGY OF PYRAN CO-POLYMER (PYRAN) AND PULSATILE ELECTROMAGNETICALLY INDUCED CURRENTS (PEMIC) AGAINST Blo MELANOMA (M) IN VIVO. (MEETING ABSTRACT). (Eng.) Norton, L. (Mount Sinai School of Medicine, New York, NY 10029); Tansman, J. S.; Regelson, W.; Geller, S.; Pilla, A. A. Proc Annu Meet Am Assoc Cancer Res 23:193; 1982 (1 ref.)

The antineoplastic activity of the immunomodulating polyanion PYRAN, in clinical trial as MVE-2, is enhanced by simultaneous exposure of tumor-bearing mice to PEMIC, a nontoxic, low power, nonthermal, nonionizing current designed to influence membrane-enzyme electrochemistry. This extends the anticancer activity of PEMIC, which has already demonstrated a synergy with cytotoxic combination chemotherapy in the M system. One hundred female BDF_1 or BCF_1 mice were given no drug or PYRAN 75 mg/kg ip 1 or 7 days after sc implantation of 1 mm^3 M. Mice randomized to receive PEMIC were placed 4/cage between air-gap coils (Electro-biology, Fairfield, NJ) inducing 2 Hz currents of 50 msec bursts of 250 usec main polarity, 4 usec opposite polarity, peak density 0.5-1 uA/cm^2, for 12 hr/day from day 2 continuously. Dummy cages were used for nonPEMIC mice. Species or day of thereapy did not influence survival. At a median survival of 7 wk, 24 mice with PEMIC alone were not different from 28 mice with PYRAN alone or untreated controls, although 20% of PYRAN-only mice has a slight survival improvement. However, 20 mice with both PYRAN and PEMIC had a median survival in excess of 10 wk (x^2 = 6.63, $p < 0.05$). This was due to an inhibition of the initial pseudo-exponential portion of the Gompertzian growth curve, resulting in an overall displacement of the survival curve for 100% of mice. Histology suggested enhanced necrosis of PEMIC-exposed tumors, which suggests the mechanism of synergy with the macrophage and NK-cell stimulating PYRAN.

0857 SELECTIVE RESPONSE OF TUMORS TO MICROWAVE HYPERTHERMIA (MEETING ABSTRACT). (Eng.) Goldfeder, A. (Cancer & Radiobiological Res. Lab., New York Univ., New York, NY 10003); Perrino, P. Proc Annu Meet Am Assoc Cancer Res 23:220; 1982 (1 ref).

Previous studies in this laboratory used microwave (MW) hyperthermia as an adjunct to x-irradiation and misonidazole. The present study is concerned with effects induced by MW hyperthermia alone. Two mouse mammary carcinomas (MT2, DBAH) and a spindle cell sarcoma (TEC) of standard size growing in isogenic hosts have been exposed to 4250 MHz induced MW hyperthermia at 42-43 C for a predetermined time of 60 min for 5 days. Measurements of treated and control tumors were made daily. At 12-24 hr post-treatment the tumors increased slightly, presumably due to edema. Shrinkage of tumors started at about 48 hr later. Of the three types of tumors treated, the DBAH proved most thermosensitive, regressing completely within 2-3 wk after treatment. The MT2 carcinoma similarly treated formed a dark crust in the center while new growth appeared at the edge of the treated tumor. Of the TEC tumors treated daily for 60 min, 75% totally regressed, the remainder continued to grow at a slower rate. The results indicate a difference in thermoresponse among the three tumor types and emphasize the significance of studying each tumor type individually. The mechanism(s) of MW effects on cellular components is being studied by high pressure liquid chromatography and will be presented.

0858 CLINICAL PILOT TRIAL OF RADIOFREQUENCY (RF)-INDUCED REGIONAL HYPERTHERMIA OF SUPERFICIAL (SF) AND DEEP-SEATED (DS) TUMOR LESIONS (MEETING ABSTRACT). (Eng.) Choksi, J. (M. D. Anderson Hosp. and Tumor Inst. Houston, TX 77030); Corry, P.; Headley, D.; Bernadino, B.; Barlogie, M. D. Proc Annu Meet Am Soc Clin Oncol 1:21; 1982.

A clinical pilot trial was conducted to evaluate anti-tumor effects and toxicities of RF-induced regional hyperthermia for the treatment of recurrent SF (27 patients) and DS (6 patients) tumor lesions unresponsive to conventional therapy. Histologic diagnosis included 16 sarcomas, 11 breast cancer and 6 miscellaneous tumors. Treatment for 1 hr at a desired starting temperature of 43 C was administered daily for 5 days/wk for 2 wk followed by a 2 wk treatment-free interval. Subsequent heating was performed using gradual increments in temperature to a maximum of 52 C. A RF apparatus operating at 13.56 MHz served as a heating source. The maximum tumor temperature was independent of histopathology, size of treated lesions and prior exposure to ionizing radiation. The overall objective response rate for 25 evaluable patients receiving at least 5 consecutive treatments was 44% including 2 complete and 9 partial remissions. Three additional patients had a minor response. RF-induced anti-tumor effects were temperature-dependent, i.e. lack of tumor regression below 42 C including 8 SF and 3 DS tumor lesions; while 55% of 11 patients treated at 42 to 48 C responded, and heating to > 48 C induced responses in all 6 patients treated. Tumors treated at $\geq$ 46 C showed longer remission duration than those treated at < 46 C. Pain was the treatment-limiting toxicity in 15 patients. Blisters were noted in 4 patients, and 1 patient each developed bleeding and infection. Thus, externally applied RF-induced regional hyperthermia is a safe and effective antitumor treatment modality with minimal biological effect at temperatures $\leq$ 42 C, whereas higher temperatures produce tumor regression in half of the treated

patients.

0859 PRODUCTION OF WHOLE BODY HYPERTHERMIA BY MICROWAVE ENERGY (MEETING ABSTRACT). (Enc.) Hornback, N. B. (Indiana Univ. Sch. Medicine, Indianapolis, IN 46223); Shupe, R. E.; Morphis, J. G.; Marshall, C. Proc Annu Meet Am Soc Clin Oncol 1:62; 1982.

Hyperthermia in cancer therapy has been viewed with increasing interest; however, an effective, reproducible method has been needed for local and whole body hyperthermia. A variety of techniques and equipent has been developed to produce localized hyperthermia with a fairly consistent degree of reproducibility. Whole body hyperthermia has been produced by either extremely expensive or mostly unsatisfactory methods including: 1) injection of bacterial toxins, 2) heated steam cabinets, 3) inhalation of heated gases with hot wax baths, 4) circulating heated water body suits, and 5) heated blood perfusion techniques. Over the past 18 mo, 29 patients with advanced cancer have undergone a total of 141 body hyperthermia treatments utilizing microwave generators. Core body temperatures of between 40.5 and 41.5 C were maintained for 60 to 120 min in these patients. The procedure and equipment used to produce the desired levels of temperature for varying periods of time provides a safe, reliable and inexpensive method for whole body hyperthermia. This simplified technique will be described in detail and preliminary results of therapy will be presented.

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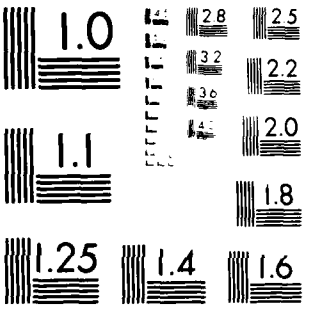

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BIOLOGICAL AND BEHAVIORAL EFFECTS OF PRENATAL AND POSTNATAL EXPOSURE TO 2450-MHz ELECTROMAGNETIC RADIATION IN THE SQUIRREL MONKEY. 0718
EFFECTS OF 200-MHz, 591-MHz AND 2450-MHz MICROWAVES ON CEREBRAL ENERGY METABOLISM. 0757

591-MHz
EFFECTS OF 200-MHz, 591-MHz AND 2450-MHz MICROWAVES ON CEREBRAL ENERGY METABOLISM. 0757

6-mm
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Biological Effects of Nonionizing Electromagnetic Radiation

A Digest of Current Literature

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Contract No:
and/or
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PERIOD FOR THIS NRP

Start Date:

End Date:

Annual Funding:

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Be as concise and specific as possible.

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Project Summary

Please include as a *minimum* the following information:

- Wavelength or frequency
- Modulation (pulsed, continuous, etc.)
- Pulse width
- Duty cycle
- Incident power density
- Specific absorption rate
- Drugs, other stimuli, ionizing radiation used in conducting experiments
- Specialized equipment employed, manufacturer's name
- Exposure duration
- Exposure regime (time, interval, schedule, etc.)
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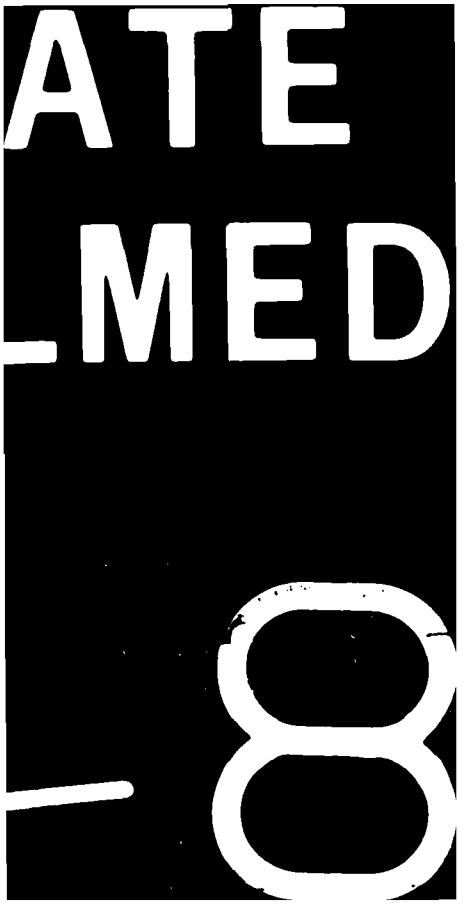
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