

Biological Effects of Electromagnetic Fields

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Abstract Life on earth has evolved in a sea of natural electromagnetic (EM) fields. Over the past century, this natural environment has sharply changed with introduction of a vast and growing spectrum of man-made EM fields. From models based on equilibrium thermodynamics and thermal effects, these fields were initially considered too weak to interact with biomolecular systems, and thus incapable of influencing physiological functions. Laboratory studies have tested a spectrum of EM fields for bioeffects at cell and molecular levels, focusing on exposures at athermal levels. A clear emergent conclusion is that many observed interactions are not based on tissue heating. Modulation of cell surface chemical events by weak EM fields indicates a major amplification of initial weak triggers associated with binding of hormones, antibodies, and neurotransmitters to their specific binding sites. Calcium ions play a key role in this amplification. These studies support new concepts of communication between cells across the barriers of cell membranes; and point with increasing certainty to an essential physical organization in living matter, at a far finer level than the structural and functional image defined in the chemistry of molecules. New collaborations between physical and biological scientists define common goals, seeking solutions to the physical nature of matter through a strong focus on biological matter. The evidence indicates mediation by highly nonlinear, nonequilibrium processes at critical steps in signal coupling across cell membranes. There is increasing evidence that these events relate to quantum states and resonant responses in biomolecular systems, and not to equilibrium thermodynamics associated with thermal energy exchanges and tissue heating. Published 1993 Wiley-Liss, Inc.

Key words: cell membrane, electromagnetic fields, cooperative processes, nonequilibrium thermodynamics, free radicals, athermal interactions

In cellular aggregates that form tissues of higher animals, cells are separated by narrow fluid channels that take on special importance in signaling from cell to cell. These channels act as windows on the electrochemical world surrounding each cell. Hormones, antibodies, neurotransmitters and chemical cancer promoters, for example, move along them to reach binding sites on cell membrane receptors [Adey, 1992a]. These narrow fluid "gutters," typically not more than 150 Å wide, are also preferred pathways for intrinsic and environmental electromagnetic (EM) fields, since they offer a much lower electrical impedance than cell membranes. Although this intercellular space (ICS) forms only about 10 percent of the conducting cross section of typical tissue, it carries at least 90 percent of any imposed or intrinsic current, *directing it along cell membrane surfaces*.

Numerous stranded protein molecules protrude from within the cell into this narrow ICS. Their glycoprotein tips form the *glycocalyx*, which senses chemical and electrical signals in surrounding fluid. Their highly negatively charged tips form receptor sites for hormones, antibodies, neurotransmitters, and for many metabolic agents, including cancer promoters. These charged terminals form an anatomical substrate for the first detection of weak electrochemical oscillations in pericellular fluid, including field potentials arising in activity of adjacent cells or as tissue components of environmental fields.

OBSERVED SENSITIVITIES TO IMPOSED EM FIELDS

As a perspective on the biological significance of this cell-surface current flow, there is evidence from a number of studies that extremely low frequency (ELF) fields in the range 0–100 Hz and radiofrequency (RF) fields amplitude-modulated in this same ELF range, producing tissue gradients in the range 10^{-7} – 10^{-1} V/cm, are involved in essential physiological functions

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Epidemiology Of Electromagnetic Fields Biological Effects Of Electromagnetics

Jin-Ying Zhang



Epidemiology Of Electromagnetic Fields Biological Effects Of Electromagnetics:

Epidemiology of Electromagnetic Fields Martin Roosli, 2014-06-03 Appeals to a Wide Audience Fueled by more than 30 years of intensive research and debate on the impact of electromagnetic fields EMF on everyday life starting with residential exposure to magnetic fields and the development of childhood cancer in the 70s and continuing with risk of exposure via wireless communications in present day *Epidemiology of Electromagnetic Fields* addresses ongoing public and scientific controversy surrounding the possible effects of electromagnetic fields EMF to human health and provides an in depth introduction into the methodology of environmental epidemiology that is appropriate for all levels from student to practicing engineer Exposure to EMF Focusing primarily on EMF examples the author presents the general principles and methodological concepts in environmental epidemiology Topics of importance in the first part of the book include epidemiological study designs exposure assessment methods and implications for the study results as well as selection bias confounding and other biases including reverse causality and ecological fallacy The second part of the book covers environmental epidemiological methods in detail and outlines key examples such as childhood leukemia and exposure to extremely low frequency magnetic fields as well as examples that look at brain tumors and mobile phone use The book also offers a detailed discussion on the range of EMF sources and exposures In addition it highlights the sophisticated assessment methods required to address exposure situations and provides a historical perspective The third part of the book examines how EMF exposure from the use of wireless communication techniques and other challenges affect risk assessment today and also details future developments Explores environmental epidemiological methods in detail while critically discussing epidemiological findings Provides a state of the art overview of the scientific evidence of the health effects of EMF Considers how novelty the steep increase of radiofrequency RF EMF exposure from wireless communications and other challenges affect risk assessment today *Epidemiology of Electromagnetic Fields* provides a thorough overview of the subject and evaluates the scientific evidence surrounding the possible health effects of EMFs

Biological and Health Effects from Exposure to Power-line Frequency Electromagnetic Fields Hiraku Takebe, 2001 The possible health effects of electromagnetic EMF from high voltage electric power lines have been discussed since the 1970s The concern was triggered by epidemiological studies in the United States and Europe that suggested a slightly increased incidence of leukaemia s and brain tumours occurred among those living and working near high voltage power lines Although studies can indicate an association between factor and effect the studies themselves cannot confirm a cause effect relationship Whether EMF is producing these ill effects must be confirmed by experimental studies

Exposure to Static and Low Frequency Electromagnetic Fields, Biological Effects and Health Consequences (0-100 KHz) Rüdiger Matthes, International Commission on Non-Ionizing Radiation Protection, 2003 **Biological and Medical Aspects of Electromagnetic Fields, Fourth Edition**

Ben Greenebaum, Frank Barnes, 2018-11-01 The two volumes of this new edition of the Handbook cover the basic biological

medical physical and electrical engineering principles They also include experimental results concerning how electric and magnetic fields affect biological systems both as potential hazards to health and potential tools for medical treatment and scientific research They also include material on the relationship between the science and the regulatory processes concerning human exposure to the fields Like its predecessors this edition is intended to be useful as a reference book but also for introducing the reader to bioelectromagnetics or some of its aspects FEATURES New topics include coverage of electromagnetic effects in the terahertz region effects on plants and explicitly applying feedback concepts to the analysis of biological electromagnetic effects Expanded coverage of electromagnetic brain stimulation characterization and modeling of epithelial wounds and recent lab experiments on at all frequencies Section on background for setting standards and precautionary principle Discussion of recent epidemiological laboratory and theoretical results including WHO IARC syntheses of epidemiological results on both high and low frequency fields ITRI lab study of cancer in mice exposed to cell phone like radiation and other RF studies All chapters updated by internationally acknowledged experts in the field

Biological Effects of Electric and Magnetic Fields David O. Carpenter, Sinerik Ayrapetyan, 2012-12-02 Recent concerns over the possible hazards of electrical and magnetic fields in the home and workplace are comprehensively addressed within this book The chapters contain detailed research on the biological effects of electric and magnetic fields and evidence for and against any interaction of electromagnetic fields EMFs and the biological systems The relative risk of exposure to EMFs Putative behavioral and neural effects of EMFs EMF effects on cells

Biological and Medical Aspects of Electromagnetic Fields Frank S. Barnes, Ben Greenebaum, 2018-10-03 Biological and Medical Aspects of Electromagnetic Fields examines potential health hazards exposure standards and medical applications of electromagnetic EM fields The second volume in the bestselling and newly revised Handbook of Biological Effects of Electromagnetic Fields Third Edition this book draws from the latest studies on the effects of exposure to electric and magnetic fields In addition to extensive reviews of physiological effects the book contains now separate reviews of behavioral and cognitive responses to various exposures The book also describes an approach to setting standards for exposure limits and explores a few of the beneficial uses of EM fields in medical applications both diagnostics and in treatment Biological and Medical Aspects of Electromagnetic Fields provides a practical overview of the experiments and methods used to observe ELF and RF fields and the possible useful and hazardous implications of these observations

Electromagnetic Fields and Radiation Riadh W.Y. Habash, 2001-12-04 This reference explores the sources characteristics bioeffects and health hazards of extremely low frequency ELF fields and radio frequency radiation RFR analyzing current research as well as the latest epidemiological studies to assess potential risks associated with exposure and to develop effective safety guidelines Compiles reports and investigations from four decades of study on the effect of nonionizing electromagnetic fields and radiation on human health Summarizing modern engineering approaches to control exposure Electromagnetic Fields and Radiation discusses EM

interaction mechanisms in biological systems Explorations into the impact of EM fields on free radicals cells tissues organs whole organisms and the population Regulatory standards in the United States Canada Europe and Asia Pacific Evaluation of incident fields from various EM sources Measurement surveys for various sites including power lines substations mobile systems cellular base stations broadcast antennas traffic radar devices heating equipment and other sources Dosimetry techniques for the determination of internal EM fields Conclusions reached by the Food and Drug Administration World Health Organization and other institutions Handbook of Biological Effects of Electromagnetic Fields, Third Edition - 2 Volume Set Charles Polk, Elliot Postow, 1995-12-21 The first edition of this book has been recognized as the standard reference on biological effects of electric and magnetic fields from DC to microwaves But much has changed in this science since the book's original publication in 1986 With contributions from eighteen leading researchers this latest edition includes authoritative discussions of many new developments and will quickly become the new must have resource handbook Dielectric properties of biological tissue are thoroughly examined followed by chapters on physical mechanisms and biological effects of static and extremely low frequency magnetic fields New chapters on topics that were treated very briefly in the first edition now receive extensive treatment These topics include electric and magnetic fields for bone and soft tissue repair electroporation and epidemiology of ELF health effects The chapter on computer methods for predicting field intensity has been substantially revised to describe new numerical techniques developed within the last few years and includes calculations of power absorbed in the human head from cellular telephones The chapter discussing experimental results on RF interaction with living matter now contains information on effects of very high power very short duration pulses A new appendix on safety standards is based on the latest publications of governmental as well as quasi governmental organizations such as the U S Council on Radiation Protection in the United States Europe and Australia With all its revisions this updated version of the CRC Handbook of Biological Effects of Electromagnetic Fields provides the most comprehensive overview available of this rapidly changing science Possible Health Effects of Exposure to Residential Electric and Magnetic Fields National Research Council, Division on Earth and Life Studies, Commission on Life Sciences, Committee on the Possible Effects of Electromagnetic Fields on Biologic Systems, 1997-02-18 Can the electric and magnetic fields EMF to which people are routinely exposed cause health effects This volume assesses the data and draws conclusions about the consequences of human exposure to EMF The committee examines what is known about three kinds of health effects associated with EMF cancer primarily childhood leukemia reproduction and development and neurobiological effects This book provides a detailed discussion of hazard identification dose response assessment exposure assessment and risk characterization for each Possible Health Effects of Exposure to Residential Electric and Magnetic Fields also discusses the tools available to measure exposure common types of exposures and what is known about the effects of exposure The committee looks at correlations between EMF exposure and carcinogenesis mutagenesis neurobehavioral effects reproductive and developmental effects

effects on melatonin and other neurochemicals and effects on bone healing and stimulated cell growth Biological Effects and Dosimetry of Static and ELF Electromagnetic Fields Martino Gandolfo, S.M. Michaelson, A. Rindi, 2013-03-09 The editors are pleased to present these Proceedings of the V Course of the International School of Radiation Damage and Protection of the Ettore Majorana Centre held in Erice Italy in November 1983 The lectures and discussions among leading scientists in various disciplines of physics engineering biophysics cellular biology physiology and medicine from 11 countries are included in this compilation In this volume we have attempted to explore all aspects of the interaction of static and Extremely Low Frequency ELF 0-300 Hz electric and magnetic fields with biological tissue systems and whole organisms we considered dosimetry and what is known or presumed concerning basic interactions responses from the cellular and molecular level to the whole organism Discussions of medical applications as well as epidemiologic investigations related to high voltage transmission were held with critiques of methodologies used and recommendations for future approaches Consideration was also given to the necessity and principles of setting protection standards for man and the environment We believe this is the first attempt to put all this information together into one volume to provide perspective for understanding the influence of static and ELF electric and magnetic fields on biological systems We hope our attempts were successful Martino Gandolfo Sol M Michaelson Alessandro Rindi v ACKNOWLEDGEMENTS This is the Fifth Course of the International School of Radiation Damage and Protection of the Ettore Majorana Centre for Scientific Culture directed by Professor A Zichichi **Index Medicus**, 2004 Vols for 1963 include as pt 2 of the Jan issue Medical subject headings **Cumulated Index Medicus**, 1980 **Biological Effects of Power Frequency Electric and Magnetic Fields** Indira Nair, Millett Granger Morgan, H. Keith Florig, 1989 Biological Effects of Power Frequency Electric and Magnetic Fields Office of Technology Assessment United States, 2002-06 This report was prepared by the Office of Technology Assessment of the United States Congress to review the health effects of high voltage transmission lines For about two decades there has been some concern about the health effects of electric and magnetic fields produced by transmission lines Recent studies have heightened this concern Health effects research is still preliminary and inconclusive but a growing number of studies suggest that under certain circumstances even relatively weak electric and magnetic fields can produce biologic changes This report discusses the present state of knowledge on the health effects of low frequency electric and magnetic fields and describes current US funding levels and research programs Also the report provides information on regulatory activity including existing and proposed field exposure standards **Biological Effects of Exposure to Non-ionising Electromagnetic Fields and Radiation**, 1991 **Radiofrequency Radiation Standards** B. Jon Klauenberg, Martino Gandolfo, David N. Erwin, 2013-11-22 The North Atlantic Treaty Organization NATO has sponsored research and personnel safety standards development for exposure to Radiofrequency Radiation RFR for over twenty years The Aerospace Medical Panel of the Advisory Group For Aerospace Research and Development AGARD sponsored Lecture Series No 78 Radiation Hazards in

1975 in the Netherlands Germany and Norway on the subject of Radiation Hazards to provide a review and critical analysis of the available information and concepts In the same year Research Study Group 2 on Protection of Personnel Against Non Ionizing Electromagnetic Radiation Panel VIII of AC 243 Defence Research Group NATO proposed a revision to Standardization Agreement STANAG 2345 The intent of the proposal was to revise the ST ANAG to incorporate frequency dependent RFR safety guidelines These changes are documented in the NATO STANAG 2345 MED Control and Recording of Personnel Exposure to Radiofrequency Radiation 2 promulgated in 1979 Research Study Group 2 RSG2 of NATO Defense Research Group Panel VIII AC1243 was organized in 1981 to study and contribute technical information concerning the protection of military personnel from the effects of radiofrequency electromagnetic radiation A workshop at the Royal Air Force Institute of Aviation Medicine Royal Aircraft Establishment Farnborough U K was held to develop and or compile sufficient knowledge on the long term effects of pulsed RFR to maintain safe procedures and to minimize unnecessary operational constraints

1994 International Symposium on Electromagnetic Compatibility, 1994 This conference is tailored for the practising EMC engineer design test engineers technicians and managers who must ensure their products meet changing global compliance requirements Technical sessions will feature expert speakers covering fundamentals through advanced level issues of EMC product standards and regulations

Electricity and Magnetism in Biology and Medicine Ferdinando Bersani, 2012-12-06 In the last few decades the research on bioelectromagnetics has expanded worldwide About one thousand researchers are now working in the field in a variety of institutions throughout the world including medical biological engineering and technical laboratories and protection agencies After many years of research a clear picture is now emerging Initially the research was mainly interested in the therapeutic applications of ELF electric and magnetic fields and the RF range was mainly taken into consideration with respect to thermal effects only Then the growing body of biological effects of ELF fields on cells and biological tissues particularly for the repair processes in bone have drawn the attention of researchers to non thermal effects ranging from static fields to microwaves A specific field of interest that has been the object of a large debate in the last twenty years has been the potential health risk associated with electric power production and distribution and more recently with domestic and industrial appliances In the last few years the explosion of the market for cellularphones has highlighted the issue of possible health dangers related to their use and to the widespread presence of base stations The first World Congress on Electricity and Magnetism in Biology and Medicine was held in Orlando Florida in 1992 and collected the widest amount of contributions from almost all the major researchers involved in the field

Bioeffects and Therapeutic Applications of Electromagnetic Energy Riadh Habash, 2007-11-19 From cell phones to treating cancer EM energy plays a part in many of the innovations that we take for granted everyday A basic force of nature like nuclear energy or gravity this energy can be harnessed and used but still holds the potential to be harmful The question remains how safe are EM products

Bioeffects and Therapeutic Applications **Biological Effects of**

Exposure to Non-ionising Electromagnetic Fields and Radiation C. I. Kowalczyk, Z. J. Sienkiewicz, R. D. Saunders, 1991
CONTENTS v 1 Static electric and magnetic fields v 2 Extremely low frequency electric and magnetic fields

Unveiling the Magic of Words: A Report on "**Epidemiology Of Electromagnetic Fields Biological Effects Of Electromagnetics**"

In a global defined by information and interconnectivity, the enchanting power of words has acquired unparalleled significance. Their power to kindle emotions, provoke contemplation, and ignite transformative change is really awe-inspiring. Enter the realm of "**Epidemiology Of Electromagnetic Fields Biological Effects Of Electromagnetics**," a mesmerizing literary masterpiece penned by way of a distinguished author, guiding readers on a profound journey to unravel the secrets and potential hidden within every word. In this critique, we shall delve in to the book is central themes, examine its distinctive writing style, and assess its profound impact on the souls of its readers.

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