

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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Biological Effects Of Electromagnetic Fields

Lingsheng Yao



Biological Effects Of Electromagnetic Fields:

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

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 Effects of Electromagnetic Fields Peter Stavroulakis, 2013-03-09 Any book under this title which creates both anticipation and anxiety must be the work of a lot of people present any new findings with objectivity and cover the subject as exhaustively as possible As such it must cover the possible reproducible mechanisms of action reaction EMF Biological Organism the appropriate models that allow quantitative measurements the basic biological reproducible effects and possible therapeutic effects along with their prevalent metrics and international exposure criteria This is exactly the main objective of this book It is also believed that it provides some new results and conclusions which complement clarify and verify the existing results in the literature included in the references 1 and 2 Electromagnetic Radiation is a form of energy which is transmitted in the form of waves which correspond to spatial and time variations of the electric and magnetic field Electromagnetic fields appear in a vast set of frequencies spectra that are divided in frequency zones according to the

manner they are produced or used Areas greater than 300 gigacycles GHz which include the solar spectrum as well as x and gamma rays have been studied sufficiently under a different angle in relation to possible biological effects People are well aware of the harmful effects of sun radiation when they are exposed to the sunlight for extended periods of time and of the catastrophic effects of nuclear bombs and nuclear reactor leaks

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 biological systems The relative risk of exposure to EMFs Putative behavioral and neural effects of EMFs EMF effects on cells

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Biological and Medical Aspects of Electromagnetic Fields Frank S. Barnes, Ben Greenebaum, 2006-10-24 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

Biological Effects of Electromagnetic Fields Amr Gabr, 2015-04-02 All populations are now being exposed to varying degrees of man made sources of electromagnetic fields EMFs and the exposure levels will likely continue to increase as technological inventions advance EMFs are thus becoming a major health concern and generate intense debate within the

scientific community and in the fellow citizens Man made EMFs are currently created mostly by mobile phone communication systems and broadcasting transmitters Therefore we provides an overview of the operating principles of electromagnetic field and discusses the mechanism s underlying the effect Additionally we review EMF interaction mechanisms with biological systems deals with the different effects of EMFs Biological Effects of Magnetic and Electromagnetic Fields S. Ueno,2007-07-23 The International Symposium on Biological Effects of Magnetic and Electromagnetic Fields was held from September 3 4 1993 at Kyushu University in Fukuoka Japan Originally it was only intended to be an informal gathering of many scientists who had accepted my invitation to visit Kyushu University after the XXIVth General Assembly of the International Union of Radio Science URSI held in Kyoto prior to our symposium However since so many distinguished scientists were able to come it was decided that a more formal symposium would be possible It was a very productive symposium and as a result many of the guests consented that it would be a good idea to gather all the information put forth at the meeting and have it published In addition although they were unfortunately unable to attend the symposium many other distinguished scientists had also expressed their wish to contribute to this effort and in so doing help to increase understanding in this as yet relatively immature field of science The question of both positive and negative effects of magnetic and electromagnetic fields on biological systems has become more and more important in our world today as they

Biological Effects of Electromagnetic Radiation John M. Osepchuk,1983

Unveiling the Energy of Verbal Beauty: An Mental Sojourn through **Biological Effects Of Electromagnetic Fields**

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