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## Preface

There is an old joke with a well-known punch line about a man who has just fallen from the 86th floor of the Empire State Building in New York. As he passes the 30th floor, he is heard saying to himself ‘so far, so good’ . . .

Most of us laugh because we know where the man is headed, and that he must know too. But, our laughter usually has a guilty edge. We know that many of us are guilty of occasionally displaying a ‘so far, so good’ attitude in our own lives. We think of the smoker who says that about the possibility of getting lung cancer or heart disease and who counts on beating the odds because he feels healthy at the moment. That smoker will not find out if he won the bet until many years later, and by then it is often too late. The ‘so far, so good’ attitude to health is so common that people even kid themselves about it. One smoker told me that smoking would only cut a few years off his life, and that he did not mind losing the last few years because they are usually not much fun anyway.

Unlike the optimist in the joke, whose end is virtually certain, many of us live like the smoker, playing the odds and reassuring ourselves ‘so far, so good’. Diseases like cancer usually take many years to develop, and we try not to think how some of the things we do casually can affect the long-term odds by compromising the natural processes that protect us. We rely on our bodies to be strong and resilient all the time. Yet, we know there are limits to the body’s natural ability to reverse damage to cells. We also know that there may be gaps in the ability of our genetic endowment to cope with damage. At some level, we all know it is just common sense to try to minimize damage to our bodies and maximize the ability to repair.

These opening paragraphs provide a quick introduction to the theme of this issue of Pathophysiology and a summary of the point of view of its authors. The public is currently interested in possible hazards from radio frequency (RF) due to cellphones, towers, WiFi, etc. The concern is certainly warranted, but we are surrounded by electromagnetic fields (EMFs) of many frequencies, and there are also significant biological effects and known risks from low frequency

EMF. The scientific problem is to determine the nature of EMF interaction with biological systems and develop ways of coping with harmful effects in all frequency ranges, as well as their cumulative effects. The practical problem is to minimize the harmful biological effects of all EMF.

The technical papers in this issue are devoted to an examination and an evaluation of evidence gathered by scientists regarding the effects of EMF, especially RF radiation, on living cells and on the health of human populations. The laboratory studies point to significant interactions of both power frequency and RF with cellular components, especially DNA. The epidemiological studies point to increased risk of developing certain cancers associated with long-term exposure to RF. Overall, the scientific evidence shows that the risk to health is significant, and that to deny it is like being in free-fall and thinking ‘so far, so good’. We must recognize that there is a potential health problem, and that we must begin to deal with it responsibly as individuals and as a society.

### Table of contents

PathoPhysiology papers	Dates Received
EMF Effects on DNA	
Blank, Goodman	9/30
Phillips, Singh, Lai	10/14
Rudiger	12/22
EMF Effects on the Brain	
Nittby, Brun, Eberhardt, Malmgren, Persson, Salford	12/17
Hardell, Carlberg, Mild	10/16
Kundi, Hutter	9/1
Morgan	11/21
EMF in the Environment	
Davanipour, Sobel	11/1
Johansson	8/23
Pourlis	8/24
Balmori	7/21
Hutunnen, Hänninen, Myllylä	1/4
Blackman	11/13
Science as a Guide to Public Policy	
Gee	12/17
Sage, Carpenter	11/13

### EMF effects on DNA

M. Blank and R. Goodman (USA): Electromagnetic Fields Stress Living Cells

*Abbreviations:* EMF, electromagnetic fields; Hz, hertz (cycles/s the unit of frequency); ELF, extremely low frequency ( $3\text{--}3 \times 10^3$  Hz) power frequency is 50–60 Hz; RF, radio frequency (band width  $3 \times 10^3$  to  $3 \times 10^{11}$  Hz); UHF, ultrahigh frequency band the RF sub-division used for cell phones ( $3 \times 10^8$  to  $3 \times 10^9$  Hz).

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J.L. Phillips, N.P. Singh and H. Lai (USA): Electromagnetic Fields and DNA damage

H.W. Rüdiger (Austria): Genotoxic effects of electromagnetic exposure in vitro

### EMF effects on the brain

H. Nittby, A. Brun, J. Eberhardt, L. Malmgren, B.R.R. Persson and L.G. Salford (Sweden): Increased blood–brain barrier permeability in mammalian brain seven days after exposure to the radiation from a GSM-900 mobile phone

L. Hardell, M. Carlberg and K. Hansson Mild (Sweden): Epidemiological evidence for an association between use of wireless phones and tumor diseases

M. Kundi and H-P. Hutter (Austria): Mobile phone base stations – effects on wellbeing and health

L.L. Morgan: Estimating the risk of brain tumors from cellphone use: published case–control studies

### EMF in the environment

Z. Davanipour and E. Sobel: Long-term exposure to electromagnetic fields and the Risks of Alzheimer’s disease and breast cancer: Further biological research

O. Johansson: Disturbance of the immune system by electromagnetic fields: A potentially underlying cause for cellular damage and tissue repair reduction which could lead to disease and impairment disturbance

A.F. Pourlis: Reproductive and developmental effects of EMF in vertebrate animal models

A. Balmori: Electromagnetic pollution from phone masts: Effects on wildlife

P. Huttunen, O. Hänninen and R. Myllylä: FM-radio and TV tower signals can cause spontaneous hand movements near moving RF reflector

C. Blackman: Cell Phone Radiation: Evidence from ELF and RF studies supporting more inclusive risk identification and assessment

### Science as a guide to public policy

D. Gee: Late Lessons from early warnings: Towards realism and precaution with EMF?

C. Sage and D.O. Carpenter: Public Health Implications of Wireless Technologies

### Special Issue on EMF

Bioelectromagnetics, the study of biological effects of electromagnetic fields (EMF), is an interdisciplinary science with a technical literature that is not easily accessible to the non-specialist. To increase access of the public to the technical literature and to the health implications of the scientific findings, the Bioinitiative Report was organized by an international group of scientists and published online at [www.bioinitiative.org](http://www.bioinitiative.org) on August 31, 2007. The report has been widely read, and was cited in September 2008 by the European Parliament when it voted overwhelmingly that the current EMF safety standards were obsolete and needed to be reviewed.

This special issue of Pathophysiology includes scientific papers on the EMF issue by contributors to the Bioinitiative Report, as well as others, and is prepared for scientists who are not specialists in bioelectromagnetics. Each paper is independent and self-contained. To help the reader appreciate how the different subjects contribute to an understanding of the EMF issue, the papers are arranged in groups that emphasize key areas, and the role of science in analyzing the problem and evaluating possible solutions. The subject headings are:

- DNA to show biological effects at the sub-cellular level that occur at very low EMF thresholds and across frequency ranges of the EM spectrum. Interactions with DNA may account for many of the effects of EMF, and they raise the possibility that genetic damage due to EMF can lead to cancer.
- The Brain is exposed to radiation from mobile phone antennas, and laboratory studies show that the radiation causes leakage of the protective blood–brain barrier, as well as the death of neurons in the brain. Radiation emitted from base stations can affect all who are in the vicinity. Epidemiological studies have shown a relation between exposure to mobile phones, base-stations and the development of brain tumors. Some epidemiological studies have significant flaws in design, and the risk of brain cancer may be greater than reported in the published results.
- In addition to the risk of brain cancer, EMF in the environment may contribute to diseases like Alzheimer’s dementia and breast cancer in humans, as well as reproductive and developmental effects in animals in the wild. EMF affect the biochemical pathways and immunological mechanisms that link the different organ systems in our bodies and those of animals. The human body can act as an antenna for RF signals, and a small percentage of the population appears to be so sensitive to EMF that it interferes with their daily lives. In addition to the growing presence of EMF signals in the environment, the complexity of the signals may be important in altering biological responses. These are among the many factors that must be considered in approaching EMF safety issues.
- Science as a guide to public policy

Four centuries ago, when Francis Bacon envisioned a course for modern science, he expressed the idea that *knowledge is power that should be applied for the benefit of mankind*. It is in keeping with that ethical standard that the last two papers in this issue show how knowledge gained from scientific research can help solve problems arising from EMF in our environment. The first of these papers discusses the Precautionary Principle, its growing acceptance as a rational approach to environmental issues, and how past experience can help us deal with the EMF issue. The second paper, by the editors of the original BioInitiative Report, is an update on how best to deal with the challenge of EMF in the environ-

ment and, specifically, the problems accompanying wireless technologies.

We trust that the reviews and original research papers will increase awareness of the growing impact of EMF in the environment, and the need for modern society to deal expeditiously with the potential health problems brought to light by EMF research.

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