

The Big Book of EMFs



*Everything You Need to Know about Electro-smog
to Optimise Your Health without Living in a Cave*

John Mauremootoo, PhD

**What are native &
non-native EMFs?**

**How do EMFs affect
your body-mind?**

**How can you enjoy the benefits of
technology and not jeopardise your health?**

POWER FREQUENCY

LIGHT

RADIO FREQUENCY

IONISING RADIATION

The Big Book of EMFs

*Everything You Need to Know about
Electro-smog to Optimise Your Health
without Living in a Cave*

*Book Sample: Part 1 Introduction
(Chapters 1–5)*

John R. Mauremootoo, PhD

Published 2025 by:
InSpiral Pathways
Bristol, UK
www.InSpiralPathways.com



The Big Book of EMFs
Everything You Need to Know about Electro-smog to Optimise Your Health
without Living in a Cave

by John Mauremootoo

ISBN: 978-1-0683396-3-9 (ePDF)
ISBN: 978-1-0683396-2-2 (ePub)
ISBN: 978-1-0683396-0-8 (Paperback)
ISBN: 978-1-0683396-1-5 (Hardback)

A CIP catalogue record for this book is available from the British Library

All rights reserved. No portion of this book may be reproduced, copied, distributed or adapted in any way, with the exception of certain activities permitted by applicable copyright laws, such as brief quotations in the context of a review or academic work. For permission to publish, distribute or otherwise reproduce this work, please get in touch with the author at John@InSpiralPathways.com. Copyright arrangements for third-party material reproduced or adapted in this product are detailed in the Image credits section.

Cover page by John Mauremootoo using the image [Female hands holding the world - over a dark background](#). Image used under license from Freestock.com.

© 2025 John Mauremootoo

Dedication

To Julie, my amazing wife who always believes in me and supports me 100% in everything I do. I am truly blessed to share my life with her.

Acknowledgements

Many thanks to the following for their valuable feedback on earlier drafts, which helped improve the content and clarity: Kevin Brennan, Gaetan Chevalier, Barry Clarke, John Frank, Paul Héroux, Holly Kim, Isobel Macfarlane, John Macfarlane, Andy McArdle, Jack Mauremootoo, and Richard Smith. Many thanks to Sophie Fong Clarke for her industrious proofreading of the manuscript. Further thanks to my wonderful wife Julie, who has encouraged me throughout the long writing process. She has skilfully balanced this encouragement “carrot” with judicious use of the “stick”—a threat to finish the manuscript herself and publish it with her additions if I dared to procrastinate any further. In an alternative universe, you may be reading Julie’s, possibly more entertaining, version.

Disclaimer

The information presented here is based on professional training, personal experience, and interpretation of information from journals, articles, books, and other media and is for informational and educational purposes only.

It is not an attempt to diagnose or prescribe. People are advised to contact their primary or specialist health professional before making medical, nutritional, lifestyle, or other health-related changes.

Every effort has been made to contact copyright holders of third-party material reproduced in this product. I would be pleased to rectify any omissions in subsequent iterations should they be drawn to my attention.

Further information

Further relevant resources, including full-colour versions of the figures from this book, can be found at

<https://www.inspiralpathways.com/the-big-book-of-emfs.html>

Preface

Politicians have honed their slogans down to a fine art – “build the wall”, “lock her up”, and “Brexit means Brexit” are some of the most memorable political soundbites of recent times. A highly effective slogan that did the rounds in the 1992 US Presidential campaign was Bill Clinton’s assertion that “it’s the economy, stupid.” This seemed to strike a chord with the American people, and Clinton won a landslide victory over the Republican incumbent George H. W. Bush. The emphasis on the economy above all other facets of our life on this planet has been a predominant theme in the 20th and 21st centuries. But this fixation has never sat easily on my shoulders. The economy is a human system built on the planet’s ecology, which provides all of our essential life-support systems. The ever-accelerating treadmill of “natural resource” extraction, transformation, consumption, and pollution (a.k.a. disposal) in the name of economic growth is tantamount to an attempted planetary coup as “civilisation’s” crude and fragile linear processes ride roughshod over Mother Earth’s robust, dynamic, circular, and cyclical complexity which has been tested and refined over aeons. In our rush to conquer nature and commoditise the planet, we have forgotten that we are not separate from the air that we breathe, the water that we drink, and the natural alchemy that makes food from sunlight and the soil beneath our feet. There have been inevitable consequences for personal, social, and planetary health.

My alternative slogan, Mr Clinton, is quite simply “It’s the ecology”. There’s no need for the stupid bit. The economy must be subservient to the ecology as, in the final analysis, nature always wins. Gaia will have the last word and will inevitably evict *Homo sapiens* – the hubristically self-proclaimed “wise man” – those pesky tenants who consistently flout the terms and conditions of their tenancy agreement. An economic system at odds with nature has precipitated a global mass extinction that undermines the biodiversity upon which we depend, runaway climate change that threatens our infrastructure and ushers in droughts, fires, and floods, land degradation to the extent that we only have an estimated 50 harvests left before our topsoil disappears, a food system that pays no heed to our health, a health system that pays no heed to our food, and a combination of forces that have led to a cataclysmic decline in human fertility that may leave us unable to reproduce within the next few decades. All these interlinked processes have helped to fuel my passion to contribute planetary health - to the rehabilitation of a biosphere that has been sacrificed at the altar of unsustainable economic growth fuelled by unfettered technological progress and the naive conflation of happiness with hedonism.

For more than three decades I have immersed myself in the fields of environmental conservation and international development, from my studies in geography and biology to my work in 38 countries and territories in a diverse range of disciplines, including protected area management, ecosystem restoration, organic agriculture, pest and disease management, public health, child protection, gender equity, and conflict resolution. The objectives of each of my superficially disparate assignments share a common thread - the restoration of balance. All the problems in the systems I have worked in have stemmed from imbalance - too many predators, too few predators, overexploitation, monoculture of crops and livestock, and a monoculture of the mind. I only came to this insight latterly, constrained as I was by my PhD level training, the ostensible peak of the Western education pyramid that rewards us for knowing more and more about less and less in our quest to become increasingly specialised “human resources”.

I have also come to appreciate the importance of balance through my personal health journey. As an aspiring endurance athlete in the 1970s and 1980s, I habitually overtrained as the embodiment of the Western mantra “If some is good, then more must be better.” My mega miles of swimming, cycling, and running were fuelled by a diet piled high with junk food, including 6-plus king-size Mars bars per day – a monoculture of confectionery. Injuries and illness inevitably followed, with my wake-up call being the ravages of chronic gum disease and the side effects of persistent use of antibiotics and painkillers. As Jack Kruse, American neurosurgeon, optimal health educator and self-confessed former “fat slob”, is fond of saying, “You cannot get well if you stay in the same environment that made you sick.” So, little by little, I have changed my environment.

Starting about ten years ago, my wife Julie and I embarked upon our health journeys in earnest, looking at the factors that caused our ecology to be out of balance with our physiology. We dived deeply into the usual pool of suspects – diet and hydration, movement/exercise, sleep, and psychosocial and spiritual health, but we also uncovered some lesser-known factors, such as correct breathing and exposure to environmental toxins. Among the lesser knowns of the lesser-knowns was the influence of natural and non-native electromagnetic fields (EMFs). As the years progressed, I put in the hard miles of research into the topic, reading thousands of scientific papers that consistently showed that chronic exposure to unnatural EMF regimes is a massive physiological stress about which health professionals and the general public are almost entirely unaware.

I figured that a fantastic way to consolidate my understanding was to write a book on the health effects of EMFs – not just on mobile phones, not just power lines, not just radioactivity, not just unnatural light regimes, but on the panoply of EMFs through the entire electromagnetic spectrum – a journey from electrical power frequencies, through radio frequencies, to visible and nonvisible light, and onto ionising radiation. I have tried to write an accessible but comprehensive tome that addresses *everything you need to know about EMFs but were too afraid to ask*. Getting to grips with this area requires some technical understanding, but I have tried to make things as simple as possible without being simplistic. The technical information is provided only as a basis for the recommended practical actions that can be carried out, some with and some without expert assistance. My emphasis is on a buffet of options that people can incrementally adopt that allow them to live a 21st-century life while minimising the electromagnetic side effects.

Even at over 150,000 words of text, it is not possible to exhaustively summarise the huge body of knowledge on the subject. So, to help you delve more deeply, I have provided a comprehensive list of references. In addition, I have signposted search engine terms you can use to find out more information on specific topics. The subject is rapidly evolving, and one's knowledge inevitably changes over time, so some of the details provided are likely to have been superseded. I have done my utmost to ensure that everything I have written is backed up by credible science, but I am willing to concede that some errors will inevitably have slipped through the net. I would be honoured if you got in touch with me to respectfully point out any errors that you spot. I will look into them and, if necessary, make any appropriate changes. That's what second editions are for.

The details may change, but the fundamentals will remain the same. Health is a balance between the forces that stress us and the forces that heal us, and ill health comes from leading a life that is disconnected from the nature we evolved with over innumerable generations. Our relationship with electromagnetic fields is not the whole story, but it is a huge and neglected piece in the environmental jigsaw puzzle that is the ultimate determinant of personal, social, and planetary health – “It's the ecology,” and nobody is stupid.

John Mauremootoo

31st January 2025.

Contents

Dedication	iii
Acknowledgements	iii
Disclaimer	iii
Further information	iii
Preface	iv
Part 1. Introduction	1
Chapter 1. Setting the Scene: Light in the Absence of Eyes Illuminates Nothing	2
This book's target audience	2
What this book brings to the table	4
What this book does not cover in depth	5
A short summary of this book	5
How to make the best use of this book – some pointers	6
References	8
Chapter 2. EMFs – What They Are and Why They Matter	9
What is an EMF?	9
The benefits of EMFs	10
EMF exposure guidelines.....	11
The rise of non-native EMFs in the modern world	11
Characteristics of non-native EMFs.....	13
A note on measurement units	18
References	19
Chapter 3. EMFs – Perspectives on Health Impacts	22
The Precautionary, the Procrustean, the Conflicted, the Confused and the Trustful	23
Confusion is our product, and how not to conduct a scientific study	24
The Schopenhauer Sequence – the road to truth.....	26
EMF Safety vs. Guidelines – the case of mobile phones and a man called SAM	29
Hidden safety warnings	31
Global standard-setting organisations and conflicts of interest – the example of ICNIRP	32
Evidence of harm from an unlikely source – the Insurance Industry	32
A spotlight on conventional wisdom – BBC and 5G	34
References	41

Chapter 4. Health Impacts of Non-Native EMFs	46
How non-ionising radiation can harm us – the voltage-gated calcium channel (VGCC) hypothesis	46
EMFs and melatonin	48
EMFs and mitochondria	48
Mother Nature Knows Best – why should we be concerned about EMFs?	49
Electro Hypersensitivity – the Canary in the Coal Mine	52
A spotlight on electro hypersensitivity – Holly’s Story	58
Making our use of technology as safe as possible – one simple question.....	59
References	60
Chapter 5. EMFs and Health – a Framework for Effective Personal Action.....	63
The UMM, RIDS and MAM approach to EMF management	63
Why individual actions matter – lessons from Mahatma Gandhi, Sir Isaac Newton, and Stephen Covey	64
References	68
Part 2. Electricity – Fallout from Tesla’s Triumph.....	69
The War of the Currents.....	70
Chapter 6. Extremely Low Frequency EMFs (ELFs) – Electric Fields (EFs) and Magnetic Fields (MFs)	72
What is ELF-EMF?.....	72
Health effects of ELF-EMFs	75
A spotlight on low frequency electromagnetic fields and childhood leukaemia.....	76
Safety limits for low-frequency electric and magnetic fields	78
Prevailing ELF-EMF levels	79
Common ELF-EMF sources	79
Measuring EMFs	87
References	90
Chapter 7. Dirty Electricity	94
What is dirty electricity?	94
Health effects of dirty electricity.....	95
A spotlight on dirty electricity and cancer clusters	95
Safety limits and prevailing levels of dirty electricity	97
Common dirty electricity sources	98
Measuring dirty electricity	98
References	100

Chapter 8. Electricity Solutions.....	101
Shielding: A note of caution.....	102
DIY.....	103
DIY/Help Required.....	106
Professional Help Required.....	107
Integrating dirty electricity filters into a DE mitigation process.....	109
References.....	110
Chapter 9. Grounding: “The Most Important Health Discovery Ever!”.....	111
Our feet never touch the ground.....	111
The Umbrella/Faraday Cage Effect.....	114
Health benefits of grounding.....	114
Grounding: the backlash.....	120
Grounding in practice.....	121
Further details on grounding.....	121
References.....	122
Part 3. Radio Frequency Radiation (RFR) — It’s not just 5G.....	123
Chapter 10. Radio Frequency Radiation.....	125
What is radio frequency radiation (RFR)?.....	125
Health effects of radio frequency EMFs.....	128
A spotlight on radio frequency EMFs and infertility.....	133
RFR safety guidelines.....	135
Prevailing radio frequency radiation levels.....	136
References.....	137
Chapter 11. Common Radio Frequency Radiation Sources.....	143
The mobile phone network: From Brick Phone to the Internet of Things.....	144
Satellite phones and Internet.....	157
TV and radio transmitters.....	161
Cordless landline (DECT) phones.....	161
Routers, modems, and Wi-Fi home/office networks.....	162
Bluetooth.....	163
Computers and tablets.....	163
Games consoles/portable game players.....	164
Printers.....	164
Wearable tech.....	164
Television and radio.....	165
GPS.....	166

Smart TVs.....	167
Microwave ovens.....	167
Radar	168
Motor vehicles	168
Wireless chargers	169
Smart meters	170
Airport body scanners	173
The Internet of Things and “hidden” Wi-Fi.....	173
Measuring Radio Frequency Radiation Levels.....	175
References	176
Chapter 12. Radio Frequency Radiation Solutions	184
Reduce Sources.....	184
Increase Distance	190
Decrease Time.....	193
Shield Yourself.....	194
Be cautious of EMF harmonisers.....	197
References	198
Part 4. Light – More Than the Eye Can See	199
Chapter 13. Light – Hidden Health Impacts	201
Introduction: A history of light.....	201
Circadian rhythms	203
What is light?.....	206
Junk light.....	208
Light spectra.....	208
Colour temperature.....	211
Light intensity	212
Flicker.....	214
Artificial light sources	215
Health effects of unnatural light regimes – ocular, dermal, and systemic effects.....	218
Ocular effects.....	218
Dermal effects.....	221
Systemic effects.....	222
Vitamin D.....	222
Synthesis of nitric oxide with health benefits	235
Synthesis of β -endorphin.....	235
A spotlight on weight gain facilitated by unnatural light regimes.....	236

Shift work and a night-shifted lifestyle	237
Measuring light	238
References	239
Chapter 14. Light Solutions	255
Reduce Sources.....	255
Increase Distance	256
Decrease Time.....	256
Shield Yourself.....	257
Seek Sensible Sun-Like Exposure.....	258
References	264
Part 5. Ionising Radiation – Something We Can All Agree Upon?.....	266
Chapter 15. Ionising Radiation	267
What is ionising radiation?.....	269
Ionising radiation – a note on measurement units.....	271
Uses of ionising radiation.....	272
How ionising radiation can harm us	272
Ionising radiation safety protocols	275
Native and non-native sources of ionising radiation.....	275
Natural sources of ionising radiation	277
Non-native sources of ionising radiation	282
Nuclear weapons	282
A spotlight on nuclear weapons testing – the Castle Bravo incident, the nuclear disaster that history forgot	284
Nuclear power generation.....	287
Coal ash and emissions from non-nuclear industries.....	294
Medical diagnostics	294
Medical therapies.....	297
Air travel.....	299
Mines	299
Household sources other than radon.....	300
Occupational sources.....	301
Vulnerable groups.....	301
Measuring radiation	301
Ionising and non-ionising radiation impacts and guidelines – compare and contrast.....	303
References	304

Chapter 16. Ionising Radiation Solutions	314
Radon	314
Household sources of ionising radiation other than radon.....	314
Occupational sources of ionising radiation.....	315
Medical diagnostics	316
Medical therapies.....	316
Air travel.....	317
References	318
Part 6. Resilience – The Silver Lining in the Cloud of Electro-smog.....	319
Chapter 17. Resilience – The Six Pillars of a Healthy Lifestyle (BESDME)	321
1. Breathing – Breathe Effectively.....	322
2. Environment – Create a Healthy Environment.....	325
3. Sleep – Sleep Soundly.....	327
4. Diet – Eat Real Food and Hydrate Properly.....	329
5. Movement – Move Frequently	333
6. Empowerment – Live on Purpose.....	336
References	340
Chapter 18. EMF Mitigation Treatments – Drugs, Supplements, Harmonisers and Beyond	345
Calcium channel blockers	345
Dietary supplements	345
The energy field – <i>here be dragons</i>	346
The Biofield as a unified explanation for energy medicine	347
Pulsed electromagnetic field (PEMF) therapy.....	349
EMF harmonisers – Gamechangers, Band-Aid Solutions or Snake Oil?	350
SRT devices.....	350
Biogeometry.....	354
In summary.....	356
References	357
Part 7. Serenity, Courage, and Wisdom – Towards Personal and Societal Change	360
Chapter 19. How Julie and I Live with EMFs – An n = 2 Experiment.....	361
Our works in progress.....	361
Future Directions	373
References	374
Chapter 20. A World Waiting to be Born – Technology as if People and the Planet Matter...375	
Technological advancement – a double-edged sword.....	375
We are all addicted	376

Local and National Precautionary Actions on EMFs	377
Stepping off our addictive hamster wheels	378
Transitioning from the reactive to the creative	379
Develop a conscious philosophy	379
1. Honesty.....	382
2. Faith	382
3. Surrender	383
4. Soul searching.....	383
5. Integrity	384
6. Acceptance	384
7. Humility.....	385
8. Willingness	385
9. Forgiveness	386
10. Awareness	386
11. Grace.....	387
12. Contribution	387
Individual and collective actions that can bubble up to a larger scale	388
References	393
List of Acronyms and Abbreviations	396
Index	400
Image credits.....	408
About the Author	416

Part 1. Introduction

“ I have no doubt in my mind that at the present time, the greatest polluting element in the earth’s environment is the proliferation of electromagnetic fields. I consider that to be far greater on a global scale, than warming, and the increase in chemical elements in the environment.”



Robert O. Becker (1923–2008) ~ U.S. orthopaedic surgeon and researcher in electrophysiology. Twice nominated for a Nobel Prize

Part 1: Introduction – In a Nutshell

- All life on our planet has evolved to depend upon the Earth’s natural electromagnetic fields (native EMFs).
- Radiation from non-native EMF sources has expanded astronomically over the past few decades and has been linked to a range of harmful health and environmental impacts.
- EMF impact is not restricted to radio frequency/microwave radiation.
- Following the tobacco industry’s playbook, multi-trillion-dollar industry-funded efforts have sown confusion in the minds of the general public about the harmful impacts of EMFs.
- EMF exposure guidelines have exclusively focused on heating effects despite the evidence that so-called non-ionising radiation has biological impacts beyond heating.
- EMFs contribute to disease together with other stressors in a cumulative and synergistic manner.
- We can benefit from technologies that use EMFs without jeopardising our health and the planet’s life support system.

Chapter 1. Setting the Scene: Light in the Absence of Eyes Illuminates Nothing

“Light in the absence of eyes illuminates nothing” is a quote from the science fiction writer Peter Chung. If our five senses do not experience something, it remains hidden and beyond our comprehension. However, humans possess the creativity to shed light on the invisible and bring it into consciousness. The microscope and telescope have brought the vanishingly small and the astronomically distant to our senses. And, with regard to the subject of this book, we are now able to detect hitherto undetectable electromagnetic fields or frequencies (EMFs) using an array of technologies.

Nevertheless, most people remain blind to all but a very thin sliver of the electromagnetic spectrum, the visible light we experience via our eyes. Bees and related insects, on the other hand, can see UV,¹ while a variety of snakes, fish, frogs and blood-sucking insects, such as mosquitoes and bed bugs, can see infrared.² Most of us act as if electromagnetic forces are of no consequence. However, the parts of the electromagnetic spectrum we cannot see are far from inert and have a critical influence on our planet and the life that it sustains.

The Earth has been bathed in a slowly evolving mix of electromagnetic radiation of various types since its birth about 4.5 billion years ago. Then, in the proverbial blink of an eye, during a period of little more than a century, *Homo sapiens* has dramatically transformed the quality and quantity of the electromagnetic radiation to which human beings and other species are exposed. Many of these changes involve radiation we cannot see. Beginning over half a century ago, a vanguard of scientists began to shed light on the consequences of the electromagnetic fallout to which we have exposed ourselves. Robert O. Becker, a twice Nobel Prize-nominated biophysicist who pioneered research into the bioelectrical nature of life,³ very soon realised the dangers inherent in the rising emissions of non-native electromagnetic fields, also known as *electro-smog* or *electro-pollution*. Now more than ever, we need to use the insights generated by Becker and other luminaries to light a path along which people and safe technology can grow together. This is the alternative to business as usual – blindly hurtling along a money-driven technological superhighway that has unwittingly catapulted us into what amounts to a massive, unprecedented, uncontrolled experiment, the consequences of which could be devastating.

Thanks to the thousands of scientific studies on EMF health impacts, we now have the eyes to illuminate the light we could not see. In this book, I translate this science into practical, actionable steps that ordinary people can take to live a healthy life while still having access to the benefits of modern technology.

This book’s target audience

The target audience principally comprises:

- Health-conscious members of the general public
- Health practitioners
- People concerned about the roll-out of 5G and the Internet of Things (IoT)
- Open-minded technology insiders
- Academics and students with a biology, health, or engineering background
- Environmentalists
- Creators of healthy homes, sustainable buildings and communities

Health-conscious members of the general public

A key target audience is curious, concerned, open-minded, intelligent lay people who have heard about the health impacts of electromagnetic fields but are confused by the contradictory messages to which they have been exposed. They have a life outside of the health and wellness realm, so they do not have the time to delve into specialist publications, and they want to enjoy the benefits of technology while minimising the downsides. With the rise of chronic diseases and the failure of conventional medicine to deal with root causes, people are increasingly turning to approaches such as functional medicine and other alternative and commentary health modalities. Despite their best efforts, many of these people are still afflicted with sub-optimal health. These people are willing to dig deep to improve their health and, during their exploration, will inevitably encounter the topic of non-native EMFs. *The Big Book* provides a one-stop shop for these people to grasp the fundamentals of how EMFs of all kinds may be affecting their health and what can be done to manage their impacts. This book and the links therein provide the inputs they need to implement the necessary lifestyle changes. Others will need expert support, and the book gives them the information required to access this expertise, ask the right questions, and become empowered clients.

Health practitioners

Both conventional and complementary health practitioners are becoming increasingly aware of the health implications of EMFs, but most have an insufficient grasp of the detailed picture. This book will equip health practitioners with sufficient knowledge to point their patients in the right direction when they seek help to address their EMF-related issues.

People concerned about the roll-out of 5G and the Internet of Things

There is a lot of publicity about 5G and the Internet of Things (IoT), with generously funded media campaigns that caricature concerned citizens as kooks, crackpots, and conspiracy theorists. This book summarises the masses of hard scientific evidence that supports these concerns and is presented in a way that is accessible to the lay audience. This will help bolster the confidence of those who feel uneasy about the speed and ubiquity of the tech roll-out. Mastering the material in the book will sharpen their rebuttals to common mainstream claims that centre around the assertion that there is no scientific evidence for non-thermal EMF health effects. While not attempting to marginalise the concerns related to 5G and IoT, this book makes it clear that these represent the tip of a very large iceberg. If you come for the 5G, you will stay for the rest of the electromagnetic spectrum. This deeper knowledge will better equip you in your advocacy work and will also help you in your personal health journey.

Open-minded technology insiders

The industry-sponsored mantra is that EMF emissions below international guidelines have no health consequences. However, there is an emerging cohort of scientists, engineers, and other technology company insiders who are “coming out of the closet” and voicing their concerns about the products they have helped to develop and market. The act of biting the hand that once fed you is likely to be the culmination of a long process of soul-searching. There are doubtless many tech insiders who are walking this lonely road. Access to this book will help to acquaint them with the real-world consequences of unsafe, unsustainable development and help facilitate their transition to becoming leaders in the promotion of biocompatible technology, which is a critical component of a world waiting to be born.

Academics and students with a biology, health, or engineering background

The Big Book is not an academic textbook. I do not know of many scientific textbooks that refer to the likes of Homer Simpson, Kim Kardashian, and Bruce Springsteen, which contain personal anecdotes or feature cartoons – all in the name of accessibility. However, this book is, in my humble estimation, the most comprehensive plain-language text on the health impacts of EMFs across the entire spectrum yet produced. It provides a bridge between biological sciences on the one hand and physics and engineering on the other. This can help to open up the world of biophysics to those schooled in conventional chemical and molecular-based biology and to alert physical scientists and engineers to the impact of EMFs on the bioelectrical realities that apply to all living things. Consequently, *The*

Big Book situates itself in an academic niche as a stand-alone text and a point of departure for a deeper dive into the primary literature.

Environmentalists

I identified myself as an environmentalist well before the term became fashionable. Environmentalism, for me, means protecting, conserving, and restoring nature in all its dimensions. The most tangible of these are habitat and biodiversity conservation, clean air, soil and water, and weather and climate. However, we are only viewing part of the picture if we ignore Arthur Firstenberg's *Invisible Rainbow*⁴ as well as visible light, the importance of which is hidden in plain sight. Although it is not the book's primary intention, *The Big Book* follows in the footsteps of *The Invisible Rainbow*, helping to anchor EMF awareness in the environmental agenda. *The Big Book* exposes the naiveté of reducing environmental impact to single dimensions and highlights the potential for scoring environmental own goals, such as the rush to promote CFL (compact fluorescent lamp) and LED (light-emitting diode) lighting without considering their immediate effects on biology and product life-cycle implications in terms of resource use and safe disposal. Bathing the world in wireless radiation is highly energy intensive, and so-called smart devices may not be energy-saving when you factor in the supporting infrastructure. *The Big Book*, therefore, can support environmentalists with a rationale to transition from a superficial sustainability agenda to one that enhances nature's life-support systems in all their wonderful complexity.

Creators of healthy homes, sustainable buildings and communities

There is a burgeoning interest in building healthy and sustainable homes, workplaces, and communities. Architects, designers, and builders can fall into the trap outlined above of reducing sustainability to a single dimension. *The Big Book* promulgates a philosophy of designing with nature to ensure buildings that are life-enhancing for all their inhabitants, not detrimental to their builders, and built with as little disruption to the environment as possible, as advocated by the *Building Biology and Ecology*⁵ movement. This will help to remind those in the sustainable building sector that EMFs and other dimensions of toxicity must be considered when dealing with the built environment.

What this book brings to the table

This book provides a launchpad for readers to implement personalised evidence-based measures to mitigate the harmful impacts of EMFs, based upon foundational knowledge of what natural and non-native EMFs are and how they can damage health. It will also provide the tools to effectively navigate your way through the maze of claims and counterclaims of EMF scientists.

In a nutshell, this book provides:

- An introduction to a simple but revolutionary and actionable health paradigm based on the overarching principle that *Mother Nature Knows Best*
- Information on the full gamut of EMFs from extremely low-frequency EMFs (ELF-EMFs) to Gamma rays – what they are, the harm they can cause and how we can mitigate this harm
- An introduction to resilience and how to cultivate it to mitigate the impacts of EMFs and other health threats
- A jumping-off point from which to access further resources that will help you go deeper

What this book does not cover in depth

The following topics are all extremely important and relevant to EMFs and health but are only touched upon in this book in order to keep it to a manageable size:

- The effects of EMFs on nature
- The health benefits of certain EMFs and other vibrational therapies – ultrasound, light therapy, etc
- The psychological, social, economic, and political consequences for a society that is online 24/7 and addicted to technology
- Cyber security and surveillance implications of increasing data sharing
- Interventions to mitigate the harm from EMFs beyond the individual and household levels

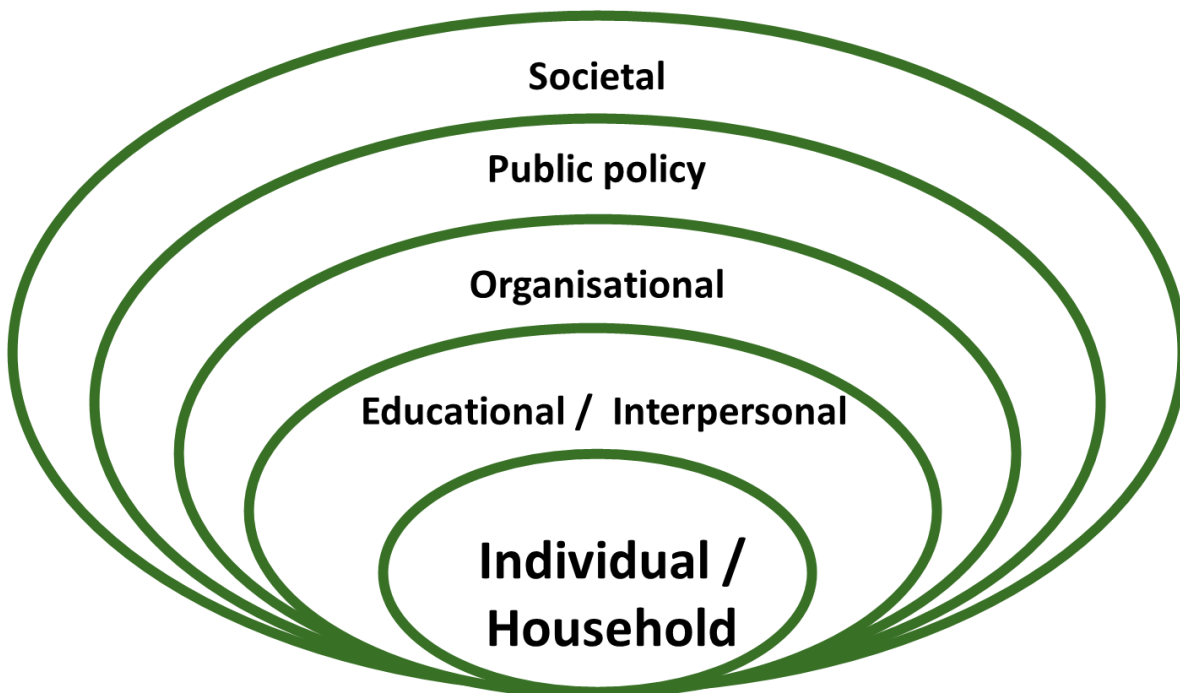


Figure 1.1: *A nested hierarchy of intervention opportunities. This book focuses on the individual/ household level.*

A short summary of this book

The book is divided into seven parts.

1. Introduction. In Part 1, I set the scene by defining EMFs, distinguishing between native (natural/pre-industrial) and non-native EMFs, outlining possible mechanisms whereby non-native EMFs induce harmful effects, documenting why there is so much confusion around the topic (hint: follow the money), and introducing the fundamental principle that *Mother Nature Knows Best* and its logical consequence – to optimise our health in the face of unnatural EMF exposure we need to adapt our lifestyle so that it is compatible with our evolutionary history. I relate this principle to the *Stress Bucket/Total Body Burden* model of chronic disease, which explains why specific disease symptoms can have multiple, diverse causes – *stressors* such as a poor diet, adverse childhood experiences, lack of sleep, a sedentary lifestyle, air pollution, etc. One practical take-home of this model is that we mostly don't need to obsess over which disease is caused by which stressor – chronic disease, in general, is caused by a specific combination of stressors acting on biologically unique individuals. This Stress Bucket model makes life easier for the reader as it is not necessary, or even possible, to map every pathology onto specific stressor(s), as they all contribute to the total body burden. It is an empowering model with its emphasis on our innate resilience and ability to prevent, arrest and reverse chronic disease through an integrated approach that addresses lifestyle practices. This includes but is not limited to, actions to mitigate EMF impacts.

Parts 2–5 focus on specific categories of EMF, with an emphasis on EMF sources, their health impacts, and practical actions people can take to minimise these harmful health impacts. If I were to exhaustively detail the panoply of health impacts, this book would be thousands of pages long. Instead, for each EMF category, I cast a spotlight on specific health effects.

2. Electricity – *Fallout from Tesla’s Triumph*. In Part 2, I examine the health issues associated with electric power (*power frequency EMFs*), specifically focusing on low-frequency electric and magnetic fields and “dirty electricity”. I cast a spotlight on low-frequency magnetic fields and childhood leukaemia, and dirty electricity and cancer clusters. I introduce the practice of grounding – a cheap and simple way to minimise EMF impact and reacquaint ourselves with Mother Nature.

3. Radio frequency Radiation (RFR) – *It’s not just 5G*. In Part 3, I document the sources of RFR and emphasise that the health threat posed by RFR did not begin with 5G. I cast a spotlight on the growing issue of RFR and infertility.

4. Light – *Health Impacts Hidden in Plain Sight*. In Part 4, I outline how we have moved from balanced natural light to a “diet” of artificial “junk light” with serious and largely unknown health consequences. I outline actions we can take to reacquaint ourselves with a more natural light regime and cast a spotlight on vitamin D, light, hormones, and the obesity epidemic.

5. Ionising Radiation – *Something We Can All Agree Upon?* Ionising radiation, which includes X-rays, radioactive waste, and radioactive elements, is probably the least controversial EMF category. Although known to be harmful and protected by biologically relevant safety standards, ionising radiation remains a little-known source of toxicity for many people. I cast a spotlight on nuclear weapons testing and the disaster that history forgot.

6. Resilience – *The Silver Lining in the Cloud of Electro-smog*. I venture beyond the EMF-specific tips outlined in Parts 2–5 to examine the importance of lifestyle practices to maximise resilience to all kinds of stressors, including EMFs.

7. Serenity, Courage and Wisdom – *Towards Personal and Societal Change*. In this section, my wife Julie and I document our personal health journeys, situating EMF mitigation in the context of our approach to living a healthy lifestyle. We talk about some of the challenges we have overcome and those we continue to face as we participate in this game called life. Hopefully, this will help you to understand that we’re not preaching from a platform of perfection but living our lives as real people, doing our best to manage our health in a way that is compatible with 21st-century circumstances.

Though not the major topic of this book, it is important to acknowledge the impactful issues that go beyond the individual and household levels. In Chapter 20, *A World Waiting to be Born – Technology as if People and the Planet Matter*, I use the lens of addiction to examine alternative avenues through which individuals and societies can usher in an era of technological innovation that works in harmony with our biology and the planet’s ecology.

How to make the best use of this book – some pointers

We each have our own explicit or implicit motives for reading any particular book. Reasons for reading this book may include any or all of the following: curiosity about EMF health impacts, a desire to gain an overview of the state of the EMF science, a search for practical actions you can take to mitigate EMF impacts, or as a jumping-off point from which to dive into the specialist literature. I hope that all of these motives will be satisfied by reading the book from cover to cover. It is how I read most books, but it is not the only way. I suggest that everybody reads Part 1 to set the scene. However, there is no need to read chapters 2 to 5 in sequence. The sequence was chosen as it represents a progressive increase in frequency from low to high, electricity to ionising radiation. Many people’s curiosity about EMFs has been provoked by concerns over radio frequency (or “radiofrequency”) radiation (RFR),

particularly from mobile phones and Wi-Fi, so you may want to read Part 3 (RFR) before Part 2 (Electricity). It's entirely up to you.

The information provided can get quite technical at times, covering topics like polarisation, modulation, mitochondria, and voltage-gated calcium channels. I have tried to explain jargon and complex concepts in everyday language, but some of the text may not be immediately understandable, depending on your technical background. This should not pose a barrier to understanding. I suggest you simply skip the parts you don't immediately understand and read on.

Throughout the book, I have cited many references for those who wish to go deeper. I have prioritised information from peer-reviewed scientific studies as this has the highest perceived reliability. These studies, published in scientific journals, will not suddenly disappear and be replaced by an "Error 404 Code – Not Found". Unfortunately, in many cases, the full text of the article is often very expensive to access. However, the abstracts of these publications are nearly always available for free, and with a bit of persistence, you can usually find the full article without having to take out a second mortgage. Search for "how to access scientific journal articles for free" for details. I have also cited blogs, YouTube videos, newspaper articles and other material with less academic credibility and often a shorter shelf life. This is because such material is relatively easy to understand, can be of high quality, and is often the only source of practical information about certain topics. I have deliberately minimised references to commercially available products. The EMF landscape is rapidly evolving, and consequently, products come and go. So, a reference to, for example, a particular brand of EMF meter/detector (an instrument for measuring EMFs) may be valid at the time of writing but obsolete by the time the words are read (more on the various types of EMF meter in Chapter 6 – *Measuring EMFs* and throughout the book). One way I have got around the evolving landscape issue is by inserting "Search the Internet" sections for particular topics so that you can find up-to-date information using search engine terms that have worked for me.

To reiterate, this book is written primarily to provide information for those seeking to minimise their exposure to non-native EMFs to improve/optimize their health, not as medical advice to those with severe chronic disease. Although ways of reducing the EMF burden for those with chronic diseases are discussed, the information provided in this book is no substitute for the support of a knowledgeable and experienced health professional.

References

1. Peitsch, D., Fietz, A., Hertel, H., de Souza, J., Ventura, D.F., Menzel, R. The spectral input systems of hymenopteran insects and their receptor-based colour vision. *Journal of Comparative Physiology. A, Sensory, Neural, and Behavioral Physiology*. **170** (1), 23–40, doi: 10.1007/BF00190398 (1992).
2. Tali, D. Animals That Can See Infrared Light. *Sciencing*. at <<https://sciencing.com/animals-can-see-infrared-light-6910261.html>> (2018).
3. Becker, R.O., Selden, G. *The Body Electric: Electromagnetism and the Foundation of Life*. William Morrow. New York. (1998).
4. Firstenberg, A. *The Invisible Rainbow: A History of Electricity and Life*. Chelsea Green Publishing Company. White River Junction. (2020).
5. What is Building Biology? *Institute of Building Biology + Sustainability IBN*. at <<https://buildingbiology.com/what-is-building-biology/>>.

Chapter 2. EMFs – What They Are and Why They Matter

What is an EMF?

An electromagnetic field (EMF), sometimes also known as electromagnetic radiation (EMR), is generated by charged particles such as electrons. All electrically charged particles are surrounded by electric fields, while magnetic fields are generated by charged particles in motion. Electromagnetism is a natural phenomenon essential to life on our planet; it is energy that travels in waves. It is also known as electromagnetic radiation because the energy radiates from a point of origin. Radiation is just a descriptive term with no inherently sinister meaning, although it has come to be commonly perceived as something harmful.

EMFs can be measured in terms of their wavelength (the distance between the crests of successive waves) and frequency (the number of wave crests or ‘cycles’ that pass a given point per unit of time). The hertz (Hz), in addition to being a vehicle rental business, is a unit of frequency. 1 Hz equals one wave or cycle per second. Commonly used multiples of hertz are:

- kilohertz (kHz) 1 kHz is one thousand (10^3) Hz,
- megahertz (MHz) 1 MHz is one million (10^6) Hz, and
- gigahertz (GHz) 1 GHz is one billion (10^9) Hz.

Less commonly used multiples of hertz include terahertz (THz) 10^{12} Hz, petahertz (PHz) 10^{15} Hz, and exahertz (EHz) 10^{18} Hz. Fractions of hertz denote frequencies of less than one cycle per second and include millihertz (mHz) thousandths of a hertz, and microhertz (μ Hz) millionths of a hertz. Wavelengths are measured in metres and multiples or fractions of metres. For example, radiation with frequencies of 1 Hz and 1 THz would have wavelengths of nearly 300,000 Km and 0.3 mm, respectively. For comparison, visible light frequencies range from about 430 THz (red) – to 750 THz (violet), with corresponding wavelengths of between 700 and 400 nanometres. A nanometre equals one billionth of a metre (10^{-9}).

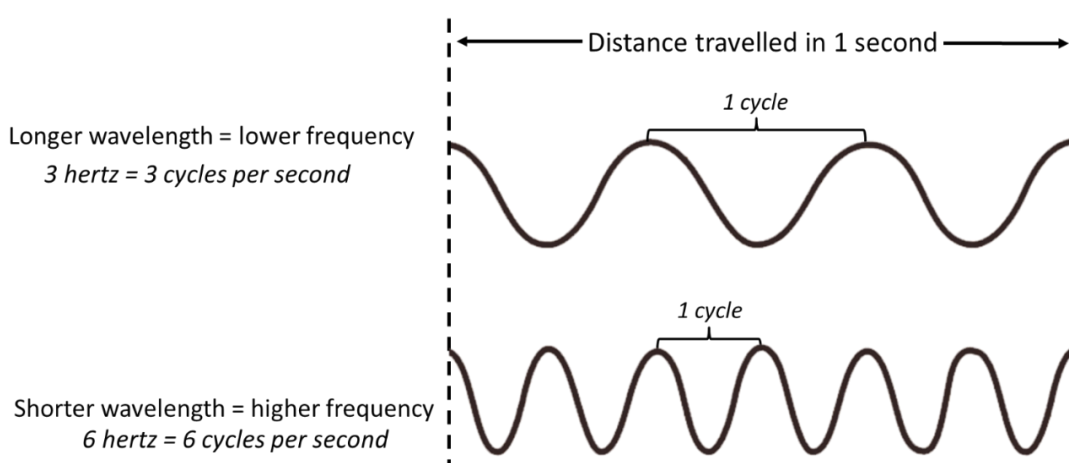


Figure 2.1: A wave with a longer wavelength (top) has a lower frequency because fewer waves pass a given point per unit of time. A wave with a shorter wavelength (bottom) has a higher frequency.

As outlined above and illustrated in the figure below, the electromagnetic spectrum (EMS) covers a vast range of frequencies ranging from extremely low frequency (ELF), such as *geomagnetic field-line resonances* with frequencies ranging between 1 mHz (millihertz) and 100 mHz and wavelengths much larger than the Earth’s circumference, and the *Schumann Resonance* (known as the *Earth’s pulse*), with a fundamental frequency of 7.83 Hz and a wavelength

of the size of the Earth’s circumference; to extremely high frequencies such as *Gamma rays* with a wavelength of a fraction of the size of an atomic nucleus and frequencies of many billions of hertz.

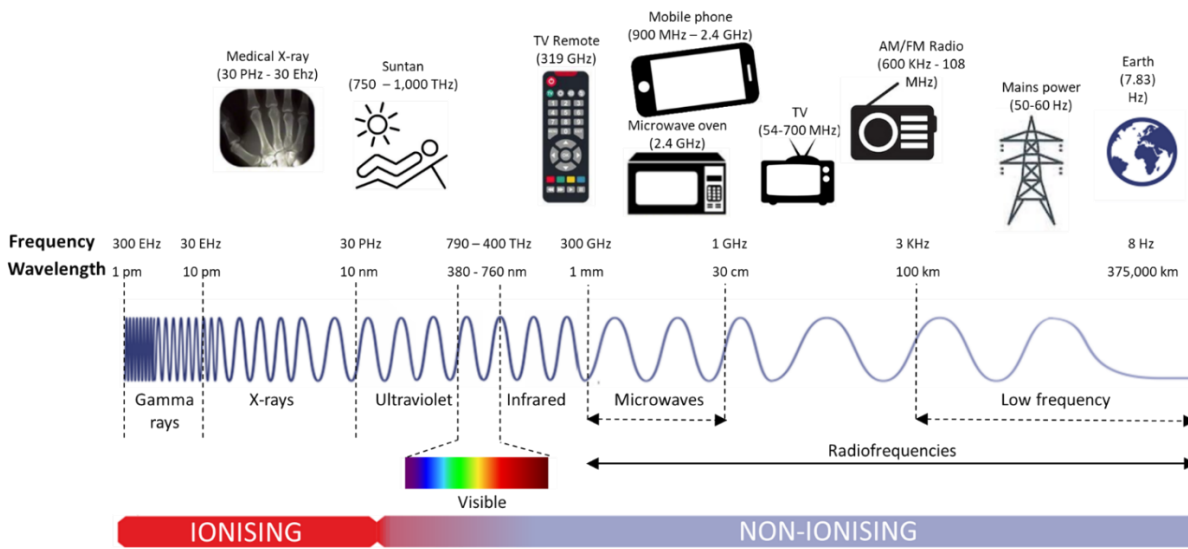


Figure 2.2: Natural and non-native EMFs along the electromagnetic spectrum. Ionising radiation (IR) dislodges electrons from atoms and molecules, causing them to become charged (ionised). Non-ionising radiation (NIR) does not have enough energy to *directly* dislodge electrons. There are no sharp, well-defined boundaries in the electromagnetic spectrum, so you will see some variation in the values quoted in the literature for the various EMF categories.

The benefits of EMFs

As previously stated, EMFs are essential to life on Earth. Here are just a few ways in which natural or “native” EMFs help to maintain the health of our bodies, ecosystems, and the planet.

The Earth’s magnetic field provides a natural shield that protects it from cosmic rays. Without this field, most of the ozone layer, which safeguards the Earth from harmful UV radiation, would be depleted. Many species, such as some birds, fish and insects, rely on the Earth’s magnetic field for long-distance migration. Humans have also utilised this field for navigation since the invention of the compass in China over 2,000 years ago. There is growing evidence that fundamental physiological systems are affected by natural extremely low frequency (ELF) fields.¹ The Schumann Resonance (SR) frequencies are approximately 7.83, 14, 20, 26, 33, 39, and 45 Hz, which closely corresponds with human brainwaves—alpha (8–12 Hz), beta (12–30 Hz), and gamma (30–100 Hz).² SR and field-line resonances also produce a range of frequencies that overlap with those of the autonomic nervous system and the cardiovascular system.³ Rhythms produced by the brain and heart have been shown to be strongly affected by changes in the Earth’s natural magnetic fields.^{4,5}

Visible light is vital for life in myriad ways, a few of which I will touch upon here. Energy from light, converted by green plants through photosynthesis, is the source of food generation for all living organisms on the planet. Photosynthesis brings Einstein’s famous $E = MC^2$ (energy = mass multiplied by the speed of light squared) equation to life. Cutting-edge research is now showing that animal cells can also derive energy directly from the sun, not, of course, to the extent that green plant cells can, but sun-derived energy is likely to play an important part in our metabolism.⁶ Vitamin D is formed by the action of medium-wavelength ultraviolet (UVB) radiation from sunlight on the skin. Vitamin D supports multiple systems, including the immune, nervous and skeletal systems.⁷ The natural rhythms of night and day calibrate the living clocks found in most animal and plant cells. The importance of these daily or *circadian* rhythms is covered in detail in Part 4 (*Light – More Than the Eye Can See*). Light, particularly short-wavelength ultraviolet (UVC), is an excellent sterilising agent, providing a safe alternative and environmentally friendly way to kill bacteria, yeast, mould and viruses.⁸

EMFs can have a wide range of beneficial health applications, with over 4,000 scientific articles on the subject.⁹ Grounding or earthing,¹⁰ discussed in Chapter 9, utilises the antioxidant properties of the Earth’s surface; various types of EMF have been used to stimulate therapeutic bone growth,¹¹ infrared saunas are growing in popularity with increasing evidence of their many health benefits,¹² lasers have been used to decrease inflammation and repair damaged tissue¹³ as have LEDs,¹⁴ and radiotherapy is a standard cancer treatment. We should also not forget that a range of EMFs are utilised in medical diagnostics and monitoring procedures, including X-rays, magnetic resonance imaging (MRI), and electrocardiograms (ECGs).

Last but not least, it is important to acknowledge that EMFs have been harnessed for innumerable technological breakthroughs. Notable benefits have stemmed from the production of electricity and the use of radio frequency radiation (RFR).

So, it is clear that EMFs can be highly beneficial and, in fact, essential for life on our planet. But can we have too much of a good thing? The simple and emphatic answer is yes. This is vividly illustrated in my family. Being half-Irish and half-Mauritian has provided me with plenty of case studies regarding the effects of excess sun exposure on the translucent Celtic skin, notably when members of the Irish clan visit Mauritius who, if they’re not careful, soon come to resemble the lobsters served up in the island’s high-end hotels. The effect of excess UVB on sunburn and its contribution to certain forms of skin cancer is very well-known,⁷ although the relationship between UVB, sunburn, and skin cancer is complex, as outlined in Part 4.

EMF exposure guidelines

The wide-ranging health impacts of non-native EMFs are less immediately obvious, not very well known and far from universally accepted. However, there are many thousands of scientific publications documenting the negative health impacts of non-native EMFs below the official exposure guidelines;⁹ and, in my opinion, and the opinion of many others, the exponential growth of EMF exposure in recent times is among the greatest threats to our health and the health of the planet upon which all life depends.

Throughout this book, I refer to exposure “guidelines” rather than “safety standards”.¹⁵ The fact is that nobody knows what the lowest safe EMF level should be. Our lack of definitive knowledge is made clear by the *BioInitiative Working Group*, which has formulated precautionary EMF exposure guidelines based on published studies of EMF health impacts. When discussing these guidelines, the authors state that “These levels may need to change in the future, as new and better studies are completed.”¹⁶ Scientific publications usually conclude with a call for more studies. A cynic might say that this is motivated by fence-sitting and job retention, but scientific knowledge is always provisional. In the absence of perfect information on the threshold levels above which the EMF causes harm, I like to follow the **ALARA** approach and keep my EMF exposure **As Low As Reasonably Achievable**.

The rise of non-native EMFs in the modern world

People started to generate EMFs in significant quantities in the late 1800s with the invention of the electric lightbulb and the spread of electrification. We are now at the point where EMF levels in certain wavelengths are dramatically higher than they were just a handful of generations ago. The figure below shows the rise in EMF levels since that first light bulb moment. The graphic might be quite tricky to interpret, but it is important to note a couple of points. First, the typical daily human exposures are below international guidelines. That does not mean that these exposures are safe, as these guidelines are irresponsibly lax and based on wilful ignorance of biology, an observation I will return to throughout the book. Second, the increases from the 1920s are truly mind-boggling although this may not be apparent at first glance when you look at the figure below. The increase in EMF emissions is portrayed on a logarithmic scale in which each increment represents a change of three orders of magnitude. For clarity, one order of magnitude represents a 10-fold change, two orders of magnitude represent a 100-fold change, and three orders of magnitude, as you may have surmised, represent a 1,000-fold change. An illustration of the astronomical numbers

we are talking about is the **one quintillion times increase in radiation at 1 GHz in 90 years** – 1 GHz is a common frequency used by mobile phones and Wi-Fi. One quintillion is one, followed by 18 zeros or one billion billion. Humans are not programmed to get their heads around very large or very small numbers, but this illustration may help. If I wanted to represent one quintillion on a linear scale with each increment represented by 1 cm, then the chart would need to be ten billion kilometres tall (for comparison, the average distance between the Sun and the Earth is around 150 million kilometres). And some people wonder why folks don't always use linear scales!

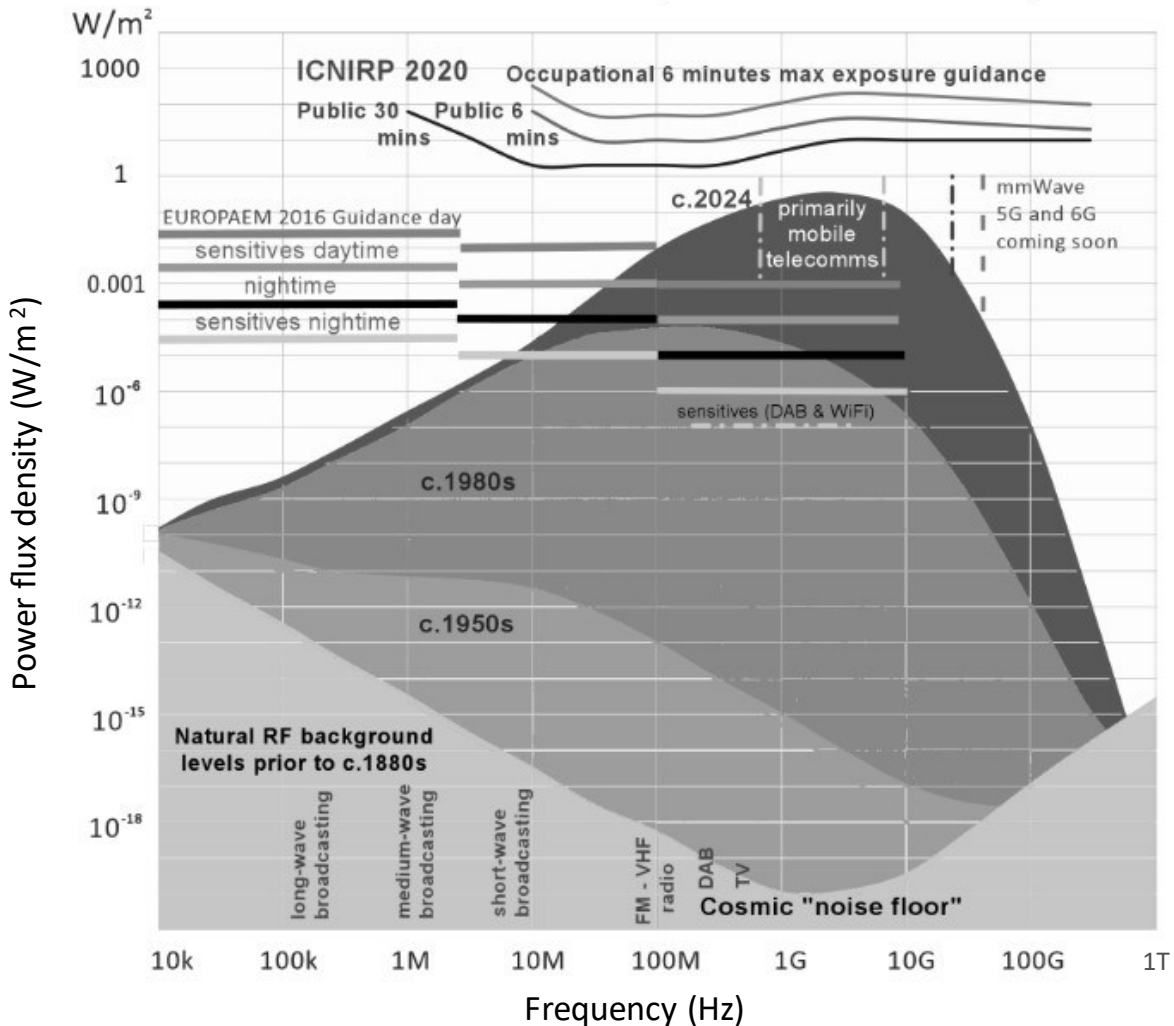


Figure 2.3: Typical maximum daily exposure to radio frequency electromagnetic radiation from non-native and natural power flux densities compared to exposure guidelines. The shaded areas show common exposure levels in different periods. Updated from Philips & Lamburn 2012.¹⁷

Notice that what was a "valley" in the natural levels of radio frequency radiation in the megahertz and gigahertz ranges prior to the 1880s has now become a "mountain".

Table 2.1: Modern EMF levels compared to natural background levels. Sources: 1. Powerwatch (no date);¹⁸ 2. Urbinello et al. (2014);¹⁹ 3. Halgamuge et al. (2018);²⁰ 4. National Research Council (US) (1997).²¹

Type of EMF	Background EMF levels ¹	Modern EMF levels	Increase
Radio Frequency (RF)	<0.000001 $\mu\text{W}/\text{m}^2$	660 $\mu\text{W}/\text{m}^2$ (outdoors in a city) ²²	660 million x
Magnetic Field (MF)	0.0000002 μT	0.085 μT (in homes) ³	422,500 x
Electric Field (EF)	0.0001 V/m	7.5 V/m (in homes) ⁴	75,000 x

These are dramatic increases that are hard to wrap our heads around. But do they actually matter? I passionately believe that they do, while many people, if they are even aware of the issue, do not. Why are people like me in such a minority? I put this down to a combination of factors: the fact that we cannot directly sense most EMF frequencies, the marketing dressed as science promulgated by powerful vested interests, and the utility and convenience of much of the technology that encourages many of us to bury our heads in the sand.

Characteristics of non-native EMFs

It is not just the quantity of non-native EMFs that is a concern but also the nature of these artificially generated frequencies. Here, I summarise some of the main qualities that characterise EMFs and how non-native EMFs differ from natural EMFs in many respects.

Energy and power. These terms are commonly used interchangeably, but when looking at EMFs, it is important to tease out the difference. Energy is the ability to do work, and the higher the frequency, the more energy. Power, measured in watts (W), is the rate at which the work can be performed. Everybody agrees that low energy radiation at high power levels can be dangerous. The impacts of two well-known low-energy but high-power phenomena, lightning strikes and the electric chair, vividly illustrate this point.²³ Higher-powered signals of similar frequencies will travel further. Hence, a cell tower at a distance of 500 metres may be a cause for concern, while a mobile phone at the same distance is much less likely to cause any problems.

Prevailing international safety guidelines are based on the belief that low-energy radiation causes less damage than higher-energy radiation, so guidelines can be more permissive for the former. It is acknowledged that microwave/radio wave radiation can be harmful, but only at the kinds of power levels used in a microwave oven, not those used in a mobile phone. This has led to the “Thermal Effects Only” dogma that, other than electrocution, the only harmful effects of non-ionising radiation (NIR) that we need to be concerned about are those caused by power levels high enough to result in heating. This dogma, which ignores the plethora of documented non-thermal effects of non-ionising radiation on fundamental biological processes⁹ has resulted in permissive and unrealistic safety guidelines.

The benchmark used is that radiation should be less than that which would cause a rise in body temperature of one degree Celsius. This is expressed as a specific absorption rate (SAR), which is the rate at which radiation is absorbed by the human body and measured in watts per kilogram (W/kg). Phones are given SAR ratings, and the higher the SAR, the greater the amount of radiation that is likely to be absorbed by the head. The UK uses a SAR guideline of 2 W/kg maximum in any 10 grams of tissue.²⁴

Ionising and non-ionising radiation. To remind you, ionising radiation is high-frequency EMFs with the energy to dislodge electrons from atoms and molecules, causing them to become charged (*ionised*). This category includes higher-energy UVB and UVC radiation, X-rays, and Gamma rays. Non-ionising radiation does not have enough energy to *directly* dislodge electrons. This category includes visible light, infrared light, radio waves and power frequency EMF.

Frequency. The frequencies of non-native EMFs are very different from those prevailing in nature, with dominant natural frequencies of between 1 and 100 mHz (field-line resonances generated by the Earth’s magnetic field and the solar wind), 7.83–45 Hz (the Schumann Resonance generated and maintained by lightning strikes around the world) and 300 GHz–3 PHz (infrared, visible light, and UVA and UVB). As discussed throughout this book, public concern over EMFs dates back many years and was initially mainly focused on power frequency EMFs.²⁵ These issues have not gone away, but most of the attention has shifted towards radio frequency EMFs, with concerns over mobile phones and Wi-Fi taking centre stage. Recent research is starting to reveal that there is not a simple progression of increasing harm with increasing frequencies. Rather, it appears that particular EMF frequency windows and patterns are beneficial while others are harmful.²⁶ This concept is not new, with scientific knowledge of the fact that nature’s electromagnetic fields are vital to health dating back to the 1960s.²⁷ Cornell University neuroscientist Allan Frey, whose studies demolished the “Thermal Effects Only” dogma way back in the 1970s^{28, 29} eloquently articulates this perspective:

“We are operating with the wrong model, expecting that we will see a dose-response relationship. The appropriate model is more like a radio tuner. You can listen to some nice music when the signal that is transduced properly is tuned to the right frequency. But if you tune it wrong, you get static that can wreak havoc. I showed that I could take a beating heart within a frog and set it up so that I put out a very, very small signal, way below our safety standards today. If I put out a single pulse at different points in the cardiogram cycle, most of the time the heart ignored it. If I put it in at a certain point in the heart cycle, I could stop the heart by tuning it incorrectly.”³⁰

The idea that our body is tuned into certain fundamental frequencies predates modern science by thousands of years and is articulated in many branches of traditional healing, notably in acupuncture.³¹ There are numerous research reports of biological effects of EMFs exhibiting intensity “windows” – regions of intensity that cause changes surrounded by higher and lower intensities that show no effects.³²⁻³⁷

Modulation. Modulation allows EMFs to transmit information. Most Wi-Fi-enabled devices nowadays operate at 2.4 GHz (the “carrier frequency”) with lower “data frequencies” incorporated. This modulation means that the radiation is transmitted in pulses rather than in continuous waves. Pulsed radiation of this kind is not found in nature and can be more harmful than continuous wave radiation.³⁸ Modulation can be visualised using the following analogy. Suppose you want to throw a note written on a piece of paper to a friend who is standing 10 metres away. If you simply chuck the paper, it will not reach your friend, but if you securely wrap the piece of paper around a stone, it will easily carry to your friend, assuming you have a sound throwing arm. The stone is the equivalent of the carrier frequency, and the note is the data frequency.

Polarisation. Most types of non-native EMFs are polarised (or “focused”), meaning that they constantly oscillate in one plane (see figure below), so all the energy is being focussed in a single direction. In contrast, natural EMFs of all types are unpolarised or partially polarised (or “balanced”), meaning that they oscillate in multiple planes. Prior to recent history, our biology has never experienced polarised EMFs.³⁹

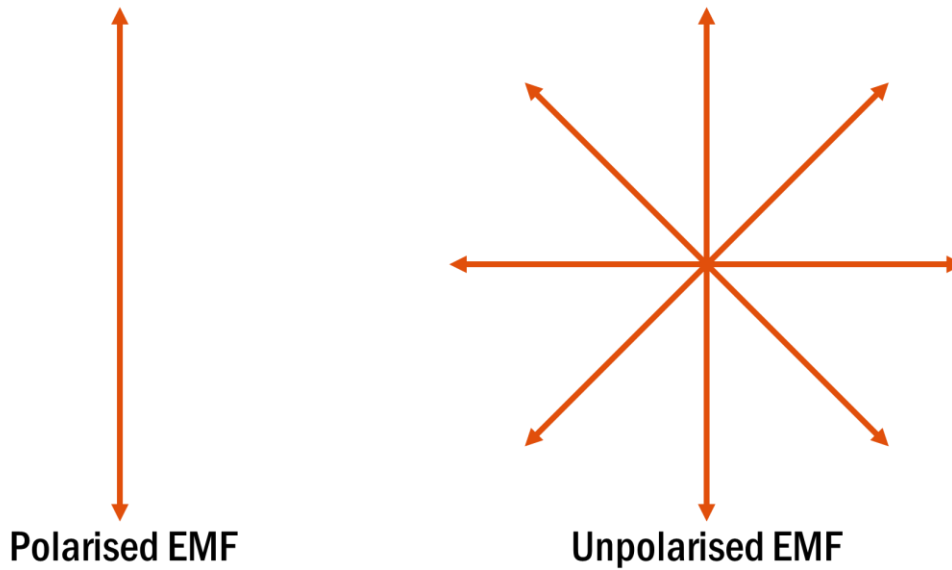


Figure 2.4: *Polarised versus non-polarised EMFs. Source: Panagopoulos (2018).⁴⁰*

Variability. To increase the capacity to transmit information, non-native EMFs in the radio frequency range are designed to be highly variable with pulsed low-frequency signals overlaid on an RF “carrier wave”. This induces a great deal of variability. Panagopoulos *et al.* (2015)⁴¹ state that “the intensity of radiation varies significantly each moment during a usual phone conversation depending on signal reception, number of subscribers sharing the frequency band each moment, air conductivity, location within the wireless infrastructure, presence of objects and metallic surfaces.” This variability is even greater when it comes to signals from cell towers which simultaneously serve multiple users. This unpredictability is likely to be a significant contributory factor in causing considerable biological effects as the body struggles to adapt to ever-changing stimuli.

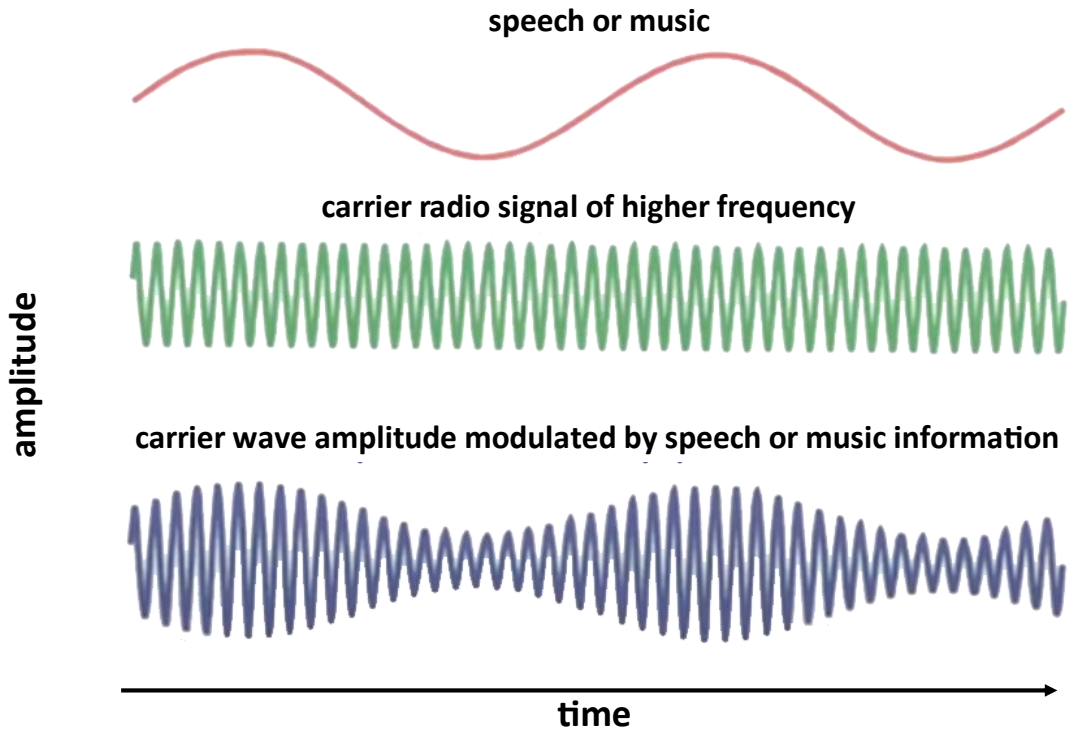


Figure 2.5: *Theoretical mobile phone signal. Adapted from Panagopoulos (2018).⁴⁰*

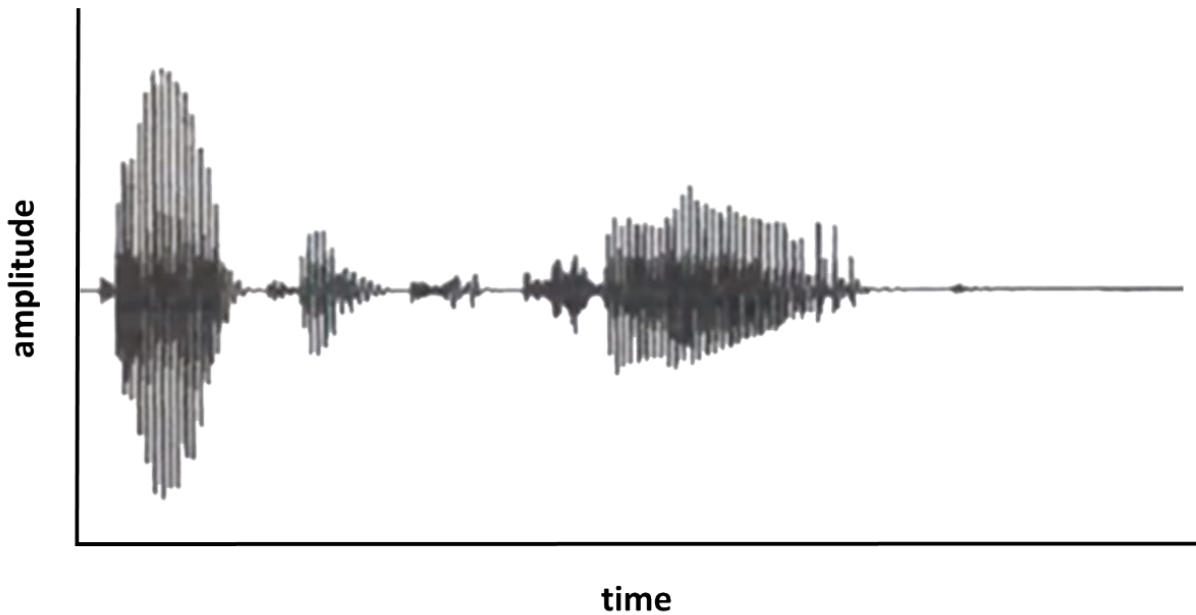


Figure 2.6: *Real-life example of mobile phone signal. Source: Panagopoulos (2018).*⁴⁰

Cell towers – a note on nomenclature

I have used the term “cell tower” for the entity that transmits and receives mobile phone signals to and from your phone (see Chapter 11 for more details). Cell towers are also known by a plethora of other names, including “mobile phone base stations”, “mobile phone antennas”, “mobile phone transmitters”, and “mobile phone masts”, often abbreviated to “masts”.

All of this has implications for studies on the safety of non-native RFR. Commercial interests and international bodies such as the International Agency for Research on Cancer (IARC) of the World Health Organization (WHO) recommend that researchers studying the biological effects of EMFs employ simulated emissions, which are much simpler than those used in the real world. The stated logic behind this is that using simulated signals will improve consistency and facilitate comparisons between studies because real-world signals are highly variable. This has massive implications for the credibility of much of the published EMF science.

In the review of real versus simulated mobile phone exposures in experimental studies quoted above, Panagopoulos et al. (2015)⁴¹ found that 60% of peer-reviewed experimental studies on RFR found biological effects. This figure fell to 50% in studies using simulated exposures and rose to a whopping 98% in studies using real-life exposures. You would have to be a highly charitable soul to conclude that those who advocate using simulated exposures are merely naïve. Could it be that those executing such studies have an interest in not showing effects? A focus on simulated signals is akin to a researcher claiming that tsunamis cannot exist because we are unable to measure them consistently and precisely.

Multiple sources. From the body’s perspective, multiple sources of radiation can be conceived of as noise which jams the natural EMF signals to which our body is adapted, resulting in a confused and sub-optimal state. A useful analogy is a scenario in which a monolingual person is trying to follow a conversation in a multilingual setting with all the speakers speaking in a different language at the same time, as illustrated in the figure below. At first, there is no problem. Then a French speaker joins in, and the signal is more difficult to interpret, but it can still be discerned. Next, an Arabic speaker enters into the fray, and the signal becomes further obscured. Finally, with the addition of a Chinese speaker, the signal is all but scrambled.

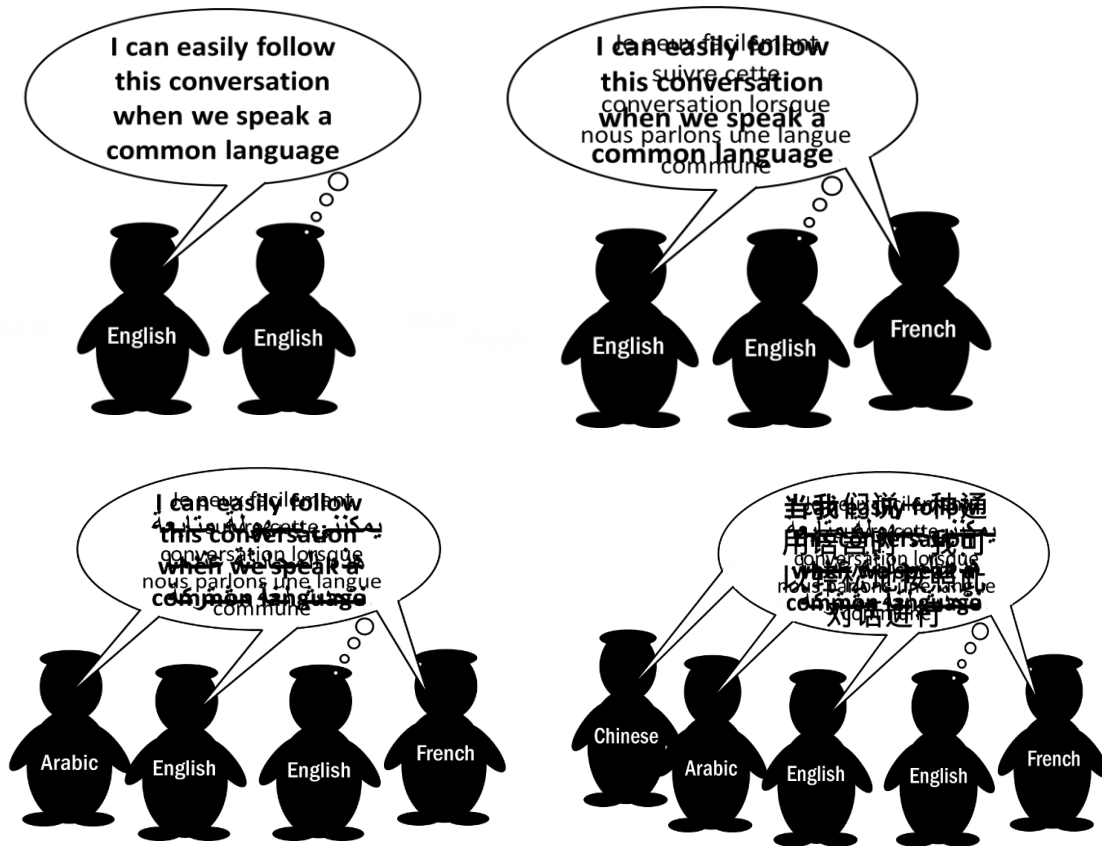


Figure 2.7: Man-made EMFs: Jamming Nature’s Signals.

As I don't know any Arabic or Chinese, I had to use Google Translate, so please forgive me if the non-English is a bit eccentric, but I think you get the point. If you managed to disentangle the signal from the noise of Arabic and Chinese writing, I am very impressed. You may even be one of those people who is not susceptible to the signal-jamming effects of non-native EMFs!

A note on measurement units

Sincere apologies for the technical material in this book. They can be hard to get one's head around. One such head-scratcher is measurement units. So far, we've been exposed to the following:

- hertz (Hz): A measure of frequency
- watts per kilogram of body tissue (W/kg): A measure of specific absorption rate (SAR)
- volts per metre (V/m): A measure of the strength of an electric field
- tesla (T) or, more likely, microtesla (μT) or nanotesla (nT): A measure of the strength of a magnetic field. $1\mu\text{T}$ is one-millionth of a tesla, and 1 nT is one billionth of a tesla

Here are a few other measurement units you will come across in your journey through the EMF landscape, either in this book or elsewhere:

- gauss (G, sometimes Gs) or, more likely, milligauss (mG): A measure of the strength of a magnetic field used in the USA and Australia. $1\text{ mG} = 0.1\ \mu\text{T}$
- watts per metre squared (W/m^2): A measure of the “power flux density” (PFD) of an electric field. PFD is the power of the radiation in watts over the size of the area covered. We usually use microwatts and sometimes milliwatts per metre squared. One milliwatt per metre squared (mW/m^2) is equivalent to 1,000 microwatts per metre squared ($\mu\text{W}/\text{m}^2$)

In principle, you can convert volts per metre into watts per metre squared, and this is quite straightforward where you have continuous waves such as high-frequency FM radio signals. However, conversions can be misleading when the signal is pulsed, as it is for most RF signals, such as those from mobile phones, routers, and DECT (Digital Enhanced Cordless Telecommunications) cordless phones. See [Powerwatch](#) for more details.⁴²

References

1. Price, C., Williams, E., Elhalel, G., Sentman, D. Natural ELF fields in the atmosphere and in living organisms. *International Journal of Biometeorology*. **65** (1), 85–92, doi: 10.1007/s00484-020-01864-6 (2021).
2. The Global Coherence Initiative Investigating the Dynamic Relationship Between People and Earth’s Energetic Systems. *HeartMath Institute*. at <<https://www.heartmath.org/research/research-library/coherence/global-coherence-initiative-investigating-dynamic-relationship-people-earths-energetic-systems/>>.
3. Timofejeva, I. *et al.* Global Study of Human Heart Rhythm Synchronization with the Earth’s Time Varying Magnetic Field. *Applied Sciences*. **11** (7), 2935, doi: 10.3390/app11072935 (2021).
4. Wang, C.X. *et al.* Transduction of the Geomagnetic Field as Evidenced from alpha-Band Activity in the Human Brain. *eNeuro*. **6** (2), doi: 10.1523/ENEURO.0483-18.2019 (2019).
5. Timofejeva, I. *et al.* Identification of a Group’s Physiological Synchronization with Earth’s Magnetic Field. *International Journal of Environmental Research and Public Health*. **14** (9), 998, doi: 10.3390/ijerph14090998 (2017).
6. Xu, C., Zhang, J., Mihai, D.M., Washington, I. Light-harvesting chlorophyll pigments enable mammalian mitochondria to capture photonic energy and produce ATP. *Journal of Cell Science*. **127** (Pt 2), 388–399, doi: 10.1242/jcs.134262 (2014).
7. Reichrath, J., Reichrath, S. Hope and challenge: the importance of ultraviolet (UV) radiation for cutaneous vitamin D synthesis and skin cancer. *Scandinavian Journal of Clinical and Laboratory Investigation. Supplementum*. **243**, 112–119, doi: 10.3109/00365513.2012.682876 (2012).
8. Yin, R. *et al.* Light based anti-infectives: ultraviolet C irradiation, photodynamic therapy, blue light, and beyond. *Current Opinion in Pharmacology*. **13** (5), 731–762, doi: 10.1016/j.coph.2013.08.009 (2013).
9. Pall, M. 5G: Great risk for EU, U.S. and International Health! Compelling Evidence for Eight Distinct Types of Great Harm Caused by Electromagnetic Field (EMF) Exposures and the Mechanism that Causes Them. at <<https://phibetaiota.net/2019/03/dr-martin-pall-5g-criminally-insane-electromagnetic-fields-emf-fry-living-things/>> (2019).
10. Ober, C., Sinatra, S.T., Zucker, M. *Earthing: the most important health discovery ever!*. Basic Health Publications Inc. (2014).
11. Pall, M.L. Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects. *Journal of Cellular and Molecular Medicine*. **17** (8), 958–965, doi: 10.1111/jcmm.12088 (2013).
12. Crinnion, W.J. Sauna as a valuable clinical tool for cardiovascular, autoimmune, toxicant-induced and other chronic health problems. *Alternative Medicine Review: A Journal of Clinical Therapeutic*. **16** (3), 215–225 (2011).
13. Alves, A.C.A. *et al.* Low-level laser therapy in different stages of rheumatoid arthritis: a histological study. *Lasers in Medical Science*. **28** (2), 529–536, doi: 10.1007/s10103-012-1102-7 (2013).
14. Kim, W.-S., Calderhead, R.G. Is Light-Emitting Diode Phototherapy (led-LlIt) Really Effective? *Laser Therapy*. **20** (3), 205–215, doi: 10.5978/islsm.20.205 (2011).
15. EHT Outdated FCC “Safety” Standards. *Environmental Health Trust*. at <<https://ehtrust.org/policy/fcc-safety-standards/>>.
16. *BioInitiative Report: A Rationale for Biologically-based Exposure Standards for Low-Intensity Electromagnetic Radiation (December 31, 2012, last updated 2019)*. at <<https://bioinitiative.org/>>. (2019).
17. Philips, A., Lamburn, G. Natural background Electromagnetic Field (EMF) Levels on Earth. at <bemri.org/publications/natural-fields/427-natural-and-human-activity-generated-electromagnetic-fields-on-earth/file> (2012).
18. International guidance levels. *Powerwatch*. at <<https://powerwatch.org.uk/science/intguidance.asp>>.
19. Urbinello, D., Joseph, W., Verloock, L., Martens, L., Rööslı, M. Temporal trends of radio-frequency electromagnetic field (RF-EMF) exposure in everyday environments across European cities. *Environmental Research*. **134**, 134–142, doi: 10.1016/j.envres.2014.07.003 (2014).

20. Halgamuge, M.N., McLean, L. Measurement and analysis of power-frequency magnetic fields in residences: Results from a pilot study. *Measurement*. **125**, 415–424, doi: 10.1016/j.measurement.2018.05.007 (2018).
21. National Research Council (US) Committee on the Possible Effects of Electromagnetic Fields on Biologic Systems *Possible Health Effects of Exposure to Residential Electric And Magnetic Fields*. at <<http://www.ncbi.nlm.nih.gov/books/NBK232736/>>. National Academies Press (US). Washington (DC). (1997).
22. Sagar, S. *et al.* Radiofrequency electromagnetic field exposure in everyday microenvironments in Europe: A systematic literature review. *Journal of Exposure Science & Environmental Epidemiology*. **28** (2), 147–160, doi: 10.1038/jes.2017.13 (2018).
23. Blank, M. *Overpowered*. Seven Stories Press, U.S. New York. (2015).
24. International Commission on Non-Ionizing Radiation Protection Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). International Commission on Non-Ionizing Radiation Protection. *Health Physics*. **74** (4), 494–522 (1998).
25. Marino, A.A. *Going Somewhere: Truth about a Life in Science*. Cassandra Publishing. Belcher, LA. (2010).
26. Geesink, J.H., Meijer, D.K.F. Bio-soliton model that predicts non-thermal electromagnetic frequency bands, that either stabilize or destabilize living cells. *Electromagnetic Biology and Medicine*. **36** (4), 357–378, doi: 10.1080/15368378.2017.1389752 (2017).
27. Danho, S., Schoellhorn, W., Aclan, M. Innovative technical implementation of the Schumann resonances and its influence on organisms and biological cells. *IOP Conference Series: Materials Science and Engineering*. **564**, 012081, doi: 10.1088/1757-899X/564/1/012081 (2019).
28. Frey, A.H. Differential biologic effects of pulsed and continuous electromagnetic fields and mechanisms of effect. *Annals of the New York Academy of Sciences*. **238**, 273–279, doi: 10.1111/j.1749-6632.1974.tb26796.x (1974).
29. Frey, A.H., Feld, S.R., Frey, B. Neural function and behavior: defining the relationship. *Annals of the New York Academy of Sciences*. **247**, 433–439, doi: 10.1111/j.1749-6632.1975.tb36019.x (1975).
30. Davis, D.L. *Disconnect: The Truth About Cell Phone Radiation, What the Industry is Doing to Hide it, and How to Protect Your Family*. Plume. (2013).
31. Wei, J., Mao, H., Zhou, Y., Wang, L., Liu, S., Shen, X. Research on nonlinear feature of electrical resistance of acupuncture points. *Evidence-Based Complementary and Alternative Medicine: eCAM*. **2012**, 179657, doi: 10.1155/2012/179657 (2012).
32. Dutta, S.K., Ghosh, B., Blackman, C.F. Radiofrequency radiation-induced calcium ion efflux enhancement from human and other neuroblastoma cells in culture. *Bioelectromagnetics*. **10** (2), 197–202, doi: 10.1002/bem.2250100208 (1989).
33. Blackman, C. Cell phone radiation: Evidence from ELF and RF studies supporting more inclusive risk identification and assessment. *Pathophysiology: The Official Journal of the International Society for Pathophysiology*. **16** (2–3), 205–216, doi: 10.1016/j.pathophys.2009.02.001 (2009).
34. Blackman, C.F., Benane, S.G., Kinney, L.S., Joines, W.T., House, D.E. Effects of ELF fields on calcium-ion efflux from brain tissue in vitro. *Radiation Research*. **92** (3), 510–520 (1982).
35. Blackman, C.F., Benane, S.G., Joines, W.T., Hollis, M.A., House, D.E. Calcium-ion efflux from brain tissue: power-density versus internal field-intensity dependencies at 50-MHz RF radiation. *Bioelectromagnetics*. **1** (3), 277–283, doi: 10.1002/bem.2250010304 (1980).
36. Blackman, C.F., Benane, S.G., Elliott, D.J., House, D.E., Pollock, M.M. Influence of electromagnetic fields on the efflux of calcium ions from brain tissue in vitro: A three-model analysis consistent with the frequency response up to 510 Hz. *Bioelectromagnetics*. **9** (3), 215–227, doi: 10.1002/bem.2250090303 (1988).
37. Dutta, S.K., Das, K., Ghosh, B., Blackman, C.F. Dose dependence of acetylcholinesterase activity in neuroblastoma cells exposed to modulated radio-frequency electromagnetic radiation. *Bioelectromagnetics*. **13** (4), 317–322, doi: 10.1002/bem.2250130407 (1992).

38. Panagopoulos, D.J. Analyzing the Health Impacts of Modern Telecommunications Microwaves. *Advances in Medicine and Biology*. **17**, 55 (2011).
39. Panagopoulos, D., Johansson, O., Carlo, G. Polarization: A Key Difference between Man-made and Natural Electromagnetic Fields, in regard to Biological Activity. *Scientific Reports*. **5**, 14914–14914, doi: 10.1038/srep14914 (2015).
40. *Dr. Dimitris Panagopoulos: Electromagnetic Fields - Health Effects - Mechanism of Action*. at <<https://www.youtube.com/watch?v=adGtb0kxsDM>>. (2018).
41. Panagopoulos, D.J., Johansson, O., Carlo, G.L. Real versus Simulated Mobile Phone Exposures in Experimental Studies. *BioMed Research International*. **2015**, e607053, doi: <https://doi.org/10.1155/2015/607053> (2015).
42. Powerwatch Conversion of RF Units. at <<https://www.powerwatch.org.uk/science/unitconversion.asp>>.

Chapter 3. EMFs – Perspectives on Health Impacts

The issue of whether or not non-native electromagnetic fields are a health threat is a “controversial” topic, meaning that there are a number of contrasting and contradictory perspectives on the issue. Everybody claims to have science on their side, which can be very perplexing to the layperson, given the fact that science is widely portrayed as being objective and monolithic. Without delving deeply into the philosophy of science, I would say that science is simply a formalised method of inquiry, using a set of tools to test hypotheses about how the world works. The scientific method is particularly powerful when it comes to the physical sciences and their technological applications. However, science becomes more ambiguous when it comes to the biological sciences. This ambiguity is further compounded when social considerations are added to the mix. So, when it comes to EMF science, should we adopt the nihilistic perspective and hold up our hands and say you can use science to prove anything you want, or should we approach the science with caution underpinned by the knowledge that the conclusions that we all draw are inevitably not as pure as the driven snow? I advocate the latter approach.

When it comes to EMFs, there are four main lines of inquiry upon which conclusions are ostensibly based: exposure and emissions, possible causal mechanisms through which EMFs contribute to health impacts, laboratory animal experiments and epidemiological studies. Exposure and emissions are introduced in Chapter 2, and there is widespread agreement that exposure levels have increased hugely in recent years; and some possible causal mechanisms are outlined in Chapter 4. Here, I will focus on animal experiments and epidemiological studies.

Many of us are not comfortable with the idea of experimenting on animals, but it is difficult to conceive of any other way of carrying out effective studies into the health impacts of potentially toxic substances. Ironically, many of us are immersed in much higher EMF levels than those to which lab animals are exposed. Apart from the ethical considerations, it is easier to undertake controlled experiments on animals than on humans. Animals can be exposed to precise doses of the variable or variables under scrutiny (the ‘treatment’) under standardised conditions. It is also possible to look at unexposed “control animals”, that is, individuals who are not exposed to the treatment. Finding a control population for equivalent human studies of EMF impacts would be essentially impossible in a world where the majority of people are chronically exposed.

Epidemiological studies look at patterns in health status in populations. Researchers investigate the relationships between certain diseases and other health parameters and characteristics of populations, such as diet, weight, smoking habits, neighbourhood, gender, and socioeconomic status. Epidemiological studies of EMF impacts are ever more problematic given the growing ambient EMF levels. To compound this challenging situation, it is becoming increasingly difficult to use personal data for epidemiological studies due to data protection considerations. This is ironic in view of the fact that society has collectively given the likes of Google, Microsoft, Apple, and 23andMe a virtual blank cheque when it comes to harvesting bucketloads of our personal data for the purpose of overt and covert behavioural manipulation, known in polite circles as marketing.

In the remainder of this chapter, I will examine how EMF science translates into perspectives on EMF health impacts and how these perspectives are translated back into science.

The Precautionary, the Procrustean, the Conflicted, the Confused and the Trustful

I suggest broadly categorising people into five groups (“tribes”) on the issue of EMFs and health:

1. **The Precautionaries.** This is my tribe, people who are fearful of the health and environmental threats posed by both ionising and non-ionising EMFs. The Precautionaries claim that current safety guidelines for acceptable radiation levels are based on flawed science. The scientists in this group are almost always funded by non-industry sources. This group cites thousands of studies that have been published over many decades showing the biological impact of EMFs on health.¹ They are guided by the “Precautionary Principle”, which emphasises looking before leaping into innovations that have potentially disastrous consequences and for which scientific investigation has found a plausible risk. Things we do not know with certainty regarding EMFs include their long-term effects, impacts of childhood exposure, cumulative effects, effects of multiple devices, differential susceptibility, interaction with other factors, and how to do long-term controlled studies. The mantra of the Precautionaries is “Prevention is better than cure.” This book is essentially a guide for those wishing to implement a precautionary approach to the management of EMF health impacts.
2. **The Procrustean.** This label was inspired by Don Maisch, who imaginatively titled his 2010 PhD thesis *The Procrustean Approach – Setting Exposure Standards for Telecommunications Frequency Electromagnetic Radiation*.² The term is derived from the ancient Greek legend of Procrustes, or “The Stretcher”, who enticed people to lie down on his bed. He would cut off the limbs of those who were too tall and stretch those too short on a rack until everybody fitted the dimensions of the bed. The term “Procrustean bed” has been used to denote an arbitrary standard to which exact conformity is enforced. Most EMF guidelines were set decades ago. Rather than using the Precautionary Principle, global guideline-setting organisations have followed a Procrustean approach of cutting out findings that do not conform to their predesignated bed of knowledge while stretching any supportive claims to fit the one-size blanket of support for pre-existing guidelines that are applicable to all life, in all circumstances, for all time. The Procrustean state that the only threat from non-ionising EMFs comes from the heating of body tissue (thermal effects) and that the radiation safety guidelines are set to prevent this from happening. So, as long as one adheres to these guidelines, there are no health risks; therefore, current RFR safety guidelines are sufficient. From my perspective, this circular reasoning represents conclusions based on “deeming” rather than evidence – it is deemed to be safe; therefore, it is safe. The scientists in this group are often funded by a multi-trillion dollar set of industries, and industry spokespeople, the mainstream media, and politicians cite the conclusions they provide. The Procrustean’s mantra is “Our emissions conform to agreed safety guidelines.” By the way, prevailing safety standards even fail when it comes to thermal effects – see *EMF safety vs. standards – the case of mobile phones and a man called SAM* later in this chapter for details.
3. **The Conflicted.** This group believes that EMFs constitute a health risk, but they also appreciate the benefits of modern technology – don’t we all? So, they are implicitly willing to accept a trade-off between convenience and health. Many people do not realise there are safer alternatives to business as usual that do not involve living in a cave or dying frozen and friendless in the dark. I will outline many of these EMF-safe options in this book. The mantra of this group is “I know I should do something, but I don’t want to give up my [insert favourite item(s)] ...”
4. **The Confused.** This group hears what appear to be convincing arguments from both the Precautionaries and the Procrustean and see-saws between believing one side or the other depending on factors such as the evidence presented, the credentials of the presenter, which one has the best music or the fanciest clothes, and who spoke loudest or last. Confused people are rarely motivated to take decisive action, and inaction by default means accepting the status quo. This results in familiar mantras such as “You can’t trust any of them” or “They’re all the same.” This plays into the hands of industry, which deliberately, skilfully, and systematically sows the seeds of confusion.

5. **The Trustful.** This might be the largest group – those people who are getting on with their daily lives, barely aware that there is any controversy at all.³ Some people may have heard that there are concerns over mobile phones, powerlines, or microwave ovens, but they assume that the necessary tests have been done and that evidence-based safety measures are in place. The unstated assumptions are that our governments don't lie (“well, they did in the past, but they don't now”) and that the mainstream media is unbiased. The mantra of the trustful is “If there were any harm, the authorities would have done something about it.”

Confusion is our product, and how not to conduct a scientific study

So, who should we trust, given that all sides of the debate claim to have science on their side? My golden rule is that we ought to be wary of the findings of industry-funded studies when the subject of these studies is their potentially harmful but highly lucrative product. Safety studies funded by industry have a long history of poor research quality and preconceived agendas. A number of literature reviews have shown that industry-funded research on adverse EMF health effects is far more likely to show no effects than those funded from non-industry sources.⁴⁻⁷

It is not difficult to design a study that finds no EMF health effects. Here are a few ways to do it.

- **Investigate damage arising from tissue heating effects only.** The heat criterion has been designated by industry because it is an immediate, direct, and extreme effect that only occurs at high power. As stated throughout this book, subscribing to the “Thermal Effects Only” dogma obviates the need to look into any other effects.
- **Focus your study on short time windows.** This will ensure an emphasis on acute over chronic effects, as most chronic conditions, by definition, have a long latency time. Only the small minority of us who are electro hypersensitive (as discussed later in this chapter) suffer acute effects. Devra Davis, in her revealing book *Disconnect: The Truth about Cell Phone Radiation, what the Industry is doing to Hide It, and How to Protect Your Family*,⁸ reported that the results of most epidemiological studies on the relationship between brain cancer and mobile phone use have been inconclusive. The majority of these studies have looked at populations over a period of less than ten years during a time when phones were not used as heavily as they are today. Davis states that “every study that has been able to look at people who have been big talkers on cell phones for a decade or more has found increased risks of brain tumors”.⁸
- **Make your exposures unrealistic.** Many experiments which show no effects do not include the types of pulsing and modulation that are characteristic of non-native EMFs, in particular RFR. A 2019 publication by Dimitris Panagopoulos and colleagues found that “~50% of the studies employing simulated exposures do not find any effects, [while] studies employing real-life exposures from commercially available devices display an almost 100% consistency in showing adverse effects”.⁹
- **Don't investigate synergies.** Most studies do not look at multiple EMF sources, nor do they account for synergistic effects of other toxic stimuli (such as chemicals and pathogens) acting in concert with the EMFs.¹⁰ The few studies that examine the effect of EMFs and other toxic stimuli show much lower levels of tolerance for each toxic stimulus in combination relative to exposure levels that produce adverse effects in isolation.¹¹
- **Turn gold-standard replication into gold-plated replication.** The widely acknowledged “gold standard” for research credibility is the independent replication of research results. In other words, subsequent investigators should be able to replicate the methods used in an experiment and get the same outcomes as the original investigator. On several occasions, subsequent investigators have shown no EMF effects when apparently replicating studies which had shown effects. However, these “independent” scientists have, wittingly or unwittingly, tweaked the methodology in small but important and not always easily apprehended ways. In the early 1990s, University of Washington researchers Henry Lai and Narendra Singh demonstrated for the first time that mobile phone radiation could directly damage the DNA of exposed animals.¹² They detected DNA breaks using a technique called the comet assay. Their findings were subsequently successfully replicated

by many other researchers.¹³ However, Washington University researcher Joseph Roti Roti and colleagues failed to find an effect.^{14, 15} Roti Roti's studies, coincidentally funded by Motorola, used a different version of the comet assay. How likely was this to have been an innocent oversight?

- **Use ambiguous categories.** In research, the greater the differences between categories or treatments, the greater the chances of finding effects. To give an extreme analogy, imagine an inquiry into the relationship between height and basketball prowess. A comparison between people taller than 2 metres and people shorter than 1.5 metres is likely to give a clear result. The results would be far more ambiguous if the categories were people between 2.0 m and 2.02 m vs. people between 2.03 m and 2.05 m. The extensive industry-funded Interphone studies, which looked at mobile phone users in 13 countries between 2000 and 2004, were designed to establish whether RFR caused brain cancers.¹⁶ However, the results were mostly inconclusive, with “regular cell phone users” showing few differences in cancer rates compared with the “unexposed” group. When you look at how the categories were selected, you find that people who used cordless phones (which emit RFR) were treated as unexposed, and a “regular cell phone user” was somebody who made at least one call a week for six months or more. The average person in this category spoke on the phone for two hours a month – about as much time as many people spend on the phone now every day. Devra Davis provides a thorough critique of the Interphone studies.⁸
- **Systematically exclude information.** For meta-analyses (syntheses of quantitative data from multiple publications), use selection criteria to exclude studies likely to show health impacts, such as rejecting studies for “inadequate dosimetry”.¹⁷ This means that the study didn't precisely measure or control the amount and type of EMF exposure used. Upon first reading, this “lack of precision” would seem like reasonable grounds for rejection. In practice, this ends up excluding studies that use real world complex EMF signals, which is ultimately what we are interested in. In other words, results based upon situations that never occur in the real world are given pre-eminence.

The above list refers to ways of designing a study to get the desired results. It says nothing about the subsequent spinning of the results you get through selective reporting and the deployment of large marketing budgets to disseminate the message you want the public to receive.

In the interests of honesty, fairness, and balance, it is important to point out that not all studies funded by industry are deliberately designed to fail, and it is a fact that EMF science is complex and challenging. Health effects are likely to be long-term, effects vary from individual to individual, and multiple sources of EMFs add to the complexity, as do other factors that contribute to ill health.

Henry Lai has been compiling a database of studies undertaken since 1990 on EMF effects on human health – he excludes his own research from the database to avoid bias.¹⁸ 30% of these studies are industry-funded, and 70% are funded by sources that are presumed to be more independent. 27% of industry-funded studies found health effects in contrast with 68% of non-industry-funded studies. In conclusion, Lai states that “a lot of the studies that are done right now are done purely as PR tools for the industry”.⁴

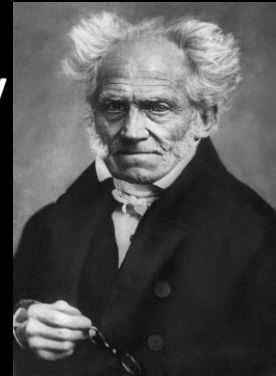
EMF studies follow a similar pattern to research concerning other “conflict of interest” products, such as tobacco, fossil fuels, pesticides, and plastics, with researchers funded to produce articles that claim no impact. Straight out of the tobacco industry's playbook, these apparent contradictions manufacture doubt and confusion in the consumers' minds. Industry does not have to win the scientific argument about safety; it only has to keep the argument going, and when there is doubt, people and politicians are easily swayed by glossy marketing supporting business as usual (aka “progress”) over inconvenient truths or precaution.¹⁹⁻²²

The Schopenhauer Sequence – the road to truth

“All truth passes through three stages. First, it is ridiculed. Second, it is violently opposed. Third, it is accepted as being self-evident.”

Arthur Schopenhauer (1788–1860)

~ German philosopher.



Based on the above well-known quote, I have coined the term *the Schopenhauer Sequence* to characterise the oft-repeated unfolding of attitudes from ridicule through opposition to acceptance that frequently plays out when people challenge conventional wisdom. In modern times, this sequence has been repeated again and again for multiple toxins previously deemed to be safe, which casts doubt on our ability to learn lessons from history. David Gee, in his 2009 publication *Late Lessons from Early Warnings: Towards Realism and Precaution with EMF?*²³ documents the histories of some well-known public health and environmental hazards, from the first scientifically-based early warnings about potential harm to the subsequent precautionary and preventive measures. His findings are summarised in the table below.

Table 3.1: Some well-known public and environmental hazards, from the first scientifically based early warnings about potential harm to the subsequent precautionary and preventive measures. Source: Gee (2009).²³

Issue	Date of first Early Warning	Date of Risk Reduction Action	Years of substantial inaction
Over-fishing	1376	1995–2008 “responsible” management: which is not very effective	c.600
Asbestos	1898	1999 EU ban by 2005	101
PCBs (polychlorinated biphenyls)	1899	1970–80s: EU and US restrictions; banned for most uses in most countries	c.90
Benzene	1897	1978 Benzene voluntarily withdrawn from most consumer products in the US	81
Radiation (ionising)	1896	1961–1996 UK, etc., then EU laws	65
MTBE (methyl tert-butyl ether) octane booster in petrol	1960 taste /odour/ persistence in water	2000 undesirable in Denmark/California: permitted elsewhere	c.40
DES (Diethylstilbestrol) a nonsteroidal oestrogen medication	1938	1971–1985 US, EU, global ban	30–50
Antibiotics as livestock growth promoters	1969	1999 EU ban	30
Sulphur dioxide (SO₂) , lung disease and lake water pollution	1952 (lung) 1968 (lakes)	1979–2001 increasing EU etc restrictions leading to c 90% reduction on 1975 levels by 2010	25–55
Halocarbons (CFCs and other ozone depleters)	1974	1987 global ban on CFCs + other ozone depleters	10-30
Hormones as cattle growth promoters	1972/3 Oestrogen effects on wildlife	1988 EU ban, US continues	16+
DDT insecticide	1962/3	1970s DDT banned in N. America & EU.	10+
French oyster fisheries collapse	1976–81	1982–7 French, UK then NE Atlantic ban; 2008 global ban	5–30

The take-home message from the above examples is that we cannot hang around waiting for the authorities to act upon early warnings. We need to do all we can to get our own houses in order using the power we possess. And the Schopenhauer Sequence is still very much alive and kicking. The evidence for health and environmental effects of the following phenomena, among others, is currently being subject to ridicule and doubt: some artificial sweeteners, notably aspartame,²⁴ the herbicide Glyphosate / Roundup®,²⁵ fracking,²⁶ phthalates (types of plasticisers),²⁷ bisphenol A (a chemical used to manufacture plastics and resins),²⁸ and, of course, EMFs.

An example of how the Schopenhauer Sequence is playing out for EMFs has been documented in a detailed exposé published in 2018 in *The Nation* by Mark Hertsgaard and Mark Dowie,²⁹ which is summarised below. Hertsgaard and Dowie lay out the tactics employed by the wireless industry to undermine science and sow confusion among the public and the authorities who are mandated to act on their behalf. They tell the story of George Carlo, hired in 1993 by the Cellular Telecommunications and Internet Association (CTIA), a US telecommunications industry trade association, to lead an investigation into mobile phone safety – the Wireless Technology Research Project (WTR). The WTR was commissioned in the wake of safety concerns that had the potential to derail the growing mobile phone market. George Carlo was considered a safe pair of hands as he had a track record of pro-industry science.

1993 was back in the 2G era when mobiles were used for a few minutes a month, and fewer than 1% of the world's population had a mobile phone subscription.³⁰ By way of comparison, mobile subscriptions in the UK now exceed the country's population,³¹ and mobile phone access far exceeds access to toilets worldwide.³² Things in the mobile phone industry had already started as they meant to continue, with safety scarcely investigated prior to the introduction of the technology.

By the time Carlo presented the WTR's findings to wireless industry leaders on February 9, 1999, the WTR had commissioned more than 50 original studies and reviewed many more. Those studies raised "serious questions" about cell phone safety. Specifically, Carlo stated that the WTR's research had found the following: "The risk of rare neuro-epithelial tumours on the outside of the brain was more than doubled... in cell phone users"; there was an apparent "correlation between brain tumours occurring on the right side of the head and the use of the phone on the right side of the head"; and "the ability of radiation from a phone's antenna to cause functional genetic damage [was] definitely positive..." CTIA chair Tom Wheeler reacted by trying to discredit George Carlo by falsely stating that the studies had not been published in peer-reviewed journals. When Carlo submitted the WTR's final report to the CTIA board in 2000 he was escorted in by two muscular security guards. Carlo spoke for ten minutes, after which he was ushered away to a taxi to take him to the airport. In the words of the Nation article:

Carlo's story... evokes eerie parallels with two of the most notorious cases of corporate deception on record: the campaigns by the tobacco and fossil-fuel industries to obscure the dangers of smoking and climate change, respectively. Just as tobacco executives were privately told by their own scientists (in the 1960s) that smoking was deadly, and fossil-fuel executives were privately told by their own scientists (in the 1980s) that burning oil, gas, and coal would cause a "catastrophic" temperature rise, so Carlo's testimony reveals that wireless executives were privately told by their own scientists (in the 1990s) that cell phones could cause cancer and genetic damage.

Like their tobacco and fossil-fuel brethren, wireless executives have chosen not to publicize what their own scientists have said about the risks of their products. On the contrary, the industry—in America, Europe, and Asia—has spent untold millions of dollars in the past 25 years proclaiming that science is on its side, that the critics are quacks, and that consumers have nothing to fear. This, even as the industry has worked behind the scenes—again like its Big Tobacco counterpart—to deliberately addict its customers. Just as cigarette companies added nicotine to hook smokers, so have wireless companies designed cell phones to deliver a jolt of dopamine with each swipe of the screen.

From November 4, 2013, until January 20, 2017, Tom Wheeler served as Chair of the Federal Communications Commission (FCC), the body which regulates the US wireless industry. In 2022, Wheeler was given a seat on the board of an Internet of Things networking company. Tom Wheeler personifies the revolving door relationship that exists between industry and regulators - captured agencies - through which industry can set extremely lax emission guidelines.³³

EMF Safety vs. Guidelines – the case of mobile phones and a man called SAM

Putting aside for the moment the fact that RFR safety guidelines only investigate thermal effects, how does the safety testing shape up with regard to the industry’s stated criteria? The following account will detail how telecommunications companies miserably fail to clear the dismally low bar they have set themselves.

To test phones and other RFR emitting devices, companies used SAM (Specific Anthropomorphic Mannequin), a dummy which has been in service since 1993. SAM is highly unrepresentative of the population he is meant to typify.⁸ Here are some of SAM’s vital statistics:

- He is 6’ 2” and weighs over 15 stone
- He has a thicker-than-average skull and a larger-than-average head
- He has a uniform brain density (water, salt, and sugar solution)
- He never carries his phone close to his body
- He talks on his phone for six or thirty minutes per day
- He talks on a phone that uses only one frequency – i.e. not a real-world frequency
- He holds his phone at least 5 mm from his head – this task is facilitated by a spacer
- He owns only one wireless device
- He never uses his phone’s Wi-Fi or Bluetooth functions
- He never socialises with anybody who uses a mobile device
- He has no ears
- He has no balls
- He has no hands (If you hold your phone in your hand, you have violated your phone safety guidelines)



Figure 3.1: *Oh Sam What a Man.* Source: *Anguera et al. (2013).*³⁴

Strictly speaking SAM has no height and weight because he's actually only a head. The estimated height and weight are derived from his head size.

Some models include ears, and others do not. Some use a spacer to represent the ear³⁵ as in Figure 3.1.

Devra Davis thoroughly demolishes the EMF Guidelines based on the SAM model.⁸ Here, I will focus on two key issues: the use of average frequencies and the one-size-fits-all version of the human race.

Actual phone signals work on pulses that last somewhere between one nanosecond and one microsecond. However, the safety guidelines use average intensities over a period of six minutes or 30 minutes to predict whether there will be biological effects or not. Martin Pall, EMF Scientist and Professor Emeritus from Washington State University, laid out this scenario to illustrate the Alice in Wonderland world that is RFR safety testing. If you average a typical pulse of 40 nanoseconds over a period of six minutes, it lowers the intensity by 10 billion. So the safety guidelines predict that “there shouldn’t be any effects,” yet there are effects over and over again.³⁶

The following analogy illustrates this failure in logic. You are driving at 150 mph in a 70-mph zone, and the police flag you down. “Do you realise you are driving at over twice the speed limit?” asks the police officer. You have a ready rejoinder – “Actually, I am following the telecom driving safety guidelines and my average speed for this journey is only 40 miles per hour, well within the speed limit”. Your logic is unlikely to hold up in a court of law.

This focus on average readings is reflected in SAR values in watts per kilogram over 10 grams of simulated body tissue as opposed to smaller units. By averaging over relatively large units, the testing fails to detect what are known as suprathreshold effects which occur only in tiny spaces or hotspots.⁸

Only 3% of the US population has a head the size of SAM, which results in large underestimates of SAR for typical mobile phone users, notably most adults, nearly all teenagers, and all children, with perhaps a few very rare exceptions. The contrast between SAM’s brain and the brain of a child is particularly dramatic. For various reasons, a child’s brain absorbs considerably more radiation than an adult’s brain. Children’s skulls are smaller and thinner, their brains are actively growing, and they have more fluid. The bone marrow in a child’s skull absorbs ten times more microwave radiation than that of an adult.³⁷ The images below show that the depth of mobile phone radiation absorption into the brain penetrates far beyond the midbrain for the 5-year-old. For the 10-year-old, the penetration is less but still beyond the midbrain, and for the adult, the penetration is much less and ends well before the midbrain.³⁸ Of course, toddlers who play with phones, tablets, computers, and consoles will show even greater absorption than a 5-year-old. To further compound the situation, children today are exposed to RFR much earlier in life than previous generations, so their cumulative exposure is increased.⁸

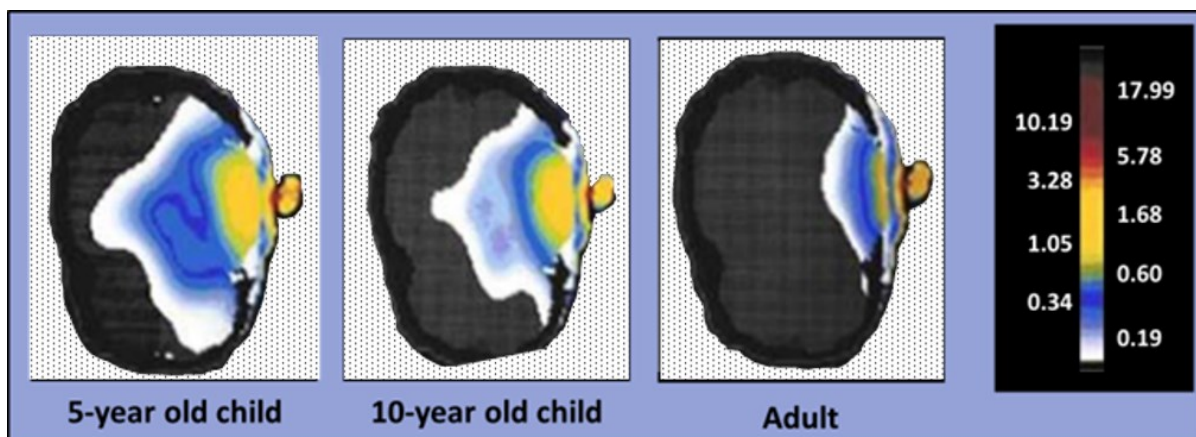


Figure 3.2: Depth of absorption of mobile phone radiation in a 5-year-old child, a 10-year-old child, and an adult from GSM mobile phone radiation at 900 MHz. The colour scale on the right shows the SAR in watts per kilogram. Adapted from Gandhi et al. (1996).³⁸

To add insult to injury, contemporary mobile phones do not comply with their SAR value when held directly to the head or kept in a pocket. In fact, recent newspaper investigations into mobile phone SAR values cast doubt on whether many of them even comply with the current inadequate safety guidelines.

In 2019, a team from the Chicago Tribune commissioned independent testing of SAR values of eleven handsets of seven mobile phone models.³⁹ The four Apple iPhone 7s tested measured over the legal safety limit and more than double what Apple reported to regulators from its own testing when held at 5 mm from the simulated head. Results for other models were mixed. The three Samsung phones tested – the Galaxy S8, Galaxy S9 and Galaxy J3 – positioned at 10 or 15 mm from the body, the distances chosen by the company in accordance with official guidelines – measured under the safety limit. The Motorola Moto e5 Play registered a SAR value nearly three times the safety limit in a 5 mm test.

The lab conducted a second phase of testing to simulate carrying a phone in your pocket, something which is not mandated in the official testing process, by placing the phones 2 mm away from the simulated body — closer than

any of the manufacturers' own tests and far less than the maximum distance allowed by the FCC. All Samsung phones were well over the standard, with the Samsung Galaxy S8 being over five times the standard. The four iPhone 7s tested were double the safety standard, the iPhone 8 measured three times over, and the Moto e5 Play measured quadruple the standard. Two phones came in under the standard in the "pocket test": an iPhone 8 Plus and a BLU Vivo 5 Mini.

Hidden safety warnings

As outlined above, mobile phones were not meant to be pressed against our bodies or held against our ears. Despite the name, laptops were not meant to go on laps, and, in keeping with the name, tablets were meant to go on tables. All of this is reasonably clear when you read the safety warnings. There are, however, a couple of problems – first, very few of us read manuals. Secondly, the safety warnings are buried deep in the digital dungeon where nobody but the most forensic of users is likely to venture.

On its webpage titled [The Fine Print Manufacturer Radio Frequency Radiation Warnings](#), the Environmental Health Trust features safety warnings from many commonly used RFR-emitting devices.⁴⁰ A few of these are reproduced below:

Apple iPhone 5: "To reduce exposure to RF energy, use a hands-free option, such as the built in speakerphone, the supplied headphones, or other similar accessories. Carry [your] iPhone at least 10 mm away from your body to ensure exposure levels remain at or below the tested levels."

Samsung 3G Laptop: "Keep safe distance from pregnant women's stomach or from lower stomach of teenagers. Body worn operation: Important safety information regarding radio frequency radiation exposure. To ensure compliance with RF exposure guidelines the Notebook PC must be used with a minimum of 20.8 cm antenna separation from the body."

Motorola XOOM Tablet: "Keep the mobile device and its antenna at least 2.5 centimetres (1 inch) from your body when transmitting. If you have an implantable medical device, such as a pacemaker or defibrillator, consult your doctor before using this mobile device. Persons with implantable medical devices should observe the following precautions: • ALWAYS keep the mobile device more than 20 centimetres (8 inches) from the implantable medical device when the mobile device is turned ON. • DO NOT carry the mobile device in the breast pocket. Small children—keep your mobile device and its accessories away from small children. These products are not toys and may be hazardous to small children."

Remember, these warnings are based on the inadequate and outdated safety guidelines built upon the crumbling edifice that is the "Thermal Effects Only" dogma. Yet, the industry wants to keep even these lukewarm warnings buried in the digital closet. Several cities, including Berkeley in California, have passed "Right to Know" ordinances obliging mobile phone retailers to provide a fact sheet on radiation to those who purchase a new phone. The fact sheet simply reproduced the FCC-mandated warning from user manuals as follows.

"The City of Berkeley requires that you be provided the following notice: To assure safety, the Federal Government requires that cell phones meet radiofrequency (RF) exposure guidelines. If you carry or use your phone in a pants or shirt pocket or tucked into a bra when the phone is ON and connected to a wireless network, you may exceed the federal guidelines for exposure to RF radiation. Refer to the instructions in your phone or user manual for information about how to use your phone safely."⁴¹

Immediately following the passing of the Berkeley Ordinance in 2015, CTIA (a US wireless industry trade association referred to previously) slapped a lawsuit on the city on the grounds that the Ordinance violates their right to free speech. Despite the industry's deep pockets and lobbying power, the Ordinance withstood legal challenges up to the level of the US Supreme Court. However, in September 2020, a federal judge ruled in favour

of the wireless industry, putting a stop to the Right to Know Ordinance. The judge argued that the law amounted to "overwarning" and emphasised the need to strike a balance between public health and safety and the advancement and expansion of telecommunications networks and related services.⁴¹

Global standard-setting organisations and conflicts of interest – the example of ICNIRP

There is no single body officially mandated for setting EMF guidelines globally. In the absence of such an authority, the International Commission on Non-Ionizing Radiation Protection (ICNIRP) has stepped into the breach. Founded in 1992, ICNIRP is a private, industry-loyal, non-governmental organisation which publishes the EMF guidelines used by most countries, including the UK. The current members of ICNIRP select new members in a manner akin to a private members club. This results in a situation where ICNIRP members perpetuate existing preconceptions about the EMF impacts, thus eliminating the need for open scientific debate. Many ICNIRP members have ties to the telecommunications, military, and power industries that are dependent on the ICNIRP guidelines.⁴² It looks like *the fox is guarding the henhouse*, as the old saying goes.

In September 2008, Professor Paolo Vecchia, Chairman of ICNIRP from 2004 to 2012, proffered these encouraging sentiments regarding the ICNIRP EMF exposure guidelines: "They are not mandatory prescriptions for safety", "They are not the 'last word' on the issue", and "They are not defensive walls for industry or others".⁴³ Indeed, they are not, but ICNIRP and its acolytes continue to treat them as such.

The ICNIRP exposure guidelines were established in 1998.⁴⁴ They consider only the thermal effects of RFR and thereby ignore the findings of thousands of published studies demonstrating detrimental health effects caused by radiation levels below those causing noticeable heating.⁴⁵ The ICNIRP public safety limit for radio frequency radiation of 1,800 MHz is 9 W/m². In contrast, the BioInitiative Reports written by a group of 29 independent scientists and health experts from around the world in 2007 and updated in 2012 and 2019,¹ which does consider non-thermal EMF health effects, has recommended precautionary action levels of 0.000003–0.000006 W/m², 1.5–3 million times lower than the ICNIRP limits! Despite the numerous studies, ICNIRP has continued to propagate the "Thermal Effects Only" dogma concerning health risks from non-ionising EMFs. The World Health Organization (WHO), which is mandated to act as the directing and coordinating authority on international health, uncritically accepts ICNIRP EMF exposure guidelines. This has enormous public health policy implications. This situation should come as no surprise as WHO and ICNIRP have enjoyed a very long and intimate relationship. An illustration of the revolving door between ICNIRP and WHO is the 1996 appointment of Australian biophysicist Michael Repacholi to lead the WHO programme on electromagnetic fields, a post he held for a decade. Repacholi had served as ICNIRP's first chairman between 1996 and 2006.⁴⁶ And the door continues to revolve.

If you wish to delve deeper into the murky world of ICNIRP, I recommend you read the 2020 report titled *The International Commission on Non-Ionizing Radiation Protection: Conflicts of Interest, Corporate Interests and the Push for 5G*, commissioned by two Members of the European Parliament – Michèle Rivasi (Europe Écologie) and Klaus Buchner (Ökologisch-Demokratische Partei).⁴⁷

Evidence of harm from an unlikely source – the Insurance Industry

Lloyd's of London, or simply *Lloyd's*, is the world's oldest and largest insurance platform, dating back to its origins in 1688 when a group of ship owners, merchants and sailors met in Edward Lloyd's Coffee House to discuss how they could manage seafaring risks in a time of wooden ships, frequent shipwrecks and piracy on the high seas. From its earliest days, a significant amount of Lloyd's business has been reinsurance – direct insurers taking out their own additional insurance. Reinsurance spreads an insurer's risks by protecting it against very large claims, reducing its exposure to peaks and troughs, spreading risk internationally, and increasing the capacity of the direct insurer.

Before deciding whether or not to provide insurance cover, the reinsurer conducts a procedure called ‘underwriting’ in which the reinsurance company will examine the circumstances surrounding a risk, such as the likelihood of it happening, the steps taken to reduce it, and the financial consequences should this risk come to pass. By its own estimation, the underwriters at Lloyd’s are “among the best in the world.”⁴⁸ The fact that the group has thrived for over three centuries would appear to support this claim.

Lloyd’s is known for accepting the highest level of risks, and it underwrites a multitude of risky ventures all over the world, such as oil exploration, land and sea transport networks, and the operation of satellites. But from 1999 Lloyd’s formally ceased to insure against EMF health impacts. The thinking behind the decision was articulated in a 2010 report from Lloyd’s Emerging Risks Team, which states, “The danger with EMF is that, like asbestos, the exposure insurers face is underestimated and could grow exponentially and be with us for many years.”⁴⁹ Lloyd’s stopped insuring asbestos companies in 1913, 86 years before the EU ban. On 18 February 2015, CFC Underwriting Limited, the UK agent for Lloyd’s, published a policy document that included the Electromagnetic Fields Exclusion (Exclusion 32) to “exclude cover for illnesses caused by continuous long-term non-ionising radiation exposure i.e. through mobile phone usage.”

Where Lloyd’s leads, the rest of the industry follows. Swiss Re, the world’s second-largest reinsurance company, and Willis Towers Watson, the world’s third-largest reinsurance company, also refuse to insure against EMF health impacts, as do the vast majority of insurance companies.

Despite their public pronouncements on the safety of their products, technology companies also do not cover EMF health risks to employees or consumers. Every phone company investigated by the Environmental Health Trust (EHT) defines all non-native non-ionising radiation as “pollutants” and refuses to cover the phone for damages from such pollutants. The EHT webpage, [Electromagnetic Field Insurance Policy Exclusion Are The Standard](#)⁵⁰ lists numerous insurance liability clauses, including the following:

Updated Zurich Community Care Liability Insurance: “We will not pay anything under this policy, including claim expenses, in respect of: Electromagnetic fields any liability of whatsoever nature directly or indirectly caused by, in connection with or contributed to by or arising from electromagnetic fields (EMF) or electromagnetic interference (EMI)”

A&M Insurance for Medical Professionals: “GENERAL INSURANCE EXCLUSIONS: Electromagnetic fields directly or indirectly arising out of, resulting from or contributed to by electromagnetic fields, electromagnetic radiation, electromagnetism, radio waves or noise.”

BIICL Product Liability Forum Insurance Perspectives on Product Liability: “Standard: Pollution, Asbestos, Electromagnetic fields. Due to potentially catastrophic losses and high clean up costs, product liability insurance contracts frequently exclude, whether partially or completely, the insured’s liability for asbestos, pollution and contamination, radiation and electromagnetic fields.”

Lloyd’s underwriters are “among the best in the world.” They read the science and understand the implications for their industry, and the industry listens.

A spotlight on conventional wisdom – BBC and 5G

In the UK, the bastion of the public's trust is the BBC (British Broadcasting Corporation). Once affectionately nicknamed Aunty, this publicly-owned entity carries no commercial advertising, and the agreement accompanying the BBC Charter requires them to ensure controversial subjects are treated with due impartiality in their news and other output. So, what does the BBC say about 5G, perhaps the most prominent EMF concern at the time of writing? I have reproduced a 2019 BBC article titled [Does 5G pose health risks?](#)⁵¹ below. Text from the article, anonymously authored by the "Reality Check Team", has been reproduced in full in italics with the paragraphs numbered. My responses are in normal font.

Does 5G pose health risks? By Reality Check team - BBC News 14 July 2019

1. *The 5G mobile network has been switched on in some UK cities and has led to questions about whether the new technology poses health risks.*
2. *So what are the concerns, and is there any evidence to back them up?*

What's different about 5G?

3. *As with previous cellular technologies, 5G networks rely on signals carried by radio waves - part of the electromagnetic spectrum - transmitted between an antenna or mast and your phone.*
4. *We're surrounded by electromagnetic radiation all the time - from television and radio signals, as well as from a whole range of technologies, including mobile phones, and from natural sources such as sunlight.*
5. *5G uses higher frequency waves than earlier mobile networks, allowing more devices to have access to the internet at the same time and at faster speeds.*
6. *These waves travel shorter distances through urban spaces, so 5G networks require more transmitter masts than previous technologies, positioned closer to ground level.*

The statements above are factually accurate. However, the implication of paragraph 4 is that prevailing EMFs are necessarily safe because they are ubiquitous. As outlined in this chapter (*Confusion is Our Product* and *The Schopenhauer Sequence*), recent history is littered with examples of substances and practices that were once deemed safe but later found to be toxic. The rise in RFR in recent years has been massive, as illustrated in Figure 2.3. The text conflates native with non-native EMFs, giving the impression that all (non-ionising) wavelengths are equivalent.

What are the concerns?

7. *The electromagnetic radiation used by all mobile phone technologies has led some people to worry about increased health risks, including developing certain types of cancer.*
8. *In 2014 the World Health Organization (WHO) said that "no adverse health effects have been established as being caused by mobile phone use".*
9. *However, the WHO together with the International Agency for Research on Cancer (IARC) has classified all radio frequency radiation (of which mobile signals are a part) as "possibly carcinogenic".*
10. *It has been put in this category because "there is evidence that falls short of being conclusive that exposure may cause cancer in humans".*
11. *Eating pickled vegetables and using talcum powder are classed in the same category.*
12. *Alcoholic drinks and processed meat are in a higher category because the evidence is stronger.*

Paragraphs 7–12 refer to the health risks of RFR with a focus on cancer.

The **IARC categories** are: Group 1 – Carcinogenic to humans; Group 2A – Probably carcinogenic to humans; Group 2B Agents - Possibly carcinogenic to humans; Group 3 – Not classifiable as to its carcinogenicity to humans.

The RFR possible carcinogen classification (Group 2B – considered by IARC as an agent where an association with cancer has been detected that can be causally interpreted but for which chance, bias and confounding cannot be ruled out with sufficient scientific certainty)^{52, 53} followed normal IARC evaluation procedure, which includes a scientific debate among invited experts to assign a category to an agent. This discussion considers four aspects of carcinogenicity: 1) exposure and emissions, 2) animal cancer studies, 3) human studies or epidemiology, and 4) possible causal mechanisms. IARC is part of WHO, but the experts are chosen independently by IARC. At the time of the evaluation (before 2011), the exposure was considerably lower than it is now; animal cancer studies showed a positive effect, but it was “limited”. Limited in IARC-speak means that the information wasn’t convincing in animals, but subsequent studies have produced sufficient information.^{54, 55} The human data was also considered limited with a number of contradictory findings (see *Confusion is Our Product* for more details of why this might be), and causal mechanisms are not definitive as outlined in Chapter 4 (...the *VGCC Hypothesis*). When you have limited human and limited animal studies, IARC will put that together as a possible human carcinogen. Limited human and sufficient information in animals would be a probable human carcinogen. Since 2011, further diverse independent studies have strengthened the weight of evidence regarding the carcinogenicity of RFR, leading to demands in the scientific literature to upgrade the IARC classification accordingly.⁵⁶⁻⁶⁰ In line with increased evidence of carcinogenicity since 2011, IARC has flagged RFR as a high priority for reassessment.^{61, 62} It appears that this particular tin can has been repeatedly kicked down the road.⁶³

Paragraphs 11 and 12, comparing the risk with eating pickled vegetables and using talcum powder, clearly illustrates the article's intentions. DDT, lead, and petrol engine exhaust have also been classified as possibly carcinogenic but are not used as comparators. It is important to note that the IARC evaluation focused on the “potential for an increased risk of cancer among those exposed to RF radiation, but does not provide a quantitative assessment of any cancer risk, nor does it discuss or evaluate any other potential health effects of RF radiation.”⁵³

The IARC classification was made in May 2011. The following month WHO issued a Fact Sheet stating that ‘To date, no adverse health effects have been established as being caused by mobile phone use’. The statement does not contradict the IARC classification statement, but it serves to undermine it. The WHO Fact Sheet also stated that ‘WHO will conduct a formal risk assessment of all studied health outcomes from radio frequency fields exposure by 2012.’ Lennart Hardell, oncologist and professor at Örebro University Hospital in Sweden, asked, “Why was WHO so keen to make a new risk evaluation shortly after the IARC evaluation? It was hardly expected that new studies would be published in [such a] short time changing the classification of RF radiation as a possible, Group 2B, human carcinogen.”⁴⁶

Instead of the announced ‘formal risk assessment’, WHO launched a draft monograph on RFR and health for public comments in 2014. The draft monograph quoted in paragraph 8 has not been finalised. Five of the six members of the Core Group in charge of the draft monograph were affiliated with the International Commission on Non-Ionizing Radiation Protection (ICNIRP). As outlined in this chapter, ICNIRP, with its close ties to industry, has major conflicts of interest.

In accepting the ICNIRP exposure guidelines^{44, 64} that consider only the thermal effects of RFR, WHO has placed itself in a highly conflicted situation of undertaking an investigation into the possible health impacts of RFR below ICNIRP guidelines led by a group that has repeatedly asserted that these guidelines are fit for purpose. If the group had concluded that there were health effects of RFR at levels below the guidelines, they would have to admit that their last twenty-plus years of work had been based on a false assumption. The fallout would be astronomical.

In a 2017 article published in the International Journal of Oncology titled “World Health Organization, Radiofrequency Radiation and Health – a Hard Nut to Crack (Review)”, Lennart Hardell states, “ICNIRP is given full access to and exclusive possibilities to influence the Monograph. In view of the huge economic interests built into the ICNIRP guidelines, and several of its expert members' ties to industry, no doubt this is a large conflict of

interest that will seriously undermine not only the credibility of the Monograph on RF radiation but also the credibility of WHO as a protector of world health.”⁴⁶

In a 2017 visit to WHO HQ in Geneva to informally discuss human health effects of non-ionising radiation, Hardell and colleagues took the opportunity to measure RFR within the WHO building. Levels turned out to conform with the recommendations of the BioInitiative Report.⁴¹ This is exceptional when compared to most public locations in Western countries. Clearly, some folks in WHO are taking RFR-related issues seriously.

13. *A toxicology report released in 2018 by the US Department of Health, and pointed to by those expressing safety concerns, found that male rats exposed to high doses of radio frequency radiation developed a type of cancerous tumour in the heart.*
14. *For this study, rats' whole bodies were exposed to radiation from mobile phones for nine hours a day every day for two years, starting before they were born.*
15. *No cancer link was found for the female rats or the mice studied. It was also found that rats exposed to the radiation lived longer than those in the control group.*
16. *A senior scientist on the study said "exposures used in the studies cannot be compared directly to the exposure that humans experience when using a cell phone", even for heavy users.*

Paragraphs 13–16: The text refers to the US National Toxicology Program (NTP) study conducted to investigate the potential health hazards, including cancer risk, from exposure to RFR like that used in 2G and 3G mobile phones, which operate within a range of frequencies from about 700–2700 MHz. As stated in the BBC article, this study has been widely cited by those expressing safety concerns. However, it does have some limitations, and these limitations may have been presented by the BBC article as a “straw man” to discredit any studies that indicate possible health impacts of RFR.

It is true that there were male and female differences, which is common in many cancers. It is also true that rats exposed to the radiation lived longer than those in the control group, but this difference was not statistically significant.

It is also true that it is difficult to scale up small animal EMF exposure results to fully grown humans. This extrapolation is standard procedure for drug trials and safety testing of other substances that are inhaled or ingested, but radiation is more problematic. For non-ionising radiation, penetration depth is a function of several factors, including frequency, tissue type and tissue density. Radiation is likely to penetrate much deeper into small animals than in fully-grown humans.⁶⁵ However, this throws up the possibility that RFR may exert disproportionate harm on babies and young children (see *EMF safety vs. guidelines – The Case of Mobile Phones and a Man Called SAM*) as well as smaller organisms, those free living in nature, domestic animals, and family pets. These effects may be even more pronounced for tiny organisms, including beneficial insects such as bees.⁶⁶ Leaf surfaces are very thin “solar panels”, so surface effects are likely to be significant for trees and other plants.^{67, 68}

Not all of the reservations expressed, however, are equally valid. Whole-body exposure for nine hours a day implies unrealistically high intensities and durations. The whole-body exposure in the NTP study was indeed higher than the recommended limits, but exposure intensities in the brains of rats were similar to localised human exposures resulting from mobile phones being held next to the head. Nine hours per day on the phone might appear to be excessive, but this was in a lab environment with a single EMF stressor. In the real world, people are often exposed around the clock to multiple EMF sources, such as cordless phone base stations, routers, laptops, tablets, and smart devices. This is on top of the myriad (non-EMF) stressors that are part and parcel of 21st-century life. In the real world, increased cancer incidence has been found at exposure levels that were orders of magnitude lower than those generated in NTP studies.⁶⁹ In addition, the rats in the NTP study were exposed to simulated mobile phone exposures using a signal generator. As we have already discovered, studies that use simulated signals are much less likely to find effects than those using realistic frequencies.⁷⁰

In 2018, The NTP released drafts of the study's full technical reports for peer review by an independent panel of scientists who had expertise in studying the biological effects of electromagnetic fields and expertise in interpreting results from experimental carcinogenicity studies.⁵⁵ The NTP studies found that high exposure to RFR (900 MHz) used by mobile phones was associated with:

- *Clear evidence* of an association with tumours in the hearts of male rats.
- *Some evidence* of an association with tumours in the brains of male rats.
- *Some evidence* of an association with tumours in the adrenal glands of male rats.

In my view, the major significance of this study is that it showed experimentally that there is clear evidence that non-ionising radiation can have adverse biological effects. This fact throws out the assumption behind ICNIRP's "Thermal Effects Only" dogma of EMF health risks. Similar studies conducted at the Ramazzini Institute in Italy using RFR, as generated by 1.8 GHz GSM cell tower antennas, reinforced the NTP study findings with exposures 60 to 6,000 times lower.⁵⁴ These studies and others have helped to drive yet more nails into the coffin of the "Thermal Effects Only" dogma.

Neither 4G nor 5G have been subject to similar safety testing.

Clear Evidence of Carcinogenic Activity is demonstrated by studies that are interpreted as showing a dose-related (i) increase of malignant neoplasms, (ii) increase of a combination of malignant and benign neoplasms, or (iii) marked increase of benign neoplasms if there is an indication from this or other studies of the ability of such tumours to progress to malignancy.

Some Evidence of Carcinogenic Activity is demonstrated by studies that are interpreted as showing a chemical-related increased incidence of neoplasms (malignant, benign, or combined) in which the strength of the response is less than that required for clear evidence.

17. *Dr Frank De Vocht, who helps advise the government on mobile phone safety says "although some of the research suggests a statistical possibility of increased cancer risks for heavy users, the evidence to date for a causal relation is not sufficiently convincing to suggest the need for precautionary action".*

18. *However, there is a group of scientists and doctors who have written to the EU calling for the rollout of 5G to be halted.*

Paragraphs 17–18 illustrate the differences of opinion on the issue. On what criteria did Dr Frank De Vocht judge that there was insufficient evidence to suggest the need for precautionary action? I am not sure which group of scientists and doctors is being referred to, but there are at least two relevant initiatives worth highlighting. The [5G Appeal](#) was prepared in 2017 by scientists and doctors who are urgently calling for the EU to halt the roll-out of 5G due to the serious potential health effects of this new technology. As of July 3, 2024, 438 scientists and medical doctors have signed the appeal. Under the [International EMF Scientist Appeal](#), scientists engaged in the study of biological and health effects of non-ionising EMFs have written to the UN, WHO, the UN Environment Programme (UNEP), and UN member nations to express their serious concerns regarding the ubiquitous and increasing exposure to EMFs generated by electric and wireless devices. This group of more than 280 scientists from 44 nations have collectively published over 2,000 papers and letters on EMFs in professional journals and arguably constitute the majority of EMF scientists worldwide. WHO and UN did not respond to the EMF Scientist Appeal.

Radio waves are non-ionising

19. *The radio wave band - used for mobile phone networks - is non-ionising, "which means it lacks sufficient energy to break apart DNA and cause cellular damage," says David Robert Grimes, physicist, and cancer researcher.*
20. *Higher up the electromagnetic spectrum, well beyond those frequencies used by mobile phones, there are clear health risks from extended exposure.*
21. *The sun's ultra-violet rays fall within this harmful category, and can lead to skin cancers.*
22. *There are strict advisory limits for exposure to even higher energy radiation levels such as medical x-rays and gamma rays, which can both lead to damaging effects within the human body.*
23. *"People are understandably concerned over whether they might elevate their risk of cancer, but it's crucial to note that radio waves are far less energetic than even the visible light we experience every day," says Dr Grimes.*
24. *"There is no reputable evidence," he says "that mobile phones or wireless networks have caused us health problems."*

Paragraph 19: Ionising radiation is not the only type of radiation that is biologically active, and DNA breaks are not the only mechanism that can cause cellular damage. See ...*The VGCC Hypothesis* for a discussion on possible mechanisms through which non-ionising radiation can cause harm including DNA damage. Dr David Robert Grimes did a paid advertisement for Vodafone in 2020, downplaying the possible health risks of 5G.⁷¹ A number of the talking points from the Vodafone advert are rehashed in the BBC piece. Grimes authored a 2021 review of RFR and cancer⁷² that was full of errors and omissions.⁷³

Paragraph 20: Agreed about the effects of ionising radiation (see Part 5 – *Ionising Radiation*), but the implication here is that the higher you go on the electromagnetic spectrum, the greater the damage. Stating that RFR is far less energetic than visible light implies that there is a simple linear progression of harm from low frequency = ‘safe’ to high frequency = ‘dangerous’. Nature does not work this way. Instead, life on Earth has adapted to the forces it has encountered most frequently over millions of years of evolution – infrared, visible and UV light constitute these frequencies, as do the Earth’s magnetic resonances. The reality is more complex, as outlined throughout this book and highlighted in the 1970s by Allan Frey.^{74,74,75}

Paragraph 20: Agreed, but see Part 4 for a more in-depth treatment of UV, visible and infrared radiation.

Paragraph 21: Swedish researchers have found that melanoma rates are strongly correlated with radio frequency radiation (see Chapter 11 for details).^{76,77} 5G radiation, even at its highest frequencies, would have a penetration depth much greater than ultraviolet radiation. UV radiation, while undoubtedly a contributor to skin cancer of various kinds, does not deserve the bad press it receives. The complex relationship between UV exposure and skin cancer is addressed in Chapter 13.

Paragraph 22: The prevailing precautionary approach to limiting ionising radiation exposure contrasts sharply with the Procrustean approach to non-ionising radiation. This dichotomy is discussed in more detail in Part 5, *Ionising Radiation*.

Paragraph 23: Stating that RFR is far less energetic than visible light reinforces the erroneous message that there is a simple linear progression of harm from low frequency = ‘safe’ to high frequency = ‘dangerous’. A charitable interpretation would be that this message is naive. According to the Bioinitiative Working Group, “Protection from multiple intensity windows has never been incorporated into any risk assessment; to do so would call for a major change in thinking. [Research] results mean that lower intensity is not necessarily less bioactive, or less harmful.”¹

Paragraph 24: What constitutes “reputable”? Does the five thousand-plus articles in peer-reviewed journals on adverse EMF effects (mainly, but not solely, RFR) ranging from myriad feelings of discomfort to life-threatening diseases compiled by Kostoff (2019)¹⁰ constitute a reputable evidence base?

Should we be worried about 5G transmitter masts?

25. *5G technology requires a lot of new base stations - these are the masts that transmit and receive mobile phone signals.*
26. *But crucially, because there are more transmitters, each one can run at lower power levels than previous 4G technology, which means that the level of radiation exposure from 5G antennas will be lower.*
27. *The UK government guidelines on mobile phone base stations says radio frequency fields at places normally accessible to the public are many times below guideline levels.*

Paragraphs 25–26: There is already considerable concern over the density of cell towers, and 5G will massively increase cell densities.⁷⁸ It has been claimed that this increased density will allow signals to use less power, which is technically correct. However, 4G will still be in place, so 5G will add to the mix of EMFs, *and* there will be more 4G (see Chapter 11 for details about 5G). Even if it were the case that overall power is reduced it does not mean that the impacts would be lower. There are many more variables than power which impact health. A singular focus on power is mind-blowingly simplistic.

Paragraph 27. See *EMF Safety vs. Guidelines – the case of mobile phones and a man called SAM* for an explanation of why guideline levels are woefully inadequate. Conformity to guidelines does not equate to safety.

What about heating dangers?

28. *Part of the 5G spectrum permitted under international guidelines falls within the microwave band.*
29. *Microwaves generate heat in objects through which they pass.*
30. *However, at the levels used for 5G (and earlier mobile technologies) the heating effects are not harmful, says Prof Rodney Croft, an adviser to the International Commission on Non-Ionizing Radiation Protection (ICNIRP).*
31. *"The maximum radio frequency level that someone in the community could be exposed to from 5G (or any other signals in general community areas) is so small that no temperature rise has been observed to date."*

Paragraphs 30–31: Industry and their skills inevitably bring the discussion back to heating effects. As outlined earlier in this chapter, there are, in fact, likely to be significant RFR heating effects, but the standard testing protocols have been designed not to find them.

Limits to exposure

32. *The UK government says "while a small increase in overall exposure to radio waves is possible when 5G is added to the existing network, the overall exposure is expected to remain low".*
33. *The frequency range of the 5G signals being introduced is within the non-ionising band of the electromagnetic spectrum and well below those considered harmful by the ICNIRP.*
34. *"The exposure that 5G will produce has been considered in great depth by ICNIRP, with the restrictions set well below the lowest level of 5G-related radio frequency that has been shown to cause harm," says Prof Croft.*
35. *The WHO says electromagnetic frequency exposures below the limits recommended in the ICNIRP guidelines do not appear to have any known consequence on health.*

Paragraph 32: This statement is misleading on two counts. First, the assertion that a small increase in RFR overall exposure is possible is naïve at best and deliberately false at worst. Massive increases in RFR have accompanied every jump in wireless technology to date. Why should 5G, with the promise of instant downloads, driverless cars and IoT, and the (non-promised) accompanying plethora of advertisements and pop-ups, be any different? Secondly, the statement repeats the claim that existing exposure is low, which is demonstrably not the case.

Paragraphs 33–35: I think I have covered WHO and ICNIRP in enough detail. The pronouncements in these paragraphs are examples of conclusions based on deeming rather than evidence. The opening quote to Part 2 from Andrew Marino is apposite in this regard. "The question *Is it safe?* is metamorphosed into the question, *Does it meet the applicable guidelines?* which is an entirely different question."⁷⁹

My conclusion

This article is classic Procrusteanism. It is written by an unnamed author/group, unreferenced, based on discredited assumptions, outdated guidelines, and unsubstantiated pronouncements from industry-related sources.

It is instructive to note that similar articles claiming that non-ionising radiation at prevailing levels is safe are common on industry-supported outlets such as the Guardian ([How baseless fears over 5G rollout created a health scare⁸⁰](#)), CNN ([Why conspiracy theorists think 5G is bad for your health and why experts say not to worry⁸¹](#)), and Wikipedia ([Wireless device radiation and health⁸²](#)). In stark contrast, popular books that support the Procrustean position with detailed evidence are nowhere to be seen.

References

1. BioInitiative Report: A Rationale for Biologically-based Exposure Standards for Low-Intensity Electromagnetic Radiation (December 31, 2012, last updated 2019). at <<https://bioinitiative.org/>>. (2019).
2. Maisch, D., Raymond The Procrustean Approach – Setting Exposure Standards for Telecommunications Frequency Electromagnetic Radiation. at <<https://www.emfacts.com/the-procrustean-approach/>> (2010).
3. SAGE Precautionary approaches to ELF EMFs. First Interim Assessment: Power Lines and Property, Wiring in Homes, and Electrical Equipment in Homes. at <<https://www.powerwatch.org.uk/pdfs/SAGE%20%20report.pdf>>. Stakeholder Advisory Group on ELF EMFs. (2007).
4. Blank, M. Overpowered. Seven Stories Press, U.S. New York. (2015).
5. Prasad, M., Kathuria, P., Nair, P., Kumar, A., Prasad, K. Mobile phone use and risk of brain tumours: a systematic review of association between study quality, source of funding, and research outcomes. *Neurological Sciences: Official Journal of the Italian Neurological Society and of the Italian Society of Clinical Neurophysiology*. **38** (5), 797–810, doi: 10.1007/s10072-017-2850-8 (2017).
6. Carpenter, D.O. Extremely low frequency electromagnetic fields and cancer: How source of funding affects results. *Environmental Research*. **178**, 108688, doi: 10.1016/j.envres.2019.108688 (2019).
7. Huss, A., Egger, M., Hug, K., Huwiler-Müntener, K., Rössli, M. Source of funding and results of studies of health effects of mobile phone use: systematic review of experimental studies. *Environmental Health Perspectives*. **115** (1), 1–4, doi: 10.1289/ehp.9149 (2007).
8. Davis, D.L. *Disconnect: The Truth About Cell Phone Radiation, What the Industry is Doing to Hide it, and How to Protect Your Family*. Plume. (2013).
9. Panagopoulos, D.J. Comparing DNA damage induced by mobile telephony and other types of man-made electromagnetic fields. *Mutation Research*. **781**, 53–62, doi: 10.1016/j.mrrev.2019.03.003 (2019).
10. Kostoff, R.N. Adverse Effects of Wireless Radiation. at <<https://smartechnology.gatech.edu/handle/1853/61946>>. Georgia Institute of Technology. (2019).
11. Kostoff, R.N., Goumenou, M., Tsatsakis, A. The role of toxic stimuli combinations in determining safe exposure limits. *Toxicology Reports*. **5**, 1169–1172, doi: 10.1016/j.toxrep.2018.10.010 (2018).
12. Lai, H., Singh, N.P. Acute low-intensity microwave exposure increases DNA single-strand breaks in rat brain cells. *Bioelectromagnetics*. **16** (3), 207–210, doi: 10.1002/bem.2250160309 (1995).
13. Phillips, J.L., Singh, N.P., Lai, H. Electromagnetic fields and DNA damage. *Pathophysiology: The Official Journal of the International Society for Pathophysiology*. **16** (2–3), 79–88, doi: 10.1016/j.pathophys.2008.11.005 (2009).
14. Roti Roti, J.L. et al. Neoplastic transformation in C3H 10T(1/2) cells after exposure to 835.62 MHz FDMA and 847.74 MHz CDMA radiations. *Radiation Research*. **155** (1 Pt 2), 239–247, doi: 10.1667/0033-7587(2001)155[0239:nticca]2.0.co;2 (2001).
15. Malyapa, R.S., Ahern, E.W., Straube, W.L., Moros, E.G., Pickard, W.F., Roti Roti, J.L. Measurement of DNA damage after exposure to 2450 MHz electromagnetic radiation. *Radiation Research*. **148** (6), 608–617 (1997).
16. Morgan, L.L. Estimating the risk of brain tumors from cellphone use: Published case-control studies. *Pathophysiology: The Official Journal of the International Society for Pathophysiology*. **16** (2–3), 137–147, doi: 10.1016/j.pathophys.2009.01.009 (2009).
17. Vijayalaxmi, V., Prihoda, T.J. Comprehensive Review of Quality of Publications and Meta-analysis of Genetic Damage in Mammalian Cells Exposed to Non-Ionizing Radiofrequency Fields. *Radiation Research*. **191** (1), 20–30, doi: 10.1667/RR15117.1 (2018).
18. Lai, H. Henry Lai’s Research Summaries. The BioInitiative Report. at <<https://bioinitiative.org/research-summaries/>>.

19. Michaels, D. *Doubt Is Their Product: How Industry's Assault on Science Threatens Your Health*. Oxford University Press. Oxford ; New York. (2008).
20. Conway, E.M., Oreskes, N. *Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming*. Bloomsbury Paperbacks. London. (2012).
21. McGarity, T.O. *Bending Science: How Special Interests Corrupt Public Health Research*. Harvard University Press. Cambridge, Mass.; London. (2010).
22. *Corporate Ties That Bind: An Examination of Corporate Manipulation and Vested Interest in Public Health*. Skyhorse Publishing. (2017).
23. Gee, D. Late Lessons from Early Warnings: Towards realism and precaution with EMF? *Pathophysiology*. **16** (2–3), 217–231, doi: 10.1016/j.pathophys.2009.01.004 (2009).
24. Shankar, P., Ahuja, S., Sriram, K. Non-nutritive sweeteners: review and update. *Nutrition* (Burbank, Los Angeles County, Calif). **29** (11–12), 1293–1299, doi: 10.1016/j.nut.2013.03.024 (2013).
25. Krimsky, S., Gillam, C. Roundup litigation discovery documents: implications for public health and journal ethics. *Journal of Public Health Policy*. **39** (3), 318–326, doi: 10.1057/s41271-018-0134-z (2018).
26. Clough, E. Environmental justice and fracking: A review. *Current Opinion in Environmental Science & Health*. **3**, 14–18, doi: 10.1016/j.coesh.2018.02.005 (2018).
27. Benjamin, S., Masai, E., Kamimura, N., Takahashi, K., Anderson, R.C., Faisal, P.A. Phthalates impact human health: Epidemiological evidences and plausible mechanism of action. *Journal of Hazardous Materials*. **340**, 360–383, doi: 10.1016/j.jhazmat.2017.06.036 (2017).
28. Rochester, J.R. Bisphenol A and human health: A review of the literature. *Reproductive Toxicology*. **42**, 132–155, doi: 10.1016/j.reprotox.2013.08.008 (2013).
29. Hertsgaard, M., Dowie, M. How Big Wireless Made Us Think That Cell Phones Are Safe: A Special Investigation. at <<https://www.thenation.com/article/archive/how-big-wireless-made-us-think-that-cell-phones-are-safe-a-special-investigation/>> (2018).
30. World Bank Mobile cellular subscriptions (per 100 people). International Telecommunication Union (ITU) World Telecommunication/ICT Indicators Database. at <<https://data.worldbank.org/indicator/IT.CEL.SETS.P2>>.
31. Baker, N. UK Mobile Phone Statistics 2024 - Stats Report. Uswitch. at <<https://www.uswitch.com/mobiles/studies/mobile-statistics/>>.
32. Wang, Y. More People Have Cell Phones Than Toilets, U.N. Study Shows. *Time*. at <<https://newsfeed.time.com/2013/03/25/more-people-have-cell-phones-than-toilets-u-n-study-shows/>> (2013).
33. Alster, N. Captured Agency: How the Communications Commission Is Dominated by the Industry It Presumably Regulates. at <https://ethics.harvard.edu/files/center-for-ethics/files/capturedagency_alster.pdf>. Edmund J. Safra Institute for Ethics, Harvard University, Cambridge, MA, USA. (2015).
34. Anguera, J., Andújar, A., Huynh Minh, C., Orlenius, C., Picher, C., Puente Baliarda, C. Advances in Antenna Technology for Wireless Handheld Devices. *International Journal of Antennas and Propagation*. **2013**, doi: 10.1155/2013/838364 (2013).
35. Gandhi, O.P., Morgan, L.L., de Salles, A.A., Han, Y.-Y., Herberman, R.B., Davis, D.L. Exposure limits: the underestimation of absorbed cell phone radiation, especially in children. *Electromagnetic Biology and Medicine*. **31** (1), 34–51, doi: 10.3109/15368378.2011.622827 (2012).
36. Pall, M. How Wireless Causes Harm, Part 1. 5G Summit: 2020 Call to Action (2020).
37. Christ, A., Gosselin, M.-C., Christopoulou, M., Kühn, S., Kuster, N. Age-dependent tissue-specific exposure of cell phone users. *Physics in Medicine and Biology*. **55** (7), 1767–1783, doi: 10.1088/0031-9155/55/7/001 (2010).

38. Gandhi, O.P., Lazzi, G., Furse, C.M. Electromagnetic absorption in the human head and neck for mobile telephones at 835 and 1900 MHz. *IEEE Transactions on Microwave Theory and Techniques*. **44** (10), 1884–1897, doi: 10.1109/22.539947 (1996).
39. Roe, S. We tested popular cellphones for radiofrequency radiation. Now the FCC is investigating. *chicagotribune.com*. at <<https://www.chicagotribune.com/investigations/ct-cell-phone-radiation-testing-20190821-72qgu4nzlfd5kyuhteieih4da-story.html>> (2019).
40. EHT The Fine Print Manufacturer Radio Frequency Radiation Warnings. Environmental Health Trust. at <<https://ehtrust.org/fine-print-manufacturer-radio-frequency-radiation-warnings/>>.
41. EHT The Berkeley Cell Phone “Right to Know” Ordinance. Environmental Health Trust. at <<https://ehtrust.org/policy/the-berkeley-cell-phone-right-to-know-ordinance/>>.
42. Koeppel, B. Wireless Hazards. *The Washington Spectator*. at <<https://washingtonspectator.org/wireless-hazards/>> (2020).
43. Vecchia, P. ICNIRP and international standards. at <https://www.radiationresearch.org/wp-content/uploads/2018/06/021145_vecchia.pdf> (2008).
44. International Commission on Non-Ionizing Radiation Protection Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). *International Commission on Non-Ionizing Radiation Protection. Health Physics*. **74** (4), 494–522 (1998).
45. Hardell, L., Nyberg, R. Appeals that matter or not on a moratorium on the deployment of the fifth generation, 5G, for microwave radiation. *Molecular and Clinical Oncology*. **12** (3), 247–257, doi: 10.3892/mco.2020.1984 (2020).
46. Hardell, L. World Health Organization, radiofrequency radiation and health - a hard nut to crack (Review). *International Journal of Oncology*. **51** (2), 405–413, doi: 10.3892/ijo.2017.4046 (2017).
47. van Scharen, H. The International Commission on Non-Ionizing Radiation Protection: Conflicts of interest, corporate capture and the push for 5G. 98, at <<https://ehtrust.org/wp-content/uploads/ICNIRP-report-FINAL-JUNE-2020.pdf>>. Europe Écologie), Ökologisch-Demokratische Partei, and the Greens/EfA group in the European Parliament. Brussels. (2020).
48. Lloyd’s of London How insurance works. at <<https://www.lloyds.com/join-lloyds-market/what-we-insure/how-insurance-works/>>.
49. EHT Reports and White Papers of Insurance Industry. Environmental Health Trust. at <<https://ehtrust.org/key-issues/reports-white-papers-insurance-industry/>>.
50. EHT Electromagnetic Field Insurance Policy Exclusions. Environmental Health Trust. at <<https://ehtrust.org/key-issues/electromagnetic-field-insurance-policy-exclusions/>>.
51. BBC News Reality Check Team Does 5G pose health risks? *BBC News*. at <<https://www.bbc.co.uk/news/world-europe-48616174>> (2019).
52. Baan, R. et al. Carcinogenicity of radiofrequency electromagnetic fields. *The Lancet. Oncology*. **12** (7), 624–626, doi: 10.1016/s1470-2045(11)70147-4 (2011).
53. IARC Non-ionizing Radiation, Part 2: Radiofrequency Electromagnetic Fields. **Volume 102**, at <<https://publications.iarc.fr/Book-And-Report-Series/Iarc-Monographs-On-The-Identification-Of-Carcinogenic-Hazards-To-Humans/Non-ionizing-Radiation-Part-2-Radiofrequency-Electromagnetic-Fields-2013>>. WHO Press. Lyon. (2013).
54. Falcioni, L. et al. Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission. *Environmental Research*. **165**, 496–503, doi: 10.1016/j.envres.2018.01.037 (2018).
55. National Toxicology Program Peer Review of the Draft NTP Technical Reports on Cell Phone Radiofrequency Radiation. Peer-Review Report. at <https://ntp.niehs.nih.gov/ntp/about_ntp/trpanel/2018/march/peerreview20180328_508.pdf>. National Institute of Environmental Health Sciences. Research Triangle Park, NC. (2018).

56. Miller, A.B. et al. Risks to Health and Well-Being From Radio-Frequency Radiation Emitted by Cell Phones and Other Wireless Devices. *Frontiers in Public Health*. **7**, 223, doi: 10.3389/fpubh.2019.00223 (2019).
57. Hardell, L., Carlberg, M. Comments on the US National Toxicology Program technical reports on toxicology and carcinogenesis study in rats exposed to whole-body radiofrequency radiation at 900 MHz and in mice exposed to whole-body radiofrequency radiation at 1,900 MHz. *International Journal of Oncology*. **54** (1), 111–127, doi: 10.3892/ijo.2018.4606 (2019).
58. Miller, A.B., Morgan, L.L., Udasin, I., Davis, D.L. Cancer epidemiology update, following the 2011 IARC evaluation of radiofrequency electromagnetic fields (Monograph 102). *Environmental Research*. **167**, 673–683, doi: 10.1016/j.envres.2018.06.043 (2018).
59. Bandara, P., Carpenter, D.O. Causes of cancer: Perceptions vs. the scientific evidence. *European Journal of Cancer*. **124**, 214–216, doi: 10.1016/j.ejca.2019.08.036 (2020).
60. Peleg, M., Nativ, O., Richter, E.D. Radio frequency radiation-related cancer: assessing causation in the occupational/military setting. *Environmental Research*. **163**, 123–133, doi: 10.1016/j.envres.2018.01.003 (2018).
61. Marques, M.M. et al. Advisory Group recommendations on priorities for the IARC Monographs. *The Lancet Oncology*. **20** (6), 763–764, doi: 10.1016/S1470-2045(19)30246-3 (2019).
62. González, A.B. de et al. Advisory Group recommendations on priorities for the IARC Monographs. *The Lancet Oncology*. **25** (5), 546–548, doi: 10.1016/S1470-2045(24)00208-0 (2024).
63. IARC Again Advised to Review RF Cancer Risk, Just Not Right Away. *Microwave News*. at <<https://microwavenews.com/news-center/iarc-again-advised-review-rf-cancer-risk>> (2024).
64. International Commission on Non-Ionizing Radiation Protection ICNIRP statement on the “Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz).” *Health Physics*. **97** (3), 257–258, doi: 10.1097/HP.0b013e3181aff9db (2009).
65. Kostoff, R.N., Heroux, P., Aschner, M., Tsatsakis, A. Adverse health effects of 5G mobile networking technology under real-life conditions. *Toxicology Letters*. **323**, 35–40, doi: 10.1016/j.toxlet.2020.01.020 (2020).
66. Odemer, R., Odemer, F. Effects of radiofrequency electromagnetic radiation (RF-EMF) on honey bee queen development and mating success. *Science of The Total Environment*. **661**, 553–562, doi: 10.1016/j.scitotenv.2019.01.154 (2019).
67. Halgamuge, M.N. Review: Weak radiofrequency radiation exposure from mobile phone radiation on plants. *Electromagnetic Biology and Medicine*. **36** (2), 213–235, doi: 10.1080/15368378.2016.1220389 (2017).
68. Waldmann-Selsam, C., Balmori-de la Puente, A., Breunig, H., Balmori, A. Radiofrequency radiation injures trees around mobile phone base stations. *The Science of the Total Environment*. **572**, 554–569, doi: 10.1016/j.scitotenv.2016.08.045 (2016).
69. Kostoff, R.N., Lau, C.G.Y. Modified Health Effects of Non-ionizing Electromagnetic Radiation Combined with Other Agents Reported in the Biomedical Literature. *Microwave Effects on DNA and Proteins*. 97–157, doi: 10.1007/978-3-319-50289-2_4 (2017).
70. Panagopoulos, D.J., Johansson, O., Carlo, G.L. Real versus Simulated Mobile Phone Exposures in Experimental Studies. *BioMed Research International*. **2015**, e607053, doi: <https://doi.org/10.1155/2015/607053> (2015).
71. Vodafone Editorial Team 5G and health: Everything you need to know. Vodafone UK News Centre. at <<https://newscentre.vodafone.co.uk/smart-living/everything-you-need-to-know-about/5g-and-health-everything-you-need-to-know/>> (2020).
72. Grimes, D.R. Radiofrequency Radiation and Cancer: A Review. *JAMA Oncology*. doi: 10.1001/jamaoncol.2021.5964 (2021).

73. Slesin, L. Open Letter to JAMA Network Retract Grimes RF Cancer Review. Microwave News. at <<https://microwavenews.com/news-center/open-letter-jama-network-retract-grimes-rf-cancer-review>> (2022).
74. Frey, A.H. Differential biologic effects of pulsed and continuous electromagnetic fields and mechanisms of effect. *Annals of the New York Academy of Sciences*. **238**, 273–279, doi: 10.1111/j.1749-6632.1974.tb26796.x (1974).
75. Frey, A.H., Feld, S.R., Frey, B. Neural function and behavior: defining the relationship. *Annals of the New York Academy of Sciences*. **247**, 433–439, doi: 10.1111/j.1749-6632.1975.tb36019.x (1975).
76. Hallberg, O., Johansson, O. Melanoma incidence and frequency modulation (FM) broadcasting. *Archives of Environmental Health*. **57** (1), 32–40, doi: 10.1080/00039890209602914 (2002).
77. Hallberg, Ö., Johansson, O. FM Broadcasting Exposure Time and Malignant Melanoma Incidence. *Electromagnetic Biology and Medicine*. **24** (1), 1–8, doi: 10.1081/JBC-200054260 (2005).
78. Russell, C.L. 5 G wireless telecommunications expansion: Public health and environmental implications. *Environmental Research*. **165**, 484–495, doi: 10.1016/j.envres.2018.01.016 (2018).
79. Marino, A.A. *Going Somewhere: Truth about a Life in Science*. Cassandra Publishing. Belcher, LA. (2010).
80. Hern, A. How baseless fears over 5G rollout created a health scare. *The Guardian*. at <<https://www.theguardian.com/technology/2019/jul/26/how-baseless-fears-over-5g-rollout-created-a-health-scare>> (2019).
81. Duffy, C. Why conspiracy theorists think 5G is bad for your health and why experts say not to worry. CNN. at <<https://www.cnn.com/2020/06/14/tech/5g-health-conspiracy-debunked/index.html>>.
82. Wireless device radiation and health. Wikipedia. at <https://en.wikipedia.org/w/index.php?title=Wireless_device_radiation_and_health&oldid=1070545446> (2022).

Chapter 4. Health Impacts of Non-Native EMFs

It is universally accepted that exposure to ionising radiation (IR), such as X-rays, causes metabolic disturbances by dislodging electrons, leading to the production of free radicals – highly reactive charged particles that can damage cells. Free radicals are part of the body’s normal metabolism, but chronic disease will result if the rate of free-radical damage exceeds the body’s capacity for repair. The Procrustean argument is that non-ionising radiation (NIR) does not have enough energy to dislodge electrons, so it cannot induce free-radical damage. Ergo, the only potential NIR effects we need to consider are those caused by heating.

The problem with this Procrustean Postulate is that there is a large and growing body of evidence that demonstrates free-radical damage from NIR in humans, other animals, plants, and microorganisms. These effects have been found for both extremely low frequency (ELF) electromagnetic fields and for radio frequency radiation (RFR).¹ When a theory is repeatedly dashed against the rocks of observation it is time to change the theory.

There are various candidate hypotheses to explain the mechanisms through which NIR induces free-radical damage. I will briefly introduce one of the leading candidates – the VGCC hypothesis, as elucidated by Professor Martin Pall in a number of publications.²⁻⁴ I will also summarise the effects of EMFs on melatonin, best known as the ‘sleep hormone’ but which plays many other vital roles, and mitochondria, our cellular “batteries”, which are also masterful metabolic multitaskers.

How non-ionising radiation can harm us – the voltage-gated calcium channel (VGCC) hypothesis

Our cells are enclosed by membranes through which information and material must be shuttled into and out of the cells as and when required. Much of this to and fro is achieved via a complex of gateways, known as channels, that are embedded in cell membranes. One such channel is the ‘voltage-gated ion channel’ (VGIC), critical for rapid electrical signalling within and between cells. These VGICs are opened and closed via voltage sensors. Some of the most abundant of these channels are the voltage-gated calcium channels (VGCCs), which allow calcium to flow into and out of our cells. Calcium levels in the cell (intracellular calcium) strongly influence a number of vital cellular attributes, such as ATP (Adenosine triphosphate) levels, oxidation status, DNA integrity, and cell death.² ATP, produced in the mitochondria, is the body’s ‘energy currency’ and is to life what money is to the economy. Too little money in circulation and the economy stagnates. Too much, and you get hyperinflation. Stagnation can be likened to disorders such as chronic fatigue syndrome and fibromyalgia, while hyper-inflation is analogous to ADHD and certain autoimmune conditions such as an overactive thyroid (Crohn’s disease). Mitochondrial perturbations are considered relevant or causative for a panoply of chronic human conditions, including type I and type II diabetes, heart disease, Parkinson’s, Alzheimer’s, multiple sclerosis, autism, and psychiatric disorders.⁵ A loss of DNA integrity causes mutations that can affect cellular function and susceptibility to cancer and have intergenerational effects via diminished sperm and egg quality. Oxidation – a chemical reaction that involves the loss of electrons – is akin to a fire. Keeping the home fire burning provides warmth and comfort, but the consequences of a raging house fire are less congenial. Cell death sounds negative, but it happens all the time, notably when a cell becomes defective or diseased, so a certain amount of cell death is essential. But cell death without compensatory new cell birth and growth will lead to loss of vigour and eventually death of the organism concerned.

The VGCC hypothesis states that NIR creates an unnatural voltage, thus deregulating VGCCs and leading to excessive levels of intracellular calcium. This initiates a cascade of events that causes an increase in the free radicals nitric oxide (NO) and superoxide ($O_2^{\cdot-}$) in close proximity to each other. These molecules, which can be beneficial in the right place at the right time in the right concentration, can combine to form a much more dangerous substance, peroxynitrite (ONOO-). Even its chemical formula has a menacing ring to it especially if you yell “ONOO” in a Scottish accent! Peroxynitrite has been shown to damage the building blocks of life, including

proteins, DNA, mitochondria, cell membranes, hormones, and stem cells.⁶ A visual summary of the VGCC mechanism for harmful and beneficial effects of EMFs is given in the figure below. So why have so few people heard about this? Well, peroxynitrite was first described only in 1990 and evidence that EMF exposure elevates cellular calcium levels began to emerge in the 1980s and 1990s.⁷ Thirty to forty years may seem like quite a long time for this information to trickle out, but as we have seen, scientific findings often take some time to enter the mainstream, especially when vested interests are at stake.

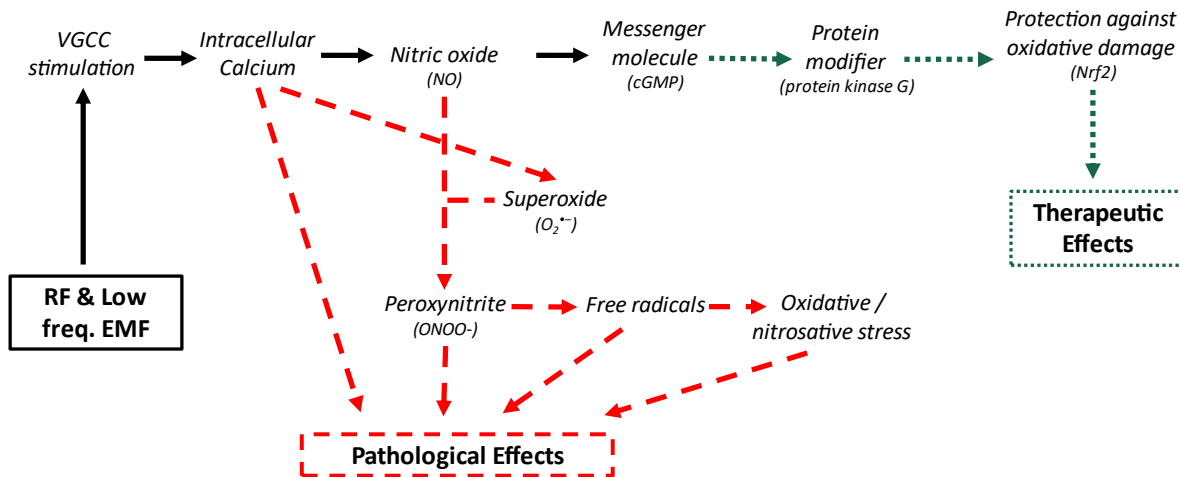


Figure 4.1: The VGCC mechanism for harmful and beneficial effects of EMFs. Adapted from Pall (2018).³

Radio frequency and lower-frequency EMFs act via VGCC activation to increase intracellular calcium levels, which can have both harmful and beneficial impacts. Elevated intracellular calcium levels increase NO synthesis, which can act along two pathways. The upper (dotted) pathway raises levels of the messenger molecule cyclic GMP (cGMP or cyclic guanosine monophosphate), which stimulates the activity of the protein modifier G-kinase, which results in therapeutic effects via Nrf2 (nuclear factor erythroid 2-related factor 2). Nrf2 helps to regulate oxidative damage triggered by injury and inflammation, among other benefits. In the lower (dashed) pathway, NO reacts with superoxide ($O_2^{\bullet-}$) to form peroxynitrite ($ONOO^-$), which can break down to form free radicals, producing oxidative/nitrosative stress. The excessive calcium signalling produced by elevated intracellular calcium levels and the peroxynitrite/free radical/oxidative/nitrosative stress pathway each contribute to pathophysiological responses.

Elucidating the precise mechanisms through which EMFs induce both harmful as well as beneficial effects in biological systems will always be a work in progress. This is the nature of research into complex real-world biological systems. However, there is widespread agreement that these effects are significant and that similar outcomes are produced from EMFs in both the ELF and RF ranges.^{1, 2, 8, 9}

The fact that a similar mechanism can be invoked for cellular damage from ELF and RFR makes it possible to map out a generic disease aetiology schematic, as per the body burden model outlined later in this chapter, without needing to immerse ourselves in the labyrinthine complexity that often accompanies attempts to map specific diseases to specific causal factors. The reality is that trying to be that precise would imply false certainty. Instead, in most cases, it is likely that the specific constellation of symptoms we label as diseases has multiple and complex root causes, one of which could be EMFs. In some, probably rare, instances, there may be simple cause-effect (*attribution*), but in the real world, it is more likely that EMFs will be among the factors contributing to the total body burden that tips a person over the disease threshold (*contribution*).

Therefore, in this book, I will present an overview of EMFs and disease as a whole in this chapter and highlight the influences of specific EMF categories—electricity, radio frequency, light, and ionising radiation—on particular pathologies as case studies (“Spotlights”) in the relevant chapters.

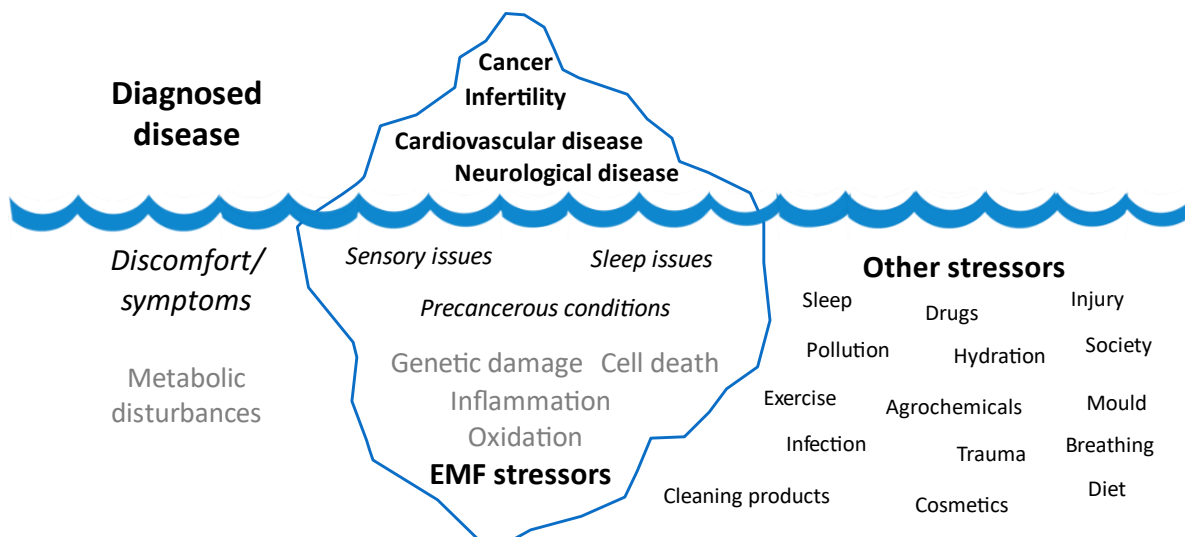


Figure 4.2: Some adverse effects of non-native EMFs on humans. The tip of the iceberg in a sea of stressors.

EMFs and melatonin

The importance of quality sleep is a theme running through this book, and melatonin is the hormone that is most associated with sleep regulation.¹⁰ Sleep is a time for rest and repair, and your bedroom is an environment that is more or less under your control. **My number one EMF health tip, therefore, is to make your bedroom a sleep sanctuary.** As laid out in Chapter 17 (*Resilience*), this can be done by taking a number of simple, though not always easy, actions, including bringing your bedroom EMF exposure down to as close to natural levels as possible.

Circulating melatonin is produced in the pineal gland found in the central part of the brain in a location that corresponds with the “third eye” familiar to yoga devotees. Melatonin production is stimulated by sunlight, while its secretion is facilitated by darkness as part of the natural cycle of day and night. Day-night – or circadian – rhythms influence almost all of our physiological functions.¹¹ In recognition of their importance, they have been granted their own branch of biology – chronobiology, which will be covered in more detail in Part 4. In addition to its chronobiological functions, melatonin is a powerful antioxidant,¹² helps regulate energy production,¹³ modulates the immune system,¹⁴ protects against cancer,¹⁵ and can even be used as a cancer treatment.¹⁶ Melatonin availability can be impacted via the VGCC mechanism outlined above.¹⁷ I will shed more light on melatonin, the master multi-tasker, in Part 4.

EMFs and mitochondria

Key mechanisms whereby mitochondria are thought to be affected by EMFs have been elucidated by Canadian researcher Dr Paul Héroux and colleagues.^{8, 9, 18, 19} Growing power and telecommunications systems have created a suboptimal electromagnetic environment for mitochondria to generate ATP. ATP turnover represents the energy budget we need to spend to survive. This budget is enormous, with the body consuming approximately its weight in ATP every day. Mitochondria, like all physiological systems, have conditions in which they work optimally. This is called the *Goldilocks Zone* – “Not too much, not too little, but just right”. Some conditions, such as iron concentration, vary considerably under ancestral conditions (the environment we have lived in for the vast majority of our evolutionary history), so the body has developed sophisticated systems to manage the concentration of iron.²⁰ Non-native EMFs to which we are exposed in modern times are unknown to the body. Mitochondria have been around for two billion years and cannot perfectly adapt to something so new – evolution did not prepare them for this. But you cannot run out of ATP; otherwise, you will die, so the body compensates to stay alive. To continue the money analogy, we compensate by spending our savings (less immediately critical physiological systems), leading to metabolic exhaustion, which increases with age, contributing to many familiar chronic conditions.

Mother Nature Knows Best – why should we be concerned about EMFs?

In this section, I will examine:

- How our disconnection from nature has led to a range of chronic diseases.
- How multiple stressors can induce these diseases.
- How EMFs can add to this total stress burden.
- The specificities of electro hypersensitivity (EHS).

The foregoing sets the scene for the one question we must ask of every new technology to maximise its benefits while minimising its adverse effects on personal and planetary health – *How can we benefit from technology without jeopardising our health and the planet's life support systems upon which we all depend?*

Evolution – the real-life test, the pleasure trap and evolutionary mismatch diseases

We live in a world of winners. Each of us alive today is a member of an exclusive club of successful descendants from an unbroken lineage dating back millions of generations from our common ancestor, who emerged from the primordial soup around 3.7 billion years ago. During this unimaginably long period of time, the power of evolution has shaped us to survive and thrive in nature. Those species that could not adapt have perished. This is nature's way.

In order to survive, all behaviours of all species have been hardwired to respond to three main motivations:

- The pursuit of pleasure – the things we like must be good for us.
- The avoidance of pain – what hurts us must be bad for us.
- The minimisation of energy – we only have a finite energy supply, so it is best not to squander it.

This motivational triad worked very well for more than 99% of the history of life on Earth until about 200,000 years ago when modern humans emerged and soon became the first ever species to systematically suspend nature's laws through the use of ever more sophisticated technology. In their ground-breaking book, *The Pleasure Trap: Mastering the Hidden Force that Undermines Health and Happiness* (2006),²¹ Doug Lisle and Alan Goldhamer introduce the idea that this motivational triad, which was good for us in the pre-technological era, no longer always serves our interests in a time when pleasure can be accessed at the flick of a switch, pain can be numbed by swallowing a pill, and our body's powers of movement can be outsourced to a myriad of contraptions. The resultant "pleasure trap" is a life of perpetual comfort which ushers in a range of chronic conditions that have become so closely associated with modern lifestyles that they are known as "Western diseases" or "diseases of civilisation". These include Type 2 diabetes, cardiovascular disease, cancer, and autoimmune disease.

Our technological innovations have been devised to bring specific benefits without necessarily taking any "side effects" into account. The term side effects is somewhat unfortunate because it implies that the main effect is the one you desire, and the side effects are an unforeseen but minor consequence. The fact is that in nature you can't just do one thing. All actions have multiple consequences, some of which may eventually come back to bite us, as the guy pushing the "dominoes" in the cartoon below will soon discover to his cost.



Figure 4.3: *You can't do just one thing.*

Some examples of “side effects” from the use of modern technology are listed below:

- Fossil fuel consumption and climate change.
- The use of halocarbons (CFCs and other related chemicals) and ozone depletion.
- The burning of sulphur-containing coal and acid rain.
- The effects of DDT and other agrochemicals on biodiversity.

And what has been bad for the planet tends to be bad for people, too:

- The dumping of non-biodegradable plastics, leading to toxins in our food.
- The role of factory farming in precipitating and spreading disease pandemics.
- Overconsumption of processed foods that the body was not designed to digest and assimilate.
- Spending long periods seated, leading to poor posture and structural problems.
- Labour-saving devices, reducing people’s movement and contributing to diseases of affluence.
- Lack of time spent outdoors, leading to vitamin D deficiencies.

All of this contributes to a variety of stresses, which combine to play a role in the development of chronic disease. The multiple “side effects” of EMFs are chronicled throughout this book.

The stress bucket/total body burden model of chronic disease

I like to use the analogy of the “stress/toxic bucket” when conceptualising the development of chronic disease. To use an inclusive definition, stress can be anything physical, chemical, or emotional that the body is exposed to in doses that are too high or too low or is something new to the body from an evolutionary standpoint. As illustrated throughout this chapter, the rise in EMF levels in recent years has been astronomical - *Too High*, and many of the frequencies used have no natural equivalent - *Too New*, while our exposure to natural light regimes has plummeted – *Too Low* during the day, *Too High* at night.

The body is constantly subjected to stressors of all kinds; for example, organic and inorganic toxins, potentially stressful life events, the news, which always seems to be depressing, processed foods stripped of nutritional value and loaded with synthetic additives, poor sleep quality and quantity, mould, infections, and drugs – both recreational and pharmaceutical. However, the body has diverse and effective mechanisms to process stressors/toxins. In fact, appropriate exposure to something potentially stressful can be a good thing. Think of exercise, which exerts its beneficial effects by pushing the body just a little beyond its current limits to stimulate a more than commensurate recovery – a phenomenon known as *hormesis*. The capacity of the body to deal with stress can be conceptualised as a bucket. As long as the bucket has spare capacity, the body does not become diseased, but if there is more stress than the bucket can hold, the stress overflows, and disease emerges as a threshold is crossed. The “spare capacity” of our stress bucket represents our resilience to a range of conditions. This can be measured by a vast array of biomarkers, including commonly used metrics such as blood pressure, blood cholesterol and triglycerides, kidney function, blood sugar, inflammation markers, etc. The degree to which an individual is resilient to any given constellation of symptoms will depend on their life history and their innate susceptibility to specific conditions (“bioindividuality”), so a similar set of external stressors can manifest as different diseases for different people. For instance, for some, it could be diabetes; for others, cardiovascular disease; and for others, it could be autoimmune conditions. But a cocktail of stressors, as broadly defined, lies at the heart of all chronic diseases.

Bioindividuality has received little attention when it comes to the study of EMF health impacts, but this situation is beginning to change. In 2020, Luo et al. published a study on thyroid cancer and mobile phone use, which found that the risk of cancer was more than doubled among mobile phone users with specific variations in four of the ten genes examined.²²

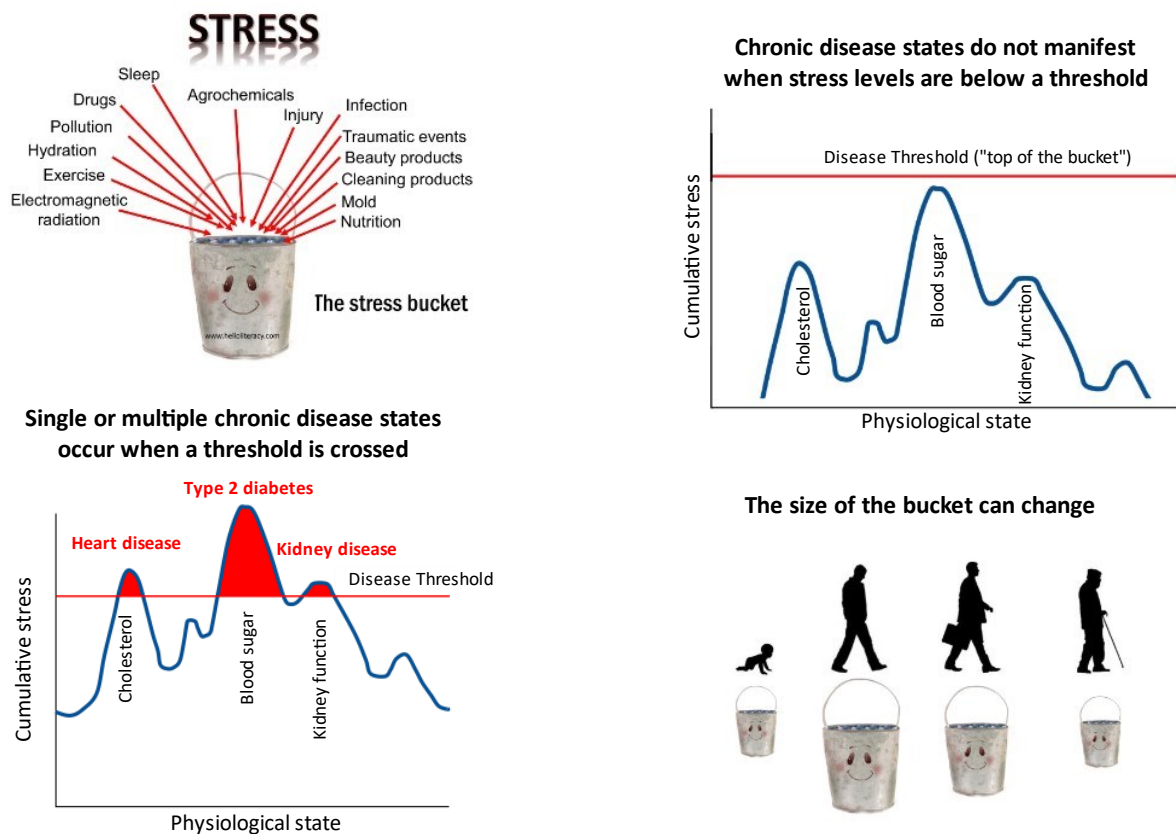


Figure 4.4: Schematic representation of the stress and disease threshold model of chronic disease.

The simple model presented here might convey the impression that diseases suddenly appear out of nowhere once a threshold is exceeded. However, it is more likely that there will be early warning signs as a disease threshold is being approached. For example, full-blown diabetes is often preceded by pre-diabetes, cardiovascular disease by hypertension, high cholesterol and other elevated biomarkers, and autoimmune diseases by allergies and intestinal symptoms of various kinds.²³ These symptoms can be likened to “canaries in the coal mine.” This common expression is used to describe warning signs of greater danger to come, which originates from the tradition of taking caged canaries into coal mines. These sensitive birds would die if the levels of carbon monoxide and other odourless toxic gases built up thus calling the miners to action before it was too late. On an individual basis, disease “canaries” can help people address the factors that influence long-term health before things degenerate into something much more serious. On a societal level, these canaries can contribute to the common good by alerting us to behaviours that do not serve our long-term interests. A group of people who can be thought of as EMF canaries are those who suffer from “electro hypersensitivity” (EHS).

Electro Hypersensitivity – the Canary in the Coal Mine

The stress bucket model characterises EMF as a stressor within a sea of stressors. The simplistic interpretation is that stressors behave as interconvertible “stress currencies”, and there is a “stress exchange rate” with x units of EMF equalling y units of sleep equalling z units of trauma, etc. Reality is more complex and certain types of stress appear to exert disproportionate impacts on certain individuals. The most obvious example of this is people with acute allergies, such as those who cannot even be close to peanuts without going into anaphylactic shock. Others experience less extreme and more delayed reactions, but they are nonetheless allergic.

Electro hypersensitivity – a short history

The term “electro hypersensitivity” (EHS) was coined in 1997 for a condition whereby people react to EMFs in a manner akin to those who have allergies,²⁴ but it was reported – as “microwave sickness” – as long ago as 1932 by

a German medical doctor, Erwin Schliephake, among people living close to radio transmitters, then by Soviet researchers in the 1950s in military personnel working with radio and radar equipment.^{25, 26} The condition is likely to date back even further, with many of the pioneers of the electrical age reporting symptoms akin to those documented in modern-day EHS sufferers. Arthur Firstenberg, in his powerful and thought-provoking book *The Invisible Rainbow: A History of Electricity and Life* (2016),²⁷ documents a number of cases. Benjamin Franklin, the renowned American polymath, suffered from a chronic neurological illness that began during his electrical research, which included the widely misunderstood 1752 kite-in-a-thunderstorm experiment.²⁸ French naturalist Thomas-François Dalibard, who re-enacted Franklin's experiments, confided in a 1762 letter to Franklin that "I am left with a convulsive tremor in my arm so that I can scarcely bring a glass to my mouth." Guglielmo Marconi, the father of wireless communication, began to develop bouts of chills and fevers after about a year and a half of experimenting with radio equipment. These episodes would continue throughout Marconi's life, along with periods of depression and ten heart attacks, including the one that killed him at the age of 63. Nikola Tesla, about whom we will hear much more in Part 2, developed extreme sensitivity to sound, light, and physical vibration when working on electricity in the 1880s, rendering him unable to work for some months.²⁹ Interestingly, I have not come across stories of similar symptoms developing in Nikola Tesla's arch-rival, Thomas Edison, although Edison was a type 2 diabetic, which was exceedingly uncommon at the time.

EHS triggers, symptoms, and progression

EHS sufferers experience a diverse range of symptoms when exposed to EMFs at levels below those that provoke responses in most other people. These folks are affected in different ways and to differing degrees. Some may be particularly sensitive to fluorescent lights, others react particularly badly to mobile phones, and others are highly reactive to medical procedures such as MRI scans or X-rays. Common symptoms of EHS include headaches, nausea, ringing in the ears (tinnitus), dermatitis, elevated blood sugar, poor sleep, fatigue, and flu-like symptoms. A list of common clinical symptoms is given in the table below.

Table 4.1: Clinical symptoms in self-reported EHS patients compared to those in normal controls. Source: Belpomme et al. (2018).³⁰ Only symptoms that showed statistically significant differences are listed.

Clinical Symptoms	Difference in occurrence between people with EHS and normal controls
Dysesthesia (unpleasant, abnormal sense of touch, sometimes painful but can often be an inappropriate, but not discomforting, sensation)	82%
Headache	88%
Concentration/attention deficiency	76%
Fatigue	76%
Ear heat/earache (otalgia)	70%
Dizziness	70%
Insomnia	68%
Loss of immediate memory	64%
Depression tendency	60%
Tinnitus (noise or ringing in the ears)	54%
Transitory cardiovascular abnormalities	50%
Ocular deficiency	48%
Myalgia (muscle pain)	42%
Balance disorder	42%
Anxiety/panic	38%
Hyperacusis (sound or noise sensitivity)	34%
Suicidal ideation (wanting to take your own life or thinking about suicide)	20%
Irritability	18%
Skin lesions	16%
Global body dysthymia (mood disorder with the same cognitive and physical problems as depression but with longer-lasting symptoms)	14%

EHS typically develops gradually over time, with symptoms coming and going initially. Repeated EMF exposure results in worsening and more persistent symptoms. Symptoms intensify with continuing exposure and can become readily triggered even by low-level EMF exposure.²⁴ This is the familiar pattern of reactions to a stressor building over time until a threshold is exceeded. Reflecting the pattern for chronic diseases as a whole, some people's symptoms can lessen and, in many cases, completely disappear over time if contact with EMFs is minimised and resilience is promoted through the kinds of practices outlined in this book.³¹ These people may then be able to expose themselves to small doses of EMFs at levels that they previously found to be debilitating, but in the medium to long run, a return to previous EMF levels will almost certainly result in regression. Others may only experience symptom stabilisation, with EMF minimisation and the adoption of health-promoting measures, while a third scenario is a continuing decline despite the mitigation efforts.

EHS diagnosis, doubts, and dubious debunking

Some doubt the existence of EHS, and to date, Sweden is the only country that has acknowledged it as a diagnosable condition.³² However, EHS is being increasingly recognised by health authorities, disability administrators and case workers, politicians, and courts of law worldwide.³³ In a recent study, Dominique Belpomme and Philippe Irigaray found detectable oxidative stress biomarkers in 80% of EHS patients, and scans revealed diminished blood flow in specific brain areas. The authors “strongly suggest that EHS is a neurologic pathological disorder which can be diagnosed, treated, and prevented.”

EHS is widely depicted in the media as a psychosomatic condition, with newspapers, magazines and TV coverage often serving up cookie-cutter portrayals of people suffering from EHS as sincere but deluded individuals who are victims of pseudoscience and conspiracy theories. Their heartfelt personal testimonies are juxtaposed with the *objective truth* portrayed by (predominantly industry-supported) science, as discussed in Chapter 3.^{34, 35} The ‘objective’ position is bolstered by the inconclusive results from numerous *provocation studies* in which EHS sufferers have been exposed to EMFs and their reactions monitored.^{36, 37} Most of these studies, however, suffer from severe methodological limitations.^{38, 39} Dr Erica Mallery-Blythe, the Founder of the Physicians' Health Initiative for Radiation and Environment (PHIRE)⁴⁰ has developed fundamental principles for robust provocation testing: pre-test, e.g., identification of trigger frequencies and intensities; during-test, e.g., proper control of non-native EMF levels from other sources throughout the test; and post-test, e.g., including delayed symptoms in the data capture. Dr Mallery-Blythe has distilled these principles down to 24 points, rated studies based on these points, and “found them all to be appalling.”³⁹

The largely dismissive attitude towards EHS in the mainstream media is reinforced by its portrayal in the popular Netflix series *Better Call Saul*.⁴¹ In this prequel to *Breaking Bad*, one of the show's main characters, Chuck McGill, a highly respected lawyer and brother of the eponymous ‘hero’, has become extremely electro hypersensitive. He takes leave of absence from his law firm and retreats into a reclusive existence in his home, devoid of electricity and electronic devices. In one scene in which Chuck is in hospital, a ‘kindly’ doctor performs her version of an atrociously designed provocation study on Chuck by surreptitiously switching on electricity to his bed. His perceived physiological state does not instantaneously change, which is taken as proof positive that his condition is purely psychosomatic – the doctor sympathetically confides in Saul, “This allergy to electricity isn’t real. It’s a manifestation of something deeper.” I rated the ‘Better Call Saul Study’ using Dr Mallery-Blythe’s 24 points, and it failed on all counts. You may be wondering why I have focused so much on a product of Hollywood, which is renowned for taking dramatic licence. It is because the *Better Call Saul* portrayal of EHS represents many people’s first encounter with the condition, and thus, it helps establish a baseline judgement – that those with EHS are just imagining it. Undoubtedly, many well-intentioned people have performed their version of the ‘Better Call Saul Study’ on unsuspecting friends and family members and have come to this conclusion. On a further side note, I actually really like *Better Call Saul*, which is a testimony to my cognitive dissonance.

It is demonstrably true that EHS can feed back into psychological disorders. First, to paraphrase Plato, the mind and body are one, so distinguishing between the physical and the mental can be problematic. There is little doubt that there is a psychological component to EHS, as there is for most pathologies. Second, it is easy to understand why EHS sufferers often develop psychological ailments on top of their initial symptoms when many of those in their social support network consider their ailments to be ‘all in the head’.⁴² Lack of support and facing potential rejection and ridicule, along with the need to avoid public places where non-native EMFs are ubiquitous, can result in extreme physical and social isolation and a vicious circle of physical and psychological decline. Unsurprisingly, EHS has been described by patients as a ‘loner's disease’.⁴³

EHS prevalence

Estimates of EHS prevalence vary, with levels commonly cited in the 1% to 5% range.⁴⁴ Reported figures have been as high as 13.3% in Taiwan, but the numbers may be exaggerated with people misattributing their symptoms to EMFs.⁴⁵ However, it is also possible that EHS prevalence is grossly underestimated, as those with EHS have made the association between EMF exposure and their symptoms, while for others, EMFs could be contributing to the “medically unexplained symptoms” that are so prevalent today.⁴⁶ In Sweden, the figure has been estimated to be between 2.6% and 3.2%³² with an increase in numbers over time.⁴⁴ This is likely to be a relatively reliable estimate because EHS is an officially recognised “functional impairment” in Sweden, so diagnosis is subject to intensive scrutiny as it is accompanied by benefits such as sick leave, financial compensation, and access to social services.

Hypersensitivity – a useful distinction or a travesty of a name?

The term “hypersensitivity” is important as every living thing is electro sensitive. The body is bioelectric, with weak electric currents controlling practically every cellular/biological function.⁴⁷ Therefore, if you are alive, you must, by definition, be electrically sensitive. Most of us just don’t feel any apparent effects during or after low-dose EMF exposure, even though it may well be causing long-term harm. An analogy can be made with the impact of gluten consumption on our physiology. Gluten (hyper)sensitive people, like me, experience predictable but delayed symptoms of gluten consumption (I won’t go into them here, but believe me, they are not fun), while those with classic coeliac disease experience acute and immediate effects of gluten consumption.⁴⁸ But, research has shown that gluten consumption precipitates intestinal inflammation in everybody.⁴⁹ This may result in widespread chronic effects for many of those not deemed gluten-sensitive. I believe electro hypersensitivity to be a useful term that helps to cast a spotlight on EMF health impacts. However, I also understand why some people, such as Arthur Firstenberg, consider that instead of highlighting the broad-spectrum toxicity of non-native EMFs, the label singles out and marginalises “Those of us whose injuries are so severe, so devastating that we can no longer ignore them, and who are lucky enough to figure out what has happened to us and why.”²⁷

Especially vulnerable people?

EHS has been described as a sensitivity-related illness (SRI), along with other multi-system illnesses such as multiple chemical sensitivity (MCS), fibromyalgia, and chronic fatigue syndrome (CFS), that develop in people with a genetic predisposition when exposed to toxic triggers such as environmental pollutants, dental materials, surgical implants and ionising and non-ionising radiation.⁵⁰ Pawel Wypychowski, a Polish electronics and telecommunication engineer with a deep knowledge of biophysics and holistic health approaches, has worked with EHS sufferers for over a decade. During this time, he has noticed the vulnerability to EHS of stereotypically sensitive people who feel highly connected to the environment, nature, literature, and art.⁵¹ This tallies with the notion of those exhibiting electro hypersensitivity as the *Canaries in the Coal Mine* – a warning to the planet that non-native EMFs are disrupting the biological coherence of life. From this perspective, EHS can be seen as a super sense³⁹ preferentially bestowed upon highly sensitive people whose insights are a disguised gift to the world.⁵²

The following is highly speculative and based on incomplete anecdotal evidence, but you could conceive of a narrative in which Guglielmo Marconi, Nikola Tesla, and Thomas Edison fall along a continuum of EMF sensitivity, with Marconi being highly sensitive, Tesla situated somewhere along the middle, and Edison being the equivalent of the oft-cited person who smoked a pack of cigarettes every day for their entire life and lived to be 95 – Thomas Edison actually died at 84, but you get the point. To reiterate, you need much larger numbers and firmer data to come to solid conclusions. However, Tesla’s case is interesting as he adopted a strict vegetarian diet and regular physical exercise and treated himself with beneficial electromagnetic frequencies (more on this topic in Chapter 18).⁵³ This may help explain the fact that he continued to work prodigiously until his death in 1943, aged 86.

EHS Treatment

Treatment involves EMF mitigation and adopting health-promoting lifestyle practices that enhance resilience and reduce total toxic load. These interventions benefit everybody, whether they are EMF hypersensitive or not. Erica Mallery-Blythe summarises these practices as her **A to Hs for EMR Health**:³⁹

- A) Avoid anthropogenic EMFs/stressors
- B) Breathe fresh air
- C) Cognition, Creativity and Care
- D) Dentition
- E) Exercise
- F) Friendly Foods
- G) Grounding
- H) Hydration
- S) Sunlight

EMF mitigation measures and healthy lifestyle practices are discussed in detail throughout this book. Pharmaceuticals can sometimes be helpful, but only as a last resort, and when used in conjunction with lifestyle changes – EHS is an individual response to environmental triggers and is not caused by a lack of pharmaceutical drugs. Some people get positive results from talking therapies such as cognitive behavioural therapy (CBT) as an adjunct to EMF mitigation and other lifestyle changes.⁴³ However, talking therapies should not be used to encourage the EHS person to expose themselves to the levels of EMF that triggered their symptoms in the first place.³⁹ This is dangerous and irresponsible.

In some ways, those who are electro hypersensitive are the lucky ones as they must limit their EMF exposure most of the time, while others are unaware of these EMFs' long-term impacts. I feel fortunate to have allergic reactions to sugar and gluten, and my wife Julie feels the same about her allergic reactions to dairy products. However, avoiding sugar, gluten, and dairy is less challenging than adopting a strict “low EMF diet”.

A spotlight on electro hypersensitivity – Holly’s Story



In 2015, I became extremely hypersensitive to electromagnetic frequency radiation. It became unbearable for me to be near Wi-Fi, my mobile phone, laptop, TV, or electronic appliances around our home. Within seconds, I would become nauseous and have pains in my head and tingling sensations all over my skin. Other symptoms included extreme fatigue and difficulties thinking clearly or concentrating, which continued long after exposure. My brain felt so frazzled that I couldn't even read a book without feeling strained. It was a very scary and isolating experience, especially as there was very little information or support available at that time.

I was lucky to know a Health Kinesiologist who was aware of EMF hypersensitivity, so could help me out. My mum was also an incredible support, doing research online for me when I was unable to. I had to take a break from technology, switching off all electronics in our house for just over a month to allow my body time to rest and recover (we used candles instead of electric lights). It was as if I'd gone back in time; I felt like I was in a Jane Austen novel, but alas, without the beautiful dresses and romance. I spent most of my time resting, taking gentle walks in the countryside, doing crafts and jigsaw puzzles, playing my acoustic guitar and handwriting letters to friends and family (by candlelight in the evenings). It sounds quite pleasant as I write about it now, but it was actually a very distressing time. At times, I was completely bedridden, exhausted, overwhelmed, unable to digest solid food, and riddled with intense anxiety. I felt very unwell, exhausted, afraid, and cut off from regular contact with friends. I also hadn't realised what a comfort listening to music or watching films had been in my life. I had many fears of the unknown – how long was I going to react like this to EMFs, and what did this mean for my future?*

It took me over two years to heal, so patience and perseverance are key (plus support from friends or family and health care professionals). I learnt how to adjust my lifestyle to reduce the amount of EMF radiation I am exposed to, and I am glad to say I have now learnt ways I can use my mobile and laptop and watch TV again without feeling ill. Plus, my resilience to EMFs is much better now. I focused on improving my health in all areas (physical, emotional, and spiritual). I received guidance/energy healing from my Health Kinesiologist, who was also a nutritionist, and she helped me improve my diet. I also saw a spiritual life coach during this time. The emotional/spiritual element of my healing was essential.

In time, my victim mentality was replaced by one of deep gratitude. I felt grateful and blessed to be in the position of knowing just how dangerous EMFs are and acquired a deep sense of knowing that I was going to recover my health. Everything that I have learned from this experience has shaped my life for the better. On that day in 2002 when I first felt the symptoms, I was lucky. I instantly knew it was my cell phone. But how many others are suffering and have no idea that EMFs are causing their ill health? Some people never put two and two together, and if they do it's only after years of functional impairment, huge expense and misdiagnosis.

Apart from close friends and family and health care providers, nobody knew about my EMF hypersensitivity until I started my blog in 2017. So why did I “come out”? Because I found out that there are other sufferers who didn't find the help/support I did and who tragically ended up taking their own lives. No one believed what they were experiencing was real, leaving them alone, depressed, and afraid of being ridiculed if they did ask for help. Many who live in cities have no choice but to leave their homes and jobs, where they are surrounded by Wi-Fi, to find safety in remote locations. It is understandable how this isolation and lack of support could lead to suicide. This broke my heart and made me realise it was time for me to speak up and share my story. The more awareness that is raised, hopefully the more support and understanding will become available.

Synthesised with permission from Holly Kim.

* Kinesiology is a holistic therapy that combines Western and Eastern techniques and knowledge.⁵⁴ It can be considered to be an energy field therapy, as highlighted in Chapter 18.

Making our use of technology as safe as possible – one simple question

At this point, I can hear my sceptical readers vociferously reminding me that technology has had many positive consequences, and with nearly 8 billion people on the planet, we cannot return to cave-person living even if we wanted to... AND THE OVERWHELMING MAJORITY OF US DO NOT! As I write this passage, I am sitting on my chair in my insulated office, under artificial lights (it's 6 am, cold, dark, and raining buckets outside), using voice activation to input text onto my computer. I have and will continue to embrace technology. However, I will be walking our dog when it gets light to mitigate the sitting and indoor living; and because our dog needs to be walked. I am wearing blue light-blocking glasses to mitigate the impacts of the artificial light sources all around me, and I have a grounding mat (more on grounding in Chapter 9) under my (wired) keyboard and mouse and on my office floor (please skip to the grounding section now if your curiosity has been piqued – it is a very simple, cheap and efficacious health modality). I am doing all these things as part of a lifestyle approach to mitigate the negative consequences of 21st-century Western living, which has benefited me in so many ways.

The great news is that both the planet and its inhabitants are resilient – we come from a very long line of survivors, and we can cope with a bit of stress. However, we must understand the potential adverse effects of our use of technology to make this process as safe as possible. We can do this once we, as a global community, seriously address this simple question – *How can we benefit from technology without jeopardising our health and the planet's life support systems upon which we all depend?*

References

1. Havas, M. When theory and observation collide: Can non-ionizing radiation cause cancer? *Environmental Pollution (Barking, Essex: 1987)*. **221**, 501–505, doi: 10.1016/j.envpol.2016.10.018 (2017).
2. Pall, M.L. Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects. *Journal of Cellular and Molecular Medicine*. **17** (8), 958–965, doi: 10.1111/jcmm.12088 (2013).
3. Pall, M.L. Wi-Fi is an important threat to human health. *Environmental Research*. **164**, 405–416, doi: 10.1016/j.envres.2018.01.035 (2018).
4. Pall, M.L. Microwave frequency electromagnetic fields (EMFs) produce widespread neuropsychiatric effects including depression. *Journal of Chemical Neuroanatomy*. **75** (Pt B), 43–51, doi: 10.1016/j.jchemneu.2015.08.001 (2016).
5. Wallace, D.C. A mitochondrial bioenergetic etiology of disease. *The Journal of Clinical Investigation*. **123** (4), 1405–1412, doi: 10.1172/JCI61398 (2013).
6. Pacher, P., Beckman, J.S., Liaudet, L. Nitric oxide and peroxynitrite in health and disease. *Physiological Reviews*. **87** (1), 315–424, doi: 10.1152/physrev.00029.2006 (2007).
7. Walleczek, J. Electromagnetic field effects on cells of the immune system: The role of calcium signaling. *FASEB journal*. **6**, 3177–3185, doi: 10.1096/fasebj.6.13.1397839 (1992).
8. Kostoff, R.N., Heroux, P., Aschner, M., Tsatsakis, A. Adverse health effects of 5G mobile networking technology under real-life conditions. *Toxicology Letters*. **323**, 35–40, doi: 10.1016/j.toxlet.2020.01.020 (2020).
9. Li, Y., Heroux, P. Extra-low-frequency magnetic fields alter cancer cells through metabolic restriction. *Electromagnetic Biology and Medicine*. **33** (4), 264–275, doi: 10.3109/15368378.2013.817334 (2014).
10. Mishima, K. Melatonin as a regulator of human sleep and circadian systems. *Nihon Rinsbo. Japanese Journal of Clinical Medicine*. **70** (7), 1139–1144 (2012).
11. Mermet, J., Yeung, J., Naef, F. Systems Chronobiology: Global Analysis of Gene Regulation in a 24-Hour Periodic World. *Cold Spring Harbor Perspectives in Biology*. **9** (3), a028720, doi: 10.1101/cshperspect.a028720 (2017).
12. Reiter, R.J., Tan, D.-X., Mayo, J.C., Sainz, R.M., Leon, J., Czarnocki, Z. Melatonin as an antioxidant: biochemical mechanisms and pathophysiological implications in humans. *Acta Biochimica Polonica*. **50** (4), 1129–1146, doi: 10.18388/abp.2003_3637 (2003).
13. Hardeland, R., Cardinali, D.P., Srinivasan, V., Spence, D.W., Brown, G.M., Pandi-Perumal, S.R. Melatonin—a pleiotropic, orchestrating regulator molecule. *Progress in Neurobiology*. **93** (3), 350–384, doi: 10.1016/j.pneurobio.2010.12.004 (2011).
14. Carrillo-Vico, A., Lardone, P.J., Alvarez-Sánchez, N., Rodríguez-Rodríguez, A., Guerrero, J.M. Melatonin: buffering the immune system. *International Journal of Molecular Sciences*. **14** (4), 8638–8683, doi: 10.3390/ijms14048638 (2013).
15. Liu, S., Madu, C.O., Lu, Y. The role of melatonin in cancer development. *Oncomedicine*. **3**, 37–47, doi: 10.7150/oncm.25566 (2018).
16. Cutando, A., López-Valverde, A., Arias-Santiago, S., DE Vicente, J., DE Diego, R.G. Role of melatonin in cancer treatment. *Anticancer Research*. **32** (7), 2747–2753 (2012).
17. Ko, G.Y.-P., Shi, L., Ko, M.L. Circadian regulation of ion channels and their functions. *Journal of Neurochemistry*. **110** (4), 1150–1169, doi: <https://doi.org/10.1111/j.1471-4159.2009.06223.x> (2009).
18. Li, Y., Heroux, P. Magnetic fields trump oxygen in controlling the death of erythro-leukemia cells. *Applied Sciences*. **9** (24), 5318, doi: 10.3390/app9245318 (2019).
19. *Comment des champs électromagnétiques très faibles peuvent-ils influencer la biologie et la santé? -- Paul Héroux Ph.D., Université McGill.* at <<https://www.youtube.com/watch?v=-ttVRdQD5BQ>>. (2016).
20. Mu, Q. *et al.* The role of iron homeostasis in remodeling immune function and regulating inflammatory disease. *Science Bulletin*. **66** (17), 1806–1816, doi: 10.1016/j.scib.2021.02.010 (2021).

21. Lisle, D.J., Goldhamer, A. *The Pleasure Trap: Mastering the Hidden Force that Undermines Health and Happiness*. Healthy Living Publications. Summertown, Tenn. (2006).
22. Luo, J. *et al.* Genetic susceptibility may modify the association between cell phone use and thyroid cancer: A population-based case-control study in Connecticut. *Environmental Research*. **182**, 109013, doi: 10.1016/j.envres.2019.109013 (2020).
23. O'Bryan, T. *The Autoimmune Fix: How to Stop the Hidden Autoimmune Damage that Keeps You Sick, Fat, and Tired Before it Turns into Disease*. Rodale. New York. (2016).
24. Bergqvist, U. *et al.* Possible Health Implications of Subjective Symptoms and Electromagnetic Fields. A report prepared by a European group of experts for the European Commission, DG V. at <https://gupea.ub.gu.se/bitstream/2077/4156/1/ah1997_19.pdf>. European Commission DG V, National Institute for Working Life. Solna, Sweden. (1997).
25. Panagopoulos, D.J., Chrousos, G.P. Shielding methods and products against man-made Electromagnetic Fields: Protection versus risk. *Science of The Total Environment*. **667**, 255–262, doi: 10.1016/j.scitotenv.2019.02.344 (2019).
26. *Influence of microwave radiation on the organism of man and animals. Report from Academy of Medical Sciences of the USSR. Translated to English "Vliyaniye SVCh- Izlucheniya na Organizm Cheloveka I Zhivotnykh"*. Meditsina Press, Leningrad. Report from NASA TT F-708, Springfield, Virginia. (1970).
27. Firstenberg, A. *The Invisible Rainbow: A History of Electricity and Life*. Chelsea Green Publishing Company. White River Junction. (2020).
28. Gupton, N. Benjamin Franklin and the Kite Experiment. *The Franklin Institute*. at <<https://www.fi.edu/benjamin-franklin/kite-key-experiment>> (2017).
29. Case Files: Nikola Tesla. *The Franklin Institute*. at <<https://www.fi.edu/case-files/nikola-tesla>> (2016).
30. Belpomme, D., Hardell, L., Belyaev, I., Burgio, E., Carpenter, D.O. Thermal and non-thermal health effects of low intensity non-ionizing radiation: An international perspective. *Environmental Pollution (Barking, Essex: 1987)*. **242** (Pt A), 643–658, doi: 10.1016/j.envpol.2018.07.019 (2018).
31. *Current concepts in diagnosis and management of electromagnetic hypersensitivity*. at <<https://vimeo.com/100623585>>. British Society of Ecological Medicine (BSEM) Electromagnetic Radiation and Health Conference. (2014).
32. Johansson, O. Electrohypersensitivity: state-of-the-art of a functional impairment. *Electromagnetic Biology and Medicine*. **25** (4), 245–258, doi: 10.1080/15368370601044150 (2006).
33. Belyaev, I. *et al.* EUROPAEM EMF Guideline 2016 for the prevention, diagnosis and treatment of EMF-related health problems and illnesses. *Reviews on Environmental Health*. **31** (3), doi: 10.1515/reveh-2016-0011 (2016).
34. Cumming, E. Green Bank: the town that banned Wi-Fi. *The Observer*. at <<https://www.theguardian.com/technology/2015/jun/21/the-town-that-banned-wi-fi>> (2015).
35. Matthews, S. Woman claims electromagnetic have left her housebound. *Mail Online*. at <<http://www.dailymail.co.uk/~/article-4050934/index.html>> (2016).
36. Hedendahl, L., Carlberg, M., Hardell, L. Electromagnetic hypersensitivity--an increasing challenge to the medical profession. *Reviews on Environmental Health*. **30** (4), 209–215, doi: 10.1515/reveh-2015-0012 (2015).
37. Rubin, G.J., Hillert, L., Nieto-Hernandez, R., van Rongen, E., Oftedal, G. Do people with idiopathic environmental intolerance attributed to electromagnetic fields display physiological effects when exposed to electromagnetic fields? A systematic review of provocation studies. *Bioelectromagnetics*. **32** (8), 593–609, doi: 10.1002/bem.20690 (2011).
38. Tuengler, A., von Klitzing, L. Hypothesis on how to measure electromagnetic hypersensitivity. *Electromagnetic Biology and Medicine*. **32** (3), 281–290, doi: 10.3109/15368378.2012.712586 (2013).
39. *Diagnosis, Treatment and Reversal of Electromagnetic Hypersensitivity by Erica Mallery-Blythe MD*. at <https://www.youtube.com/watch?v=_iP-Zv3VLV4>. (2019).
40. PHIRE Physicians' Health Initiative for Radiation and Environment. at <<https://phiremedical.org/>>.

41. The EI Wellspring Better Call Saul's portrayal of electrical sensitivity. *EI Wellspring*. at <<https://www.eiwellspring.org/reviews/BetterCallSaul.htm>>.
42. Parsons, S. Living with EHS; A Survival Guide. at <<http://www.weepinitiative.org/livingwithEHS.html>> (2011).
43. Genuis, S.J., Lipp, C.T. Electromagnetic hypersensitivity: fact or fiction? *The Science of the Total Environment*. **414**, 103–112, doi: 10.1016/j.scitotenv.2011.11.008 (2012).
44. Hallberg, O., Oberfeld, G. Letter to the editor: will we all become electrosensitive? *Electromagnetic Biology and Medicine*. **25** (3), 189–191, doi: 10.1080/15368370600873377 (2006).
45. Salines, G. Électrohypersensibilité : baisse simultanée de la prévalence et de la couverture médiatique à Taïwan. *Environ Risque Sante*. **17**, 3 (2018).
46. Carpenter, D. Excessive exposure to radiofrequency electromagnetic fields may cause the development of electrohypersensitivity. *Alternative therapies in health and medicine*. **20**, 40–42 (2014).
47. Panagopoulos, D.J. Electromagnetic interaction between environmental fields and living systems determines health and well-being. *Electromagnetic fields: principles, engineering applications, and biophysical effects* (2013).
48. Sollid, L.M. Coeliac disease: dissecting a complex inflammatory disorder. *Nature Reviews Immunology*. **2** (9), 647–655, doi: 10.1038/nri885 (2002).
49. Fasano, A. Zonulin and its regulation of intestinal barrier function: the biological door to inflammation, autoimmunity, and cancer. *Physiological Reviews*. **91** (1), 151–175, doi: 10.1152/physrev.00003.2008 (2011).
50. Genuis, S.J. Sensitivity-related illness: the escalating pandemic of allergy, food intolerance and chemical sensitivity. *The Science of the Total Environment*. **408** (24), 6047–6061, doi: 10.1016/j.scitotenv.2010.08.047 (2010).
51. Pineault, N. Pawel Wypychowski, Part 3 - The Basics of Electromagnetic Vitality Engineering (E.V.E.). *The EMF Guy*. at <<https://theemfguy.com/007/>> (2020).
52. Aron, E.N. *The Highly Sensitive Person: How to Survive and Thrive When the World Overwhelms You*. Thorsons Classics. London. (2017).
53. Connolly, R. The Vital Light of Nikola Tesla: Healing Power of Ultraviolet Rays. *Vitality Magazine*. at <<https://vitalitymagazine.com/article/the-vital-light-of-nikola-tesla-healing-power-of-ultraviolet-light/>> (2021).
54. Gin, R.H., Green, B.N. George Goodheart, Jr., D.C., and a history of applied kinesiology. *Journal of Manipulative and Physiological Therapeutics*. **20** (5), 331–337 (1997).

Chapter 5. EMFs and Health – a Framework for Effective Personal Action

This book is designed to empower, not to emasculate. But based on what you have learned so far, many of you may be feeling impotent in the face of forces that are much greater than the power of any one individual. This is undoubtedly true at the macro scale. However, at the individual level, there is a lot that you can do, and there are real benefits in undertaking some of the actions suggested in this book.

The UMM, RIDS and MAM approach to EMF management

Based on the precautionary foundations laid down in Chapter 3, the remainder of the book seeks to empower the reader to take the necessary evidence-based actions to mitigate the harmful health impacts of EMFs. To do this, I follow the “UMM Approach” introduced by Lloyd Burrell in his excellent book, *EMF Practical Guide: The Simple Science of Protecting Yourself, Healing Chronic Inflammation, and Living a Naturally Healthy Life in our Toxic Electromagnetic World* (2019).¹

- **U** is for Understand – knowledge is power, but only if you use it.
- **M** number 1 is for Measure – making the invisible visible. It is difficult, though not impossible, to mitigate something when you have no measure of the situation before and after mitigation. The subsequent measurements allow you to judge the effectiveness of your mitigation measures. Anybody serious about managing the impact of EMFs on their health will pretty soon learn that they will need to acquire some EMF meters.
- **M** number 2 is for Mitigate – taking actions to minimise the harmful health impacts of EMFs.

The range of mitigation options can seem daunting at first, but all of them essentially revolve around four processes, which can be summarised using the mnemonic **RIDS**:

- **R**educe harmful EMF sources
- **I**ncrease your distance from harmful EMF sources - *distance is your friend*
- **D**ecrease your time spent close to harmful EMF sources
- **S**hield yourself from harmful EMF sources

The key to effective and sustainable implementation is to approach things methodically and incrementally. Apart from those who are electro hypersensitive, most people don't need to try to do everything at once. Rome wasn't built in a day, and we are all a work in progress.

I outline possible mitigation actions in the solutions section for each EMF category. I have divided the suggested actions into three categories:

- **DIY**: Actions that can be done by most people after reading this book and any relevant referenced information.
- **DIY/help required**: Actions many people can do, but possibly with some professional assistance or advice.
- **Professional help required**: Actions for which most people would need specialist intervention. Specialists belong to a variety of professions, and specific help needed will depend on the task at hand. Some demands will require traditional tradespeople such as builders and electricians. In other instances, specialist support from those with a deep understanding of EMFs will be required. These folks go on under various names, including EMF consultants and Building Biologists. Building biology, pioneered in Germany in the 1970s, has been defined by Winfried Schneider, the Director of the Institute of Building Biology and Sustainability (IBN – Institut für Baubiologie and Nachhaltigkeit), as "the study of the holistic relationships between humans and their built environment. The aim is to create a healthy, natural, sustainable, and beautifully

designed living and working environment".² Building biologists assist clients with home and workplace issues related to the optimisation of the built environment, including mould, toxins, and household pests. In recent years, their workload has been dominated by the measurement and remediation of EMF impacts.

Of course, these categories are not entirely watertight, and one person's "DIY" will be another person's "help required." It is important to point out to even the most competent of DIYers, however, that there are certain actions, notably those involving working with mains electricity, that should be undertaken by a competent professional. In the UK, all wiring installations must fully comply with [BS7671 Requirements for Electrical Installations](#). If you are unqualified, you can only undertake major electrical work with formal independent third-party inspection and testing.

There is a common saying in the project and programme management business that "what gets measured gets done". A version of this maxim applies to the EMF world – "what gets measured gets done well". In order to gauge the effectiveness of any intervention it is important to measure EMF levels before and after you implement the intervention. This can be summarised in the simple mnemonic **MAM** (Measure – Apply – Measure). This underscores the importance of having access to accurate EMF meters. Unfortunately, you will need more than one device. Details of how to measure EMFs and what to look for when choosing a meter are given in Chapter 6 for power frequency electric and magnetic fields and radio frequency radiation, and Chapter 7 for dirty electricity.

Why individual actions matter – lessons from Mahatma Gandhi, Sir Isaac Newton, and Stephen Covey

I fervently believe in the Gandhian exhortation to "Be the change you want to see in the world," and I do my utmost to apply this in my daily life by acting locally to contribute to global issues such as climate change mitigation, waste minimisation, biodiversity conservation, and sustainable agriculture. If you believe that personal actions have an effect that goes far beyond the individual – ideas promulgated by maverick thinkers such as Carl Jung,³ Bruce Lipton,⁴ and Rupert Sheldrake⁵ – then you also consider that you have power beyond your status as a single drop in a vast ocean. I explore ideas relating to nonlocal effects in Chapter 18 – EMF Mitigation Treatments.

But when it comes to EMFs there is no need to focus exclusively on appeals to altruism wrapped in metaphysics, as individual action directly benefits the person concerned in very tangible ways. The things you do to protect yourself as an individual will benefit you most, even though it may appear that you are drowning in an EMF soup. This is primarily due to the fact that distance is your friend to a greater extent than most of us may realise. This is because physical quantities (such as an EMF signal) emitted from a point source (such as a phone) into a three-dimensional space (such as a room) are subject to geometric dilution with distance. This phenomenon, known as the *inverse square law*, was used by Newton in his law of universal gravitation and describes the behaviour of electric, magnetic, light, sound, and other radiation phenomena. The inverse square law states that the energy from a source changes in inverse proportion to the square of the distance from the source ($1/R^2$, where R = distance from the source). Simply stated, **as you move away from an energy source, the strength decreases, and the decrease is more than you might expect.** In practical terms, this means that if you just get several feet away from EMF-emitting devices, the intensity of the EMFs will go way down.

This is expressed pictorially in Figure 5.1. An EMF source can be likened to a stone thrown into an undisturbed pond. Waves ripple outwards in a circle with the outer ripples creating much less disturbance than those close to the centre.

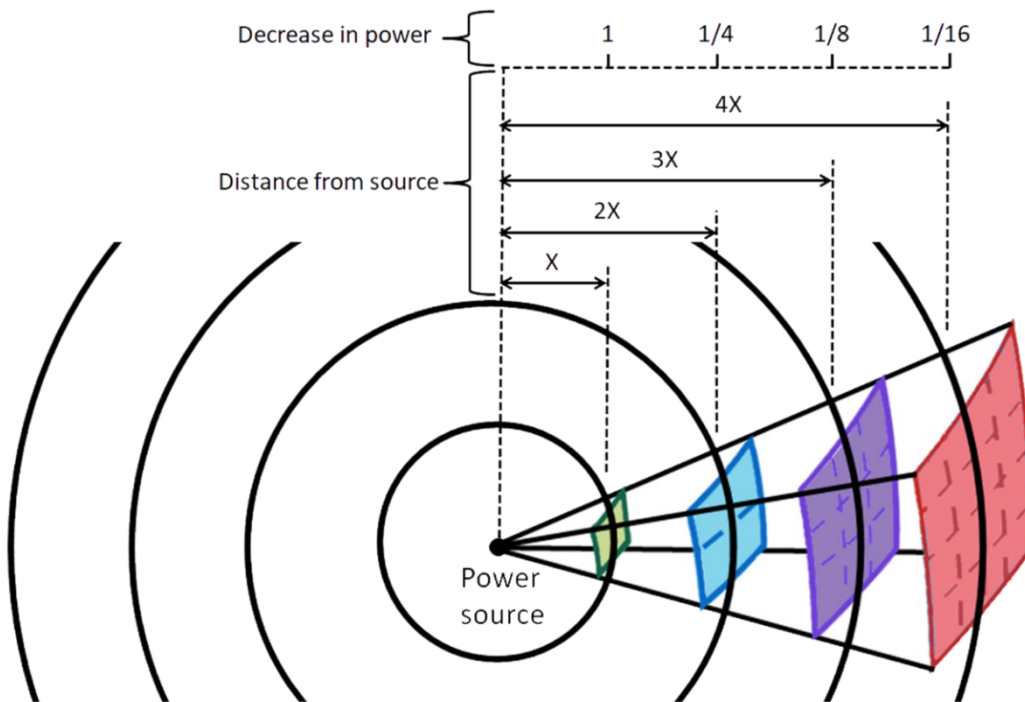


Figure 5.1: *Reduction in power with distance from source.*

In the real world, there is usually a complex of EMFs from multiple sources that are absorbed and reflected in a maze of objects. Thus, the actual picture will usually look more complex than depicted in the illustration above. However, these real-world nuances do not detract from the take-home message that distance is your friend.

The following chart illustrates a typical pattern of power (power density) for a mobile phone operating at different powers.⁶

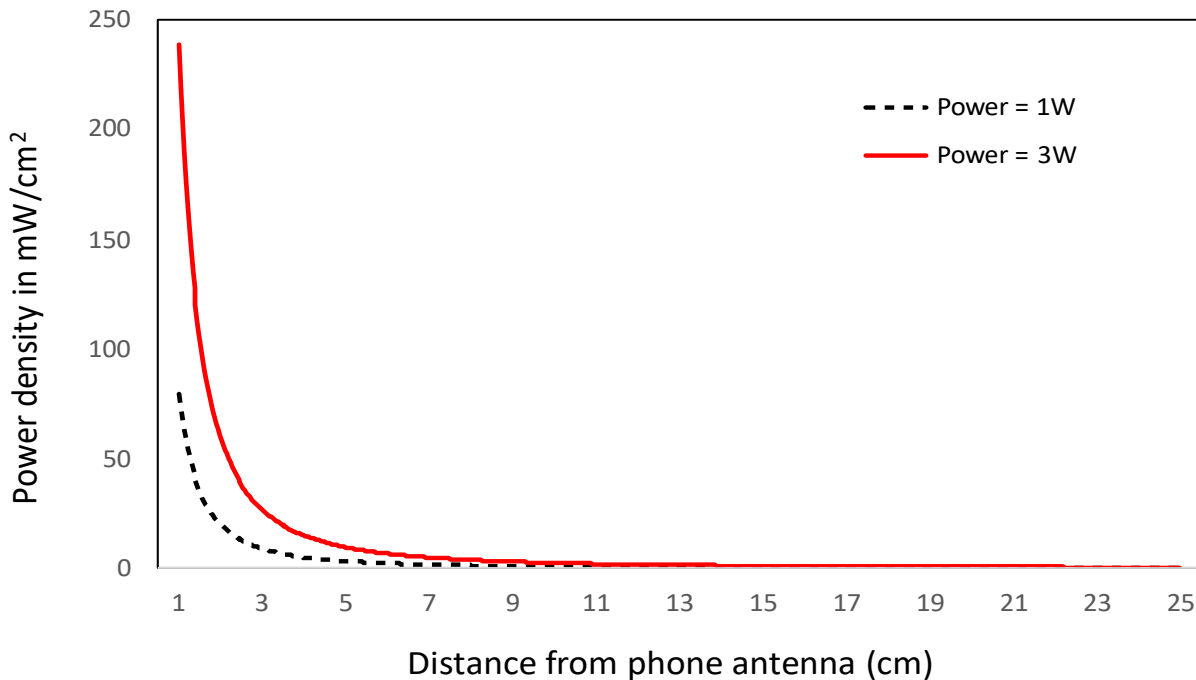


Figure 5.2: Power densities of mobile phones, transmitted power and distance from the antenna. Derived from data from Saeid (2012).⁶

This focus on personal power echoes the teachings of Stephen Covey, famous for his best-selling book *The 7 Habits of Highly Effective People* (2004)⁷ in which he introduces the circle of control, influence and concern (Figure 5.3). Our main power lies in what we can do ourselves – the circle of control. We have varying degrees of influence on those around us, for example, within our families and places of work, and we can indirectly influence those in our wider circle. People often place their energy in the sphere of interest/concern without addressing the things over which they have the power to change. This evokes the wisdom of Reinhold Niebuhr’s *Serenity Prayer*, famously adapted by twelve-step recovery programmes:

*God, grant me the serenity to accept the things I cannot change,
The courage to change the things I can,
And the wisdom to know the difference.*

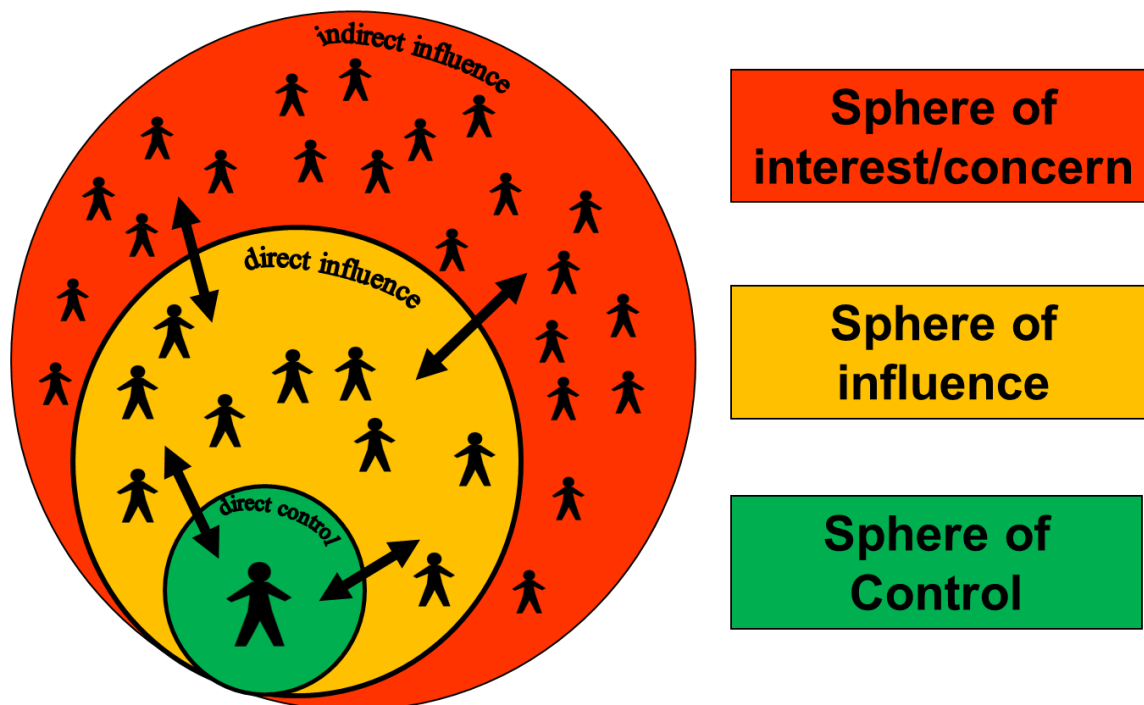


Figure 5.3: Schematic representation of Stephen Covey's circles of control, influence, and interest/concern.

The one place that we have the greatest amount of power is in our homes and this just happens to be the most important place for EMF exposure for most people. As a rough approximation, most people spend about half their lives in their homes and gardens, and pretty much all their sleep (one-third of their lives for many people) is in their bedroom. Sleep, in particular, is a time for regeneration, so if EMFs can be minimised in this environment, this time can be used to repair the damage caused during the day when exposed to the stresses that are hallmarks of modern living. This underpins the importance of taking action to create a low EMF home environment with particular emphasis on the bedroom as an EMF-free sanctuary and a place in which stress as a whole is minimised. The importance of sleep and minimising EMFs in the bedroom is a theme that I return to throughout this book.

The ubiquity of non-native EMFs may be overwhelming at first. And the list of actions we can take to reduce their impact might seem to be similarly daunting. Most of us, however, do not have to do everything at once and a few apparently small but strategic actions really can make a significant difference. This is illustrated by the result of an Austrian study by Johannes Tomitsch and colleagues, who measured EMF exposure in bedrooms before and after undertaking some simple EMF mitigation measures.⁸ These measures included removing or repositioning clock radios, transformers, bedside lamps, and extension cables and disconnecting or rearranging cordless phones and base stations, routers, and mobile phones. Following these interventions, bedside measurements of electric fields, magnetic fields, and radio frequency EMFs were reduced by 61%, 40% and 50%, respectively. By implementing some of the actions recommended in this book, we can most likely reduce our exposure much further. But this is a long-term issue, and a long-term or gradual approach is advised. I repeat, Rome wasn't built in a day.

References

1. Burrell, L. *EMF Practical Guide: The Simple Science of Protecting Yourself, Healing Chronic Inflammation, and Living a Naturally Healthy Life in our Toxic Electromagnetic World*. AFNIL / ISBN France. (2019).
2. What is Building Biology? Institute of Building Biology + Sustainability IBN. at <https://buildingbiology.com/what-is-building-biology/>.
3. Jung, C.G. *The Archetypes and the Collective Unconscious*. Routledge. London. (1991).
4. Lipton, B.H. *The Biology of Belief: Unleashing The Power of Consciousness, Matter and Miracles*. Hay House. (2015).
5. Sheldrake, R. *The Science Delusion: Freeing the Spirit of Enquiry*. Coronet. (2020).
6. Saeid, S.H. Human exposure assessment in the near-field of antennas used by mobile phone devices. *Journal of Asian Scientific Research*. **2** (5), 10 (2012).
7. Covey, S.R. *The 7 Habits of Highly Effective People: Powerful Lessons in Personal Change*. Simon & Schuster. London. (2004).
8. Tomitsch, J., Dechant, E., Frank, W. Survey of electromagnetic field exposure in bedrooms of residences in lower Austria. *Bioelectromagnetics*. **31** (3), 200–208, doi: 10.1002/bem.20548 (2010).

List of Acronyms and Abbreviations

Acronym	Name in Full
5G	Fifth generation of wireless technology
AAEM	American Academy of Environmental Medicine
AAS	American Astronomical Society
AC	Alternating Current
ADHD	Attention deficit hyperactivity disorder
ADS	active denial system (a non-lethal directed energy weapon system using mmWaves)
ALARA	As Low As Reasonably Achievable
ANSES	The French Agency for Food, Environmental and Occupational Health & Safety
AR	Augmented Reality
ARMD	Age-related macular degeneration
ASD	Autism spectrum disorders
ATP	Adenosine triphosphate (the body's "energy currency")
BBC	British Broadcasting Corporation
BCC	Basal cell carcinoma
BLT	Bright light therapy
BMI	Body mass index
CCT	Correlated colour temperatures
CD	Circadian desynchrony
CDC	Centers for Disease Control (USA)
CFE	Critical flicker fusion frequency
CFL	Compact fluorescent lamp, also compact fluorescent light
CFS	Chronic fatigue syndrome
CLL	Chronic lymphocytic leukaemia
CNPP	Chernobyl Nuclear Power Plant
CRT	cathode-ray tube (TVs and monitors - the heavy units with long backs)
CT	Computer-assisted tomography
CTBT	Comprehensive Nuclear-Test-Ban Treaty
CTIA	Cellular Telecommunications and Internet Association
DAB	Digital Audio Broadcasting
DAS	Distributed Antenna Systems
dB	Decibels
DC	Direct current
DE	Dirty electricity
DECT	Digital Enhanced Cordless Technology
DES	Digital eye strain
dLan	Direct Local Area Network
ECG	Electrocardiogram
ED	Erectile dysfunction
EF	Electric Field
EHF	Extremely high frequency
EHS	Electro hypersensitivity
EHT	Environmental Health Trust
ELF-EMFs	Extremely low frequency/power frequency EMFs

Acronym	Name in Full
EMFs	Electromagnetic fields or frequencies
EMI	Electromagnetic interference (another term for dirty electricity)
EMR	Electromagnetic radiation
EMS	Electromagnetic spectrum
EOP	Ethernet over powerline
EPA	Environmental Protection Agency (USA)
EUROPAEM	European Academy for Environmental Medicine
EWG	Environmental Working Group (USA)
EZ water	Exclusion-zone water
FCC	Federal Communications Commission
FDA	Food and Drug Administration (USA)
FDNPP	Fukushima Daiichi Nuclear Power Plant
FM	Frequency Modulation
GNSS	Global Navigation Satellite Systems
GPS	Global Positioning System
GSM	Global System for Mobile Communications
HAN	Home Area Network
HEV	High energy visible (light)
HF	High frequency
HFT	High-frequency trading
HSE	Health and Safety Executive (UK)
HVDC	High voltage direct current
HWE	Healthy worker effect
IARC	International Agency for Research on Cancer
IAU	International Astronomical Union
IBN	Institute of Building Biology and Sustainability (Institut für Baubiologie and Nachhaltigkeit)
ICBE-EMF	International Commission on the Biological Effects of Electromagnetic Fields
ICNIRP	International Commission on Non-Ionizing Radiation Protection
ICRP	International Commission for Radiological Protection
IHD	In-Home Display
IoT	Internet of Things
IPCC	Intergovernmental Panel on Climate Change
ipRGCs	intrinsically photosensitive retinal ganglion cells
IR	Ionising radiation, Infrared radiation, or Infrared
ISP	Internet Service Providers
LAN	Local Area Network
LED	Light-Emitting Diode
LEO	Low Earth Orbit
LF	Low frequency
LQMS	La Quinta Middle School
MAM	Measure – Apply – Measure - approach to EMF management (notably shielding)
MCS	Multiple chemical sensitivity
MED	Minimal erythematous dose
MEP	Microsurge electrical pollution
MF	Magnetic Field or Medium frequency

Acronym	Name in Full
MIMO	Multiple input multiple output
MM	Malignant melanoma
MMS	Multimedia Messaging Service (standard way to exchange messages that include multimedia content over a cellular network)
mmWave	Millimetre wave, also known as millimetre band (range of electromagnetic frequencies between microwaves and infrared)
MoCA	Multimedia over Coax Alliance aka Ethernet over coaxial cable or Ethernet over Coax
MRI	Magnetic Resonance Imaging
NIR	Non-ionising radiation, or near-infrared
NMSC	Nonmelanoma skin cancer
NTP	National Toxicology Program (USA)
Ofgem	Office of Gas and Electricity Markets (the government agency that oversees the electricity and gas markets in Great Britain)
OLEDs	Organic light emitting diodes
PFD	Power flux density
PHE	Public Health England (former government organisation that provided public health services and advice in England)
PHIRE	Physicians' Health Initiative for Radiation and Environment
PLC	Powerline communication
PTBT	Partial Test Ban Treaty (for nuclear weapons)
RAS	Royal Astronomical Society (Britain)
RFR	Radio frequency Radiation
RIDS	Reduce harmful EMF sources, Increase your distance from harmful EMF sources, Decrease your time spent close to harmful EMF sources, Shield yourself from harmful EMF sources
RIDSS	RIDS actions plus Sensible Sun-Like Exposure
SACN	Scientific Advisory Committee on Nutrition (UK)
SAGE	Stakeholder Advisory Group on ELF EMFs (UK)
SAM	Specific Anthropomorphic Mannequin
SAR	Specific absorption rate
SCC	Squamous cell carcinoma
SCHEER	Scientific Committee on Health, Environmental and Emerging Risks (European Commission)
SHF	Super high frequency
SMPS	Switched-mode power supply
SMS	Short Message Service (text messaging)
SPF	Sun Protection Factor
SR	Schumann Resonance
SRI	Sensitivity-related illness
SSL	Solid-state lighting
SWANA	Southwest Asia and North Africa
TSH	Thyroid-stimulating hormone.
UCS	Union of Concerned Scientists
UHF	Ultra high frequency
UKHSA	UK Health Security Agency
UMM	Understand, Measure, Mitigate – approach to EMF management
UNEP	UN Environment Programme
UV	Ultraviolet
VDD	Vitamin D deficiency
VGCC	Voltage-gated calcium channel

Acronym	Name in Full
VGIC	Voltage-gated ion channel
VHF	Very high frequency
VLF	Very low frequency
VR	Virtual reality
WAN	Wide Area Network
WHO	World Health Organization
WTR	Wireless Technology Research Project

Index

- 1G, 124, 147
 2G, 28, 36, 147, 149, 155, 157
 3G, 31, 36, 146, 147, 148, 149
 4G, 37, 39, 147, 148, 149, 151
 4G LTE (Long Term Evolution). *See* 4G
 5G, 3, 124, 127, 144, 147, 153, 160, 162, 173, 377, 378, 391
 augmented humans and, 155–56
 cybercrime and, 154–55
 defining, 148–49
 energy consumption and, 151–52
 fears/impacts, 149–56
 impacts on plants and animals and, 152–53
 increased radiation levels and, 151
 increased signal variability and, 151
 inevitability of, 156–57
 measuring, 88
 mmWave (millimetre wave) EMF and, 148
 reduced weather forecasting capabilities and, 153–54
 surveillance/privacy and, 154
 tech addiction and, 155
 AC electricity. *See* alternating current (AC) electricity
 active denial system (ADS), 127
 aether. *See* ether
 Agency for Food, Environmental and Occupational Health & Safety (ANSES) - France, 217
 ALARA (as low as reasonably achievable) principle of radiation safety, 11, 136, 184, 274, 295
Allen, David, 380
 alternating current (AC) electricity
 “stray voltage” or ground currents and, 120
 body voltage and, 74, 121
 dirty electricity and, 94, 98
 dirty electricity, electronic transformers and, 98
 War of the Currents and, 71
 American Academy of Environmental Medicine (AAEM), 171, 378
 American Astronomical Society (AAS), 159
 American Contact Dermatitis Society, 232
Applewhite, Roger, 114
 approaches to EMF management
 MAM (Measure, Apply, Measure), 64
 RIDS (Reduce EMF sources, Increase distance, Decrease time, Shield), 63
 UMM (Understand, Measure, Mitigate), 63
 approaches to EMF management (light)
 RIDSS (RIDS plus Seek sensible sun-like exposure), 255
Armstrong, Lance, 119
 atomic bombs. *See* nuclear weapons
Baggerly, Carole, 222
Becker, Robert O., 2
Belpomme, Dominique, 54, 55
 Berkeley, California Right to Know ordinances, 31, 378
 biofield, 347–49, 351, 352
 bioindividuality, 51, 206, 332, 353
 BioInitiative Report, 36, 130, 131, 132, 135, 377
 Blue Zones, 235, 263, 330, 332, 333
Blumenthal, Richard (US Senator), 149, 150
 Bohr Effect, 322
Bohr, Christian, 322
Bohr, Harald, 322
Bohr, Niels, 322
 BOLT Test (Body Oxygen Level Test), 322
Bowman, Katy, 333, 336
Brand, Jo, 375
 breathing, 113, 323, 324, 322–24, 328, 337, 346, 368
 Buteyko breathing, 322, 368
Brown, Richard, 114, 117
Buchner, Klaus, 32
Buettner, Dan, 333
 Building Biology, 4, 63
Burrell, Lloyd, 63
 calcium channel blockers, 345
Campbell, Joseph, 337, 339
Campbell, T. Colin, 112, 333
 canaries in the coal mine, 52, 133
Carlo, George, 27, 28
Carpenter, David, 131, 132, 135
 Castle Bravo incident, 284–86
 Centers for Disease Control (CDC) - USA, 231
Chamberlain, Neville, 284
 Chernobyl (Ukraine), 267, 271, 286, 289–90, 291, 301
Chevalier, Gaétan, 111, 121
Chung, Peter, 2
 circadian rhythms, 203–6, 217, 236, 257, 258, 299, 350
Cleopatra, 349
Coghill, Roger, 78
Cohen, Gayle, 95, 97
Colborn, Theo, 325
 Comprehensive Nuclear-Test-Ban Treaty (CTBT), 286
Contador, Alberto, 119
Covey, Stephen, 64, 66, 67
Coward, Noël, 235
 CTIA (Telecommunications and Internet Association), 27, 28, 31
Cumberbatch, Benedict, 71
Curie, Marie, 267
Dalibard, Thomas-François, 53
Davidson, Jay, 266, 267
Davidson, Jim, 375
Davis, Devra, 24, 25, 29, 375
 demand switches, 108
 dietary supplementation, 330, 332, 370, 371
 antioxidants, 112, 233
 EMF impact mitigation and, 345–46
 melatonin, 329
 niacin, 346, 370

- olive leaf extract, 346
- selenium, 346
- vitamin D, 222, 223, 224, 226, 227, 234, 235, 259–60
- zinc, 346
- direct current (DC) electricity
 - body voltage and, 121
 - dirty electricity and, 94
 - dirty electricity, electronic transformers and, 98
 - War of the Currents and, 70–71
- dirty electricity
 - cancer clusters and, 95–97
 - common sources, 97–98
 - filters, 108–9
 - health effects, 94–97
 - measuring, 98–99, 367
 - safety guidelines and prevailing levels, 97
- dirty power. *See* dirty electricity
- diseases. *See* health conditions
- distance is your friend. *See* inverse square law
- Dyer, Wayne**, 334, 336, 380, 385
- earthing (electrical), 73, 74, 84, 85, 87, 106, 107, 184, 188, 195, 196, 366, 367
- earthing (of the body). *See* grounding (of the body)
- Eco router, 366
- Edison, Thomas**, 53, 56, 70, 74, 206
- Eger, Horst**, 128
- Einstein, Albert**, 10, 282, 348, 349
- electrical noise. *See* dirty electricity
- electromagnetic interference (EMI). *See* dirty electricity
- electromagnetic spectrum, defined, 9–10
- EMF harmonisers, 197, 345–59
 - Biogeometry®, 353–56
 - Sympathetic Resonance Technology™ (SRT) devices, 350–53
- EMF meters
 - body voltage meters, 74, 88, 121
 - choosing an EMF meter, 87–89
 - dirty electricity meters, 98–99, 367
 - AM radio as a dirty electricity detector, 99
 - Graham-Stetzer Microsurge Meter, 99
 - Greenwave Broadband EMI Meter, 99
 - flicker detectors, 238
 - Geiger counters, 301, 302
 - light meters, 238
 - lux meters. *See* light meters
 - oscilloscopes, 98
 - power frequency meters, 82, 84, 88
 - RFR meters, 88, 189, 389
 - smartphones or digital cameras as flicker detectors, 238
 - spectrometers, 238
 - spectrum analysers, 88, 98
- EMF safety guidelines, 13, 23, 29, 30, 31, 79, 135, 145, 167, 259, 303
- EMF sources, 157–60
 - “hidden” Wi-Fi, 144, 173, 184, 189
 - “Smart Brooms” from Disney's Fantasia, 175
 - air conditioners, 86
 - airport body scanners, 173, 188
 - alarm clocks. *See* digital clocks
 - baby monitors, 161, 162, 174, 189
 - bed frames, 86, 196
 - bedside lights, 104
 - Bluetooth, 29, 127, 145, 163, 164, 166, 168, 186, 188, 189, 191
 - cars. *See* motor vehicles
 - ceiling fans, 86
 - cell phones. *See* mobile phones
 - cell towers, 13, 15, 39, 98, 128, 133, 134, 144–46, 147, 148, 152, 162, 165, 192, 194, 195, 355, 377
 - compact fluorescent lights (CFLs). *See* fluorescent lights
 - computers. *See* computers and tablets
 - computers and tablets, 31, 162, 163, 164, 165, 168, 189, 190, 193, 217, 218, 256, 376
 - consumer units. *See* fuse boxes
 - DECT cordless phones (Digital Enhanced Cordless Technology), 161, 187, 366
 - digital clocks, 86
 - dishwashers, 86
 - dLan (direct Local Area Network). *See* EOP (ethernet over powerline)
 - electric blankets, 103
 - electric can openers, 86
 - electric drills, 86
 - electric ovens, 86
 - electric pencil sharpeners, 86
 - electric razors, 86
 - electrically powered seats, 103
 - electrified railways, 87, 106
 - elevators. *See* lifts
 - EOP (ethernet over powerline), 98, 109, 185
 - extension cords/power strips, 105
 - fluorescent lights, 86, 98, 103, 202, 214, 216, 217, 352, 367
 - fuse boxes, 79, 86, 99, 105, 108, 109
 - GPS (Global Positioning System), 166, 187
 - hair dryers, 79, 86, 87, 103
 - heaters, 86, 87
 - household wiring, 84–85, 107
 - Induction hobs, 98
 - inverters
 - electric vehicles, 98
 - solar panels, 98, 107, 108, 367
 - wind power, 98
 - IoT (Internet of Things), 3, 144, 147, 148, 170, 173–75, 189
 - iPotty, 104
 - knob-and-tube (K&T) wiring, 85
 - laptops. *See* computers and tablets
 - LED bulbs, 98, 103, 216–17
 - lifts, 87, 103
 - light filtered through windows, 218
 - light-emitting diodes (LEDs), 202, 209, 210, 214, 255, 369
 - mattress springs, 86, 103
 - microwave ovens, 86, 102, 127, 167–68, 188, 189

- mobile phones, 13, 15, 16, 24, 25, 27, 28, 29–32, 33, 51, 66, 104, 128, 133, 135, 144–50, 152, 156, 170, 191, 193, 195, 376, 378
- modems. *See* routers, modems, and Wi-Fi home/office networks
- motor vehicles, 87, 104, 127, 168, 187
driverless cars, 39, 148, 149
- net currents, 74, 83
- PLC (powerline communication). *See* EOP (ethernet over poweline)
- power supplies/transformers, 71, 85, 98, 104, 105, 171
- PowerLAN. *See* EOP (ethernet over poweline)
- powerlines, 75, 76, 77, 79–83, 94, 106
- printers, 164, 186
- radar, 53, 127, 130, 133, 152, 167, 168
- Radaranges. *See* microwave ovens
- radio, 164–65
- refrigerators, 86
- remote vacuum cleaners, 174
- routers, modems, and Wi-Fi home/office networks, 131, 136, 145, 148, 161–63, 163, 164, 184, 185, 186, 189, 190, 193, 194, 366, 367
- satellite phones, 157
- satellites, 127, 153, 157–60, 165, 166
- screens, 219, 256
cathode-ray tube (CRT) TVs and monitors, 165
LED screens/displays, 218
plasma TVs, 98
- smart beds, 174
- smart blinds and curtains, 174
- smart burglar alarms, 174
- smart cameras, 174
- smart clothing, 174
- smart doorbells, 174, 189
- smart insoles, 174
- smart light switches and lightbulbs, 174
- smart meters, 130, 136, 172, 169–73, 188, 194, 378
- smart picture frames, 174
- smart refrigerators, 154
- smart speakers, 174, 375
- smart thermostats and humidity controls, 174
- smart TVs, 165, 167, 189
- smart washing machines and dryers, 174
- Smart water taps, 174
- smartphones. *See* mobile phones
- smartwatches. *See* wearable tech
- stairlifts, 87, 103
- substations (transformers), 79, 83–84
- television (non-smart), 164–65
- toasters, 86
- transmitters, TV and radio, 160–61
- tumble dryers, 86
- underfloor heating, 103, 107
- vacuum cleaners, 86
- vagina speakers, 104
- virtual personal assistants, 164
- Virtual reality/augmented reality headsets and associated wearables, 164
- washing machines, 86, 174
- water beds, 98, 103
- water heaters, 87
- wearable tech, 164
- Wi-Fi. *See* routers, modems, and Wi-Fi home/office networks
- wireless chargers, 169
- Emotional Freedom Techniques (EFT), 338, 347, 365
- empowerment, 336–39, 372
- Environmental Health Trust (EHT), 33
- Environmental Protection Agency (EPA) -USA, 86
- environmental toxins (non-EMF), v, 26–27, 51, 237, 261, 267, 324–27, 368
- Environmental Working Group (EWG) - USA, 261, 326
- ether, 346, 347–49
- Ethernet over Coax, 185
- Ethernet over coaxial cable. *See* Ethernet over Coax
- Ethernet/wired network, 184–85, 186, 366, 367
- European Academy for Environmental Medicine (EUROPAEM), 78, 79
- Exclusion-zone water (EZ water), 207, 220, 347
- extremely low-frequency EMFs (ELF-EMFs)
childhood leukaemia and, 76–78
common sources, 79–87
defined, 72–75
health effects, 75–78
measuring, 87–89
prevailing levels, 79
safety guidelines, 78–79
solutions
decrease time, 105, 107, 108
increase distance, 104–5, 106–7, 108
reduce sources, 103–4, 106, 107
shield yourself, 105–6, 107, 108
- Faraday cage, 87, 101, 102, 114, 187, 194, 195, 196
- umbrella effect, 114
- fasting, 331, 332–33, 370
- Federal Communications Commission (FCC) - USA, 28, 31, 130, 132, 135, 149, 153, 160
- Feynman, Richard**, 114
- Finsen, Niels Ryberg**, 221
- Firstenberg, Arthur**, 4, 53, 56, 159
- Fitzpatrick scale (skin colour types), 228
- Food and Drug Administration (FDA) - USA, 149, 150
- Frankl, Viktor**, 380, 387
- Franklin, Benjamin**, 53
- free radicals, 46, 47, 112, 131, 188, 205, 211, 212, 219, 230, 231, 232, 233, 237, 261, 272, 345, 346
- Freeman, Morgan**, 382, 383, 387
- Frey, Allan**, 14, 38
- Fuhrman, Joel**, 331, 333
- Fukushima (Japan), 267, 286, 289, 290–92, 292
- gamma rays, 38, 269, 271, 281, 283, 300, 301
- Gandhi, Mohandas K., (Mahatma)**, 64, 173
- Gandhi, Om P.**, 30
- Gates, Bill**, 388
- Gee, David**, 26
- Ghaly, Maurice & Teplitz, Dale**, 113, 115

- Gotzsche, Peter**, 296
- Grace, Janey Lee**, 327
- Graham, Martin**, 96
- Grant, William**, 222, 233
- Greer, Beth**, 327
- Greger, Michael**, 332, 333
- Grimes, David Robert**, 38
- grounding (electrical). *See* earthing (electrical)
- grounding (of the body)
- benefits, 114–20, 369
 - criticisms of, 120
 - practice of, 121, 367, 371
 - rationale, 111–14
- Guise, Stephen**, 321, 339
- Haidt, Jonathan**, 323
- Hallberg, Örjan**, 161
- Harari, Yuval Noah**, 155, 156
- Hardell, Lennart**, 35
- Havas, Magda**, 97, 389
- Health and Safety Executive (HSE) - UK, 279, 301
- health conditions, 204
- adrenal gland tumours, 37
 - age-related macular degeneration (ARMD), 207, 219–20
 - Alzheimer's disease, 46, 75, 222, 327, 362
 - amyotrophic lateral sclerosis (ALS), 75, 361
 - asthma, 77, 78, 322
 - asthma in children, 75
 - attention deficit hyperactivity disorder (ADHD), 46, 349
 - autism. *See* autism spectrum disorders (ASD)
 - autism spectrum disorders (ASD), 46, 129, 349
 - basal cell carcinoma (BCC). *See* skin cancer
 - bone health, 222, 225, 227, 229, 234, 350
 - brain cancers, 24, 128, 222
 - brain tumours, 24, 28, 37, 96
 - breast cancer, 75
 - aircrew and, 299
 - dirty electricity and, 95
 - melatonin and, 204
 - radio frequency EMFs and, 128
 - routine mammographic screening for, 295–96
 - cardiac tumours, 36, 37
 - cardiovascular disease, 54, 77, 116, 131, 132, 133, 222, 227, 237, 298, 327, 332, 346
 - cataracts, 150, 167, 218, 219, 220–21, 275, 298
 - celiac disease. *See* coeliac disease
 - cervical cancer, 285
 - childhood leukaemia, 75, 81, 131, 288
 - ELF-EMFs and, 76–78
 - chronic fatigue syndrome (CFS), 46, 56
 - chronic pain, 54, 113, 115, 350, 364–65
 - circadian desynchrony (CD). *See* circadian rhythms
 - CNS tumours, 128
 - coeliac disease, 229, 259
 - cognitive impairment, 222, 377
 - colon cancer, 222
 - computer vision syndrome. *See* digital eye strain (DES)
 - COVID-19, 222
 - Crohn's disease, 222, 229, 259
 - cystic fibrosis, 229
 - dementia (non-Alzheimer's), 222
 - depression, 54, 75, 132, 349
 - severe depression, 54, 75
 - dermatological disorders, 221
 - digital dementia, 377
 - digital eye strain (DES), 218–19
 - dysesthesia, 54
 - electro hypersensitivity, 49, 52–58, 102, 104, 132, 152, 171, 186, 349
 - portrayal in *Better Call Saul*, 55
 - portrayal in the mainstream media, 55
 - electro sensitivity. *See* electro hypersensitivity
 - endocrine disruption. *See* hormonal disruption
 - epilepsy, 214, 349
 - erectile dysfunction, 133
 - fertility. *See* reproductive health
 - fibromyalgia, 46, 56
 - glaucoma, 220
 - global body dysthymia. *See* depression, severe
 - headaches, 54, 131, 214
 - hormonal disruption, 133, 203–5, 207, 232, 237
 - iHunch or Tech Neck, 155, 214
 - infertility. *See* reproductive health
 - RFR and, 132–34
 - inflammation, 47, 112, 117, 118, 205, 237, 322, 323, 349
 - influenza, 222
 - insomnia. *See* sleep disorders
 - kidney cancer, 222
 - leukaemia, 130, 161, 274, 275, 282, 284, 288, 289, 297, 298
 - lung cancer, 277, 278, 285, 299
 - lupus vulgaris, 221
 - malignant melanoma (MM). *See* skin cancer
 - microwave sickness. *See* electro hypersensitivity
 - migraines, 214
 - multiple chemical sensitivity (MCS), 56
 - multiple sclerosis (MS), 46, 222
 - myopia, 219
 - neuro-epithelial tumours, 28
 - nomophobia (aka 'no mobile phone phobia'), 156
 - nonmelanoma skin cancer (NMSC). *See* skin cancer
 - ovarian cancer, 222
 - overweight and obesity, 229, 327
 - light and, 236–37
 - pancreatic cancer, 222
 - Parkinson's disease, 46, 171, 327, 363–64
 - photoageing (actinic elastosis) or "sun wrinkles", 218, 221
 - prostate cancer, 222
 - psoriasis, 221
 - psychiatric disorders, 46
 - radiation sickness, 271, 272, 285, 291
 - radiation-induced second malignancies (RISM), 298, 317

- reproductive health, 129, 131, 132–34, 152, 214, 232, 237, 327
 miscarriage, 75, 134
 rheumatoid arthritis, 222, 349
 rickets, 206, 228, 229
 Seasonal affective disorder (SAD), 214
 skin cancer, 11, 38, 150, 161, 207, 218, 221, 229–34, 299
 sleep disorders, 67, 115, 129, 131, 132, 207, 217, 237, 257, 327–29, 349, 369
 squamous cell carcinoma (SCC). *See* skin cancer
 suicide, 58, 75
 tech addiction, 155, 376–77
 thyroid cancer, 51, 274, 275, 283, 284, 290
 thyroid tumours, 285
 tuberculosis, 206, 221, 222
 type 1 diabetes, 46, 222
 type 2 diabetes, 222, 232, 237, 327, 332, 346
 ulcerative colitis, 229
 vitiligo, 221
 wound healing, impaired, 114, 119, 207, 349, 350
 healthy worker effect (HWE), 288
- Herbert, Martha**, 129
- Héroux, Paul**, 48, 389
- Hertsgaard, Mark & Dowie, Mark**, 27
- high voltage direct current (HVDC), 71
- Hiroshima (Japan), 267, 282
- Hobbes, Thomas**, 375
- Holick, Michael**, 226, 233, 234, 259
- honeybees, 152, 352
- Hoover, Herbert**, 173
- hormesis, 51, 273, 274
- Hoult, Nicholas**, 71
- Huss, Anke**, 75
- hydration, 331–33, 370
- Illuminating Engineering Society (IES), 238
- Institute of Building Biology and Sustainability (IBN), 63
- insurance companies, 32–33
 A&M Insurance, 33
 Lloyd's of London, 32–33
 Swiss Re, 33
 Zurich Insurance, 33
- Intergovernmental Panel on Climate Change (IPCC), 293
- International Agency for Research on Cancer (IARC), 16, 34, 35, 78
 ELF-MFs as a Group 2B (possible) carcinogen, 77
 night shift work as a Group 2A (probable) carcinogen, 237
 RFR as a Group 2B (possible) carcinogen, 35
 sunlight as a Group 1 (known) carcinogen, 223
- International Astronomical Union (IAU), 159
- International Commission for Radiological Protection (ICRP), 299
- International Commission on Non-Ionizing Radiation Protection (ICNIRP), 32, 35, 37, 39, 78, 79, 130, 132, 135, 171, 377
- intrinsically photosensitive retinal ganglion cells (ipRGCs), 204
- inverse square law, 64, 162, 187, 190
- ionising radiation, 269
 defined, 269–71
 health effects, 272–75
 measuring, 301–2
prevailing levels, 275–77
 safety protocols, 315–16
 solutions
 air travel, 317
 household sources other than radon, 314–15
 medical diagnostics, 316
 medical therapies, 316–17
 occupational sources, 315–16
 radon gas, 314
- sources
 air travel, 299
 coal ash and emissions from non-nuclear industries, 293–94
 cosmic radiation, 281–82
 household sources other than radon, 300–301
 medical diagnostics, 294–97
 medical therapies, 297–98
 mines, 299
 natural radionuclides other than radon & terrestrial gamma radiation, 281
 nuclear power generation, 286–93
 nuclear weapons, 282–86
 occupational sources, 301
 radon gas, 276, 277–81, 299, 301–2, 314, 315, 316
 terrestrial gamma radiation, 276
 vulnerable groups, 301
- Irigaray, Philippe**, 55
- Jacobson, Terry**, 346
- Jaksch, Wolfgang**, 349
- Jerabek, Jiri & Pawluk, William**, 350
- Ji, Sayer**, 319
- Johansson, Olle**, 161, 269, 389
- Johnson, Brian**, 334
 Jung, Carl, 64
- Kardashian, Kim**, 166
- Karim, Ibrahim**, 353–56
- Kemmler, William**, 71
- Kennedy, John F.**, 173
- kill switches, 108
- kinesiology, 58
- King, Martin Luther**, 173, 360
- Klinghardt, Dietrich**, 366
- Kliukiene, Jolanta**, 75
- Kostoff, Ronald**, 38
- Krotofil, Marina**, 172
- Kruse, Jack, iv**, 199, 236
- Kübler-Ross, Elisabeth**, 192
- Kundi, Michael**, 78, 131
- La Quinta Middle School (LQMS), 95, 96, 97
- Lai, Henry**, 24, 25, 129, 389
- Late Lessons from Early Warnings. *See* Schopenhauer Sequence – the road to truth

- Laughlin, Robert B.**, 349
- Li, De-Kun**, 75, 134
- Lieberman, Daniel**, 326
- light
- common artificial light sources, 215–18
 - defined, 206–15
 - flicker, 214–15, 216, 217, 218, 238, 255, 256, 369
 - health effects of natural light regimes, 218–35
 - health effects of unnatural light regimes, 218–37
 - history of, 201–3
 - measuring, 238
 - solutions
 - decrease time, 256
 - increase distance, 256
 - reduce sources, 255–56
 - seek sensible sun-like exposure, 257–63
 - shield yourself, 257
 - vitamin D and, 222–33
 - weight gain, unnatural light regimes and, 236–37
- Lincoln, Abraham**, 375
- line noise. *See* dirty electricity
- Lipton, Bruce, 64
- Lisle, Doug & Goldhamer, Alan**, 49, 376
- Luo, Jiajun**, 51
- Magras, Ioannis & Xenos, Thomas**, 131, 134
- Maisch, Don, 23
- Malik, Ajay**, 156
- Mallery-Blythe, Erica**, 55, 57
- Mansfield, Michael**, 391
- Marconi, Guglielmo**, 53, 56
- Marino, Andrew**, 39, 69
- Marley, Bob**, 383
- Maslow, Abraham**, 336
- Massive MIMO (multiple input multiple output)**, 148
- Maxwell, James Clerk**, 346, 347
- McKeown, Patrick**, 322, 324
- McKusick, Eileen Day**, 346, 347–48
- McTaggart, Lynne**, 346, 349, 380
- measurement units (dirty electricity)
- Graham-Stetzer (GS) units, 99
 - millivolts (mV), 99
- measurement units (electric field strength)
- volts per metre (V/m), 18
- measurement units (frequency)
- hertz (Hz), 18
- measurement units (ionising radiation)
- becquerel (Bq), 271
 - electronvolt (eV), 271
 - gray (Gy), 271
 - rem (roentgen equivalent man), 271
 - roentgen (R), 271
 - sievert (Sv), 271
- measurement units (light)
- Kelvin (K) – colour temperature, 211
 - lux (light intensity as perceived by the human eye), 213
 - nit (used to describe the brightness of a display), 217
- measurement units (magnetic field strength)
- gauss (G, sometimes Gs), 18
 - tesla (T), 18
- measurement units (SAR)
- watts per kilogram of body tissue (W/kg), 18
- Mediation Authority for Mobile Communication and Environment (OMK) - Switzerland, 355
- meditation, 323, 324, 328, 338, 372, 382, 383, 386, 387
- melatonin
- circadian rhythms and, 203–5
 - EMFs and, 48
 - leptin disruption and weight gain, 237
 - seasonal affective disorder (SAD) and, 214
 - stimulation and suppression by light, 207, 208–11, 213, 255, 257
 - supplementation, 329
 - temperature and, 328
- Mercola, Joseph**, 331, 345, 346
- Mercury Resonance Hypothesis, 216
- Mercury, Freddie**, 336
- microsurge electrical pollution (MEP). *See* dirty electricity
- microwave radiation. *See* radio frequency radiation (RFR)
- Milham, Sam, 95–97
- Miller, Oram**, 165
- mini habits, 321, 339
- mitochondria
- EMFs and, 46–47, 48
 - melatonin and, 204
 - near-infrared light and, 207, 211
- mmWave (millimetre wave) EMF, 127, 148, 160, 168
- military applications and, 127
- MoCA (Multimedia over Coax Alliance). *See* Ethernet over Coax
- Morgan, Lloyd**, 96, 97
- Morris, Tom**, 337, 339
- movement, 333–36, 371–72
- Mumford, George**, 322
- Musk, Elon**, 157
- Nagasaki (Japan), 267, 282
- National Toxicology Program (NTP) - USA, 36, 37, 149
- Nehru, Jawaharlal**, 286
- Nestor, James**, 324
- Neuert, Michael**, 84, 88, 109, 195
- Newton, Isaac**, 64
- Niebuhr, Reinhold**. *See* Serenity Prayer
- Nightingale, Florence**, 237
- nitric oxide
- breathing and, 322
 - role as a free radical and, 46
 - therapeutic effects and, 207, 222, 235, 322
- Noval, Benjamín**, 119
- Nrf2 (NF-E2-related factor 2), 47
- nutrition, 329–31, 332–33, 370–71
- Ober, Clint**, 113, 120
- Office of Alternative Medicine (OAM) – of the NIH (USA), 347

- Ofgem (Office of Gas and Electricity Markets) - UK, 172
- Olsson, Anders**, 323, 324
- OneWeb, 158
- Oschman, James**, 118, 347
- oxybenzone, 231–32
- Pall, Martin**, 29, 46, 123, 156, 389
- Panagopoulos, Dimitris**, 15, 16, 24, 102
- Paracelsus**, 349
- Partial Test Ban Treaty (PTBT), 286
- peroxynitrite, 46, 47, 322
- Perrault, Mike**, 95
- Philips, Alasdair**, 72, 98, 103, 104, 106, 144, 165, 168, 184
- Philips, Jean**, 72, 98, 103, 104, 106, 144, 165, 168, 184
- phototherapy, 214, 221
- Physicians' Health Initiative for Radiation and Environment (PHIRE), 55
- Pineault, Nick**, 187
- Plato**, 55
- pleasure trap, 49, 156, 378
- Pollack, Gerald**, 220
- Pollan, Michael**, 329, 331, 333, 339
- Popper, Pam**, 316
- power flux density (PFD), 18
- power frequency or powerfrequency EMFs. *See* extremely low-frequency EMFs (ELF-EMFs)
- Powerwatch, 13, 18, 104, 131, 132, 135, 136, 144, 168, 184, 391
- Precautionary Principle, 23, 94, 134
- Preece, William**, 388
- Public Health England (PHE), 276, 278, 279, 302, 314
- Pulsed electromagnetic field (PEMF) therapy, 349–50
- radio frequency radiation (RFR)
- common sources, 143–75
 - defined, 125–27
 - health effects, 128–34
 - infertility and, 132–34
 - measuring, 87–89
 - prevailing levels, 135–36
 - safety guidelines, 134–35
 - solutions
 - decrease time, 192–94
 - increase distance, 190–92
 - reduce sources, 184–89
 - shield yourself, 194–97
- radiofrequency radiation. *See* radio frequency radiation (RFR)
- radiotherapy, 267, 272, 274, 297, 298, 301, 317
- radium dial luminisers, 267
- radium girls. *See* radium dial luminisers
- Reichrath, Jörg**, 233
- Repacholi, Michael**, 32
- Rheaume-Bleue, Kate**, 227
- Richo, David**, 380
- Roentgen, Wilhelm Conrad**, 294
- Rollier, August**, 230
- Rösli, Martin**, 83
- Rosling, Hans**, 333
- Royal Astronomical Society (RAS) - Britain, 159
- Rubik, Beverley**, 346, 351–52
- Sadhguru** (born Jagadish Vasudev), 331, 380, 385
- Sage, Cindy**, 129
- SAM (Specific Anthropomorphic Mannequin), 28–30, 150
- Santayana, George**, 383
- SAR (specific absorption rate), 13, 18, 30, 135, 191
- saunas, 11, 207, 327, 369, 372
- Savitz, David**, 75
- Schliephake, Erwin**, 53
- Schopenhauer Sequence – the road to truth, 26–28, 34, 157, 160, 267, 325, 326
- Schopenhauer, Arthur, 26, 325
- Schumann Resonance (SR), 9, 10, 14
- Scientific Advisory Committee on Nutrition (SACN) - UK, 225
- Scientific Committee on Health, Environmental and Emerging Risks (SCHEER) - EU, 233, 234
- Segar, Michelle**, 336
- Serenity Prayer, 66, 384
- shielding (ELF, DE & RF)
- aluminium foil, 187, 194, 195, 196, 197, 392
 - bed canopies, 196
 - challenges and, 102, 106, 108, 194, 195, 196
 - clothing, EMF-blocking, 196–97
 - extension cords/power strips, 105
 - fabric, EMF-blocking, 195
 - Faraday cages for EMF-emitting devices, 194
 - grounding as an alternative to, 107, 197
 - laptop shields, 106
 - magnetic fields and, 108
 - metal mesh, 195
 - metal sheets, 195
 - mu-metal, 108
 - Mylar film, 195
 - natural EMFs and, 102
 - paint, 107, 195
 - partial, 195
 - sleeping bags, 196
 - total, 195
 - vegetation and, 106
 - wallpaper, 195
 - windows and, 195
- shielding (ionising radiation), 316
- shielding (light)
- blackout blinds/curtains, 257, 328
 - blue light screen filters, 257
 - blue-blocking glasses, 257
 - dark bedrooms, 257
 - eye masks, 257
 - sunglasses, 230, 262
- Simpson, Homer**, 368
- Sinatra, Steven**, 116
- Singh, Narendra**, 24, 129
- small cell antennas, 148, 149, 150
- Snowden, Edward**, 154
- Socrates**, 337
- Sorenson, Marc**, 230, 232

- SpaceX, 157, 159, 160
Spencer, Jeff, 119
Spencer, Percy LeBaron, 167
Springsteen, Bruce, 379
Stakeholder Advisory Group on ELF EMFs (SAGE) - UK, 81
Starlink network. *See* SpaceX
Stetzer, Dave, 96
Stevenson, Shawn, 329
Stress Bucket (model of chronic disease), 5, 50–52, 52, 77, 171, 278, 321
sunlamps, 234, 258, 259, 260
 vitamin D sunlamps, 259
sunscreens, 232
superoxide, 46, 47
supplements. *See* dietary supplementation
suprachiasmatic nucleus (SCN), 204
Tapping. *See* Emotional Freedom Techniques
Teller, Edward, 285
Tesla, Nikola, 53, 56, 69, 70, 71, 74, 347
The Endocrine Disruption Exchange (TEDX), 325
Three Mile Island (USA), 267
Tolstoy, Leo, 336
Tomitsch, Johannes, 67, 105
Total Body Burden. *See* Stress Bucket (model of chronic disease)
Tribes - EMFs and health, 22–24
 The Conflicted, 23
 The Confused, 23
 The Precautionaries, 23
 The Procrustians, 23
 The Trustful, 24
twelve steps of recovery, 381–88
UN Environment Programme (UNEP), 37, 277
Union of Concerned Scientists (UCS), 158
Vecchia, Paolo, 32
Verkasalo, Pia, 75
Vernikos, Joan, 336
VGCC (voltage-gated calcium channel)
 defined, 46
 hypothesis for harmful and beneficial effects of EMFs, 35, 38, 46–47, 345
Vivekananda, Swami (born Narendranath Datta), 347
Voldemort, 348
Walker, Matthew, 327, 329
Walsh, Neale Donald, 321, 379, 380
Watson, Thomas J., 388
Weil, Andrew, 322
Wertheimer, Nancy & Leeper, Ed, 76, 77
Wheeler, Tom, 28, 155, 173
Wilczek, Frank, 346
Wilde, Oscar, 338
Williamson, Marianne, 373, 380
Windscale (UK), 267
Wireless Technology Research Project (WTR), 27, 28
Woolsey, James, 172
World Health Organization (WHO), 16, 32, 34, 35, 36, 37, 39, 130, 135, 152, 223, 230, 233, 234, 237, 327
World Meteorological Organization (WMO), 153
Wunsch, Alexander, 201, 203, 204, 208, 210, 214, 216, 218, 220, 230
Wypychowski, Pawel, 56, 162
X-rays, 165, 267, 269, 271, 272, 281, 294, 295, 297, 300, 301
Yang, You, 78
Zalyubovskaya, N.P., 150
Zaret, Milton, 167
Zimmerman, Scott, 391

Image credits

Cover page

By John Mauremootoo using the image [Female hands holding the world - over a dark background](#). Image used under license from Freestock.com. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Chapter 1

Figure 1.1: A nested hierarchy of intervention opportunities. This book focuses on the individual/household level. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Chapter 2

Figure 2.1: A wave with a longer wavelength (top) has a lower frequency because fewer waves pass a given point per unit of time... By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 2.2: Natural and non-native EMFs along the electromagnetic spectrum. Ionising radiation (IR) dislodges electrons from atoms and molecules, causing them to become charged (ionised)... By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 2.3: Typical maximum daily exposure to radio frequency electromagnetic radiation from non-native and natural power flux densities compared to exposure guidelines... Updated from Philips & Lamburn 2012. Used with the permission of the authors.

Figure 2.4: Polarised versus non-polarised EMFs. Source: Panagopoulos (2018) (doi:<https://doi.org/10.1155/2015/607053>). Wiley CC-BY-3.0 creativecommons.org/licenses/by-sa/3.0.

Figure 2.5: Theoretical mobile phone signal. Adapted from Panagopoulos (2018). (doi:<https://doi.org/10.1155/2015/607053>). Wiley CC-BY-3.0 creativecommons.org/licenses/by-sa/3.0.

Figure 2.6: Real-life example of mobile phone signal. Source: Panagopoulos (2018) (doi:<https://doi.org/10.1155/2015/607053>). Wiley CC-BY-3.0 creativecommons.org/licenses/by-sa/3.0.

Figure 2.7: Man-made EMFs: Jamming Nature's Signals. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Chapter 3

Figure 3.1: Oh Sam What a Man. Source: Anguera et al. 2013 (doi:[10.1155/2013/838364](https://doi.org/10.1155/2013/838364)). Wiley CC-BY-3.0 creativecommons.org/licenses/by-sa/3.0.

Figure 3.2: Depth of absorption of mobile phone radiation in a 5-year-old child, a 10-year-old child, and an adult... Adapted from Gandhi et al. 1996. Used with the permission of the Institute of Electrical and Electronics Engineers (IEEE).

Chapter 4

Figure 4.1: The VGCC mechanism for harmful and beneficial effects of EMFs. Adapted from Pall 2018 (doi:[10.1016/j.envres.2018.01.035](https://doi.org/10.1016/j.envres.2018.01.035)). Elsevier Ltd CC BY 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 4.2: Some adverse effects of non-native EMFs on humans. The tip of the iceberg in a sea of stressors. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 4.3: You can't do just one thing. By John Mauremootoo CC BY-SA 4.0. creativecommons.org/licenses/by-sa/4.0

Figure 4.4: Schematic representation of the stress and disease threshold model of chronic disease. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Chapter 5

Figure 5.1: Reduction in power with distance from source. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 5.2: Power densities of mobile phones, transmitted power and distance from the antenna. Derived from data from Saeid 2012 (<https://archive.aessweb.com/index.php/5003/article/view/3349/5360>). By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 5.3: Schematic representation of Stephen Covey's circles of control, influence, and interest/concern. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Chapter 6

Figure 6.1: Electric and magnetic fields: a) when a lamp is switched off, and b) when a lamp is switched on... adapted from Philips and Philips 2017 (<https://www.powerwatch.org.uk/library/downloads/low-emf-home-1-house-wiring-2017-11.pdf>). Used with the permission of Jean and Alasdair Philips.

Figure 6.2: UK electric wire colour coding. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 6.3: The current on the line wire creates a magnetic field that flows around in one direction, while the current from the neutral wire flows in the opposite direction. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 6.4: High magnetic field caused by unpaired wires resulting in a current “loop”. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0

Figure 6.5: A fluorescent tube lit up by electromagnetic fields from a 400 kV powerline. Source: BaronAlaric (2010). Fluorescent tube glowing under electric power lines (https://commons.wikimedia.org/wiki/File:Fluorescent_tube_under_electric_line.jpg) CC BY-SA 3.0 creativecommons.org/licenses/by-sa/3.0.

Figure 6.6: Distance of address at birth from nearest National Grid line and estimated percentage increase in relative risk of leukaemia in England and Wales... Derived from data from Draper et al. (2005). By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 6.7: Electricity distribution simplified – from the power station to our homes. CC 4.0 Derivative of PD work by US DOE.

Figure 6.8: A range of UK overhead powerline types. a) By Frank Skinner CC BY-SA 2.0 creativecommons.org/licenses/by-sa/2.0. b) & c) By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 6.9: Typical magnetic fields produced by various voltages of overhead lines. Adapted from SAGE 2010 (<https://www.powerwatch.org.uk/pdfs/SAGE%20Second%20Interim%20Assessment%202010%20-%20final.pdf>).

Figure 6.10: A plug-in socket tester showing wiring status based on LED indicators... By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 6.11: Some different types of EMF meter... By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Chapter 7

Figure 7.1: a) Dirty electricity example. Source: Milham & Morgan 2008 (doi: 10.1002/ajim.20684). Used with the permission of Wiley.

Figure 7.1. b) Representation of clean electricity (smooth line) and the superimposition of dirty electricity, which makes the line jagged. Source: SATIC Inc (2024).

Figure 7.2: Expected cancers versus actual cancers for LQMS teachers from 1988-2005. Adapted from Milham 2012 (<http://www.sammilham.com/>).

Figure 7.3: Median dirty electricity values in LQMS compared with another school, homes and an office building. Data from Milham & Morgan 2008 (doi:10.1002/ajim.20598).

Chapter 8

Figure 8.1: Man in a Faraday cage protected from a high voltage electric current... by Tesla Downunder (<https://tesladownder.com/Tesla18Dalek10003Ft.jpg>) CC BY-SA 2.5 creativecommons.org/licenses/by-sa/2.5.

Chapter 9

Figure 9.1: Examples of commercially available and homemade grounding products... By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 9.2: Fresh fruit and vegetables, dark chocolate, and breathing and relaxing exercises help provide antioxidants... By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 9.3: Average body voltage before and during grounding. Source: Ghaly & Teplitz 2004 (doi:10.1089/acm.2004.10.767). The publisher for this copyrighted material is Mary Ann Liebert, Inc. publishers. Used with the permission of Mary Ann Liebert, Inc.

Figure 9.4: The umbrella effect of grounding. Source: Ober et al. 2014 (<https://www.earthing.com/>). Used with the permission of Turner Publishing Company, LLC.

Figure 9.5: Cortisol levels before and after grounding... Adapted from Ghaly, & Teplitz 2004 (doi:10.1089/acm.2004.10.767). The publisher for this copyrighted material is Mary Ann Liebert, Inc. publishers. Used with the permission of Mary Ann Liebert, Inc.

Figure 9.6: Blood cell clumping before and after grounding. Source: Ober et al. 2014 (<https://www.earthing.com/>). Used with the permission of Turner Publishing Company, LLC.

Figure 9.7: Pain perception and white blood cell count following exercise in grounded and non-grounded subjects. Adapted from Brown et al. 2010 (doi:10.1089/acm.2009.0399). The publisher for this copyrighted material is Mary Ann Liebert, Inc. publishers. Used with the permission of Mary Ann Liebert, Inc.

Figure 9.8: Infrared images of the leg of a 33-year-old woman with chronic right knee pain... Source: Oschman 2007 (doi:10.1089/acm.2007.7048). The publisher for this copyrighted material is Mary Ann Liebert, Inc. publishers. Used with the permission of Mary Ann Liebert, Inc.

Chapter 10

Figure 10.1: Associations between proximity to mobile phone masts and incidence of cancer.

- a) Derived from data from Eger et al. 2004 (https://fliphtml5.com/btup/mtll/basic#google_vignette). By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.
- b) Source: Wolf & Wolf 2004 (www.emf-portal.org/en/article/19820).

Chapter 11

Figure 11.1: Typical exposure levels from common RFR sources. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 11.2: Simplified representation of how mobile phone signals are transmitted and received. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 11.3: Frequency reuse... By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 11.4: 1G-5G: From Brick Phone to the Internet of Things... By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 11.5: The contribution of ICT to the forecasted growth in demand for electricity. Data from Andrae & Edler 2015 (doi:10.3390/challe6010117). By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 11.6: Three lime trees under three different high frequency (HF) exposure conditions... Source: Schorpp 2007 (www.puls-schlag.org).

Figure 11.7: Starlink satellites, photographed soon after launch, pass overhead near Carson National Forest, New Mexico (www.astronomy.com/wp-content/uploads/sites/2/2023/03/ASYMC0323_01.jpg) By M. Lewinsky CC BY 2.0. creativecommons.org/licenses/by/2.0.

Figure 11.8: An illustration of the massive recent increases in objects launched into space. Part of the following publication: Edouard Mathieu and Max Roser (2022) - "Space Exploration and Satellites". Data adapted from United Nations Office for Outer Space Affairs. Retrieved from <https://ourworldindata.org/grapher/yearly-number-of-objects-launched-into-outer-space> [online resource].CC BY

Figure 11.9: Median malignant melanoma incidence versus the average number of FM transmitters in each municipality in Sweden. Source: Hallberg & Johansson 2005 (doi:10.1081/JBC-200054260). Used with the permission of Taylor & Francis.

Figure 11.10: The Bluetooth logo (https://cdn.pixabay.com/photo/2015/03/12/12/22/bluetooth-670069_640.png). Public Domain.

Figure 11.11: An old-fashioned CRT computer monitor. Cathode-ray tube. Wikipedia (User:B137) https://en.wikipedia.org/wiki/Cathode-ray_tube CC-BY-3.0 creativecommons.org/licenses/by-sa/3.0.

Figure 11.12: How a GPS system works through trilateration... By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 11.13: Wireless Communication and Sensors in Self-Driving Cars. Source: Pisarov & Mester 2020 (doi:10.5937/fme2101029P). CC BY 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 11.14: Maximum recorded power density values for examples of smart meter devices used in Great Britain, adapted from Peyman et al. 2017.... (doi:<https://doi.org/10.1002/bem.22044>). Wiley CC-BY-4.0 creativecommons.org/licenses/by-sa/4.0.

Chapter 12

Figure 12.1: Absorption of RFR in human tissue in relation to typing antenna radiation position. Source: Guterman et al. 2009 (doi:10.1109/MAP.2009.5338680). Used with the permission of IEEE.

Figure 12.2: Ferrite beads fitted to an air-tube headset... By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Chapter 13

Figure 13.1: Evolution of light sources from sunlight to LEDs. Adapted from Wunsch 2018 (vimeo.com/301352213). Used with the permission of Alexander Wunsch.

Figure 13.2: Our night-shifted World... From Lorenz 2022 (<https://djlorenz.github.io/astronomy/lp2022/>).

Figure 13.3: Practically all of our biological functions are influenced by circadian rhythms. Adapted from Wunsch 2018 (vimeo.com/301352213). Used with the permission of Alexander Wunsch.

Figure 13.4: Blue light, via nonimage-forming cells in the retina, affects melatonin levels and pituitary gland activity... By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 13.5: Ideal day-night fluctuations in circulating cortisol and melatonin levels under close-to-natural conditions. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 13.6: Percentages of light energy in different wavelengths received at the earth's surface... By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 13.7: Changes in natural light spectra of the day. Adapted from Wunsch 2018 (vimeo.com/301352213). Used with the permission of Alexander Wunsch.

Figure 13.8: Natural and artificial light spectra, and melatonin suppression. Adapted from Brainard et al. 2001 (10.1523/JNEUROSCI.21-16-06405.2001). Copyright 2001 Society for Neuroscience.

Figure 13.9: Spectral distribution of different artificial light sources and effects of different wavelengths on the eye. Adapted from Wunsch 2018 (vimeo.com/301352213). Used with the permission of Alexander Wunsch.

Figure 13.10: Comparison of near-infrared to visible light exposure levels from 1800 to Present. Adapted from Zimmerman & Reiter 2019 (doi: 10.32794/mr11250016 (Supplemental Materials)). CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 13.11: Colour temperatures of typical natural light at different times of day and typical artificial light sources on the Kelvin scale. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 13.12: Representation of light intensity over 24 hours in a city compared with an environment with limited artificial light... By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 13.13: Flicker characteristics of different electric light sources. Source: Wunsch 2018 (vimeo.com/301352213). Used with the permission of Alexander Wunsch.

Figure 13.14: Acceptable and unacceptable limits of flicker... Adapted from Lehman and Wilkins 2010 (doi:10.1109/MPEL.2014.2330442). Used with the permission of IEEE.

Figure 13.15: Accelerated skin ageing on one side of the face of a man who had spent 28 years as a driver... Source: Gordon & Brieva 2012 (10.1056/NEJMicm1104059). Used with the permission of the Massachusetts Medical Society.

Figure 13.16: Blood vessels within the macula. Source: Snodderly et al. 1992 (10.1523/JNEUROSCI.12-04-01169.1992). Copyright 1992 Society for Neuroscience.

Figure 13.17: Percentage of people in different parts of the world with vitamin D deficiency... By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 13.18: Vitamin D metabolism and the vitamin D receptor. Adapted from Lugg et al. 2015 (doi:10.1155/2015/864370). Wiley CC BY-SA 3.0 creativecommons.org/licenses/by-sa/3.0.

Figure 13.19: Changing impacts of vitamin D levels. Adapted from Tavera-Mendoza and White 2007 (doi:10.1038/scientificamerican1107-62). Used with the permission of Springer Nature America.

Figure 13.20: Ancestral levels of vitamin D in the blood in comparison with recommended minimum levels. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 13.21: The effect of latitude on UVB intensity available for the synthesis of vitamin D. Source: Tavera-Mendoza and White 2007 (doi:10.1038/scientificamerican1107-62). Used with the permission of Springer Nature America.

Figure 13.22: The Fitzpatrick scale. Source: D’Orazio, et al. 2013 (doi:10.3390/ijms140612222). MDPI CC BY 3.0 creativecommons.org/licenses/by-sa/3.0.

Figure 13.23: Sunscreen sales and age-adjusted melanoma incidence rates per 100,000. Melanoma data from the Connecticut Tumor Registry and sales data for the USA. Adapted from Gorham 2010 (https://www.youtube.com/watch?v=-vt9Lc_PcWM).

Figure 13.24: Body mass index (BMI) in the UK and artificial light exposure over a 150-year period... By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Chapter 14

None.

Chapter 15

Figure 15.1: Advertisement for “Undark” from 1921. Unknown author, Public domain, via Wikimedia Commons. [https://commons.wikimedia.org/wiki/File:Undark_\(Radium_Girls\)_advertisement,_1921,_retouched.png](https://commons.wikimedia.org/wiki/File:Undark_(Radium_Girls)_advertisement,_1921,_retouched.png).

Figure 15.2: Nuclides of hydrogen... By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 15.3: How the percentage of radionuclide atoms in a sample changes over time... By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 15.4: Some possible dose-response curves describing the risk of health effects at different radiation doses. Adapted from Belli & Indovina 2020 (doi: 10.3389/fpubh.2020.601711). CC BY 4.0 creativecommons.org/licenses/by/4.0.

Figure 15.5: The relationship between radiation dose and the incidence of non-leukaemia cancers. Adapted from McLean et al. 2017 (doi:10.1098/rspb.2017.1070). The Royal Society Publishing CC BY 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 15.6: Lifetime risk of cancers per gray of absorbed radiation and age at exposure... Source: Simon et al. 2006 (doi: 10.1511/2006.57.982). Used with the permission of Sigma Xi.

Figure 15.7: Relative doses of different ionising radiation sources. From UNEP 2016 (<http://www.unep.org/resources/report/radiation-effects-and-sources>), Nairobi. Used with the permission of UNEP.

Figure 15.8: Cumulative absolute risk of death from lung cancer by age 75 years versus usual radon concentration at home for cigarette smokers and lifelong non-smokers. Source: Darby et al. 2005 (doi:10.1136/bmj.38308.477650.63). Used with the permission of BMJ Publishing Group Ltd.

Figure 15.9: Illustrative annual doses from inhaling radon in different parts of the UK. Source: PHE 2016 (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/518487/PHE-CRCE-026_-_V1-1.pdf). Contains public sector information licensed under the Open Government Licence v3.0 (www.nationalarchives.gov.uk/doc/open-government-licence/version/3).

Figure 15.10: Percentage of homes in the UK at or above the radon action level. ©UK Health Security Agency (UKHSA) and British Geological Survey (BGS) (<https://www.bgs.ac.uk/news/updated-radon-map-for-great-britain-published/>). Used with the permission of UKHSA and BGS. Contains National Statistics data © Crown copyright and database right 2022. Contains Ordnance Survey data © Crown copyright and database right 2022. Based on Crown copyright and reproduced with permission of Land Property Services under delegated authority of the Controller of His Majesty’s Stationery Office © Crown copyright and database right 2022, EMOU 206.2.

Contains Ordnance Survey Ireland data © 2022 Government of Ireland and Ordnance Survey Ireland. Radon potential classification UK Health Security Agency © Crown copyright 2022. British Geological Survey © UKRI 2022. All rights reserved (BGS permit no. CP24/044).

Figure 15.11: Consumption of dairy products – a major means by which fallout is transferred to people. Source: Simon et al. 2006 (doi: 10.1511/2006.57.982). Used with the permission of Sigma Xi.

Figure 15.12: a) Castle Bravo mushroom cloud from Bikini Atoll, b) Mushroom cloud rising in the atmosphere seconds later. ©Public Domain. a) Unknown author. b) United States Department of Energy (https://en.wikipedia.org/wiki/File:Castle_Bravo_Blast.jpg).

Figure 15.13: The fallout plume from the Castle Bravo nuclear test. Source: Simon et al. 2006... (doi: 10.1511/2006.57.982). Used with the permission of Sigma Xi.

Figure 15.14: Radiation burns of a crew member of a Japanese fishing boat caused by fallout from the Castle Bravo nuclear test. ©Public Domain Unknown author (https://commons.wikimedia.org/wiki/File:The_head_of_the_crew_of_Daigo_Fukuryu-maru.JPG).

Figure 15.15: Atmospheric concentration of radioactive carbon-14 (¹⁴C) almost doubled as a result of atmospheric testing of nuclear weapons... Adapted from Hokanomono ©Public Domain (<https://commons.wikimedia.org/w/index.php?curid=634564>).

Figure 15.16: Trend in relative risks for UK nuclear industry workers for non-CLL leukaemia and non-leukaemia cancers. Data from Gillies et al. 2019 (doi:10.1667/RR15358.1) and Haylock et al. 2018 (doi:10.1038/s41416-018-0184-9). Nature CC BY 4.0 creativecommons.org/licenses/by-sa/4.0. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 15.17: The height of the tsunami that struck the Fukushima Daiichi nuclear power plant... Source: Shigeru23 ([https://commons.wikimedia.org/wiki/File:Fukushima_I_Powerplant_\(Tsunami_height\).png](https://commons.wikimedia.org/wiki/File:Fukushima_I_Powerplant_(Tsunami_height).png)) - CC BY-SA 3.0 creativecommons.org/licenses/by-sa/3.0.

Figure 15.18: Nuclear power plants (circles) and heatmap of earthquake-prone areas worldwide (2011). Source: J.L.Saavedra (2011). CC BY 4.0. <https://creativecommons.org/licenses/by/4.0>.

Figure 15.19: The location of UK nuclear power plants, their elevations above sea level and flood threats. Adapted from the Climate Central Flood Map (<https://www.climatecentral.org/what-we-do>). By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 15.20: Variation in radon levels in a building in Vietnam over several days. Source: Viet et al. 2018 (doi: <https://doi.org/10.32508/stdj.v21i2.432>) Science & Technology Development Journal. CC BY 4.0. creativecommons.org/licenses/by/4.0.

Chapter 16

None.

Chapter 17

Figure 17.1: The wholefood plant-rich diet plate... By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Chapter 18

Figure 18.1: Representations of a.) The earth's magnetic field, and b.) The heart's electromagnetic field. The Earth's Magnetic Field by College Physics (<https://pressbooks.online.ucf.edu/phy2054lt/>) CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0. The magnetic field of the human heart – Public domain (<http://uniteunderfreedom.com/?p=1006>).

Figure 18.2: Passive Sympathetic Resonance Technology™ (SRT) device components. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 18.3: a.) Photos of live red blood cells in subjects without Q-Link; b.) Photos of live red blood cells in the same subject with Q-Link. Source: Rubik 2002 (10.1089/10755530260511711). The publisher for this copyrighted material is Mary Ann Liebert, Inc. publishers. Used with the permission of Mary Ann Liebert, Inc.

Figure 18.4: Summary of 136 Amazon customer ratings of the Q-Link Triangle Acrylic SRT-3 Pendant... By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Figure 18.5: Summary of results of a survey of Hemberg residents' health complaints before and after biogeometric installations. Source: Karim 2004 (https://ecf2f96e-2fee-4f3c-814b-5caa5a63b36e.filesusr.com/ugd/35c39f_ff18a77e979b465c9513d3a21e5b2d41.pdf). Used with the permission of GIBB Information Organization for Building Biology. Moosackerstrasse 22 CH-8405 Winterthur ZH, Switzerland.

Chapter 19

Figure 19.1: John Mauremootoo's Parkinson's disease symptom severity (PRO-PD scores) since diagnosis... By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

Chapter 20

Figure 20.1: Six simple engineering fixes that can reduce mobile phone radiation. Derived from Héroux et al (2023). ICBE-EMF. CC BY 4.0. creativecommons.org/licenses/by/4.0.

About the Author

Educated in biosciences at the Universities of Cambridge (undergraduate) and Southampton (postgraduate), John Mauremootoo, PhD, is an experienced environmental consultant and passionate advocate for planetary health, with nearly four decades of practical expertise in diverse fields, including biodiversity conservation, sustainable agriculture, and ecosystem restoration. A lifelong environmentalist, John has worked in 38 countries and territories, championing initiatives to restore balance to natural systems and improve lives.

His work combines rigorous scientific understanding with practical, human-centred approaches to individual and societal empowerment. His personal health challenges, including a diagnosis of Parkinson's disease, have inspired his explorations into links between personal and planetary health, which have catalysed *The Big Book of EMFs*, in which he outlines the impact of electromagnetic fields on health and provides actionable steps for living in harmony with modern technology.

John lives with his wife, Julie, who shares his commitment to living purposefully and healthily in a fast-changing world.



Further information

Further relevant resources, including full-colour versions of the figures from this book, can be found at

<https://www.inspiralpathways.com/the-big-book-of-emfs.html>