ELECTROSMOG

THE HEALTH EFFECTS OF MICROWAVE POLLUTION

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May 2021 edition

PREFACE

The term 'military industrial complex' was invented (or, if not invented, at least popularised) in 1961 by outgoing US President Dwight D Eisenhower. In his remarkably prescient farewell address, Eisenhower said[1]:

> In the councils of government, we must guard against the acquisition of unwarranted influence, whether sought or unsought, by the military-industrial complex. The potential for the disastrous rise of misplaced power exists and will persist.
>
> We must never let the weight of this combination endanger our liberties or democratic processes. We should take nothing for granted: only an alert and knowledgeable citizenry can compel the proper meshing of huge industrial and military machinery of defense with our peaceful methods and goals, so that security and liberty may prosper together

With regard to the industrial part of the military-industrial complex, Eisenhower was talking about the then-new arms industry, spawned as a direct result of two disastrous world wars. This book is written to alert and inform the citizenry about the way in which a different industry – the telecommunications industry – has over the last fifty years piggy-backed off the perceived interests of the US military to blanket the world with electromagnetic waves of a sort that have never before been seen on planet earth. Life evolved in the complete absence of these waves. Thus, this new version of the military industrial complex has done serious damage to not only our liberties and democratic processes, but also our bodily health.

Part I of the book first describes in a non-mathematical way the technology underpinning the problem, then shows how public exposure limits have been manipulated, all over the world, through the orchestrated capture of regulatory agencies by the very industry those agencies were set up to regulate.

Part II then summarises a huge volume of scientific evidence showing that exposure to power densities of pulsed radiofrequency radiation a tiny fraction of those permitted by the aforementioned, industry-manipulated, public exposure limits actually causes cancer, DNA damage, diabetes, immune system and cardiovascular problems in humans – and similarly serious problems for wild-life (birds, bees and trees).

Finally, Part III discusses some of the biological mechanisms mediating these health harms, to counter the absurd suggestion that if we are unsure HOW such damage occurs, we should rightfully ignore all evidence that it does occur.

No specific fixes for this increasingly inescapable problem are proposed. Basically, the only fix for corruption (and its ugly spawn, propaganda and lies) is determined intervention by humans who have lost neither their common sense nor their moral compass. Such people appear to be increasingly rare – but do still exist. Kia kaha, e hoa ma.

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[1] https://www.ourdocuments.gov/doc.php?flash=false&doc=90&page=transcript

[2] https://microwavenews.com/short-takes-archive/bfs-support-icnirp

[3] http://www.icmje.org/about-icmje/ faqs/icmje-recommendations/

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PART I

THE SITUATION

Chapter 1

THE TECHNOLOGY

In order to understand the technology causing the problem, it is necessary to take a deep breath and dive into the physics of the situation. If you don't want to deal with this right now, dear reader, it would be fine to skip this chapter and come back to it as indicated throughout the rest of the book. (It is rather interesting, though, and no mathematics is involved at this level, I promise ...).

What is electromagnetism*?*

Electromagnetism is a fundamental feature of the universe. The word 'fundamental' as used here is shorthand for the somewhat unsatisfactory but far from unique situation in which we know something exists – indeed we often know in considerable detail how to manipulate and thus use it – but we do not really understand in any deep way what it IS. That is to say, we cannot explain it in terms of anything with which we are more familiar.

More helpfully perhaps, the word electromagnetism is used to describe a variety of fundamental force – the electromagnetic force – which affects matter. A force field known as *the electromagnetic field* pervades the entire universe, as far as we can tell. Excitations or perturbations in this field can be generated by means we know how to specify, and can then travel through space in a way that is very reminiscent of water waves in a pond (but much faster – electromagnetc waves travel at approximately 186,000 miles or 300,000 kilometres per second in a vacuum, or slightly slower in various other media). The characteristics of these waves are described by the words wavelength and frequency.

What are wavelength and frequency?

Like any sort of wave, an electromagnetic wave is a series of repeating peaks and valleys. The interval between one peak and the next peak (or one valley and the next valley) is called a cycle (Figure 1)

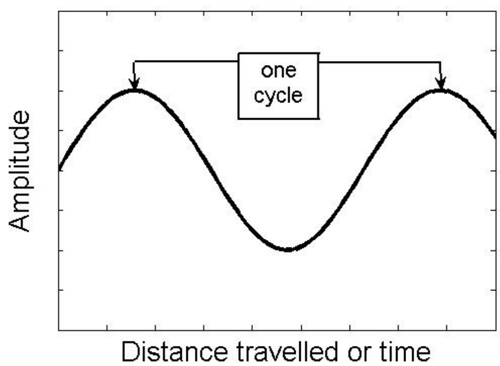

Figure 1: Meaning of 'cycle' with regard to electromagnetic waves

- Wavelength is the distance the wave travels before it completes one cycle.

- Frequency is the number of cycles that occur in one second.

Frequency is measured in hertz (Hz).

- One Hz is one cycle per second.
- One kilohertz (KHz) is a thousand (10^3) cycles per second.
- One megahertz (MHz) is a million (10^6) cycles per second.
- One gigahertz (GHz) is a billion (10^9) cycles per second.

Higher frequencies have shorter wavelengths (simply because a high frequency wave can not travel as far before it repeats itself).

The electromagnetic spectrum

Electromagnetic waves of different frequencies have different properties. Table 1 shows the accepted subdivisions of the electromagnetic spectrum.

Name	Frequency	Wavelength	Effects on biology
Gamma rays	> 10^{19} Hz	< 10^{-11} m	Not visible, very energetic, penetrate everything, cause radiation sickness, death.
X-rays	$3\text{x}10^{16}$ to $3\text{x}10^{19}$ Hz	0.01 to $10\text{x}10^{-9}$ m	Not visible, slightly less energetic, penetrate soft tissue but not bone, too much causes burns and cancer.
Ultraviolet	$8\text{x}10^{14}$ to $3\text{x}10^{16}$ Hz	$10\text{x}10^{-9}$ to $4\text{x}10^{-7}$m	Visible as 'black light', both harmful (sun-burn, skin cancer) and beneficial (Vitamin-D synthesis) effects on biology. Shortest wavelengths largely filtered out by the atmosphere.
Visible light	~$7.5\text{x}10^{14}$ Hz (violet) to ~$4.3\text{x}10^{14}$ Hz (red)	~$4\text{x}10^{-7}$m (violet) to ~$7\text{x}10^{-7}$m (red)	Visible, many beneficial effects on biology: photosynthesis in plants, vision and diurnal rhythms in animals.
Infrared	~$4.3\text{x}10^{14}$ Hz to $3\text{x}10^{11}$ Hz (300 GHz)	$7\text{x}10^{-7}$ m to $1\text{x}10^{-3}$ m (1mm)	Not visible, heats tissue, other potential biological effects not studied.
Radio waves High frequency range also known as **Microwaves**	$3\text{x}10^{11}$ Hz (300 GHz) to $3\text{x}10^{3}$ Hz (3 kHz) (definitions vary on the lower limit of the radio spectrum)	1 mm to 100 km (definitions vary re upper limit)	Not visible, cook tissue at very intense levels, but multiple harmful non-thermal effects – and some beneficial non-thermal effects – also being discovered.
Domestic electricity	50 Hz or 60 Hz depending on country	~6,000 km or ~5,000 km	Not visible, biological effects disputed.

Table 1: Divisions of the electromagnetic spectrum

The highest frequencies and shortest wavelengths of EM radiation are called gamma rays. The next highest frequencies are X rays. Gamma waves and X rays are collectively known as ionizing radiation. It is now well accepted that ionizing radiation can cause cancer and other health harms (although that was not clear when these rays were first discovered). The highest frequencies of ultraviolet light also fall into this category.

Waves of lower frequencies (and thus longer wavelengths) are often called non-ionizing radiation. It used to be thought that non-ionizing radiation does not cause cancer, or indeed any biological effect other than acute tissue heating. This belief has now been conclusively disproved – but because acknowledging that would cost the telecommunications industry considerable revenue and the military considerable technological efficacy, the military-industrial complex continues to claim that the question is debatable. Therefore, much of the rest of this book is devoted to laying out the peer-reviewed scientific evidence that levels of non-ionizing radiation too weak to heat tissue DO cause both cancer and a number of other biological harms.

At frequencies just below ultraviolet light are the various colours of visible light. Animals have evolved to be able to see these frequencies, and to be relatively immune to their effects in other respects (although intense enough visible light, as in lasers, can be dangerous).

At still lower frequencies and longer wavelengths we have infrared light. Humans cannot see infrared light, but we can feel it because it causes heating of biological tissue. Too much of it can damage eyes and skin, and trapped infrared radiation contributes to global warming. Hardly any work has been done on other potential biological effects.

Radio waves are a type of electromagnetic radiation with frequencies lower than infrared light. Radio waves have frequencies from as high as 300 gigahertz to as low as 3 kilohertz. At a frequency of 300 GHz, the corresponding wavelength is 1 mm, which is why radiation in this region of the spectrum is known as millimeter waves. At a frequency of 300 MHz the wavelength is 1 metre and at 300 kHz the wavelength is 1 km.

Waves at the upper end of the radio frequency spectrum are also known as microwaves. This is the region of the spectrum used by microwave ovens, and by increasingly ubiquitous technologies like cellphones, Wi-Fi and "smart" electricity meters.

At a still lower frequency is the sort of AC (alternating current) electricity that runs fridges and stoves and vacuum cleaners. This comes in frequencies of 60 Hz in North America and 50 Hz in the rest of the English speaking world.

How do wireless telecommunications work?

The human brain works rather slowly in terms of this spectrum of frequencies. We can just about cope with events in the outside world that happen once a second (so can be described as having a frequency of 1 Hz). By the time whatever it is happens ten times a second, we are starting to struggle. And events in the outside world that happen faster than about 100 times a second are beyond us.

It is thus a bit of a problem that electromagnetic frequencies below 100 Hz have enormously long wavelengths and as a result are not readily usable for the transmission of information through the air. Information with this sort of frequency is easily transmitted over a copper wire or fibre optic cable. But electromagnetic waves with a frequency of 50 or 60 Hz have wavelengths of 6,000 or 5,000 KILOMETRES, so transmitting them requires huge antennae and is not feasible on an everyday basis.

If you really need to broadcast this sort of low frequency signal, rather than sending it over a cable, the solution is to generate a much higher frequency *carrier* wave – one that is much better behaved in terms of propagation through the air – and *modulate* this carrier wave with your lower frequency information, or signal. The signal can be made to modulate either the amplitude of the carrier wave (AM radio), the frequency of the carrier wave (FM radio) or the phase of the carrier wave (PM modulation: Wi-Fi, some types of cellphone, satellite television). The modulated carrier wave is then broadcast through the air from a transmitter. Finally a receiver demodulates the carrier wave and displays the extracted information as either sound or visual images.

This is fine for analog carriers and signals, and analog radio and TV broadcasting has been carried on without any obvious problems for about a century. But analog waves take a lot of storage space and are hard to perform signal processing on. So tape recorders have been superseded by digital storage media.

The modulation technique developed for digitised carrier waves (i.e. analog waves that have been chopped into multiple discrete samples, for ease of storage) is called pulse modulation. By analogy with AM, FM or PM modulation of analog signals, either the amplitude, the width, or the position of a digitised carrier can be pulse modulated by a digitised signal. Unfortunately from a biological point of view however, it is (somewhat belatedly) becoming apparent that *pulsed* radiation is very much more harmful to biological organisms than analog radiation.

This should perhaps not be surprising, given that biology evolved in an environment where there was virtually no *radio frequency* electromagnetic radiation at all (Bandara and Carpenter 2018) and sunlight, which of course is just a higher frequency form of the same sort of radiation, only ever changed gradually, coming on slowly at dawn and and going off slowly at dusk. Thus, as has recently become clear, biological organisms treat sharp *pulses* of electromagnetic radiation as an unprecedented attack on the system, and respond accordingly.

How do cell phones work?

A cell phone is basically a device that both sends and receives radio waves, aka microwaves. In other words, it is both a radio receiver *and a radio transmitter.* Since the power density of electromagnetic radiation falls off exponentially with distance from the transmitter, a transmitting cellphone held close to any part of the body will emit strong radiation into that part of the body. And it does this even when the phone is not in use, because modern smart phones continually emit hand-shake pulses to locate the closest cell tower. The only way to stop the phone emitting these handshake pulses is to put it in airplane mode.

When the phone is in use as a phone, information to be transmitted is encoded in a similar ways to those described in the preceding section. The phone sends its modulated radio waves to the nearest *base station*, which is usually located in a *cell tower*. The word 'cell' here refers to the fact that the land has been divided up by the telecommunications company or companies (the Telcos) into a patchwork of geographic cells, each of which contains and is served by its own base station or cell tower. Since the intensity of radio waves drops off exponentially with distance from the site of generation, the further a phone is from a base station, the stronger are the radio waves it has to emit.

The base station closest to the phone receives the phone's signal, then transmits the signal to a base station nearer to the intended recipient, which in turn transmits to a base station even closer to the recipient, and so on across a network of base stations, until the message reaches a base station close enough to the recipient for their phone to receive and demodulate the message. If the sender is moving while they are transmitting, their phone switches to the next initial base station automatically, without interrupting the call.

This is a clever and highly effective system, but it involves one major technical difficulty. There is a limited number of radio frequencies available to mobile phone networks. A mobile phone conversation needs one frequency for speaking (transmitting) and one for listening (receiving), so a mere few hundred conversations, all going on at the same time, could use up all of the available bandwidth.

This problem has been solved in different ways by different "generations" of cellphone technology. In what follows, the term 'G' refers to generation, not gigahertz. The classification of any given phone as one or another generation of technology is somewhat loose, as various branches of the industry basically developed new technologies *ad lib* in the absence of any regulatory oversight, and fought out their differences on a commercial basis (Stüber 2017).

1G

The first generation of cell phones, which became widely available in the early 1980s, used analogue (that is to say, not digital), frequency modulated (FM) technology and were designed to carry narrow-band, circuit-switched voice services only. Circuit-switching is essentially the technology used in the early fixed-wire telephone network, where switches in the telephone exchange created a continous wire circuit between the two phones involved in the call, which circuit lasted for as long as the call lasted. The 1G cellphone version worked in essentially the same way, using radio waves instead of physical wires to carry the signal, but functioning as if the two nodes in the circuit were physically connected by a wire.

However, by the late 1980s an exponential growth in cellular service subscriptions meant that capacity limits had been reached, and 2G systems were introduced in the early 1990s.

2G

2G phones used the GSM system (Global System for Mobile communications). GSM solves the multiple-user problem using Time Division Multiple Access (TDMA), a technique which shares the same carrier frequency among multiple users by giving different users different time slots. Each sequential short block of time is divided into a series of eight slots, each slot a little over half a millisecond long, and any given user is permitted to transmit only during one time slot. This means that the phone has to generate periodic short bursts of power, which makes it quite different from the continuous power emitted by traditional radio and TV stations and, as mentioned above, already introduces the sort of pulsed radiation that as mentioned above is now being recognised as especially harmful to biological organisms.

While TMDA systems dominated in Europe, Code Division Multiple Access (CDMA) techniques also made an appearance in 2G systems in North America. In CDMA systems, users are differentiated from one another by being allocated not a particular time slot, but a particular code. The signal to be transmitted is modulated with a pseudorandom code temporarily allocated to the user, and this code essentially functions as an extra carrier frequency (on top, if you like, of the radiofrequency carrier which is modulated by the signal + code). Code Dependent Multiple Access is sometimes known as a "spread spectrum" technique, because it spreads the signal over the whole spectrum of the code. This makes CDMA encoded signals more secure, because unless you have the key to the code it is difficult to intercept the message.

Either form of multiple access technique (TDMA or CDMA) worked well enough for a speech-only system, which needs a relatively low data transmission rate. But the realization that internet access was possible meant much higher rates of data transmission were needed, and this soon drove further evolution.

2.5G

The first evolutionary step was a change to the general packet radio service (GPRS) system. As Andersen et al (2010) put it, this "is fundamentally different from the basic GSM set up of a fixed connection between two users. In contrast, GPRS is a packet-switched system which stops transmitting when there are no packets to send .... From an [biological] exposure point of view there are several changes. The transmissions are more bursty and intermittent with possible time periods with no power. When the transmission is on, the power increases in proportion to the number of time slots, so with four slots active the mean power reaches 1W for GSM900. It should also be realized that the user terminal will not necessarily be close to the head when in the GPRS mode but more likely some distance from the body, which reduces the SAR values significantly." SAR values measure "specific absorption rate" of microwaves by the body, which used to be regarded as the only important factor, on the erroneous assumption that tissue heating is the only means by which radio waves can affect biological organisms.

So 2.5G is already worse than 2G biologically speaking, because it is even more pulsed.

3G

Third generation technology, launched in 2001 in Japan, supports not only phone calls, but also text messaging and internet access. The improved data transmission rates needed for the added functionalities are achieved by combining the packet system with a new method of solving the multiple access problem. Instead of giving each user either their own time slot or a simple code, Wide Band Code Division Multiple Access (WCDMA) gives each user a code that is spread over a wider frequency band, making it harder to hack. About the same as 2.5G in terms of biological harm, then.

4G

In the search for greater speed and accessibility, 4G systems use several even more complex multiplexing techniques. One of these is orthogonal frequency division multiple access (OFDMA). As well as being used in 4G cell phones, the OFDM technique of multiplexing has developed into a popular scheme for use in digital television and audio broadcasting (cable TV), internet access over fixed telephone lines (ADSL broadband connections, which allow simultaneous landline phone conversations and internet access, using the same wires), power line networks (in which information is sent over the electricity lines) and Wireless Local Area Networks (WLANs, aka Wi-Fi). It is therefore worth making the effort to understand how Orthogonal Frequency Division Multiplexing (OFDM) works.

When used for cell phone transmissions, the original form of Frequency Dependent Multiple Access suffered from the problem that was solved in the TDMA and CDMA systems described above by giving each individual user a different time slot or a different code, respectively. FDMA gives each individual user a different carrier frequency. But the original problem with FDMA was that there were not enough carrier frequencies available to give each user their own.

That was at least partly because modulation of a high frequency carrier wave with a lower frequency signal causes the carrier wave to 'spread' in the spectral sense, in that the information to be transmitted is actually carried not at the carrier frequency itself, but by sidebands at frequencies slightly above and below the narrow sine wave of the carrier. Thus in order to prevent overlap and interference between different users' signals, there has to be a *guard band* between carrier frequencies which is not allocated to any user. The addition of a guard band effectively makes each user's frequency band considerably wider, which reduces the number of users that can be accommodated.

Orthogonal Frequency Division Multiple Access (OFDMA) solves this problem by computing and using the exact minimum frequency spacing between different signals to make them 'orthogonal', so that more sub-carrier frequencies – and thus more users – can be squeezed in without interfering with each other.

And from a biological point of view, this means even more harmful pulsing.

4G LTE

The current development, sometimes referred to as low-band 5G, uses essentially the same frequency spectrum as 4G, (from 700 MHz to 2.7GHz – or sometimes 3.5 GHz) but raises download and upload speed by the use of MIMO (Multiple Input Multiple Output) and beamforming technology. In this paradigm, Massive MIMO groups multiple antennas into a single box on a single cell tower, to create multiple simultaneous beams, each sent to a different user.

Beamforming technology sends a focused signal to every user in the cell, and the system uses this to monitor each user to make sure they have a consistent signal. Since these concentrated beams of radiation are focused directly on each device communicating with the system, hot-spots of radiation where individual beams intersect are inevitable. So even individuals who choose not to own a 5G phone are exposed to completely unpredictable intensities of radiation, especially in situations where they are surrounded by others with 5G phones – on public transport for example, or at large gatherings like rock concerts, with literally thousands of people all sending videos and texts to their social media groups. It is ridiculous to claim that even the very high power densities of RF that are permitted by ICNIRP-inspired Guidelines (see Chapter 2) would not be exceeded intermittently in such situations.

5G

All of the above innovations notwithstanding, the wireless industry's relentless search for profit demands ever more bandwidth. After squeezing as many users as physically possible into the available carrier frequencies, the focus has shifted to increasing the number of available carrier frequencies.

With the market for mobile voice telephony, text messaging and internet access more or less saturated – an estimated 90% of the population now owns at least one cell phone – a money-making proposal known as the Internet of Things is presently being energetically pushed. In this scenario, everything about one's home will be automated, with appliances chattering endlessly to each other and menial tasks like ordering milk when it runs out done independently by ... the refrigerator. The genius of the advertising world is to coopt use of the word 'smart' to describe this dystopian scenario. As recently as a decade ago, 'smart' meant clever and desirable. Now a 'smart' home is one completely inundated with radio-controlled and controlling appliances, all acting independently.

But of course on a practical level, the introduction of so many more users – maybe half a dozen appliances per human, with the appliances all working away in the background ALL the time – would require exponentially more radio bandwidth. How is this to be achieved?

National governments have always controlled the use by operators in their countries of most of the radio spectrum. Licenses for exclusive use of various portions of the spectrum for various periods of time are sold by auction to commercial companies, with huge amounts of money being raised for the government involved. A great deal of the spectrum is presently unused – particularly in the 'mm wave' region between about 30 GHz and 300 GHz. Hence the push is on to release this gold-mine.

But again, so many new (non-human) users will require many more base stations. Hundreds of thousands of new base stations, in fact. The humans are already complaining about how many giant cell towers are appearing in their neighborhoods. The answer is obvious – move to smaller geographic cells, with one base station every second or third lamp post in suburbia. Fortunately from the Telcos' point of view, physics dictates that the optimum antenna length for sending or receiving radio waves is around a half to a quarter of the wavelength being sent or received. Wavelength is inversely proportional to frequency – the higher the frequency, the smaller the wavelength – so the higher the frequency, the smaller the antennae needed. 'Millimeter waves' need antennae so small they can be hidden anywhere.

Admittedly, the inability of continuous mm waves to penetrate objects (walls, for example) does pose a bit of a problem. But whenever PULSED mm waves pass through "dispersive" material (i.e. material with a lot of water in it) they generate very handy, very sharp transient electromagnetic spikes at the beginning and end of each pulse (see Chapter 14). And these Brillouin precursors allow pulsed-mm-wave radar, for example, to penetrate anything that contains any significant amount of water – most kinds of walls, leaves, human bodies, even earth. But not metal; which is what makes ground-penetrating radar so useful for locating buried metal.

But getting back to telecommunications, in the short to medium time frame, the term 5G does not necessarily refer to the use of mm waves. Much of what is currently called 5G is actually 4G LTE – in other words, sub-6 GHz radiation focussed into beams directed at individual devices. This makes it very difficult to ascertain exactly where in a geographic sense mm waves are and are not being used (let alone when they started to be used); which is an important question in the context of sorting out the real causes of the health problems currently being attributed to a novel coronavirus.

Wi-Fi

The term Wi-Fi is actually a brand name dreamt up by an advertising agency, which was hired to come up with a more user-friendly term for the IEEE 802.11 standard. The IEEE 802.11 standard is a set of technology standards issued and maintained by the Insitute of Electrical and Electronic Engineers (IEEE), and used to implement Wireless Local Area Network (WLAN) communication.

Wi-Fi is primarily used to provide internet access to any and all devices that have the correct password to connect them to the Wi-Fi WLAN in question. Its great perceived advantage is that it provides internet connection without the need for wires. The fact that wireless connection is quite a lot less efficient than wired connection is generally ignored.

Both the original IEEE 802.11 standard and the 'b' version of that standard which was introduced in 1999 used essentially the same 2.4 GHz frequency that is used by household microwave ovens. This often resulted in interference (most microwave ovens leak dreadfully) and provided relatively slow data transfer rates. The 'a' amendment to the standard introduced orthogonal frequency division multiplexing (OFDM) and operated in the less crowded 5 GHz frequency band, making it both faster and less prone to interference – but the 'a' version was more expensive than the 'b' version of the standard that was introduced at the same time, so was used mainly by business customers. In 2003 a 'g' version was introduced, which had the same speed advantage as the 'a' version and better coverage (worked over a wider area) but also operated in the crowded 2.4 GHz band, so was still prone to interference. In 2009 the 'n' version (now renamed Wi-Fi 4) was introduced. This was much faster and used MIMO (Multiple Input Multiple Output) where multiple transmitters/receivers operate simultaneously at one or both ends of the link, operating in both the 2.4 GHz and 5 GHz bands. In 2014 the 'ac' version (Wi-Fi 5) brought speeds almost up to the speeds provided by a wired connection, by operating exclusively in the 5 GHz frequency band and using beamforming techniques and multiple-user MIMO.

Differences from traditional radio transmissions

Biological organisms evolved in an environment where there was virtually no radiofrequency radiation (Bandera and Carpenter 2018). Daily changes in the level of electromagnetic radiation were slow. Visible light appeared gradually at dawn and disappeared gradually at dusk. Ultraviolet light increased and then decreased gradually during the day. Seasonal variations in electromagnetic radiation, or in the earth's geomagnetic field, were even slower. Biology had time to adjust.

When commercial radio broadcasting began in the early 20th century, radio stations started transmitting amplitude or frequency modulated (AM or FM) carrier waves that stayed relatively constant while the station was on-air. After the second world war, television stations followed suit.

From a biological point of view, the pertinent difference between these technologies and those described above is that the earlier technologies were not too different from the natural situation in the sense that the radiation they emitted was relatively constant. Cell phone and Wi-Fi technologies, on the other hand, transmit repeated sharp pulses of radiation. It is increasingly clear that it is the pulsed nature of the radiofrequency radiation to which we are all increasingly exposed that particularly affects biological organisms (Panagopoulos et al 2019). This fact is not taken into account AT ALL by the public exposure limits pushed by the WHO and its creature ICNIRP, which average power densities over 6 minutes on the discredited assumption that tissue heating is the only possible effect of microwaves on biology.

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Chapter 2

PUBLIC EXPOSURE LIMITS

In most English-speaking countries and much of Western Europe, the official regulations prescribing the level of radiofrequency radiation (RF) to which the public can safely be exposed are based on the unsubstantiated but firm assertion that the only possible biological effect of RF is tissue heating. This 'thermal-only' dogma is such an important assumption that it is instructive to look at where it came from.

History of the thermal-only dogma

"Truth, it has been said, is the first casualty of war" (Snowden 1916). The thermal-only dogma originated in the 1950s, during the period known as the Cold War between the United States of America (USA) and the Union of Soviet Socialist Republics (USSR).

At this time, the US Department of Defense (DoD) was charged with developing RADAR (RAdio-based Detection And Ranging) systems capable of detecting incoming Soviet missiles. This meant that the US military had a major vested interest in producing radar installations that were as powerful as possible. Objections raised by local US communities upset at the unheralded appearance of such facilities in their neighborhoods were dismissed as a minor cost in comparison with the perceived benefit of preventing nuclear annihilation.

A further complication during this historical period was that microwaves were widely used in diathermy, a then-popular medical treatment for a number of conditions thought to be improved by tissue heating. Hence, it was convenient for both military and to a certain extent medical circles in the US to ignore early scientific indications to the contrary and choose to believe uncritically what was actually just the hypothesis that the only way in which microwave radiation could affect biological organisms was by heating them.

Interestingly though, when it came to the setting of standards regulating the level of microwave radiation to which people could safely be exposed, the medical profession was deemed to have too much vested interest in diathermy to participate, while the obvious conflict of interest involved in making the military responsible for setting acceptable microwave power limits was ignored (Maisch 2010). By 1960, all three branches of the US military had concluded, on the basis of one man's calculations and some minimal experimentation involving disruption of food-motivated behavior in irradiated laboratory animals (i.e. the point at which rats got too hot to eat) that 10 W/m^2 was a safe power density limit to prevent excessive tissue heating. After some debate, this figure duly became the basis of the first IEEE/ANSI C95.1 microwave standard in 1966.

And thereafter, the DoD treated all reports of biological effects at RF power densities less than 10 W/m^2 as a threat to national security, and shut down any lab that produced them (Becker and Seldon 1985; Marino and Ray 1986; Frey 2012).

In contrast the Soviets, whose imagined missiles the DoD was charged with detecting and destroying, concentrated on following up early reports of sub-thermal microwave effects and set their exposure limit at 0.1 W/m^2. This hundred-fold stricter limit posed a serious problem for US military planners—if any of America's western European allies were tempted to adopt it, deployment of American radar installations in Europe would be jeopardized.

Therefore, concurrent with the space/arms race, an RF standards race was played out in various international organizations like the WHO (World Health Organization) and NATO (the North Atlantic Treaty Organization). Internationalization of what was by now the unchallengable dogma that tissue heating was the only possible biological effect of RF was achieved by the simple expedient of embedding individuals committed to the thermal-only narrative in WHO and NATO (Maisch 2010).

In 1971 Sol Michaelson, the American who had been most instrumental in the adoption of the thermal-only standard by ANSI C95.1, was appointed to a committee called the Task Group on Environmental Health Criteria for Radiofrequency and Microwaves, jointly convened by the WHO and the International Radiation Protection Agency (IRPA). The founding chairman of IRPA was Michael Repacholi, an Australian also committed to the thermal-only dogma. In 1992, IRPA morphed into ICNIRP (the International Commission on Non Ionizing Radiation Protection), with Repacholi still in the chair. And in 1998 – despite the fact that Repacholi himself had by that time become first author on a paper clearly showing that *sub-thermal* power densities of cellphone radiation caused lymphoma in mice (Repacholi et al 1997) – ICNIRP brought out the Guidelines document *(*International Commission on Non-Ionizing Radiation Protection 1998) which still enshrines the thermal-only dogma as the basis of national standards throughout the English-speaking world – thereby giving the telecommunications industry free rein to addict a large proportion of the human race to their product (in somewhat startling repetition of the tactics of the tobacco industry) and spread the necessary technology all over the planet.

Some Existing Standards

Three of the existing guidelines specifying limits for safe public exposure to RF at frequencies relevant to 3G and above phones, Wi-Fi and Bluetooth are:

ICNIRP Guidelines (ICNIRP 1998): ≤10 W/m^2 i.e. ≤ 10,000,000 $\mu W/m^2$

Building Biology Standard (Maes 2008)

- No concern: ≤ 1 $\mu W/m^2$
- Slight concern: 1–10 $\mu W/m^2$
- Severe concern: 10–1,000 $\mu W/m^2$
- Extreme concern: ≥ 1,000 $\mu W/m^2$

These values refer to peak measurements (not measurements averaged over 6 minutes, as in the ICNIRP Guidelines) and are applicable to single RF sources such as GSM, UMTS, WiMAX, TETRA, Radio, Television, DECT cordless phone technology and WLAN except radar signals. This standard treats pulsed or periodic signals (mobile phone technology, DECT, WLAN and digital broadcasting) as more critical sources than non-pulsed signals, and recommends that pulsed sources should be assessed more seriously, especially in the higher concern ranges. Non pulsed and non periodic signals like FM, short, medium, long wave and analog broadcasting can be addressed more generously, especially in the lower concern ranges.

The exposure limits prescribed by the medical associations of many countries are based on the Building Biology Standard. For example, the guidelines prescribed by the Austrian Medical Association (Austrian Medical Association 2012) refer to the Building Biology limits, renaming them as `Within normal limits', `Slightly above normal', `Far above normal' and `Very far above normal'.

Bioinitiative Standard (Bioinitiative 2012)

Based on studies of health effects caused by mobile phone and base station radiation, this standard proposes a

- lowest observed effect level of 30 μW/m^2 .

Taking into account the higher electrosensitivity of children and a safeguard for chronic and long term exposures, this is reduced by 10 times to set a

- precautionary level for chronic exposure to pulsed RF of 3 - 6 μW/m^2

These figures are not regarded as definite and may decrease or increase based on information from newer studies.

(NB: The limits above are expressed in the Bioinitiative Report as power per square centimetre, not per square metre, as above. There are 100 cm x 100 cm = 10,000 square centimeters in one square meter).

Some existing measurements

(1) Power densities measured in the city centers of Canberra, Sydney, Los Angles, and Addis Ababa (Fig. 3 of Sagar et al 2018) generally ranged between 2,000 and 10,000 μW/m^2. These figures are well below the ICNIRP Guidelines, but far into the "extreme concern" range of the Building Biology Standard.

(2) At 10.05 am on April 5 2019, the present author measured the peak power density of RF on the street at the Three Lamps bus stop in Ponsonby Auckland at 129,000 μW/m^2 . This is four orders of magnitude higher than the Bioinitiative "lowest observed effect level" of 30 μW/m^2 and more than a hundred times the Building Biology Standard's level for "Extreme Concern".

(3) The following figure based on a figure from Naren et al (2020) show that personal exposures to commonly used devices such as cellphones, Wi-Fi modems and Blue-tooth headphones again fall far above the limit specified by the Building Biology Standard as cause for "extreme concern" (≥1,000 μW/m^2).

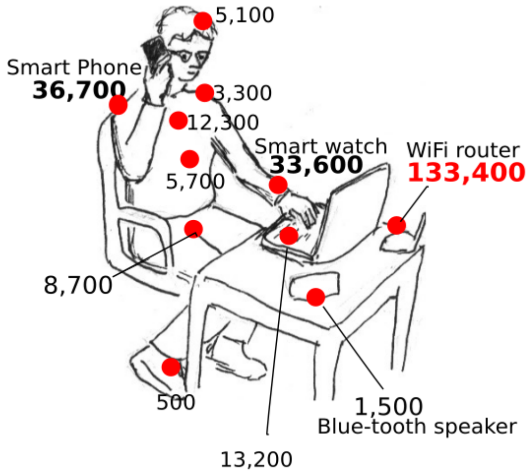

Figure 2: After Fig 11 from Naren et al (2020). EMF readings in a typical exposure scenario. Numbers are measurements in microwatts per square metre (μW/m²) at the sites shown as red dots. NB: Building Biology Standard regards anything over 1,000 μW/m² as cause for "extreme concern".

Conclusion

The 'safe' levels permitted by ICNIRP, which in turn are the basis of the official Standards used by most national governments in the English-speaking world (e.g. New Zealand's NZS2772.1:1999) are many orders of magnitude higher than the safe levels permitted by standards based on documented biological effects. According to standards based on documented biological effects, measured current exposure levels in Western society are cause for extreme concern.

For reasons that can only be speculated about, most of the epidemiologists officially recognised as 'experts' in those countries that stick like glue to the ICNIRP Guidelines continue to insist on ignoring the now huge volume of evidence for harmful biological effects of microwave radiation at levels a tiny fraction of those permitted by ICNIRP. It shames the institution of science that these people are allowed to get away with it.

In an attempt to mitigate such wilful ignorance, PART II of the present book documents some of the many health effects of sub-thermal microwave pollution that have been published in the peer-reviewed scientific literature, and PART III addresses the mechanisms by which these effects occur. I can only hope that *eventually* the officially mandated protectors of population health in the Western world will take notice of the totality of evidence, and stop relying on biassed literature reviews published by members of ICNIRP.

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Chapter 3

THE REGULATORS

This chapter is largely a story of conflict of interest (COI). While the existence of a COI can indicate a situation in which the individual involved does not consciously realise that their conflict of interest is affecting their judgement, it is more often than not simply a polite term for corruption.

The main institutional players in the 'western' world who are responsible for setting regulatory guidelines on how much radiofrequency radiation the public may safely be exposed to are :

(1) In Western Europe, the UK, Canada, Australia and New Zealand: the International Commission for NonIonising Radiation Protection (ICNIRP), in collaboration with the World Health Organisation (WHO) and the Institute of Electronic and Electrical Engineers (IEEE). Lately the EU's Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) has also entered the picture (Hardell and Nyberg 2020).

(2) In the USA: the Federal Communications Commission (FCC).

1. ICNIRP, the WHO International EMF Project and the IEEE

1.1 ICNIRP and the IEMFP

ICNIRP is a small, self-selected, private club based in Germany. Its genesis and some of its relationships with the World Health Organisation (WHO) are described in Chapter 2.

ICNIRP was founded and run for many years by Michael Repacholi. In 1996 Repacholi also established the WHO International EMF Project (IEMFP), remaining in charge of that until 2006, when he reportedly resigned after allegations of corruption (Adlkofer 2018) to officially become an industry consultant (Slesin 2006). In 2004, Repacholi stated in a conference presentation that the WHO IEMF Project was able to "receive funding from any source through the Royal Adelaide Hospital, an agency established through the WHO Legal Department's agreement to collect funds for the project" – which arrangement reportedly allowed receipt of annual payments of $150,000 from the cellphone industry (Slesin 2005; Maisch 2010). This sort of open money laundering has led to persistent allegations that both ICNIRP and the relevant section of the WHO – the personnel of which are virtually identical (Hardell 2017) – are riddled with undeclared conflicts of interest (Maisch 2006; Pascual 2013; Mercer 2016; Hardell and Carlberg 2020).

Since Repacholi's resignation, ICNIRP (still overseen by Repacholi, in the role of 'observer') has been continued by a carefully selected group of individuals, all committed to maintaining the dogma that microwaves too weak to heat tissue are biologically harmless. Since the only way to get onto ICNIRP is to be invited by existing members, this thermal-only dogma can be, and is, rigidly maintained.

Perhaps because maintenance of the thermal-only dogma is so obviously essential to the activities of the military-industrial complex, ICNIRP is very concerned to claim scientific purity and independence from the telecommunications industry. Most of its disclosed funding comes from the German and other governments[2] (whose memberships in military organisations like NATO and Five Eyes are quietly ignored). In support of their protestations of scientific independence, all ICNIRP members are required to post Declarations of Interest on the organisation's website, and it is written into the ICNIRP statutes that: 'No member of the Commission shall hold a position of employment that, in the opinion of the Commission, will compromise its scientific independence'.

But of course, the key words in this sentence are "in the opinion of the Commission". There is no independent oversight of ICNIRP. On its self-regulation with regard to conflict of interest, ICNIRP itself says:

> "The evaluation of personal integrity is very complex and might never be achievable in a perfect way. It is the duty of the ICNIRP Commission to carefully consider and decide if the declared interests potentially constitute a conflict of interest." [emphasis added].

So ICNIRP has no sharp definition of Conflict of Interest and no well-developed policy for avoiding such conflicts. This contrasts with the perfectly clear definition of conflict of interest used by the International Committee of Medical Journal Editors[3]:

> "A conflict of interest exists when professional judgment concerning a primary interest (such as patients' welfare or the validity of research) may be influenced by a secondary interest (such as financial gain).… Financial relationships (such as employment, consultancies, stock ownership or options, honoraria, patents and paid expert testimony) are the most easily identifiable conflicts of interest and the most likely to undermine the credibility of the journal, the authors and science itself…. Purposeful failure to disclose conflicts of interest is a form of misconduct."

In light of this definition, it is perhaps not surprising that a good many of the sections in a good many of the DOI forms on the ICNIRP website remain unfilled. Indeed, a group of concerned citizens called the Vallisoletana Association of people affected by mobile phone antennas (AVAATE) says "It is hard to understand whether ICNIRP investigates the Declarations filed by appointed members of the ICNIRP Commission and Scientific Expert Committee, since in some cases these members report that they work or have worked for these organisations but do not specify what they have done or whether they were paid. It is also hard to understand how ICNIRP controls the content of the declarations by their Expert Committees when in most cases the most contentious aspects of

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2 https://microwavenews.com/short-takes-archive/bfs-support-icnirp

3 http://www.icmje.org/about-icmje/ faqs/icmje-recommendations/

the biographical statement are not reported in these statements ... and in at least five cases the persons concerned have not signed their statements."

So basically, the DOIs on the ICNIRP website are not worth the paper they're not written on. And perhaps consequently, the ICNIRP website [4] carries the disclaimer: "We do not assume any responsibility for any damage, including direct or indirect loss suffered by users or third parties in connection with the use of our website and/or the information it contains, including for the use or the interpretation of any technical data, recommendations, or specifications available on our website."

To summarise then, despite its protestations of scientific independence, ICNIRP (a) signally fails to take conflict of interest seriously and (b) does not stand behind any of the information it provides. Given that no insurance company will indemnify the telecommunications industry against damages resulting from use of their products, (b) is hardly surprising. What IS surprising – at least to an innocent who retains some trust that their national government has the welfare of its citizens at heart – is that organisations like the New Zealand Ministry of Health not only say in their public 'fact sheets' that they "rely on" ICNIRP, but actually support them with New Zealand taxpayers' money.

How can this be? Well actually, it's remarkably simple. The explanation is that Play 5 in the ICNIRP Playbook (see Chapter 4) has been well and truly implemented. The New Zealand Ministry of Health, for example, like the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) and probably most of the other regulatory agencies in Europe, the UK and Canada, is staffed almost exclusively by affiliates of ICNIRP.

Since the only way to become an ICNIRP member is to be appointed by existing ICNIRP members, nobody who disagrees with the thermal-only dogma has ever become a member of, or scientific advisor to, ICNIRP in the first place. It is clear that any member who dared change their mind about the validity of the thermal-only dogma as a result of studying the evidence would quickly become *persona non grata* in ICNIRP, just as certainly as any Catholic priest who started publicly denying the existence of God would be excommunicated from his Church. This means that affiliation with ICNIRP <u>in and of itself</u> constitutes a conflict of interest in any member of a supposedly independent scientific advisory group, quite irrespective of whether or not the individual has any demonstrable financial relationship with any of the many arms of the military-industrial complex.

All of which rather makes the question posed by Slesin (2020) – "will the WHO kick its ICNIRP habit?" – quite important. Are <u>both</u> ICNIRP and the WHO still under the thrall of the military-industrial complex? Or might the World Health Organisation be in the process of emerging into the light of scientific truth? The extremely tight deadline imposed by the WHO for expressions of interest in writing a section of its pending report on this issue is not encouraging.

1.2 IEEE (Institute of Electronic and Electrical Engineers)

[4] (https://www.icnirp.org/en/legal-notice.html)

Meanwhile, the IEEE are not quite such fundamentalists about the thermal-only dogma, despite the fact that they initiated it 50-odd years ago. As pointed out in Chapter 2, it is at least possible to publish in an IEEE journal a paper that acknowledges the significant health harms resulting from chronic exposure to sub-thermal RF (Naren et al 2020) and still retain membership of the IEEE. [UPDATE: Or it used to be – the IEEE has now RETRACTED the paper by Naren et al (2020)].

And the FCC? Well, this US government-appointed agency, which supposedly controls the telecommunications industry in the United States of America, is not even slightly concerned to project the image of scientific independence.

2. FCC (Federal Communications Commission)

The FCC's website makes it crystal clear that the major concern of the FCC is to smooth the regulatory path for the military-industrial complex.

Its website says the FCC has four 'strategic goals':

Strategic Goal #1 Closing the Digital Divide
Develop a regulatory environment to encourage the private sector to build, maintain, and upgrade next-generation networks so that the benefits of advanced communications services are available to all Americans. Where the business case for infrastructure investment doesn't exist, employ effective and efficient means to facilitate deployment and access to affordable broadband in all areas of the country.

Strategic Goal #2 : Promoting Innovation
Foster a competitive, dynamic, and innovative market for communications services through policies that promote the introduction of new technologies and services. Ensure that the FCC's actions and regulations reflect the realities of the current marketplace, promote entrepreneurship, expand economic opportunity, and remove barriers to entry and investment.

Strategic Goal #3 : Protecting Consumers & Public Safety
Develop policies that promote the public interest by providing consumers with freedom from unwanted and intrusive communications, improving the quality of communications services available to those with disabilities, and protecting public safety.

Strategic Goal #4 : Reforming the FCC's Processes
Modernize and streamline the FCC's operations and programs to increase transparency, improve decision-making, build consensus, reduce regulatory burdens, and simplify the public's interactions with the agency.

The only one of these Strategic Goals that even mentions public safety equates it with protection from cold-call scams. Public health is just ... not of interest to the FCC. Their emphasis is solely on reducing regulatory burdens for the telecommunications industry and encouraging the introduction of new technologies – with (as always) zero pre-release safety testing.

This approach is documented by Alster (2015) as resulting from the complete capture of the FCC by the industry it is supposed to be regulating. In this regard the degree of open corruption that has been accepted – even welcomed – by both major political parties in the United States of America is frankly astonishing.

The American people should be deeply ashamed.

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Chapter 4

THE ICNIRP PLAYBOOK

In order to maintain the fiction that tissue heating is the only biological effect of microwaves, ICNIRP and its disciples use a comprehensive playbook of tactics.

In many ways the strategies in this playbook mimic those used by the tobacco and various agrichemical industries (Michaels 2008, 2020). As Wikipedia says of Michaels (2008):

> "Doubt is our product," Michaels quotes a cigarette executive as saying, "since it is the best means of competing with the 'body of fact' that exists in the minds of the general public. It is also the means of establishing a controversy." Michaels argues that, for decades, cigarette manufacturers knew that their product was hazardous to people's health, but hired mercenary scientists who "manufactured uncertainty by questioning every study, dissecting every method, and disputing every conclusion". In doing so the tobacco industry waged a campaign that "successfully delayed regulation and victim compensation for decades".

The difference between this and the present situation is that the products of Big Wireless are in many ways even more addictive than those of Big Tobacco. "Smart" technology is certainly more ubiquitous than cigarettes ever were. On a domestic level, virtually all parents now actively buy cellphones, WiFi internet connections, Bluetooth headphones and wireless baby monitors <u>for their children</u>. They are happy to send their precious offspring to schools where they are bombarded with WiFi radiation and bring them back to homes where WiFi boosters hit them even harder. People would never do these things to their kids if they realised how harmful they are. Israel, France and Cyprus have already taken action to restrict the use of cell phones and WiFi in elementary schools. The fact that other countries refuse to do so is a damning indictment of the total lack of basic ethics shown by the huge propaganda machine deployed by Big Wireless.

On a medium scale, well-funded industry lobbyists have engineered the adoption of widespread legislation that allows Telcos to erect cell towers virtually wherever they like, and electricity companies to install "smart" electricity meters with no possibiliy for consumers to opt out. Even vehicle manufacturers have very quietly introduced "collision mitigation" radar.

On larger scale still (and in many ways worse, since this seriously constrains national governments concerned to maintain membership of multinational military organisations like Five Eyes) the US Congressional Research Service (2020a) openly details the many ways in which military interests rely on "the spectrum", freely using terms like "electronic warfare". The military particularly likes 5G's promise of autonomous or driverless vehicles (US Congressional Research Service 2020b) adding " 5G for the military could additionally improve intelligence, surveillance, and reconnaissance (ISR) systems and processing; enable new methods of command and control (C2); and streamline logistics systems for increased efficiency, among other uses." And of course all of these military uses would be greatly facilitated if the military didn't have to install their own 5G access points, but could simply use those already installed by national telcos. It would appear that Eisenhower's warning (Eisenhower 1961):

> " In the councils of government, we must guard against the acquisition of unwarranted influence, whether sought or unsought, by the military-industrial complex. ... We must never let the weight of this combination endanger our liberties or democratic processes. We should take nothing for granted – only an alert and knowledgeable citizenry can compel the proper meshing of huge industrial and military machinery of defense with our peaceful methods and goals, so that security and liberty may prosper together."

has never been more relevant.

Because of this enormous and increasing adoption of microwave/wireless technologies, the tactics used to deny the everyday health harms caused by microwave pollution are employed even more strenuously than were those pioneered by Big Tobacco – and with both more and (when deemed desirable) less sophistication. Only if we the people can accurately identify these tactics and thus hold to account those who use them in official statements can we protect our lives and democratic liberties from the weight of the military-industrial complex.

Here is a summary of the strategies.

The Playbook

A useful mnemonic for the strategies that comprise the ICNIRP Playbook is S.L.I.M.E.D. Here's how to do it.

Play 1: S is for SNEER

This is one of the less sophisticated techniques employed by the military-industrial complex. It is implemented equally by those 'science journalists' and 'experts' employed to push industry interests in the mainstream media, and by hired shills in the wild-west free-for-all of social media. In these fora, the tactic of sneering at opponents in a way specifically calculated to allow uncommitted readers to *feel superior* is an easy first line of defense.

Many people have an unlovely tendency to seize and enjoy any opportunity to feel superior to other people. Users of the playbook are therefore trained to provide such opportunities, by deploying meaningless slogans the sole purpose of which is to sneer at anyone who does not share the thermal-only dogma. Popular phrases are "conspiracy theory", "flat-earther", "tin-hatter" and (if the opponent has enough obvious qualifications to make them dangerous) "scaremonger". More scientific-sounding phrases are "confirmation bias", "nocebo effect", "riskfactorphobia" and (in a truly delightful example of the pot calling the kettle black) "pseudoscientic misrepresentation"!

The general idea here is to stay away from <u>facts</u> at all costs and simply sneer the opposition into submission.

Play 2: L is for LIE

The basic aim of the outright lie is to generate doubt and confusion. There are many ways to achieve this, and thus many varieties of lie.

1. One shockingly direct way to create an air of uncertainty about the science is simply to pay corrupt practitioners to cheat, and then lie about their experimental findings. Basically, whenever an independent scientist publishes incontrovertible evidence of harm caused by exposure to 'non-thermal' microwaves (radiation too weak to heat tissue), the military-industrial complex hires a different practitioner to claim that they have repeated the experiment and found no evidence of harm. A particularly bad example of this is described by Frey (2012) in the following words:

   > "after my colleagues and I published in 1975 [Frey et al 1975] that exposure to very weak microwave radiation opens the regulatory interface known as the blood brain barrier (bbb), a critical protection for the brain, the Brooks AFB group selected a contractor to supposedly replicate our experiment. For 2 years, this contractor presented data at scientific conferences stating that microwave radiation had no effect on the bbb. After much pressure from the scientific community, he finally revealed that he had not, in fact, replicated our work. We had injected dye into the femoral vein of lab rats after exposure to microwaves and observed the dye in the brain within 5 minutes. The Brooks contractor had stuck a needle into the animals' bellies and sprayed the dye onto their intestines. Thus it is no surprise that when he looked at the brain 5 minutes later, he did not see any dye; the dye had yet to make it into the circulatory system."

2. Usually the scam is not as clearcut as that described above. But the fact – acknowledged even by ICNIRP (Huss et al 2007) – that scientific papers funded by the wireless industry are statistically twice as likely as papers not funded by the wireless industry to report no harmful effects of radiofrequency radiation suggests that the above may not be an isolated case. Bizarrely, this disparity is now starting to be spun as evidence that industry-funded research is *better* than independent research (Vijayalaxmi et al 2019). Specifically, the claim is that features of 'good' research include not only the generally accepted practices of blind evaluation and statistically valid comparison of experimental groups with negative and/or sham control groups, but also (i) inclusion of "positive controls" (which nobody except industry-coached practitioners sees any reason to use) and (ii) a demand for "adequate dosimetry". This latter demand is a very handy excuse for dismissing the results of all experiments that use actual cellphone radiation (which is hard to measure, because it varies on a second-by-second basis) and accepting only the results of experiments using lab-generated, continuous radiation (which is more easily measured, but has also been shown to be much less biologically damaging than the pulsed radiation used by actual telecommunications devices– see Panagopoulos et al 2019 and also Chapters 1 and 5 of the present book).

3. There are, of course, a number of more convincing explanations for the fact that industry-funded reseach is twice as likely as independent

research to find that microwaves are harmless. These include:

(a) Sometimes industry-funded scientists deliberately design their studies to produce the answers they know their funders want (Frey and Parascandola 2002). Does this count as lying? Legally, probably not. But morally, it is at the very least an utter rejection of the "normative structure of science", which has been described in rather flowery terms as an unwritten agreement that "the unfettered and disinterested pursuit of truth and the universal accord among scientists that nature, not culture or religion or economics or politics, are the final arbiters of conflicting views about the nature of the universe" (Krimsky 2003 Ch 5). In other words, during the long apprenticeship the system demands of professional scientists, they are supposed to absorb the honor-code that they are engaged in a genuine search for truth. Deliberately designing your experiments to produce the result you want is the opposite of this code.

(b) Sometimes either industry sponsors directly or industry-friendlly journal editors indirectly can suppress research that shows inconvenient harm caused by industry products. This play is assisted by the fact that it has always been true in the faction-ridden world of science for manuscripts reporting results unwanted by certain scientific groups to be rejected by journal editors who are members of those groups, on the basis of "peer-review" reports written by individuals who are anonymous to the author, but have clear conflicts of interest known to the editor. Scientists are only human. Some journals try to deal with this by allowing their authors to specify a certain number of people to whom their manuscript should not be sent for review. But the author never has any knowledge of, let alone control over, whether or not these preferences are honoured; and even if they are, there are always unknown graduate students keen to write reports upholding their boss's preferences. The sad truth is that there has always been far too much unhealthy anonymity embedded in the bones of science for the normative ideal described in (a) above to be protected. 'Peer' reviewers are not even required to lie about their conflicts of interest. Unlike the authors whose work they are reviewing, they never have to declare whether or not they have any. (The take-home message for non-industry players is choose your journal carefully – both when you're submitting a paper for publication and when you're deciding what published papers to believe).

(c) If this informal suppression mechanism should fail and a paper inimical to miltary-industrial interests be "mistakenly" published, it has lately become fashionable for pressure (yet again anonymous for the most part, at least to the author of the targeted paper) to be exerted on the journal to unilaterally retract the paper. No actual reason need be given, and the whole process is made much easier by the rise of online-only journals. These never produce hard copies, so they can just plaster the word RETRACTED over each and every page of the offending paper and leave it on the web, in macabre imitation of the fictional tradition of leaving the corpses of hanged pirates dangling at the entrance to the harbour, as a message to future offenders.

(d) The authors of such papers can then be professionally discredited by industry hit-squads (Bandara et al 2020), using tactics described above.

(e) And finally, if <u>none</u> of that works, unfortunate physical events can always mysteriously happen to particularly incorrigible scientists (Kovac 2007). We're not playing tiddly-winks here. There are trillions of dollars at stake. Public health is of zero interest to the military-industrial complex. To them this is a public relations exercise, not a milk-sop-liberal pursuit of some abstract notion like truth.

Play 3: I is for Ignore

Making things go away by ignoring them is a very ancient strategem, here raised to a fine art. There are a number of ways of doing it.

1. Ignoring questions one can't answer – either by sending a form letter that doesn't even try to answer the question or by simply not replying at all – has always been a go-to tactic in politics.

2. Cherry-picking the scientific papers one chooses to cite is also a *sine qua non*. While you're at it, be sure to accuse of cherry-picking anyone who points out a few of the thousands of papers you have chosen to ignore (another example of 'the pot calling the kettle black'). Having installed enough "no-harm" results in the scientific literature using means described above, just IGNORE all the undesirable results (the ones saying weak microwaves DO cause all manner of biological harms – the ones described in Part II of the present book) and keep repeating the blatant lie "<u>there is no evidence</u> that cell phones / cell towers / WiFi cause harm".

(Could it be possible that some of the people who keep repeating this lie eventually come to believe it, on the magical-thinking grounds that if you tell a lie often enough, it becomes true? Nah, more likely they're just your run-of-the-mill, venal psychopaths. There's a lot of that about).

3. In the event that somebody quotes irrefutable scientific evidence at you and you can't ignore the evidence – ignore Philosophy of Science 101 instead.

Philosophy of Science 101 says that logically, the hypothesis "all swans are white" is falsified by one sighting of a black swan. This means that logically, the hypothesis "all sub-thermal microwaves are harmless" is falsified by even one good paper reporting a biological harm caused by sub-thermal microwaves. Saying "but that's just one paper" and "there are lots of papers saying microwaves don't cause harm" or "the <u>scientific consensus</u> is that microwaves are harmless" is irrelevant. Science may be a social enterprise, but logic is not. Logically, even one well-done experiment showing harm disproves the idea that sub-thermal microwaves are harmless.

And anyway, the sociology of science is ACTUALLY firmly on the side of an urgent need to action the precautionary principle. The consensus among scientists who have published – or even read critically – in this area is that sub-thermal microwaves are most emphatically NOT harmless. At most a couple of dozen such scientists agree with ICNIRP about the harmlessness of weak microwaves, against hundreds who do not. It's just that those who do agree with ICNIRP have seized control of not only all relevant government departments in the world, but also (thanks largely to the industry's bottomless advertising budget) all the mainstream media (see Part I Chapter 4). But not to worry, because as mentioned, this is a public relations exercise, not a scientific one. And we know all about public relations.

4. Finally, a good way of ignoring review papers you don't want to acknowledge is to dismiss them with the single word "Opinion". All the review papers you choose to cite should be written by ICNIRP members, specifically to uphold the opinion YOU want to promulgate – that microwaves too weak to heat tissue are biologically harmless.

Play 4: M is for Minimise

This section of the Playboook describes what to do when scientific reports are published that show thumping, major, irrefutable evidence of biological harm. Good examples here are the 10 year, $25 million study by the National Toxicology Program (NTP) of the US Department of Health (which clearly demonstrates that radiofrequency fields cause cancer in rats) and the similar study from the Ramazzini Institute in Italy (which fully confirms the NTP findings). According to the 19-member peer review panel that examined the NTP study (National Toxicology Program 2019), its results provide “clear evidence” — the highest standard of proof — that RF fields cause schwannomas (malignant tumors of the Schwann cells that sheath all myelinated nerves) in the hearts of male rats, as well as less clear evidence that RF causes gliomas in the brain, pheochromocytomas in the adrenal gland, and tumors of the prostate and pancreas. The Ramazzini study (Falcioni et al 2018) concurs.

ICNIRP's response to the publication of these studies in 2018 was commendably immediate. They simply released a non-peer-reviewed Note minimising the importance of both papers (ICNIRP 2018). When the contents of this Note were themselves refuted (Melnick 2019) and the whole issue could not be made to go away by ignoring it, the 2018 Report to Ministers of the New Zealand Government provided a textbook example of the ICNIRP Playbook in action. This document simply states, apparently with a straight face, “Animal studies do not suggest an effect of RF fields on cancer.”

How could they say that? While the wording of the statement (“effect *on* cancer”) is ambiguous in a legalistic sort of way, the intent is clear. The intent is to convey the incorrect and misleading idea that black is white – that animal studies do not even <u>suggest</u> (let alone show) that RF fields can cause cancer in animals. In support of this splendidly Alice-in-Wonderland statement, the New Zealand report devotes a long section to acknowledging the existence, but minimising the importance, of the NTP study. It completely fails to mention the Ramazzini study (despite the fact that an Official Information Act copy of the minutes of the committee's last meeting before the report came out shows that they were well aware of that study), cites approvingly the non-peer-reviewed ICNIRP note, and ignores the comprehensive rebuttal of that note (Melnick 2019) by the simple expedient of stating a cut-off date for publications cited by the report of 7 September 2018, coincidentally the precise date on which Melnick's paper was accepted by the journal *Environmental Research*. Brilliant!

Also mentioned but dismissed as unpersuasive by this 2018 Report to Ministers is an earlier mouse study showing that lifelong exposure to RF facilitates the development of lung, liver, kidney, and blood cancers caused by *in utero* injection of the chemical carcinogen ethyl nitrosourea (Lerchl et al 2015). To quote the RETRACTED paper by Pockett (2019):

> "The authors of that study [Lerchl et al 2015] specifically comment on the fact that this result is not dose-related with respect to RF; which actually accords well with the unexpected finding of a counterintuitive, inverted-U-shaped dose–response curve in relation to RF damage of the blood–brain barrier reported much earlier (Nittby et al 2009). However, none of the scientists involved comments on this correspondence with earlier work: instead, the absence of the 'expected' dose–response relationship is taken as a reason for dismissing the facilitation study, by a research group who also make statements like "exposed groups were compared only to the sham-exposed control group : in a carcinogenesis study, it is essential to compare results to the negative control group and to in-house historical data and/ or to published database(s) in the case of no or insufficient internal data." (Nesslany et al 2015). This is pure nonsense. When a scientific study finds significant differences between an exposed group and a sham-exposed group, it is disingenuous to claim that those differences are meaningless because there was no group of animals that was completely unexposed. Sham controls are universally acknowledged to be more rigorous than negative controls. However, since no laboratory scientist who could have pointed this out sits on the NZ InterAgency Committee, their report is able to use the untenable claims made by Nesslany et al (2015) to dismiss the legitimate findings reported by Lerchl et al (2015).
>
> The least that can be said about all this is that the existence of two major rodent studies, both of which report clear evidence that RF directly causes malignant cardiac tumors, renders wrong and misleading the statement "animal studies do not suggest an effect of RF fields on cancer". Indeed, given that a relative lack of animal evidence for carcinogenicity was the main stated reason for the IARC/ WHO classification of RF as only a Group 2B ("possible") carcinogen in 2011 [see Chapter 5 of the present book] the combination of the NTP and Ramazzini studies must be seen as lending strong support to recent calls (Miller et al 2018; Hardell and Carlberg 2019) for the upgrading of the IARC/ WHO classification to Grade 1: "carcinogenic to humans"."

And so on, and on, and on. Is it any wonder that ICNIRP financial reports cite the NZ Ministry of Health as a source of financial support? Such a cosy little club (see Chapter 3).

Play 5: E is for Expert

This is the most important play of all. It is absolutely vital for ICNIRP players to:

1. Populate all bureaucratic agencies within their sphere of influence with hand-picked, ICNIRP-affiliated "experts", and then

2. Bamboozle the politicians into believing that it's ALL TOO HARD for them to understand – but again, not to worry, because they don't need to actually engage with the science. All they need do is trust the experts.

(But which experts? Don't be conned, politician! Read this book).

Play 6: E is also for Ethics

Forget you ever had any. Continue to advocate "more research". Never mind that the subjects of this research are citizens who, so far from having given their informed consent to participate in the experiment, will keep demonstrating in the streets in a futile attempt to avoid it. This is Big Business, babe. Get with the program.

(This approach is strongly reminiscent of the activities of certain Nazis in World War Two concentration camps. Only this time, the perpetrators already know the results of their thirty year mass experiment. The results are described in Part II of this book).

Play 7: D is for Distract

Distraction is a technique much loved by stage magicians and the parents of small children. The aim is to divert attention away from whatever you do not want people to concentrate on, or even see.

For example, if you're asked a question you don't want to answer, just adopt the very old tactic of using a lot of words to answer a different question. Say something completely random and irrelevant if you have to. With a bit of luck, the person reading or hearing this distraction will assume that the reason they don't understand what on earth you're talking about is not that what you're saying is complete gobbledygook – it's that you are immensely clever and they are too dumb to keep up. Surprisingly many people are quite unwarrantedly insecure about their own intellectual ability, particularly in areas where they don't have much background. Exploit that. Use the Cult of the Expert to scam them. It's easy.

Alternatively – and this is effective in a very much broader sense – concentrate everyone's attention on a completely different issue. Climate change is a good one. Never mind that the climate has been changing in long slow sweeps for millennia, with desertification episodes (Dillehay et al 2004) and ice ages (Hodell 2016) rolling round regularly since before humans started burning sticks to roast their mammoth steaks. THIS cycle is not only a world-ending disaster, but also *man-made* (the latter being eminently believable, on the same principle that makes children believe they are responsible for their parents' divorce).

And then, of course, the ultimate distraction – declare a dangerous global pandemic, due to a member of the family of viruses that cause the common cold. Again, never mind that most of the people declared "cases" in this pandemic (on account of a positive result in a test employing a PCR reaction that was never designed for diagnostic use and delivers a significant number of false positives (Wernike et al 2020)) are actually not sick unto death, but suffer only a brief cold-like illness or no symptoms at all. Crank up the propaganda machine. Lock down whole economies. Throw thousands out of work. Delay the treatment of genuine illnesses. Deliberately generate anxiety and outright fear. And then – throw all the public research money that SHOULD be going into determining the biological effects of 5G mm wave radiation into producing a *vaccine* against this virus from a family of viruses well known to mutate with the speed of breeding rabbits.

Do all this and voilà: nobody will have any energy left to worry about the pending huge increase in inescapable RF irradiation, courtesy of mm wave 5G, the Internet of Things and a phalanx of military surveillance satellites. They'll be too busy worrying about whether or not they have to wear a surgical mask to save granny from an untimely death.

Yes indeed, students of the ICNIRP Playbook – COVID-19 is the best distraction EVER.

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And there you have it – badabing, badaboom – by judicious use of these seven easy plays, you have successfully SLIMED the public. Well done! We in ICNIRP really should change our name to ICTIP (International Commission for Telecommunications Industry Protection). But that would be letting the cat out of the bag, wouldn't it.

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PART II

THE EVIDENCE

Chapter 5

CANCER

What is cancer?

All animals and plants are composed of cells. A cell – using the word in this specialised context – is an entity that is very much bigger than an atom or molecule, but in most cases still too small to be seen with the naked eye. You can easily see cells with a microscope though, and although they come in a wide variety of shapes, they all have certain structural elements in common (Figure 3).

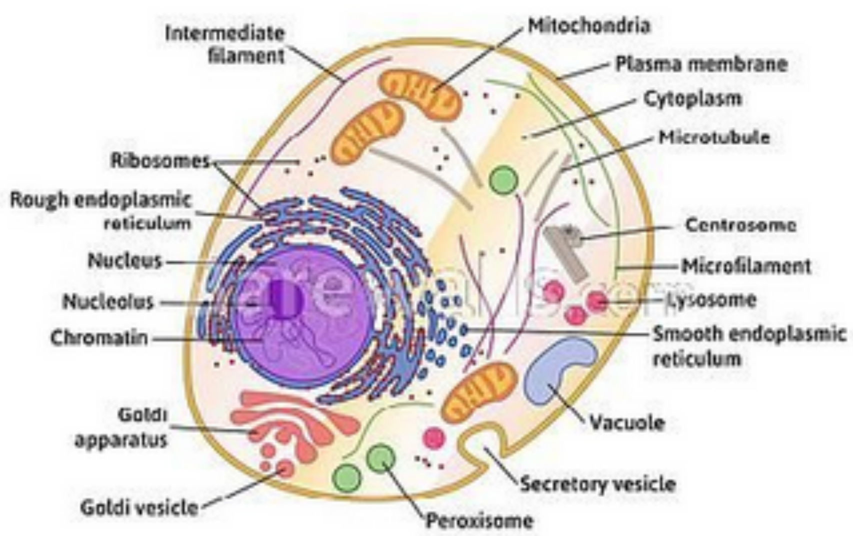

Figure 3: Structual elements of a generic animal cell

One of the main characteristics of cells is that they tend to get old or damaged and eventually die (this process is called apoptosis). Thus, in the interests of maintaining the organism as a whole, many if not most cells retain the ability to divide and reproduce themselves.

Cancer is basically a disorder of cell division, manifesting as the uncontrolled production of new cells.

Do microwaves cause cancer?

On 31st of May 2011, the International Agency for Research on Cancer (IARC), a section of the World Health Organisation (WHO), classified radiofrequency electromagnetic fields (microwaves) as a Group 2B –"possible" – carcinogen (cause of cancer) in humans.

Since that time, much has been made of the fact that pickles and 'being a carpenter' are also classed by IARC as Group 2B carcinogens. Why did IARC adopt such a weak classification with regard to microwaves?

In any attribution of carcinogenicity, two main data sets are considered: animal studies and epidemiological (human) studies. We will consider these two sources of information one at a time, with emphasis on the reasons for IARC's weak classification of RF.

1: Animal Studies

1.1 Animal studies considered by the IARC Report

Was IARC's classification of RF as only a "possible" cause of cancer justified? Was the evidence available in 2011 – and is the evidence available now - really so weak? Here is what IARC said ....

1.1a: Demand for mechanism

Section 1.5 of the report that was eventually published on the deliberations of IARC's 2011 Working Group (IARC 2013) says "Although numerous experimental studies have been published on the non-thermal biological effects of RF-EMF, multiple computational analyses based on biophysical and thermodynamic considerations have concluded that it is theoretically implausible for physiological effects (except for reactions mediated by free radical pairs) to be induced at exposure intensities that do not cause an increase in tissue temperature (Foster 2000; Adair 2002, 2003; Sheppard et al 2008)."

Interestingly though, when one actually looks at these "multiple compuational analyses based on biophysical and thermodynamic considerations", the first paper cited (Foster 2000) says "The issue of nonthermal effects is also a factor in an ongoing debate about possible health risks of RF energy from communications systems. *The problem is not whether effects exist (they surely do)* but to understand their nature and anticipate the exposure conditions that will elicit them" [italics added].

And the next three papers cited are a series of mathematical speculations published by (a) Robert K. Adair, a Yale theoretical physicist known mainly for having written a book called 'The Physics of Baseball' (and for being married to Eleanor Adair, a life member of the IEEE and prominent proponent of the harmlessness of telecommunications and radar) and (b) Asher Sheppard of

Asher Sheppard Consulting, who along with Mays Swicord (IARC panel member) is on the Institute of Electrical and Electronics Engineers (IEEE)'s International Committee on Electromagnetic Safety (ICES).

So one of the main reasons given by the IARC for refusing to classify microwaves as a known carcinogen boils down to a bunch of speculation, published by individuals with known bias in favor of the benefits and harmlessness of microwave technologies, that microwaves shouldn't be able to cause cancer.

Yet in spite of the weakness of this reason, the clear message of Section 1.5 in the 2013 IARC report is that in the absence of a proven mechanism, all reports of biological effects at levels of radiation insufficient to cause tissue heating were regarded by the panel as being simply wrong, with no additional justification other than this speculation.

To reiterate this important point, those members of the IARC committee whose opinion prevailed when it came to the writing of the 2013 report are essentially saying "yes, there is plenty of experimental evidence that sub-thermal RF is harmful to biological organisms – but because it has not been proven how this harm happens, we justify disbelieving the evidence that it does happen".

The idiocy of this stance is illustrated in Chapter 11 of the present book, the Appendix to which points out that presently, we do not fully understand even the mechanism by which microwave ovens heat water. Yet nobody concludes on these grounds that microwave ovens CAN'T heat water.

In any case, some of the many mechanisms by which sub-thermal intensities of microwaves can and do interact with biology will be treated in detail in Part III of the present book. (Of particular interest in light of the IARC's wording above is Chapter 13). For now, let us continue looking at the 2011 IARC Working Group's deliberations.

1.1b: Exclusion of experiments using real-world exposure parameters

The bizarrely antiscientific attitude described above is repeated in the decision of the IARC Working Group to exclude from consideration some of the most important pieces of evidence for sub-thermal harm, on the spurious methodological grounds that studies using commercially available mobile phones as sources of irradiation suffer from "unreliable dosimetry".

As described in Chapter 1 of the present book, real-life cellphone, cordless phone, Wi-Fi, baby monitor and smart meter radiation is characterised exactly by its constant variability and pulsed nature.

Panagopoulos et al (2019) point out that "pulsed or modulated electromagnetic signals (radiation) are found in numerous studies published since the mid-seventies to be more bioactive than continuous signals of identical other parameters – intensity, frequency, duration, waveform, etc (Bawin et al 1974; Bawin & Adey 1976; Bawin et al 1978; Blackman et al 1980, Lin-Liu & Adey 1982; Somosy et al 1991; Veyret et al 1991; Bolshakov & Alekseev 1992;

Thuroczy et al 1994; Penafiel et al 1997; Höytö et al 2008; Franzellitti et al 2010; Campisi et al 2010). Moreover, intermittent exposure to mobile phone radiation (real or simulated) with short intermittence durations (which makes the field even more variable) is repeatedly found to be more bioactive than the corresponding continuous exposure (Diem et al 2005; Chavdoula et al 2010). This experimental evidence further supports the argument that the more complicated and variable the field/stressor is, the more difficult it is for a living organism to adapt to it.

Yet IARC explicitly demands and the Health Protection Agency (HPA) explicitly recommends (Health Protection Agency 2012) that exposures in animal experiments should be performed by devices or handsets set to produce emissions at fixed frequency and output power. This edict has the effect of simultaneously (a) ensuring that the experiments will not replicate real life exposure parameters and (b) eliminating the most potent cause of health harm.

So again, the reasoning behind the IARC 'consensus' on this matter is frankly ludicrous. Those Working Group members whose opinions prevailed chose to exclude from consideration experiments in which animals were exposed to radiation parameters <u>of the sort that are actually experienced by human users</u>, and consider only those experiments where RF exposures were qualitatively quite different from everyday, real life exposures – on the rationale that real-life exposures are harder to quantify.

1.1c: Selective nit-picking

The IARC Working Group's general attitude to studies that did show a cancer promoting effect of RF is illustrated by the following exerpts from the report (italics added thoroughout):

- "The authors reported a twofold increase in the incidence of lymphoma in Eμ-Pim1 mice exposed to GSM RF radiation (P = 0.006 versus the sham exposed group) (Repacholi et al., 1997). [*The Working Group considered the complete lack of pathology data to be a major limitation in the design of this study.*]"

- "An increased incidence of total malignant tumours (all sites) was observed in rats exposed to RF radiation compared with sham-exposed controls (Chou et al., 1992). [*The Working Group considered this finding to be of limited biological significance, since it resulted from pooling of non-significant changes in tumour incidence in several sites.*]"

- "In groups exposed to ENU, UMTS RF radiation increased the incidence of bronchioloalveolar carcinoma and hepatocellular adenoma (Tillmann et al., 2010). [*The Working Group noted that this experimental model had not been used previously in other studies of hazard identification, and its concordance with the humancarcinogenic response is unknown.*]"

- "Irradiation by either schedule resulted in an acceleration in the development of benzo[a]pyrene-induced skin carcinoma and decreased

> the lifespan of the animals (Szudziński et al., 1982). [*The Working Group noted that the study design and experimental data were poorly presented and difficult to interpret. Survival and tumour data from groups receiving pre-exposure to microwave radiation may be invalid due to the lack of concurrent sham-exposed controls.*]"

In marked contrast to this pattern of nitpicking, studies reporting no cancer-promoting effect of RF appeared to be immune from Working Group criticism.

1.2: Post-2011 Animal Studies

Two more recent animal studies have prompted calls for IARC to upgrade the classification of RF to "probably carcinogenic to humans" (Group 2A), or (and more accurately in the present author's view) just "carcinogenic to humans" (Group 1).

1.2a: NTP

The final report of the US National Toxicology Program's 10 year, $30 million study of carcinogenesis in rats and mice was released on November 1 2018 (NTP 2018). The extensive peer review process documented on the website insisted that the NTP group upgrade their claims to reflect what the peer reviewers consider to be "clear evidence" – the highest standard of proof – that two different types of cell phone signals, GSM and CDMA, increased the incidence of malignant tumors in the hearts of male rats over the course of the two-year study. Higher incidences of brain and adrenal tumors were also seen, but those associations were judged to be somewhat weaker.

The tumours found by the NTP researchers in the hearts of male rats were an extremely rare type of cancer called a schwannoma. Schwannomas affect Schwann cells, which provide the fatty 'insulation' around the axonal 'wires' of peripheral nerves. Schwann cells are the equivalent in the rest of the body of the glial cells that become cancerous in the type of brain tumour called a glioma (see Epidemiology below). Acoustic neuromas (previously known as vestibular schwannomas), also suspected of being caused by cellphones, are schwannomas of the acoustic nerve which runs from the ear to the brain. NTP also found schwannomas in a number of other organs of the body, albeit not in statistically significant numbers.

So this all fits together. Glial cells, be they in the brain or the rest of the body, are for some reason especially susceptible to the cancer-causing action of microwaves. A reasonable hypothesis is that this is because, unlike the neurons they service, glia do a lot of dividing normally – and cancer is a disorder of cell division. The reason that glia seem to be more susceptible to the carcinogenic action of microwaves in male animals than female animals is at this point completely unknown, but the increased susceptility of males is repeated in the actions of microwaves on a variety of other biological functions.

1.2b: Ramazzini

At about the same time as the NTP results were released, a second large rat study, this time from the Ramazzini Institute in Italy, also reported malignant schwannomas in the hearts of male rats exposed to cellphone radiation (Falcioni et al 2018). Given the extreme rarity of cardiac schwannomas, this cannot be a coincidence.

Conclusion from Animal Studies

Cellphone radiation clearly does cause cancer in rats.

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2: Epidemiological Studies

But does it cause cancer in humans?

Since it <u>should</u> be regarded as unethical to expose humans to a potential harm in the same way as lab animals (although in fact this is exactly what the telecommunications industry and the governments that permit them to do whatever they like <u>have</u> done – and without the proper experimental design necessary for institutional ethics committees to approve animal experiments, either) the main method by which the question above has been addressed is through epidemiological studies.

Wikipedia defines epidemiology as " the study and analysis of the distribution, patterns and determinants of health and disease conditions in defined populations. It is a cornerstone of public health, and shapes policy decisions and evidence-based practice by identifying risk factors for disease and targets for preventive healthcare." In other words, epidemiologists are restricted to looking at what has happened to humans who have been exposed to various factors in a completely unmonitored and uncontrolled way. Thus the major problem with epidemiological studies is that there are always a multitude of uncontrolled variables that <u>could</u> be blamed for whatever health harm is being studied. To put it plainly, epidemiology is a very blunt instrument.

Nevertheless, it appears to be the only method that carries weight with politicians. Therefore, this section of the present book will first examine the epidemiological studies of brain cancers that were considered by IARC. It will then look epidemiological studies of brain cancers that came out after the IARC report was published. Finally it will branch out to epidemiological studies of cancers in organs other than the brain.

2.1: Epidemiological studies considered by the IARC report

With regard to epidemiological evidence, the 2011 IARC report says "Two sets of data from case–control studies were considered by the Working Group as the principal and most informative basis for their evaluation of the human evidence". This means that the IARC committee considered only the INTERPHONE study and the Swedish case–control studies. Both sets of data focused on brain tumours among mobile-phone users: particularly gliomas, the most lethal form of brain tumour.

2.1.1: INTERPHONE

The above statement (and the fact that the 13 country, 6 year, $15-plus million INTERPHONE study was actually an IARC project) notwithstanding, the 2011 Working Group chooses not even to acknowledge, let alone on comment on, the fact that in all centres except Australia, France and New Zealand (where <5% industry funding is declared and odds ratios are not specified in the final report) INTERPHONE reports overall odds ratios that are actually less than 1.0 for gliomas (INTERPHONE Study Group 2010).

An odds ratio (OR) of less than 1.0 means you have LESS chance of getting a brain tumour if you do use mobile phones than if you don't.

In other words, an OR <1.0 implies either a methodological problem, or a genuine protective effect of cellphone use.

Most commentators have assumed the methodological problem explanation. Some of the obvious methodological deficits in INTERPHONE are as follows.

- One problem is that amount of cellphone use was determined simply by asking participants to recall the number of hours a week they had used a cellphone over the last *n* years. Memory is notoriously unreliable, so this methodology could introduce bias in either direction.

- Another problem is that INTERPHONE does not consider the incidence of brain tumours in people over the age of 60 years. This is exactly the group who, 20 years previously, would have been the heaviest of all users, as middle-aged corporate executives during a period when cell phones were too expensive for most domestic users.

- A third problem is that the INTERPHONE protocol defines a "regular user" as someone who made as little as one call a week for six months. It would be more accurate to classify such a person as a non-user.

Yet even suffering from all of these problems, INTERPHONE found that the highest decile of cumulative time that mobile phones were recalled as being used (>1,640 hours) was associated with significantly increased probability of glioma (OR 1.4; 95% CI 1.03–1.89). This finding apparently generated enormous controversy among the Working Group, but in the end was inescapable.

2.1.2: Swedish case-control studies

Nineteen papers describing the Swedish case-control studies done by Lennart Hardell and associates – later summarised by Hardell and Carlberg (2015) – actually formed by far the largest tranche of material studied by the 2011 IARC Working Group. In a nutshell, these were the papers that made it impossible for the group to conclude that mobile phones are not associated with brain cancer.

Indeed, to quote the IARC report, it was only a "minority opinion that current evidence in humans was inadequate" that was instrumental in "permitting no conclusion about a causal association. This minority saw inconsistency between the two case–control studies and a lack of exposure–response relationship in the INTERPHONE study. The minority also pointed to the fact that no increase in rates of glioma or acoustic neuroma was seen in a nationwide Danish cohort study, and that up to now, reported time trends in incidence rates of glioma have not shown a trend parallel to time trends in mobile-phone use."

In summary then, an anonymous minority of the 2011 IARC Working Group (who all had to sign non-disclosure agreements before their participation was accepted) was instrumental in the classification of cellphones as only a 'possible' cause of cancer. Since (a) IARC requires all participants in its deliberations to sign a confidentiality agreement, (b) the final report supplies neither the identity of the individuals making up this minority, nor any of the declarations of interest that were reportedly sought from all participants, and (c) the majority of the working group wanted a stronger classification, the 2B classification must be regarded as suspect at best.

2.2: Post-IARC Report studies of brain cancer

2.2.1: Danish cohort study

An update of the Danish study referred to by the minority of the IARC Working Group as providing evidence against the idea that cellphones cause brain tumours was published a few months after the IARC report (Frei et al 2011). Its press release trumpeted "no link between mobile phone use and [brain] tumors". But as Slesin (2011) puts it, "From the very beginning, the Danish project was criticized for eliminating more than 200,000 corporate subscribers, one third of the actual number of Danish cell phone users, the intended study population. The researchers had little choice: They did not know the names of the people using phones paid for by their employers and so had no way to match those on mobile phone subscriber lists with those on tumor registries. Everybody agrees that those who were dropped were the heaviest users. In the time period covered in the Danish project —from 1987 through 1995— cell phones were expensive and it's no stretch to assume that those who did not have to pay their own bills racked up the most talk time." Nevertheless, as Philips and Lamburn (2011) point out, all of those corporate users ended up in the control group. Tumor risk is estimated by comparing the number of cell phone users who get tumors with the number of non-users who get tumors. This study treats the heaviest of all users as non-users.

Another problem is that individuals who took up a cellphone subscription *after 1996* are also put in the control (non-user) group. That includes more than 20% of the population, who by the end of the 2007 cut-off period for the 2011 BMJ paper could have racked up 10 or 11 years of cellphone use – and still been treated by the study as though they were complete non-users. And nobody even thought of asking about the use of cordless landline phones, which produce almost as much RF as cellphones.

So basically, this Danish study compares brain tumour incidence in one group of cellphone users, with brain tumour incidence in what they pretend is a group of non-users, but is actually just ... another group of users. And finds no difference between the two groups. Golly.

The egregiously obvious flaws inherent in this finding strongly suggest that not only the authors of the study itself, but also the peer reviewers and editors who passed it for publication in the BMJ were either incompetent, or corrupt. However, Joachim Schüz, the last named author on the paper, was and still is section head of IARC's Section of Environment and Radiation. So IARC's response to publication of this paper was to release a press statement to the effect that the updated Danish cohort study "confirms the overall Interphone findings of no association, but with reduced potential for bias."

2.2.2: Time trend studies of brain cancer

A much contested[5] review (Röösli et al 2019) on the epidemiology of brain and salivary gland tumours, written by ICNIRP/IARC stalwarts Martin Röösli, Joachim Schüz and Maria Feychting, argues that "elevated risks [reported by case-control studies] are not coherent with observed incidence time trends" – and concludes on this basis that "epidemiological studies do not suggest increased brain or salivary gland tumor risk with MP use". [The acronym MP here stands for Mobile Phone, not Member of Parliament – though in light of the actions of most "democratic" governments on this matter, arguably either would fit]. In other words, Röösli and colleagues claim that the overall incidence of brain tumours has not increased since the advent of mobile phones, and therefore evidence from case control studies that show more tumours in mobile phones users than non-users is either wrong or irrelevant.

The truth is somewhat different. Actually, there is significant evidence that the incidence of brain tumours has at least doubled since the advent of mobile phones, in countries including the USA, Canada, France, Israel, Denmark, Australia and England. However, in many of these countries the dedicated followers of ICNIRP appear to have done all in their power to suppress evidence of increases in brain tumour incidence. Perhaps not surprisingly, one of the most blatant examples of simple suppression seems to have happened in Denmark.

[5] https://microwavenews.com/short-takes-archive/row-over-review

(a) Time trends in Denmark:

In 2012, the Danish Cancer Society put out a press release quoting Hans Skovgaard Poulsen, Head of Neuro-oncology at the Rigshospital (National or State Hospital) in Copenhagen, as saying that the number of men diagnosed with "den allermest ondartede form for kræft i hjernen (Glioblastom), er næsten fordoblet hen over de seneste ti år " (the most malignant form of brain cancer (Glioblasoma) has nearly doubled over the last ten years). Poulsen is quoted as characterising this as a "frightening development'.

Then however, everybody involved went quiet[6]. Christoffer Johansen, an author on the Danish Cohort Study discussed above, was appointed head of research at the Rigshospitalet, and started telling everyone who asked that Poulsen had been mistaken[7] . The press statement mentioned above was quietly removed from the Cancer Society's website (but can still be found on the Wayback Machine[8]). And poof, the evidence was gone. Easy.

But then, in 2019, a Danish Member of Parliament requested government statistics on the time trend incidence of glioblastoma multiforme, and released these to the public. And suddenly, the doubling of glioblastoma multiforme in Denmark was back[3] . (History does not relate whether this made any difference to the attitude of Danes to their mobile phone addiction: it's doubtful).

However, technology addiction or not, an objectively observable sequence of events like this suggests that both the Danish Cancer Society as an organisation, and a significant number of Danish scientists as individuals, were and are committed to a policy of suppressing the truth in this matter. It is notable that the only person willing to speak out was a practising brain surgeon, whose daily work involves the (all-too-often futile) attempt to clean up the mess. But he was quickly shut down.

Sadly, this is not a situation that is unique to Denmark.

(b) Time trends in Australia:

Again a brain surgeon was the first to bring up this issue in Australia. In 2008, an editorial in the journal Surgical Neurology (Pawl 2008), begins "In March of this year, Dr Vini G. Khurana, an Australian Neurosurgeon, made news headlines declaring that, based on his research of the literature, the long-term use of cell phones was leading to brain tumors and was more dangerous to health than smoking cigarettes". Khurana and colleagues (Dobes et al 2011) later published the information that there had been a "significant increase in primary malignant brain tumors from 2000 to 2008" in Australia, which they said was largely due to

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[6] https://microwavenews.com/news-center/something-rotten-denmark
[7] https://microwavenews.com/short-takes-archive/gbm-denmark
[8] https://web.archive.org/web/20121128153253/http://www.cancer.dk/Nyheder/nyhedsartikler/2012kv4/Kraftig+stigning+i+hjernesvulster.htm

an increase in the 65 plus age group.

Despite this, five years later a different Australian group (Chapman et al 2016a) published a paper in which the abstract says "Significant increases in brain cancer incidence were observed (in keeping with modelled rates) only in those aged ≥70 years (both sexes), but the increase in incidence in this age group began from 1982, before the introduction of mobile phones" . The authors conclude that "the observed stability of brain cancer incidence in Australia between 1982 and 2012 in all age groups except in those over 70 years compared to increasing modelled expected estimates, suggests that the observed increases in brain cancer incidence in the older age group are unlikely to be related to mobile phone use. Rather, we hypothesize that the observed increases in brain cancer incidence in Australia are related to the advent of improved diagnostic procedures when computed tomography and related imaging technologies were introduced in the early 1980s."

This publication was immediately followed by not one but two separate calls for retraction of the paper (Bandara 2016; Morgan et al 2016), on the grounds that it

- contradicts its own findings three times
- uses a 'what-if' methodology with at least 4 false assumptions
- selectively cites a finding from Dobes et al (2011) that is consistent with its 'results', while ignoring findings from the same paper that are inconsistent with its 'results'
- uses estimated and apparently 'made up' numbers.

The published response to these criticisms (Chapman et al 2016b) is wordy, though less than convincing. And the paper was not retracted.

However, neither the nest of ICNIRP members in Australasia nor the BMJ were inclined to give up, and a further salvo soon followed (Karapidis et al 2018). The abstract of this paper again concludes that "In Australia, there has been no increase in any brain tumour histological type or glioma location that can be attributed to mobile phones." AND once again, the criticism follows hard upon (Philips 2019). Philips is blunt. He says of the Karipidis et al study "The fact that it passed peer-review raises questions as to the competence and independence of the review process." (And sure enough, though BMJ Open did publish Philip's letter online, it refuses to make a pdf available, and has disappeared it completely from all search engines relating to BMJ Open. Is there a pattern here)?

The essence of Philip's criticism of Karipidis et al is that their decision to eliminate from their study anyone over the age of 59 effectively removes from consideration 63% of the Australian glioma cases diagnosed between 1982 and 2013. Karipidis et al's response is that they did this to maintain comparability with INTERPHONE. But this hardly answers the criticism that 60 year olds in 2013 were exactly the middle-aged executives who made the most use of cell phones of anyone 20 and 30 years previously, when cell phones were too expensive to be used by anyone without a corporate job.

(c) Time trends in England:

The same Alasdair Philips who criticised Karipidis et al's 2018 paper did so on the basis of having himself just published a report showing that gliomas more than doubled in England over a comparable time period (Philips et al 2018). Philips et al find very significant increases in GBM (glioblastoma multiforme, the most deadly form of brain cancer) in males as young as 15-19 years old – an age group which Karapidis et al say shows no increase at all. Figure 5 reproduces Fig 4 from Philips et al (2018), showing a trebling of rates of GBM in 15-19 year old males between 1995-1999 and 2011-2015, an increase of around 50% over the same period for teenaged females and all other groups between 5 and 70 years old, and a sharp rise to, again, treble the incidence in the over-70s of both genders.

One pervasive issue here is that Figure 4 below plots age-specific figures (numbers of cases divided by numbers of individuals in the population in each age cohort) while Karapidis et al report only age-standardised figures (age-specific figures with the numbers readjusted on the basis of the number of individuals of each age in a fictional "standard" population). If the standard population has a different age structure from the actual population, this standardisation process can introduce serious errors – essentially in any direction desired by the constructors of the 'standard' population (which in Karipidis et al's case is the WHO).

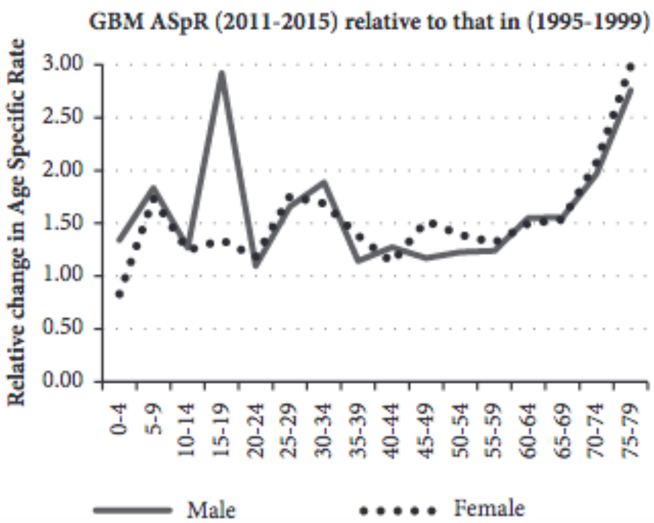

Figure 4: Fig 4 from Philips et al (2018) : Age-Specific Rates (as opposed to Age-Standardised Rates) of glioblastoma in the UK, showing a trebling of rates from (1995-1999) to (2011-2015) in 15-19 year old males and also in both sexes older than 65 years. NB: no change over this period would be represented by 1 on the vertical axis.

Further evidence follows about the causation by microwaves of cancers in other areas of the human body.

2.3: Breast Cancer

West et al (2013) present a series of four cases where young women (ages 21 to 39), with no family history of breast cancer and no other risk factors, all developed similar tumours in the breast over which they had been in the habit of carrying active cell phones in their bra. Pathology of the *in situ* and invasive ductal carcinomas observed in all four cases showed striking similarity. Each patient had multifocal cancer, but the tumors were all clustered within the area of breast tissue directly underlying the cellular device and nowhere else. While the cancers were centralized to the region of the breast exposed to the cellular device, they still had the ability to metastasize (spread to other sites in the body): three patients in this series had lymph node metastasis and one had bone metastasis.

The authors conclude somewhat limply that "These cases raise awareness to the lack of safety data of prolonged direct contact with cellular phones." Given the recent report by Gandhi (2019) that "most cell phones exceed [*even the ridiculously high*] safety guidelines when held against the body by factors of 1.6 to 3.7 times for the European/ICNIRP standard or by factors as high as 11 if 1-g SAR values were to be measured as required by the U.S. FCC " [*comment in italics inserted by present author*], stronger warnings would seem to be appropriate.

Here, then, is a stronger warning.

Don't carry your cell phone in your bra or shirt pocket.

2.4: Colorectal Cancer

Although colorectal cancer is one of the few cancers that are actually decreasing in the elderly (a situation which most epidemiologists attribute to improved screening, although how screening could reduce morbidity, as opposed to mortality, is not clear) the incidence of colorectal cancer has increased sharply in younger age groups (Araghi et al 2019; Vuik et al 2019). A survey of Australian women aged 15-40 showed that many of them routinely carried their cellphones on standby mode in pockets below the waist (Redmayne 2017). No similar study has been done on the habits of young men, but anecdotal observation suggests that carriage of cell phones in below-the-waist pants pockets is very common. This habit may well explain the rise of colorectal cancer in the young.

In fact, even most cellphone manufacturers now recommend (albeit in very fine print, which most people never read) that the owners of their product should not carry active cellphones in their clothing.

So here is another explicit warning.

Don't carry your cellphone in your pants pocket.

2.5: Blood Cancers

Michelozzi et al (2002) find an excess of both adult and childhood leukemia within a 6km radius of Vatican Radio, a very powerful radio transmitter in a northern suburb of Rome, Italy.

Zheng et al (2002) found an OR of 3.1 for non-Hodgkin's lymphoma and chronic lymphocytic leukemia among workers in the telecommunications industry.

Atzmon et al (2016) meta-analyse 57 studies published between 1982 and 2012 and find an elevated risk of morbidity (*getting the disease*) and mortality (*dying of it*) for MW/RF exposure as follows:

- lymphoma morbidity OR = 1.55 (95% CI 1.22, 1.97);
- childhood leukemia morbidity OR =1.35 (95% CI 1.17, 1.56);
- adult leukemia morbidity OR = 1.24 (95% CI 1.12, 1.37);
- adult leukemia mortality OR = 1.29 (95% CI 1.13, 1.47).

No statistically significant association was found for lymphoma and multiple myeloma mortality OR=1.17 (95% CI 0.96, 1.42).

[Explanation of terminology: *An OR or Odds Ratio compares the chance of getting a particular cancer if you are exposed to microwaves divided by the chance of getting it if you're not exposed. So an OR of 2 means you are twice as likely to get whatever it is if you are exposed and an OR of 1 means exposure confers no increased risk. CI means Confidence Interval – so 95% CI means 95% of the ORs in these studies were between the two numbers given*.]

So the bottom line here is that these researchers found an increased risk of lymphoma and leukemia (as well as melanoma, breast and brain/central nervous system cancers) associated with exposure to MW/RF radiation.

2.6: Miscellaneous other cancers

2.6.1: It has been known for a long time that police officers exposed to traffic radar tend to develop testicular cancer (Davis and Mostofi 1993). This fact is well-known to various national police forces, which is why speed trap radars tend to be left in locked police cars abandoned by the side of long straight stretches of road.

The association between testicular cancer and occupational use of radar should also be of interest to those whose nice new domestic vehicle boasts 'anti-collision' radar, and to those like road workers, whose occupation exposes them on a long-term basis to traffic that makes increasing use of such radar. Is avoidance of a few fender-benders really worth contracting, or causing others to contract testicular or other kinds of cancer? Risk-benefit analysis and consequent regulations really need to take this into account.

2.6.2: Tumours of the parotid gland (aka salivary gland, located just in front of the ear) were found to be associated with heavy cellphone use by Sadetzki et al

(2007). The biased Röösli et al review mentioned earlier cites this paper, albeit clearly as an enforced afterthought – the paper is numbered 95a in the Reference List – and is not mentioned at all in the text of the review.

2.6.3: Thyroid cancer has now been reported to be associated with cell phone use in individuals with a particular genetic makeup (Luo et al 2020). Specific variants of five separate genes each conferred a two to three-fold higher than normal risk of contracting thyroid cancer as a result of cell phone use. Presumably anyone unlucky enough to be born with these variants of all five genes would be ten times as susceptible as an individual with a different genetic makeup.

2.6.4: Acoustic neuroma, a benign tumor of the nerve from the inner ear to the brain, is known to be associated with use of mobile and cordless phones (Hardell et al 2013).

Conclusion from Epidemiological Studies

It is becoming increasingly difficult to avoid the twin conclusions that:

(1) RF/microwaves definitely cause cancer – in various organs of the body and at power densities that are common in the current environment.

(2) The IARC, its parent agency the WHO, and some – too many – of the scientists, peer reviewers and journal editors currently active in this area choose to dispute this fact, because they are irretrievably biased in favor of ICNIRP's view that microwaves are harmless at sub-thermal power densities. It would seem that too much cold, hard cash is at stake here for the telecommunications industry to let science proceed honestly.

In this regard, an Advisory Group has recently recommended that IARC should reconsider the relationship between RF and cancer, with a view to promoting RF from a possible cause to a probable or definite cause of cancer in humans. Unfortunately any such reconsideration has been pushed back to the second half of the 2020–2024 time frame – presumably by the same minority who engineered the 2B classification in the first place (https://monographs.iarc.fr/wp-content/uploads/2019/10/IARCMonographs-AGReport-Priorities_2020-2024.pdf).

And meanwhile, despite ever more persuasive evidence that sub-thermal levels of microwaves cause various kinds of cancers in humans, the multinational telecommunications industry is permitted – nay, encouraged – by governments all over the world to blanket the planet with ever more inescapable microwave pollution. The launch of hundreds of satellites all transmitting radio waves will eventually make microwave pollution escapable only by retreating to a concrete and steel bunker. And meanwhile, high band "5G" technology (see Chapter 1) requires installation of a radio transmitter on every second or third lamp post in suburbia.

If a halt is not called to this insanity soon, humanity faces an existential crisis.

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Chapter 6

DNA DAMAGE

What is DNA?

DNA (DeoxyriboNucleic Acid) is a large biological molecule found in the nucleus of every cell of every living being (see Chapter 5 for a diagram showing the location of this kind of nucleus).

DNA's function is to carry the "genetic code", which provides instructions telling each cell in the body what proteins to manufacture on a minute by minute basis and when to divide. Thus DNA provides instructions for the organism as a whole on how to develop into a unique individual.

This genetic code is carried in the sequence of base pairs along the long sugar backbone of the DNA molecule. The sequence of base pairs is different in every individual (although very similar in identical twins), and is basically what causes offspring to grow up to look like their parents. In short – as Francis Crick is reported to have crowed in the pub one evening in 1953, while he and James Watson were building the first concrete model of a DNA molecule – DNA is "the secret of life."

Hence, damage to a cell's DNA can stop that cell from working properly – at least until the damage is repaired by one of the many repair mechanisms that have evolved to fix DNA damage. If these repair mechanisms fail, a build-up of uncorrected DNA damage can eventually lead to diseases like cancer, in which cell division ceases to be regulated and "goes haywire". (Thus DNA damage equally belongs in the Mechanisms section of this book. It is included in the Evidence section because of the debate about whether or not it occurs).

It is therefore a matter of some concern that there is now a great deal of scientific evidence (discussed further in this chapter) that cellphone radiation causes not just damage to, but actual breakage of, DNA molecules.

Politics of DNA damage

Not surprisingly perhaps, this evidence has been extensively "war-gamed" by the cellphone industry, in a concerted attempt to discredit and/or suppress it (Slesin 2016).

The war games have been conducted on a number of fronts:

- Individual scientists who dare to produce inconvenient results mysteriously lose their funding and/or their jobs (Slesin 2006).
- Every time a study appears showing that cellphone radiation causes DNA breaks, the cellphone industry or the US military[9] fund a study that says it doesn't. This strategy appears to have started on the reasoning that each

[9] Military interests are keen to maintain the fiction that their radar installations are harmless biologically.

negative study cancels out one positive study, with an algebraic sum of zero indicating no effect (Pockett 2018). But if this is pointed out, the argument changes to a claim that the negative studies are *superior to* the positive studies (Elwood and Wood 2019). Since 75% of studies showing no effect are funded by the cellphone industry or the military (Huss et al 2007) and the quality of many of the industry-funded, no-effect studies is seriously bad (Slesin 2006) this argument is less than convincing.

- Another tack in the war-gaming enterprise has been to ignore the experimental evidence altogether and simply claim that it must be wrong, because the physics of the situation says it is impossible for "non-ionizing" radiation to have any non-thermal effect on biology (see Chapter 11). This argument rather falls over when it is realised that if its main plank were true, RF could not have any thermal effect either (see Appendix I to Chapter 11).
- This 'physics says' argument is particularly used in the area of DNA breaks, where mathematical models can be constructed to pronounce that microwaves couldn't possibly cause DNA breaks (Adair 2002, 2003). But mathematical models of biological processes inevitably involve a great number of simplifying assumptions and as such are nothing more than hypotheses, which are always subject to confirmation by experiment.

The next section of this chapter details some of the many experimental observations showing that microwaves can and do break DNA molecules. It also discusses some of the pitfalls of interpretation in this area.

Assessing evidence for DNA damage 1: importance of "good practice"

The first criterion to be considered when assessing experimental evidence is how well the experiments were done. In this context, a recent paper by Vijayalaxmi and Prihoda (2019) is much cited by writers who support the idea that there is no good evidence that microwaves cause DNA (or indeed any other kind of biological) damage. Vijayalaxsmi and Prihoda start from the assumption that four factors indicate goodness of research. To quote them, "The four specific quality control measures were as follows: 1. ''Blind'' collection/analysis of the data to eliminate individual/observer ''bias''; 2. Adequate description of ''dosimetry'' for independent replication/confirmation; 3. Inclusion of ''positive controls'' to confirm the outcomes; and 4. Inclusion of ''sham-exposed controls'' which are more appropriate to compare the data with those in RF exposure conditions." No justification for including these particular factors as 'quality control measures' is offered, so let us examine them one by one. 1. Blind data collection is undoubtedly important when the criteria for assignment of data to one or another class are subjective or fuzzy. However when the datum is the objectively measured length of DNA strands, or 'comet tails' in the comet assay, blind assessment would seem to protect only against active cheating – and there are many ways to achieve that. 2. Adequate dosimetry. As mentioned in Chapter 11, rejection of experiments with "inadequate dosimetry" was how IARC managed to exclude all experiments using actual cellphone radiation rather than artificially generated radiation. Actual cellphone radiation is extremely variable, both on a minute-to-minute and on a second-to-second time frame. Indeed the variable, pulsed nature of actual Wi-Fi and cell-phone radiation is exactly what makes it so biologically harmful (see Chapter 1 and Panagopoulos 2019). 3. Inclusion of positive controls. No definition of positive controls is offered and no papers that use them are specifically cited, so it is difficult to assess this criterion. Presumably positive controls for experiments on radiation-induced DNA damage would involve treatment with a chemical agent known to cause DNA damage. Quite how this is relevant is not clear: such controls are not common in biological experimentation by competent scientists, and their inclusion in this list would seem to be designed purely to enable rejection of any experimental results disliked by the telecommunications industry. At the very least inclusion of this criterion in a list of factors indicating 'good laboratory practice' requires justification. In the opinion of the present author, the only thing positive controls would be good for is either to validate an assay method which should have been beyond question before the experiment even starts, or to exclude active fraud – and in the case of industry-funded papers denying the repeatability of experiments showing RF-induced DNA damage, so-called 'positive controls' signally fail to do that [10]. 4. Sham exposed controls. These are certainly relevant: but also easily mishandled, as witness the next section of the present chapter.

In fact, although the above criteria may seem convincing to epidemiologists who have never set foot in a biology lab in their lives (which is most of them), the following factors, completely ignored by Vijayalaxmi and Prihoda (2019), are clearly much more relevant to the production of credible results in experiments on the effects of exposure to electromagnetic fields.

Assessing the evidence for DNA damage 2: *in vitro* vs *in vivo* experiments. The importance of static magnetic fields in laboratory incubators

Biological experiments in general are classified as being done either *in vitro* (Latin for 'in glass') or *in vivo* (Latin for 'in life'). *In vitro* experiments involve harvesting a particular tissue from the experimental animal and in this case exposing the tissue, or cells cultured from it, to RF in a Petri dish. *In vivo* experiments involve exposing the whole animal to RF and then harvesting whatever tissue is being studied and examining it immediately. Thus, *in vitro* experiments invariably involve growing tissue in oxygenated saline solutions kept warm in a laboratory incubator.

The one major critical factor that is ignored by the four criteria promoted by Vijayalaxmi and Prihoda (2019) is that Portelli et al (2013) found that all of the laboratory incubators studied by him and his colleagues generated strong static magnetic fields. These fields varied both between and within incubators and were unrecognised by almost all of the experimenters using the incubators. To quote Portelli et al (2013): "This report shows that the background magnetic field in biological incubators can vary by orders of magnitude within and between incubators. These variations can be observed within the same incubator in locations that are centimeters apart from each other as well as between incubators that are identical and located in the same laboratory. Additionally, the values measured were frequently outside the range of magnitudes found naturally on the Earth's surface or ordinary habitation spaces. Exposure to such altered magnetic field environments has been experimentally shown to be sufficient to cause numerous effects in cell cultures. Examples of the effects reported span from differential generation of free radicals and heat shock proteins to differences in cellular proliferation, differentiation, and death. Although the effects are not well established and the molecular mechanism of action is currently under debate, these observations alone support the notion that the inhomogeneity of the background magnetic field in incubators is a potential confounding

[10] https://microwavenews.com/news-center/singh-comet-assay-radiation-research

source of the variability and reproducibility for studies performed on cell cultures." [emphasis added].

It is the present author's opinion that these findings render null and void all *in vitro* experiments that do not explicitly take into account such incubator-generated fields – which so far is basically all of them.

The above findings are interesting in light of Table 6 below, which summarizes the results of 76 experiments done before April 2017 using the comet assay for DNA damage.

	Effect	**No effect**
In vitro	25 (54%)	21 (46%)
In vivo	22 (81%)	5 (19%)

Table 3: Comparison of *in vitro* and *in vivo* studies on DNA damage and RF exposure

A little over half of 46 *in vitro* studies showed DNA damage after RF exposure: enough for "Effect" to win a first-past-the-post democratic election, but in scientific terms not hugely different from a random result (which would be 50:50). In contrast, 81% of 27 *in vivo* studies showed a DNA damaging effect of RF exposure, while only 19% showed no effect.

The general lack of reproducibility of *in vitro* studies in this area, both between and within laboratories, has caused huge controversy, with accusations of fraud and demands for withdrawal of papers flying around not only the scientific literature, but also the public media. For a small sampling of this sort of stoush see Speit et al (2007); Lerchl (2009); Rüdiger (2009); Lerchl & Wilhelm(2010). In 2014, Elizabeth Kratochvil (né Diem) finally sued Alexander Lerchl for pursuing a years-long campaign of defamation against her in an attempt to get her findings removed from the literature [11]. She won the law suit, but her career had already been destroyed.

However, less biased players also indicate that replication of *in vitro* results is problematic, even using the same cell line within the same laboratory (Adlkofer 2014). The general conclusion that has been drawn from this seems to be that cell lines (a) differ and (b) can change in their susceptibility to RF over time. The tragedy though, is that the findings of Portelli et al (2013) provide a much more transparent explanation of the lack of reproducibility in these experiments, in terms of the unsuspected and therefore unmeasured extreme variations in the magnetic environment within and between the lab incubators in which cell cultures are grown.

These magnetic field variations are still unknown by virtually all users of lab incubators. Indeed, if the anecdotal experiences of the present author are anything to go by, virtually all users of lab incubators flatly refuse even to consider the possibility that these hitherto unsuspected magnetic fields might be confounding the results of their life's work. On a human level, it is not hard to see why. However, seven years after publication of the report revealing the

[11] https://www.stopumts.nl/doc.php/Berichten%20Internationaal/9330/alexander_lerchl_has_met_his_waterloo_his_fraud_allegation_against_the_reflex_study_is_unlawful

problem (Portelli et al 2013), it is past time for this particular scientific confound to be widely acknowleged, so that it can be dealt with in future investigations. As Slesin (2013) puts it, the Cheshire Cat is dead.

Meanwhile, the above discussion shows why at least the present author regards the results of essentially all *in vitro* experiments on the biological effects of RF that have been published so far as unreliable, whatever their outcome. Therefore the rest of this chapter will consider only *in vivo* results.

Animal *in vivo* experiments on genotoxic effects of RF

Over the past twenty five years multiple papers have been published reporting DNA damage caused by exposure of rodents to low intensities of cellphone and/or Wi-Fi frequencies (Lai and Singh 1995; 1996; 1997; 2005; Lai et al 1997; Paulraj and Behari 2006; Kesari et al 2010; Lakshmi et al 2010; Torić et al 2011; Jiang et al 2012; Deshmukh et al 2013; 2016; Pandey et al 2017; Pandey and Giri 2018). Finally the National Toxicology Program of the US Government became sufficiently interested to mount a ten year, $25 million study in which they exposed a large number of rats and mice to GSM and CDMA modulated cell phone radiation (see Chapter 1 for explanation of those acronyms) over 2 years and examined the effects of this on DNA breakage, among other things. DNA results were included in NTP's published Technical Reports, released on November 1, 2018 [12] but a paper specifically on DNA damage (Smith-Roe et al 2020) reports analyses of data not included in the Technical Reports. Smith-Roe and colleagues report that RF exposure was linked with significant increases in DNA damage in

- the frontal cortex of the brain of male mice (both modulations)
- leukocytes (white blood cells: see Chapter 7) of female mice (CDMA only)
- hippocampus (the brain region involved in memory and spatial maps) of male rats (CDMA only).

Increases in DNA damage judged to be equivocal were observed in several other tissues of both rats and mice.

A particularly misleading attempt by ICNIRP to discredit these NTP results (ICNIRP 2019) is rebutted by Melnick (2020) and has led to a call for ICNIRP to be disbanded (Slesin 2020).

Human *in vivo* experiments on genotoxicity of microwaves.

Again, multiple studies have been published showing that using a mobile phone – or indeed simply living near a cell tower – results in increased DNA damage. For example:

- Ji et al (2004) report that talking on a mobile phone for 4 hours causes DNA damage in peripheral blood lymphocytes.
- Gandhi and Anita (2005) report that individuals using mobile phones sustain a higher rate of DNA damage in peripheral blood lymphocytes than those who do not use mobile phones.

[12] (https://www.niehs.nih.gov/news/newsroom/releases/2018/november1/index.cfm)

- Garaj-Vrhovac et al (2011) report more DNA damage in peripheral lymphocytes of workers occupationally exposed to marine radar than matched control subjects.
- Cam and Seyhan (2012) report that talking on a 900 MHz GSM mobile phone for as little as 15 or 30 minutes significantly increases the number of single strand DNA breaks in hair root cells from the ear closest to the phone: 30 minutes exposure caused significantly more DNA breaks than 15 minute exposure.
- Gandhi et al (2015) find significantly more DNA damage in individuals living near a mobile phone base station than controls matched for age, gender, alcohol consumption and occupation.
- Gulati et al (2016) report three times more DNA damage in peripheral blood lymphocytes in people living close to cell towers than people living further away, with no difference in the genetic polymorphisms involved in DNA repair mechanisms.

Nevertheless, the only data on DNA damage cited in the WHO sponsored review by Röösli et al (2010) is a paper by Maes et al (2006). Maes and colleagues compare DNA damage in an 'exposed' group of mobile phone company employees with a 'non-exposed' group who were not employees of this particular company. Some of the individuals in the 'exposed' group were administrative staff and some were radio field engineers. Some of the radio field engineers expressed the opinion that although they did routinely turn the radiation off before repairing an antenna, they were probably rather more exposed to RF than normal people. No hard data to back up this perception were available however, because it was not the policy of this company to make their radio engineers wear dosimeters. Despite this, Maes and colleagues make no attempt to collect any dosimetric data themselves – they just conclude that their measurements found no evidence for increased DNA damage due to RF exposure.

And Röösli et al (2010), having cast a few perfunctory, non-specific aspersions about goodness of evidence and thereby justified simply failing to mention any of the properly done, peer-reviewed papers that do show significant DNA damage in people living near cell towers, cite this extraordinarily sloppy paper by Maes and colleagues as evidence that low intensity RF has no genotoxic effect. Which allows Röösli and colleagues to conclude their WHO-sponsored 'systematic review' with the pronouncement that "At present, there is insufficient data to draw firm conclusions about health effects from long-term low-level exposure typically occurring in the everyday environment."

In light of this deplorable level of honesty, ethics and scientific acumen, it is perhaps not surprising that this particular official report from the United Nations agency charged with protecting the world from health harms comes with the disclaimer "The responsibility for the interpretation and use of the material lies with the reader. In no event shall the World Health Organization be liable for damages arising from its use."

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Chapter 7

IMMUNE SYSTEM EFFECTS

What is the immune system?

The immune system is a large, non-localised set of independent but interacting cells that have the collective function of protecting the body from damage by entities the system perceives as invaders (bacteria, viruses, cancer cells, deliberately implanted foreign tissues).

Probably the major players in this orchestra are the white blood cells known as leukocytes (leukos = white; cytos = cell in Greek). There are a dizzying number of types of leukocyte, including (in no particular order) neutrophils, basophils, eosinophils, lymphocytes, monocytes and macrophages. Table 1 shows the functions and characteristics of each of these.

Table 2: Summary of immune cell types

Type of leukocyte	Location	Function and characteristics
Neutrophil	Blood, interstitial fluid	***Phagocytosi****s* (phago= to eat; cytos = cell). First to arrive at any infection site, which they detect by following chemical gradients of cytokines. Neutrophils are the main component of pus.
Basophil	Produced in bone marrow, travel to and reside in many tissues	Cause inflammation, serious allergic reactions, asthma, dermatitis, hay fever. Similar to mast cells: both release histamine. Basophils also release cytokines and interleukin-4.
Eosinophil	Similar to basophils	Similar to basophils. Specialise in fighting multicellular parasite invasions (worms etc). Accumulate in the nose during allergic rhinitis.
Lymphocyte	Mainly lymph, also blood	Lymphocytes include natural killer cells (innate cell-mediated immunity), T-cells (adaptive cell-mediated immunity: source of TNF (Tumour Necrosis Factor), B-cells (antibody-driven immunity).
Monocyte	Essentially all tissues	Largest leukocyte. Can differentiate into macrophages. Main function phagocytosis (engulfing invaders).
Macrophage	Essentially all tissues	***Phagocytosis***: "big eaters" of cellular debris, foreign substances, microbes, cancer cells, anything that lacks the type of proteins specific to healthy body cells. M1 macrophages encourage inflammation, via TNF production. M2 macrophages discourage inflammation and encourage tissue repair, wound healing.

The cells described in Table 2 combine to deliver two basic types of immune response: antibody-mediated immunity and cell-mediated immunity.

1. **Antibody-mediated** (also known as humoral) immunity involves activation of B lymphocytes (see Table 2), which recognise an **antigen** (toxin or other foreign substance) and differentiate to form either plasma cells or memory cells. Plasma cells synthesise and secrete **antibodies** specific for that particular antigen. Memory cells are the basis of long-term immunity – if the antigen enters the body again at a later time, memory cells can immediately be reactivated to become plasma cells, which then secrete the specific antibodies they were programmed to produce by the earlier exposure.

Antibodies are proteins that circulate in the blood and react specifically with the antigen that provoked their production. They are often refered to as **immunoglobulins,** and come in five classes. **IgM** is the major component of the primary antibody response in adult humans and is the first antibody to appear in the immune reaction. **IgG** is the principal component of the secondary immune response in adults and also provides natural passive immunity by crossing the placenta and protecting the foetus and newborn. **IgA** is present in breast milk, as well as in tears, saliva, urine etc. **IgD** and **IgE** are found in very small quantities and are important in anaphylaxis: a localised IgE reaction is called allergy. Antibodies work by attaching themselves to invaders like viruses, thus (a) rendering the virus more attractive to phagocytes (see Table 2) and (b) preventing it from entering body cells, which it needs to do in order to reproduce itself.

2. **Cell-mediated** immunity involves the direct activation of **phagocytes** (cytotoxic T-lymphocytes and macrophages: see Table 2) to release various kinds of cytokine and thereby take out the invader directly.

Cytokines are small proteins involved in cellular signalling and the killing of any cells not recognised as part of the body. A breakdown of this self vs not-self recognition and the resulting chronic overproduction of cytokines that cause inflammation is the basis of autoimmune diseases like rheumatoid arthritis and lupus. Inflammation is also implicated in the genesis of pathogenic blood clotting, heart disease, stroke and cancer. This makes inflammatory cytokines very much a double-edged sword (Aggarwal 2003). Specifically, they are known to cause the sorts of 'ground-glass opacities' in the lungs that appear in the respiratory distress syndrome attributed to the coronavirus COVID-19 (Huang et al 2020; Wu et al 2019).

Effects of microwaves on leukocytes

Biological experiments on the effects of microwaves on lab animals involve exposure to microwaves either *in vitro* (Latin for 'in glass') or *in vivo* (Latin for 'in life'). *In vitro* experiments involve harvesting the tissue of interest from the animal, culturing it in a petri dish and exposing the dish to radiation. *In vivo* experiments expose the whole animal to radiation, then harvest and study the tissue of interest. In both kinds of experiment the irradiated tissue is compared with 'contol' tissue that has not been irradiated at all, and/or 'sham-control' tissue that has been exposed to non-activated irradiation equipment.

For the reason explained in the chapter on evidence for DNA damage, only *in vivo* studies will be considered here. Portelli et al (2013) found that an unknown but large percentage of the laboratory incubators that are necessarily used during *in vitro* experiments generate unrecognised and very variable magnetic fields. In the present context such fields represent important uncontrolled variables –

which effectively means that all existing *in vitro* experiments, whatever their outcome, must be regarded as unreliable.

Exposure of lab animals to mm or near-mm wave radiation

It is widely believed that no experimentation has been done on the biological effects of very high frequency microwaves – and indeed virtually none has been done in America. However, in the former Soviet Union, very high frequency microwaves have long been used in the immunotherapy of cancer (Logani et al 2011), so some studies of their effect on the immune system of lab animals have been done in Russia.

For example, Fesenko et al (1999) exposed male mice to whole-body irradiation with either 10 GHz continuous or 8.15-18 GHz swept radiation, at an average power density of 1 μW/cm^2 (actually 0.2–1.6 μW/cm^2, depending on location in the cage). This caused significant release of TNF (tumour necrosis factor) by the animals' immune systems. In other words, the irradiation caused significant release of the major cytokine involved in producing inflammation and thereby destroying cells.

Figure 5 shows that the major increase in TNF release occurs after 5 hours of exposure to 10 GHz radiation; then there is a decrease in production, followed by a lesser, slow increase lasting 5 days – and then a complete decrease in the capacity for cellular immunity, with the cytotoxic abilities of macrophages becoming undetectable. This reduction in capacity lasts at least 7 days: the effect of longer lasting microwave exposure is unknown. Exposure to swept frequency radiation (8.15–18 GHz, 1μW/m^2) was even more effective in increasing TNF production by macrophages, which perhaps suggests that higher microwave frequencies are more effective at producing a 'cytokine storm' of inflammatory immune activity.

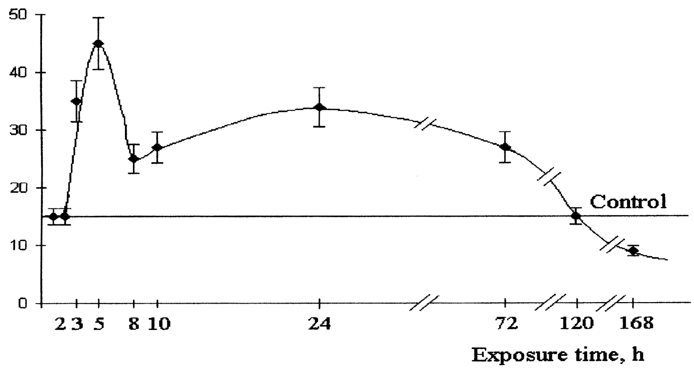

Figure 5: Fig 1 from Fesenko et al 1999. Vertical axis: TNF concentration (picograms/ml)

Further *in vivo* papers on the effects of high frequency, low intensity microwaves include two studies published only in Russian (Lushnikov et al 2001; Kolomytseva et al 2002). English-language summaries of these (Szmigielski 2013) report that :

- Lushnikov et al (2001) exposed male mice to 42 GHz radiation with a power density of 150 μW/cm^2 (0.015 μW/m^2), either once for 20 min or for 20 min a day for 5 or 20 days before immunization with an unspecified antigen, or for 20 min a day for 5 days after immunization – and measured the effects on the number of antibody forming cells in the spleen and thymus and the titer of antibodies. Repeated irradiation for 20 days before immunization reduced the number of immune cells in the spleen and thymus, but the other patterns of irradiation had no effect.

- Kolomytseva et al (2002) found that the phagocytic activity of neutrophils in mouse blood was reduced by about 50% within 2-3 hours after a single 20 min exposure to 42 GHz radiation at a power density of 150 μW/cm^2. This effect persisted for a day, then the phagocytic activity of the neutrophils returned to normal within 3 days. In mice exposed to the radiation for 5 days the number of leukocytes increased by 44%, mostly but not completely due to an increase in lymphocyte count. So apparently a burst of radiation briefly reduced the ability of neutrophils to carry out their assigned function of eating invaders, but continued exposure to the radiation resulted in an increase of neutrophil numbers – so the overall effect of prolonged irradiation may have been to increase immune function, as found with the lower frequency radiation studied by Fesenko et al (1999).

The message from these two studies seems to be that very high frequency microwaves (millimetre waves) do have direct effects on the immune system – but in ways that change over the course of a week or so. Basically, the immune system adapts to continued irradiation, in ways that are not *a priori* predictable and may or may not be beneficial to the animal.

More recently, Gapeyev et al (2008) find that low intensity mm waves cause an overall decrease in the inflammatory activity of macrophages and neutrophils in response to injection of the yeast antigen zymosan – which decrease is, however, strongly dependent on all of frequency, power and duration of exposure. With regard to frequency, some frequencies reduce the inflammation caused by injection of zymosan, while others do not, and this effect is quite narrowly frequency-dependent.

With regard to power and duration of exposure, the dependence on these was complex. A bell-shaped dependence of the anti-inflammatory effect on exposure duration was seen at a power density of 0.1 mW/cm^2, with the most effective duration of exposure being 20–40 min. However at a power density of 0.01 mW/cm^2 there was a linear dependence on exposure duration, with a significant effect appearing only after 2 hours of exposure.

In summary, mm waves demonstrably have catastrophic effects on the ability of the immune systems of lab animals to respond to challenges – either increasing the immune response to levels counterproductive to the organism, or reducing it to zero – and these effects are strongly dependent on both the precise frequency and the precise power density of radiation, and the duration of exposure.

Exposure of lab animals to longer wavelength microwaves

(a) Pulsed radiation

Here reported results – or at least the conclusions drawn from them in the abstract – tend to correlate well with both the source of funding for the research and the journal in which the research is published.

Gatta et al (2003), working at the ENEA (Italian Agency for New Technologies, Environment and Energy) in Rome and funded by the Elettra2000 Consortium, (the Italian arm of ICNIRP) published in the journal *Radiation Research* that *in vivo* exposure of female mice to 900 MHz GSM-modulated radiation for 2 hours a day for one, two or four weeks had no effect on populations of T and B lymphocytes in the spleen. However, after one week of daily exposure they observed an increased release of interferon-gamma (an inflammatory cytokine released primarily by Natural Killer cells and T lymphocytes), which increase disappeared after 2 and 4 week exposure. The authors comment "This suggests that the immune system might have adapted to RF radiation as it does with other stressing agents", and conclude that "a clinically relevant effect of RF radiation on the immune system is unlikely to occur". An alternative conclusion is that these results recapitulate the findings of Fesenko et al (1999), who show that exposure to higher frequency microwaves also causes an initial 'cytokine storm', followed by an adaptation or exhaustion of the cellular immunity system.

Three years later Nasta et al (2006), also working at the ENEA in Rome, funded by the ICEmB and again publishing in *Radiation Research*, report that exposing female mice to 900 MHz GSM-modulated microwaves for 2 hours a day for 1, 2 or 4 weeks still causes no change in the percentage of T or B lymphocytes in the spleen. But this time, instead of looking at the functioning of the cellular immune system, the group investigated antibody-driven immunity. They report that the antigen specific IgG and IgM response was not changed by irradiation, which again leads them to conclude that their results "provide no support for health-threatening effects". It should be noted however that the overall results from this group also support the rather less sanguine conclusion that the proven effects of pulsed 900 MHz radiation on the immune system involve cell-mediated immunity, but not antibody-mediated immunity (see the section at the start of this chapter called What is the immune system? for information on the difference between cell-mediated and antibody-mediated immunity). Since the enhanced release of inflammatory cytokines involved in cell-mediated immunity has multiple undesirable effects on the animal as a whole, this is not a particularly good endorsement for the idea of exposing humans to unregulated microwave irradiation. Either the initial weeks of exposure could generate inflammatory problems, or the later complete extinguishing of the capacity for cellular immunity could generate the opposite sort of problem. Either way, the conclusion that constant microwave irradiation produces "no health threatening effects" on the immune system would appear to be completely unjustified.

Other research groups produce similarly worrying results (but unlike the Italians acknowledge the fact). El-Gohary and Said (2017), working in Egypt, exposed two month old rats to 900 MHz radiation from a GSM mobile phone for either one hour a day or two hours a day. After a month, both exposure durations had caused a significant significant increase in neutrophil and monocyte counts, and a significant decrease in all of : immunoglobulin levels (IgA, IgE, IgM, and IgG); total leukocyte, lymphocyte, eosinophil and basophil counts. These changes were more pronounced in the group exposed for 2 h/day, but did not appear at all in animals exposed for only 7, 14 or 21 days. In other words, after a month of exposure of adolescent rats to a working cellphone for an hour or two a day – not an unusual exposure for adolescent humans addicted to a cellphone – these workers too observed an increase in those cells particularly involved in cellular immunity: but they additionally found a strong decrease in antibody-immunity. Interestingly, Vitamin D protected against both effects.

Esmekaya et al (2010), working in Turkey, exposed two-month-old rats to pulse modulated 900 MHz radiation for 20 minutes a day for three weeks and report that this inhibited secretion of thyroid hormones and caused cell death in and shrinkage of the thyroid gland. They conclude that "overall findings indicated that whole body exposure to pulse-modulated RF radiation similar to that emitted by global system for mobile communications (GSM) mobile phones can cause pathological changes in the thyroid gland."

Kimata (2002) found an enhancement of allergic skin wheal responses in patients with atopic eczema/dermatitis was caused by exposure to mobile phone irradiation, and the same author (Kimata 2005) then reported that this was mediated by increased allergen specific IgE production.

(b) Continuous radiation

It might be expected *a priori* (see Chapter 1) that continuous radiation might have less effect on biology than pulsed radiation. And indeed the reported biological effects of continuous microwave irradiation do appear contradictory. Some report stimulation, some report suppression and some report no effect on leukocyte numbers and function (for examples see the Discussion sections of Fesenko et al 1999 and Busljeta et al 2004).

Some of the results playing into this confusion are clearly suspect: for example the report of Anderson et al (2004) originates from a contract research company employed to do this piece of work by Motorola, and again is published in *Radiation Research*.

It is possible that some of the apparent confusion is simply an artefact of failure to measure the right immunological factors. For example, Nageswari et al (1991) exposed rabbits to 2.1 GHz radiation at 0.5μW/m^2 for 3 hours a day, 6 days/week for 3 months and found that this led to the apparently self-contradictory results of lowered T lymphocyte counts in the spleen and lymph nodes, no change in the tissue T lymphocyte counts, and what they interpreted as an overall increase in T lymphocyte function as measured by footpad thickness after a tuberculin challenge. Footpad thickness after an antigen challenge is indeed an accepted proxy measure of T lymphocyte function as evidenced by production of Tumor Necrosis Factor (which does cause, among other things, thickening of the footpad). However footpad thickness is also an accepted proxy measure of the production of TNF by M1 macrophages (see Table 1). So it is possible that the results of Nageswari et al (1991) again indicate an effect of 2.1 GHz irradiation on macrophages, but not lymphocytes This would certainly fit with other findings that microwave irradiation affects cell mediated immunity but not antibody mediated immunity.

The alternative interpretation above is in a sense generalised by Marino et al (2001), who introduce the ideas behind chaos theory (Ruelle 1991) into the interpretation of the apparently contradictory results generated by exposure of animals to microwave irradiation. In their words : In earlier EMF bioeffects studies of the effect of fields on the immune system it was generally assumed that any real effect would be proportional to the field, unidirectional, and would occur more or less consistently in a particular variable. Sometimes the assumptions were explicit, but more often they were implicit in the statistical procedures utilized. In contrast, we assumed that: (1) a true deterministic response could be either an increase or a decrease, depending on the animal; and (2) the particular variable affected by the field could be a priori undeterminable. A roulette wheel exemplifies the latter idea. An input (releasing the ball) always results in an output (ball in a slot) but the particular slot is not predictable." They then hypothesized that "an effect of the EMF would not be observed by comparing means in large samples, because oppositely-directed changes would be averaged away. A single small sample might reveal the putative effect as a consequence of incomplete averaging, but statistical tests on small samples generally lack statistical power".

So Marino and colleagues made more than 3600 individual measurements of 20 different immune variables in a series of mice exposed to very carefully controlled magnetic and 60 Hz electromagnetic fields for 1, 5, 10, 21 and 49 days, and applied a novel statistical procedure to compare the results with those produced in sham-exposed animals. Using a test statistic sensitive to the difference between the exposed and control groups but not to the direction of the difference, they tested the single overall hypothesis of an EMF-induced change. After 1 or 5 days of exposure there were 4 statistically significant differences. After 10 days there were 3 differences, after 21 days 5 differences and after 49 days of exposure, statistically significant differences were found in 4 of the immune variables tested. Only one significant difference was found in a sham experiment where both groups were non-exposed. Marino and colleagues conclude that the immune system does respond to electromagnetic fields, but that the system is more complex than generally acknowledged and may well be best studied by chaos theory. Chaos theory is a branch of mathematics focusing on the study of non-linear systems, whose apparently-random irregularities and states of disorder are often governed by deterministic laws that are highly sensitive to the initial conditions present in any given animal ('the butterfly effect').

Further haematological effects of exposure to electromagnetic fields are reviewed by Jbireal et al (2018).

Summary and Conclusions

A fair summary of this evidence is that all forms of radiofrequency electromagnetic fields, but especially those employed in mm wave '5G' technology (see Chapter 1) cause

- large increases in the release of inflammatory cytokines from the immune cells underpinning cell-mediated immunity, but
- no change or a decrease in antibody production after an antigen challenge and
- a wide variety of reported effects on leukocytes.

Thus, the only thing that appears to be clear is that exposure to high frequency 5G radiation alone exactly mimics the lethal health effects currently being attributed to a coronavirus (Huang et al 2020). Unfortunately, no reliable information is currently available about either:

(1) the geographic locations where and the switch-on times when mid-band 5G technology has been deployed (the umbrella term '5G' appears to be applied equally to the low-band version of the technology) or

(2) what percentage of deaths reported in various locations are actually due to the acute respiratory syndrome first described in Wuhan (which includes a number of features consistent with the effects of a great increase in release of inflammatory cytokines – as Huang et al (2020) specifically put it, a 'cytokine storm') and what percentage might more reasonably be attributed to existing 'underlying conditions'.

In the absence of such information, it is not possible to rule in or out the hypothesis that COVID-19 deaths are actually due not to a coronavirus at all, but to the onset of chronic irradiation by mid-band 5G technology.

The only thing that is clearcut at this stage is that the widespread pronouncements by The Establishment that "there is no scrap of evidence for any effect of high frequency radiation on the immune system" are simply wrong (see Figure 6). Yet again, the complaint that anti-5G activists are "spreading misinformation" is an egregious example of the pot calling the kettle black. What "there is no scrap of evidence for" is the pronouncement that 5G is harmless.

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Chapter 8

DIABETES

What is diabetes?

When food is digested in the stomach, one of the main breakdown products is glucose, which is released into the bloodstream. The pancreas (a gland located behind the stomach) senses any increase in blood glucose and responds by secreting the hormone insulin. Insulin stimulates receptors on the muscles and other tissues to allow glucose to move from the blood into the tissues, where it is used for energy.

Diabetes is a condition in which

- the pancreas fails to secrete insulin, and/or
- insulin fails to work in allowing glucose to enter the tissues that need it. (This latter condition is called insulin resistance).

Either way, the result is that glucose builds up in the blood. A build-up of glucose in the blood is called hyperglycaemia (hyper = too much; glyc = glucose; aemia = in the blood). Chronic hyperglycaemia above a generally accepted glucose concentration is called diabetes.

Diabetes is not something you want to have. It is associated with the development of all manner of nasty effects on the heart, eyes, brain, circulatory and immune systems. People go blind and have feet amputated. This is not a nice condition.

Diabetes pandemic

It is therefore deeply unfortunate that the world presently appears to be in the grip of a world-wide epidemic of diabetes (Hu et al 2015; Zimmet 2017).

According to Harvard researchers Hu et al (2015)

"In 2014, more than 380 million people were living with diabetes worldwide, representing 8.3% of the global population. This number is expected to rise to 592 million by 2035. Diabetes is no longer a disease of the affluent, with lower socio-economic groups being disproportionately affected in high income countries (HICs), and 77% of the world's diabetic population living in low and middle income countries (LMICs). It is also no longer predominantly a disease of the old, with almost half of the people with diabetes in the 40–59 year age range. Low and middle income countries face the added challenge of dealing with a dual burden of disease, as they are seeing a rise in obesity and diabetes levels, while still grappling with undernutrition and infectious diseases.

In 2013, diabetes was associated with an astounding $548 billion USD in health expenditures globally. This figure is expected to increase when indirect costs due to lost productivity and comorbidities are taken into account. The escalating diabetes pandemic has the potential to overwhelm health care systems and threatens to reverse the gains of economic development in many LMICs. Considering the serious human, societal, and economic consequences, there is an urgent need for health professionals, policy makers, and the public to recognize the magnitude of the diabetes epidemic and the potential devastation it may inflict throughout the world, particularly in LMICs."

When it comes to speculation about the cause of this pandemic, victim blaming generally prevails, with rampant obesity suggested (obesity is postulated to cause insulin resistance) and sugar taxes proposed. Completely unmentioned are the twin facts that:

1. One major environmental pollutant that has increased world-wide in parallel with the development of the diabetes pandemic is pulsed radio-frequency radiation (RF), aka microwaves (Bandera and Carpenter 2018)

2. There is clear evidence that pulsed radiofrequency radiation (RF) causes:

(a) in animals, both a failure of the pancreas to secrete insulin (Jolley et al 1982; Sakura and Satake 2004; Topsakal et al 2017; Masoumi et al 2018) and a direct modification of the insulin molecule such that the insulin cannot be recognised by the tissues that need it (Meo and AlRubeaan 2013; Li and Dai 2005)

(b) in humans, chronic hyperglycaemia (Meo et al 2015; Havas 2008; Altpeter and Krebs 1995).

Animal studies

Impaired insulin release by the pancreas

The section of pancreas that secretes insulin is called the Islets of Langerhans. As long ago as 1983 (before even 2G cellphones were widely available) Loma Linda researchers Jolley et al (1983) exposed rabbit Islets of Langerhans to 5 ms bursts of magnetic pulses repeating at a 4 kHz rate and noted a significant decrease compared with controls in insulin release during glucose stimulation. Twenty years later, Japanese researchers Sakurai et al (2004) found a decrease of 30% in insulin secretion from islet cells exposed to low-frequency magnetic fields as compared with a sham-exposed control. But these reports were not followed up.

More recently, and more relevantly to current conditions, Egyptian workers Topsakal et al (2017) and Iranian workers Masoumi et al (2018) both report that 2.45 GHz WiFi irradiation causes significant damage to rat pancreatic tissue, resulting in reduced insulin secretion and hyperglycaemia. In other words, exposure to WiFi has become a standard method for creating a rat model of diabetes.

Since there are so many diabetics in the United States, one might imagine that funding for further study of this rat model of the disease should be relatively easy to obtain in the United States. Inexplicably, it does not appear to be so ....

Insulin resistance

Saudi researchers Meo and Rubeaan (2013) report that rats exposed for more than 15 min a day for three months to the pulsed microwaves generated by a mobile phone had significantly higher fasting blood glucose and serum insulin compared to the control group, with the increase in fasting blood glucose being due to insulin resistance.

It is generally assumed that insulin resistance (the failure of insulin to work) is due to alterations in the insulin receptor. However, Shanghainese researchers Li et al (2005) exposed a solution of insulin to pulsed 50 Hz electromagnetic fields and reported that this caused a conformational change in the insulin molecule, which resulted in a decrease in the binding capacity of the insulin to its receptors.

Epidemiological evidence

Again from Saudi Arabia, Meo et al (2015) report on the results of an experiment in which the independent variable was RF exposure from a cell tower. Two elementary schools were chosen and the power densities of RF were measured inside their buildings. Because of proximity to a cellphone tower, RF exposure inside one school was found to be 9 times higher than RF exposure inside the other school. Two populations of school children, one from each school, were then selected on the basis of being similar in all respects except for this daily RF exposure (which they had experienced for 6 hours a day, 5 days a week for 2 years, since the erection of the towers). In Saudi Arabia only boys get to go to school, so all subjects were male. Their age ranged from 12–16 years in one school and 12–17 years in the other, with an average age in both schools of about 14 years. Any student who was either an athlete or a frequent consumer of junk food was excluded from the study, as were smokers and students with marked obesity, or a family history of diabetes, anaemia, or asthma. So as far as could be ascertained, these were two identical groups of ordinary, normal pupils.

With appropriate parental consent, the investigators then measured the levels of glycated haemoglobin (HbA1c) in the blood of both groups. They found that levels of HbA1c in the high-RF group were significantly greater than those of the lower-RF group.

What does that mean? Haemoglobin is the protein in red blood cells that carries oxygen from the lungs to the rest of the body. Glycated haemoglobin molecules are haemoglobin molecules that are bound to a molecule of glucose. Since this binding lasts for the life of the red blood cell (about 120 days) the percentage of haemoglobin molecules that are glycated is generally accepted as a convenient marker of the average glucose level in a person's blood over the past few months (WHO Report 2011). Thus a statistically significant finding of greater amounts of HbA1c in the blood of the group chronically exposed to higher RF suggests an association between high RF exposure and the development of diabetes.

But 'statistically significant' is not necessarily the same as 'important'. How important is this finding?

The normal level of HbA1c in blood is less than 6%. The level accepted as indicating "pre-diabetes" is anything between 6% and 5.6%. The mean levels in the blood of the two groups of students were 5.445 ± 0.22 (mean±SD) in the high-RF group and 5.325 ± 0.34 in the group with the lesser RF exposure. While this difference is statistically significant ($p<0.007$), it is hardly a cause for panic. However, it was also found that 31.25% of the high RF exposure group exceeded the minimum level for being diagnosed with pre-diabetes, while only 27% of the low-exposure group did. Thus, this result does indicate a real and concerning effect of RF exposure.

Are there any other results supporting this effect? One earlier study (Alpeter and Krebs 1995) finds that the incidence of frank diabetes mellitus was higher among subjects living close to a shortwave transmitter in Schwarzenburg, Switzerland than in a population living further from the transmitter, with a linear relationship between RF exposure and prevalence of diabetes.

Canadian researcher Havas (2008; 2009) also reports that exposure to pulsed electromagnetic pollution causes higher plasma glucose levels in people who already have diabetes.

Conclusions

Taken as a whole, this evidence strongly suggests that the real cause of the current diabetes pandemic may be the pulsed electromagnetic radiation emitted by cell phone technology, WiFi and an increasing proliferation of 'smart' devices.

Certainly the precautionary principle would dictate that cell towers should not be built close to schools. It would also be prudent to

- ban the use cell phones in schools
- replace school Wi-Fi routers with wired LANs (Local Area Networks).

These measures have already been taken in Israel, France and Cyprus.

Arguably, similar measures should also be implemented by individual parents.

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Chapter 9

CARDIOVASCULAR PROBLEMS

Despite vast improvements in primary and secondary prevention of cardiovascular disease over the last 60 years, including sterling and largely successful public health efforts to reduce the prevalence of modifiable risk factors like smoking and lack of exercise, cardiovascular disease remains the leading cause of death world-wide (Vernon et al 2017). Indeed the proportion of STEMI[13] patients with no acknowledged risk factors is high and increasing.

This suggests the existence of some risk factor that is yet to be recognised. Bandara and Weller (2017) propose that this unrecognised factor may be the increasingly inescapable exposure of the entire population to microwaves emitted by wireless devices – mobile phones and their base stations, WiFi, baby monitors, smart meters, vehicular 'anti-collision' radar and more recently, even satellite emissions.

Some evidence supporting this proposal is as follows:

1. **Effect of microwaves on heart rate variability**

A group of heart cells called the sino-atrial node works as a natural pacemaker, determining when the heart muscle contracts. The SA node receives inputs from both sympathetic and parasympathetic nervous systems – sympathetic input generally causes the heart to beat faster (tachycardia; the 'fight or flight' response) and parasympathetic input makes the heart beat more slowly (bradycardia; deep breathing, digesting food, non-dreaming sleep). It has lately been recognised that the variability in time between successive heart beats is an important measure of how well the body can respond to varying environmental or internal conditions. In very general terms, low HRV (heart rate variability) is a bad sign. According to Sessa et al (2018), low HRV has been found to be a predictor of mortality (a) after heart attacks (b) in chronic heart failure – and also (c) to be an independent predictor of sudden cardiac death, which accounts for approximately 25% of deaths in clinical cardiology. Maheshwari et al (2016) also find that low HRV, as measured by a simple 2 minute electrocardiogram (ECG), is an independent predictor of sudden cardiac death in the general population.

It is therefore important that microwave/radiofrequency emissions have repeatedly been shown to lower HRV (Alassiri et al 2020; Andrzejak et al 2008; Bellieni 2008; Bortkiewicz et al 2009, 2012; Ekici et al 2016; Saili et al 2015).

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[13] STEMI stands for ST Elevation Myocardial infarction. 'Myocardial infarction' is the medical term for heart attack. 'ST elevation' refers to an abnormality in a particular part of the electrocardiogram (ECG – the waveform that can be recorded from electrodes placed on the chest).

2. **Effect of microwaves on blood pressure**

Braune et al (1998a) report that blinded exposure of healthy men and women to cellphone radiation caused statistically significant increases in both systolic and diastolic blood pressures, both standing and at rest. Measurements of capillary perfusion showed significantly more pronounced vasoconstriction during exposure. Braune et al (1998b) then answer criticism by Reid and Gettingby (1998) that the number of participants in the original experiment was too small to provide adequate results by pointing out that small numbers of participants are indeed prone to produce false negative results, but when a positive result with a significance of $p<0.0001$ is achieved with only a small number of participants, this is more than usually convincing. They then go into great detail about the statistics of the situation, which had not been possible in the original report because of editorial constraints with regard to length. In short, this is a very well-executed and analysed experiment.

Acute exposure to WiFi radiation also increases heart rate and blood pressure in rabbits (Saili et al 2015).

3. **Effects of microwaves on blood chemistry and oxidative damage to the mycardium**

Kismali et al (2012) report that whole body exposure of rabbits to 1.8 GHz GSM-like radiation for a mere 15 minutes a day for seven days caused changes in blood cholesterol, total protein, albumin, uric acid, creatinin – and particularly in creatine kinase and creatine kinase-myocardial band isoenzyme, which are accepted biomarkers of oxidative stress (see Chapter 13).

Jbireal et al (2018) review multiple effects of electric and magnetic fields on various blood parameters, hypothesising a pathway from these effects to congestive heart failure.

Kalanjati et al (2019) find that exposure of rats to cellphone-like radiation for 4 hours a day for 30 days causes significantly lower leukocyte and neutrophil counts and higher corticosterone levels compared with controls. Histology also revealed increasing areas of fibrotic myocardium and cardiomyocytes (damaged heart muscle) in the ventricles (the pumping chambers of the heart) in RF-exposed animals.

4. **Effects of microwaves on causation of cardiac Schwannoma**

Both the US National Toxicology Program (NTP 2018) and the Italian Ramazzini Institute (Falcioni et al 2018) report that microwave exposure causes cardiac schwannomas in rats. A cardiac schwannoma is a tumour of the Schwann cells that sheath nerves in the heart. Since these tumours have traditionally been extremely rare, autopsies on human sudden cardiac death patients almost never consider the possibility that the cause of death was a fatal arrythmia caused by a cardiac schwannoma. Given the widespread practice of carrying active cellphones in breast pockets, it might be a good idea if coroners were to start considering this possibility.

5. Effects of microwaves on the causation of amyloidosis

Amyloidosis, the buildup of an abnormal protein called amyloid, is a rare condition that can affect many organs, including the heart. There is some evidence that amyloidosis can result from radiofrequency irradiation (Dasdag et al 2012).

In summary, there are multiple ways in which microwave radiation can and does cause cardiovascular problems. This provides a transparent explanation for the otherwise inexplicable increase in heart disease occuring in people with none of the previously acknowledged risk factors.

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Chapter 10

WILDLIFE

The health effects of microwave pollution are not confined to humans. Since all life exists in virtue of much the same physiological mechanisms, all life is affected by electrosmog. Mammals, birds, fish, amphibians, insects, plants and even bacteria are affected by microwave pollution.

TREES

Haggerty (2010) lists a number of incidents of aspen decline that have been recorded in North America over the last fifty years and suggests that the vastly increased RF background in that part of the world may have "strong adverse effects on growth rate and fall of anthocyanin production in aspen and may be an underlying factor in aspen decline." In support of this hypothesis, she points out that "Globally, the highest [RF] field strengths occur in central Europe, the eastern United States, and in China (figure showing areas of highest radio background intensity in the eastern United States, central Europe, and China, acquired by the Los Alamos National Laboratory FORTE spacecraft). Forest decline was first recognized and defined based on observed events in central Europe and the eastern US, and China, at this time, is experiencing rapid desertification" . She then reports results from a preliminary experiment showing that growing aspen seedlings in a Faraday cage (which measurably excluded a large percentage of ambient radiofrequency radiation) resulted in enhancements of both growth during the growing season and the production of anthocyanin (red coloration of leaves) during the fall. In the latter regard, fall leaf tissue in the RF-exposed seedlings remained light green or yellow, with a high percentage of leaves affected by necrotic lesions. Since anthocyanins are a type of flavonoid, a class of compounds with potent antioxidant effects (see Chapter 13), the lack of their normal appearance in autumn leaves facilitates photooxidative stress.

Proximity to cell towers is also strongly and obviously correlated with damage to both deciduous and non-deciduous trees (Waldmann-Selsam et al 2016). Two examples of local tree damage are shown in Figures 6 and 7.

Figure 6: Cell tower and pine tree, Matiatia, Waiheke Island, New Zealand.

Figure 7: Cell tower and liquid amber tree, Grey Lynn, Auckland.

BIRDS

Since the early 21st century, there has been a well-documented decline in the population of urban birds, coinciding with increased densification of cell towers. In England, numbers of house sparrows declined so much between 1994 and 2002 (Prowse 2002; Raven et al 2002) that the species was added to the Red List of U.K. endangered species (Summers-Smith 2003). Balmori and Hallberg (2007) show that remaining sparrows actively avoid cell towers (Figure 8).

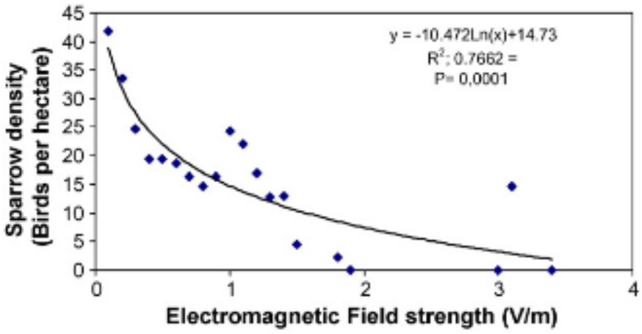

Figure8: Mean sparrow density as a function of electric field strength (Balmori and Hallberg, 2007)

In Belgium, Everaert and Bauwens (2007) also report a statistically significant negative correlation between the strength of 900 and 1800 MHz electric fields and numbers of male house sparrows. In Spain, Balmori (2005) reports a harmful effect of proximity to a cell tower on white stork reproduction.

Bird migration

With regard to the effects of electrosmog on the navigational abilities of migratory birds, Engels et al (2014) write " For more than 50 years, it has been known that night-migratory song-birds can use the Earth's magnetic field to orient spontaneously in their migratory direction when placed in an orientation cage at night, in spring and autumn." These authors therefore conducted an experiment to see whether urban electromagnetic noise might disrupt this ability. The clear result was that it did. To quote the authors: "When European robins, Erithacus rubecula, were exposed to the background electromagnetic noise present in unscreened wooden huts at the University of Oldenburg campus, they could not orient using their magnetic compass. Their magnetic orientation capabilities reappeared in electrically grounded, aluminium-screened huts, which attenuated electromagnetic noise in the frequency range from 50 kHz to 5 MHz by approximately two orders of magnitude. When the grounding was removed or when broadband electromagnetic noise was deliberately generated inside the screened and grounded huts, the birds again lost their magnetic orientation capabilities. The disruptive effect of radiofrequency electromagnetic fields is not confined to a narrow frequency band and birds tested far from sources of electromagnetic noise required no screening to orient with their magnetic compass. These fully double-blinded tests document a reproducible effect of anthropogenic electromagnetic noise on the behaviour of an intact vertebrate."

Radiotelemetry
Balmori (2016) points out that the increasingly widespread practice of radiotracking migratory and other birds can produce serious unintended consequences. A case of particular interest to the present author is the critically endangered New Zealand parrot the kakapo. This large, flightless bird (which some time ago apparently ingratiated itself with the British public by mating with Stephen Fry's photographer's head[14]) is on the verge of extinction[15]. It is therefore very concerning that every single remaining kakapo in the world has been implanted by the NZ Dept of Conservation with a tracking transmitter, which continually emits radio waves of the sort *known* to cause immune problems (such as would predispose the birds to the fungal infection that recently killed a number of them) and developmental abnormalities (like embryo death and the hatching of chicks with holes in their skull[16]). Repeated attempts by the present author to alert any of the Department of Conservation, Auckland Zoo (when critically ill kakapo were being cared for there) and various university academics to this situation either went either unanswered, or in the case of a couple of the academics were met with responses that amounted to "not my problem" or "everybody does it, so it must be all right".

In the perhaps unlikely event that any of the people in charge of the kakapo rescue project read this, here's a hint: **If you want to prevent a species from going extinct, avoid fixing RF-emitting hardware to their bodies.**

BEES

Like birds, fish, whales, dophins, ants and yes, even microbes, honey bees have a magnetoreception sense (Gould 2014).

There now exists a *huge* scientific literature, nicely summarized by Ferrari (2014) on the fact that this magnetoreception sense is used (in conjunction with polarized light, an internal clock, the position of the sun and the earth's

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[14] https://www.youtube.com/watch?v=9T1vfsHYiKY

[15] https://www.theguardian.com/world/2019/jun/13/worlds-fattest-parrot-endangered-kakapo-fungal-infection-new-zealand

[16] https://www.bbc.com/news/world-asia-48229317

geomagnetic field) to allow foraging bees to find their way back to their hive. Thus, not only natural geomagnetic storms but also artificial cell phone radiation can result in colony collapse disorder, in which worker bees simply disappear from the hive with no evidence of disease among remaining bees. Of course colony collapse disorder has been described, under various names, since long before cell phones made an appearance in the mid 1980s – but in the first decade of the 21st century, it abruptly became more prevalent (Hamzelou 2007). George Carlo described the situation when this was first noticed in the following terms[17]:

Unfortunately, the situation with the bees is a page out of the playbook that we deal with all the time with the mobile phone industry. When the bee story first broke, it was based on a German study that showed information carrying radio waves disrupted the ability of bees to make it back to their hives. That work was made public about two months ago. There were other data to support it as well. The news media ran with the story, bolstered a great deal by a quote attributed to Albert Einstein something along these lines: 'Watch the bees. When they disappear, man will disappear within four years'.....The mobile phone industry was caught off-guard by the widespread media attention the story garnered.

After the first news cycle, the mobile phone industry 'hit squad' went into action. First, they planted stories that cast doubt on the Einstein quote. Never before have I seen such a desperate attempt to distance from a figure as revered as Albert Einstein. In the process, his name was besmerched. Very sad. Next, they conscripted scientists from a number of universities to begin going public with other explanations...viruses, bacteria, pesticides etc., etc., etc.. These alternatives have been making the rounds over the past month. The mobile phone industry is putting quite a bit of money into the pockets of these scientists by supporting their work regarding viruses and alternative explanations. The industry is dealing with it as a politics and public relations problem....thus, manipulation of the public perception is the appropriate remedy for them. Sadly, this is business as usual for the mobile phone industry.

Most people in the public don't know the back story, so they do not see the manipulation coming or have the necessary bases for skepticism to see through it. But here is the bottom line:

- The colony collapse disorder has occurred concurrently on four continents within a very short time frame. If the reason was biological or chemical, there would be a pattern of epidemic spread....we would be able to trace the spread of bee disappearance or Colony Collapse Disorder from a source, similar to the spread of SARS a few years ago. That is not the case. The condition has hit each continent at roughly the same time. That would mean the cause has to have hit the continents at the same time as well. Mobile phones meet that criterion.
- None of the biological or chemical hypotheses actually have a mechanistic explanation that is plausible. The science for the biological and chemical alternatives is far thinner than the science supporting the EMR connection. A case of the pot calling the kettle black.
- The disruption of intercellular communication hypothesis that we now know affects cell membranes in most species is biologically plausible...and no other theory has that support.
- The basis for a biological mechanism, coupled with the saturation in information carrying radio waves we have globally in the past 14 months, provides the underpinning. In 2004, we had the first billion cell phone users globally, the accumulation over 20 years; by mid 2006, we had the second billion; today we have surpassed three billion. That suggests we are near a saturation point of these waves in the ambient environment. The bees are likely the harbinger or the proverbial 'canaries in the coal mine'.
- Taken together, EMR is the only explanation that makes sense regarding the disappearing bees: the timing is correct -- the problem has occurred primarily within the past two years....when we have nearly tripled the background level of information carrying radio waves; the pattern is global so that suggests a cause that is globally present; there is at least one peer-reviewed study that supports it, and there is a mechanism documented that lends biological plausibility.

In support of this analysis, Favre (2011) report that placing mobile phone handsets near a hive for 20 hours caused worker bees to respond with the piping sounds that normally occur before swarming (relocation of the hive). No

[17] https://www.buergerwelle.de/assets/files/radiation_is_killing_the_bees.htm?cultureKey=&q=pdf/radiation_is_killing_the_bees.htm

swarming occurred in Favre's experiment, but phones left in place for ten days or more did reliably cause colony swarming (Sainudeen 2011). Sharma and Kumar (2010) observed statistically significant declines in colony strength and in the egg laying rate of the queen in cellphone radiation exposed colonies compared with unexposed colonies. The behaviour of exposed foragers was negatively influenced by the exposure, to the extent that there was neither honey nor pollen in the colony at the end of the experiment.

While bees do not usually live in close proximity to working cellphones, they are increasingly at risk from cell phone base stations or cell towers. Taye et al (2017) report essentially a dose response curve, in which bee colonies placed progressively closer to a cell tower fared progressively worse with regard to pollen foraging efficiency and numbers of workers leaving and returning to the hive.

Hirata et al (2007) and Thielens et al (2018) both show that the amount of radiation absorbed by bees' bodies varies depends on the frequency of the radiation. Absorption is greatly increased at 5G frequencies compared to 3G and 4G, simply because mm waves have wavelengths about the same size as a bee.

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PART III

THE MECHANISMS

Chapter 11

THE 'OFFICIAL' STORY

The wireless industry – and those of the political and scientific commentariat who, for one reason or another, accept the wireless industry's views – make two assertions:

(1) Without a proven mechanism by which microwaves could harm biology, all scientific evidence that they do harm biology should be either ignored or rejected.

(2) Microwaves are non-ionizing radiation, which means they are non-harmful (at least at power density levels too low to literally cook the organism).

These assertions are not usually laid out with such stark clarity. But they do represent the essence of official pronouncements on the matter.

This chapter argues that both assertions are indefensible.

1. In the absence of a proven mechanism, evidence of harm is not credible

This assertion shows either a complete lack of understanding of science, or (more likely) a desperate attempt to deny the reality that low intensity microwaves are harmful. Appendix I of this chapter points out that there is currently no certainty even about the mechanism by which high power density microwaves heat water – yet nobody would dream of claiming this means we should disbelieve the evidence that microwave ovens heat water.

Part II of this book documents a great deal of evidence that levels of microwaves too low to heat water have a large number of harmful effects on biological organisms. The rest of Part III discusses some of the many mechanisms by which these sub-thermal effects have been shown to occur.

2. Microwaves are 'non-ionizing' and therefore non-harmful

This assertion is wrong on two counts.

First, it is invalid to equate 'non-ionizing' with 'non-harmful'. There are many ways in which microwaves can affect biological organisms that do not involve ionization. Some of them are discussed in later chapters.

But secondly, it is actually debatable whether microwaves are necessarily 'non-ionising radiation'.

2.1: Are microwaves really "non-ionizing" radiation?

To discuss the disgracefully iconoclastic suggestion that microwaves may not necessarily be non-ionizing radiation after all, it is necessary to unpick the chain of assumptions and reasoning behind the confident assertion that they are. This chain is a long one, so is here subdivided into parts A through D, the better to identify the underlying assumptions and the point at which these become untenable.

2.2: Assumptions and reasoning underlying assertion that "microwaves are non-ionizing radiation"

2.2 A. Assumptions on the nature of radiation

- 2.2A.1 Electromagnetic (EM) radiation has a dual nature. It is simultaneously (a) a classical wave with a particular oscillation frequency and (b) a series of quanta, or tiny unbreakable packages of energy, called photons. The power carried by EM radiation is proportional in model (a) to the amplitude and frequency of the wave, and in model (b) to the number of photons and the energy carried by each photon.

- 2.2A.2 The two models are tied together by the Einstein Planck equation, which says that the energy carried by each individual photon is directly proportional to the oscillation frequency of the radiation, such that

$$E = \mathrm{hf}$$

where E is photon energy, h is Planck's constant and f is radiation frequency.

- 2.2A.3 Using the Einstein Planck equation, it can be calculated that the energy carried by each photon of microwave radiation is (depending on the frequency of the radiation) between 10^{-5} and 10^{-3} eV (that is to say, between one hundred thousandth and one thousandth of an electron volt).

2.2 B. Assumptions on the nature of matter

- 2.2B.1 Matter consists of particulate atoms, which may or may not be bound together in molecules. Each atom consists of an atomic nucleus containing protons and neutrons, surrounded by a cloud of negatively charged electrons, which afre confined to 'orbitals' around the nucleus. (An orbital is basically a cloud of probabilities of finding an electron, not a specific orbit or route taken by any particular electron).

- 2.2B.2 Ionization is a process that creates ions (electrically charged particles) by either (a) bumping an electron out of its orbital, or (b) disrupting the covalent chemical bond holding together different atoms in a molecule.

- 2.2B.3 At least 2.2B.2 is how *physicists* see ionization. *Chemists* take it for granted that ions also come into being whenever an ionic chemical like NaCl (a.k.a. sodium chloride, a.k.a. common or table salt) simply dissolves in water, and also when free radicals are generated as a normal byproduct of virtually all biochemical reaction pathways. More on this in the next two chapters.

- 2.2B.4 Both the bonding energy of any particular electron (the energy that has to be exceeded to bump it out of its orbital) and the covalent bond energies holding atoms together in molecules (the energy that has to be exceeded to break a covalent bond) are of the order of one to several hundreds of eV. (Compare this with the energy carried by a single microwave photon – 2.2A.3 above).

2.2 C. Assumption on the nature of radiation-matter interactions

- 2.2C.1 All interactions between radiation and matter proceed by way of single-photon events.

2.2 D. Conclusion

- 2.2D.1 Single microwave photons carry much less energy than needed to bump an electron out of its orbital. Therefore microwaves cannot ionize atoms or molecules.

So that's the argument. In order to see whether the conclusion is justified, we need to examine the validity of each of the underlying assumptions. And in order to do that, a brief excursion into the history of physics is called for.

A brief history of the physics of radiation and matter

On our present understanding, all of the assumptions under A and B above are substantially correct. However, a very brief overview of history in this area shows that, as in other fields of science, the overall pattern of development in this area has been for new ideas to be initially rejected, then treated as obvious, then replaced by yet newer ideas. In other words, the physics of this situation is not, and never has been, black and white.

With regard to electromagnetism in general, when James Clark Maxwell first published his seminal paper a little over 150 years ago (Maxwell 1865), the physicists of the time failed to understand his mathematics, the mathematicians of the time failed to understand his physical explanations, and Maxwell's now classical theory of electromagnetism was widely ignored for more than 20 years.

According to Freeman Dyson (Dyson 2007), this was partly because Maxwell failed to blow his own trumpet loudly enough, but mainly because he had, as Dyson puts it "replaced the Newtonian universe of tangible objects interacting with one another at a distance by a universe of fields extending through space and only interacting locally with tangible objects. The notion of a field was hard to grasp because fields are intangible". In fact, as Steven Weinberg (Weinberg 1977) says "Maxwell himself did not yet adopt the modern idea of a field as an independent inhabitant of our universe with as much reality as the particles on which it acts. Instead (at least at first) he pictured electric and magnetic fields as disturbances in an underlying medium – the aether – like tension in a rubber membrane." It was only after the failure of repeated attempts to measure any influence of the movement of Earth through space on the speed of light that the notion of the aether was quietly dropped, to eventually be replaced by Einstein's theory of special relativity (Einstein 1905a). Special relativity solved the problem by introducing the counter-intuitive postulate that the observed space-time coordinates of an event change with changes in the velocity of the observer, according to rules "specifically designed so that the observed speed of a light wave would be just that speed calculated in Maxwell's theory, whatever the velocity of the observer" .

In any case, Maxwell's classical wave equations were eventually accepted by all as accurate descriptions of how radiation behaves. But almost as soon as that happened, Albert Einstein made another gentle suggestion, that "According to the assumption to be contemplated here, when a light ray is spreading from a point, the energy is not distributed continuously over ever-increasing spaces, but consists of a finite number of energy quanta that are localized in points in space, move without dividing, and can be absorbed or generated only as a whole" (Einstein 1905b). And the entities that later came to be known as photons were born.

At the time there were no experimental data supporting this radical suggestion, and it too was roundly rejected. In fact as late as 1922, Neils Bohr's Nobel Prize lecture contained the bald statement "The hypothesis of light-quanta is not able to throw light on the nature of radiation." (Rigden 2005). Since then of course, a great deal of experimentation has enshrined photons as unquestionably real entities.

But again, almost as soon as *that* was generally accepted, the recognition of the dual nature of electromagnetic radiation as simultaneously waves and particles triggered a similar realisation about the nature of matter. Now, particles of matter are understood by quantum field theorists as the quanta of various fields, just as the photon is understood as the quantum of the electromagnetic field. As Weinberg (1977) puts it "the inhabitants of the universe [are now] conceived to be a set of fields – an electron field, a proton field, an electromagnetic field – with particles reduced to the status of mere epiphenomena." This view of the situation, however, has yet make it into physical arguments like that laid out above. How much difference it will make when it does remains to be seen.

Assumption 2.2 C : All radiation/matter interactions involve single photons

This very brief historical summary already suggests that assumption C of what I am calling the official argument – that radiation/matter interactions are necessarily single-photon events – might be far from an established fact. Certainly it is confidently stated as a fact by the proponents of the argument we are discussing. However, as Bridgeman (1927) puts it "we have no reason to think that present best opinions are in any way final".

And indeed, it turns out that multi-photon models of the interaction between radiation and matter are already legion in the literature on laser light (e.g. Spasibko et al 2017; Mouloudakis & Lambropoulos 2019). Interestingly, Spasibko et al (2017) specifically comment that ""noisy" light sources are much more efficient for multiphoton effects than coherent sources with the same mean power, pulse duration, and repetition rate" – which strongly suggests that the variable, pulsed emissions generated by modern cellphone and Wi-Fi technology (see Chapter 1 for details) might be particularly effective at producing multiphoton effects.

Of course, multiphoton models are very much harder to deal with mathematically than single-photon models (which might conceivably explain the general preference for single-photon models). At present the best that has been done is a model that fits the experimental results for a 14 photon process (Gold & Bebb 1964). Moreover – and in some ways even worse for the official argument – under some circumstances classical wave or quantum field models of radiation-matter interaction seem to provide better explanations of the observed facts than do quantum models (Gold & Bebb 1964; Leone et al 1989).

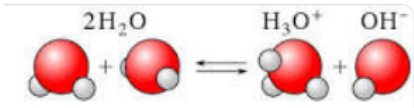
Thus, while it is true that nobody has yet done the fearsome math necessary to <u>model</u> the interaction between matter and the large numbers of *microwave* photons that would be necessary to shift any given wave function of the electron field between orbitals, there is no reason to believe that multiphoton interactions between microwaves and matter are impossible.

How many microwave photons would you need to shift an electron? If the energy supplied by any given photon is 10^{-3} eV and the electron binding energy is 1eV, arguably 1,000 photons should do the trick. Could you get that many microwave photons from the power density of microwaves commonly found in one square cm of any modern city street (Sagar et al 2018)?

The calculations in Appendix II certainly suggest that you could. These show that a common photon flux density at the Three Lamps bus stop in Ponsonby, Auckland (where the present author measured a microwave power density of 129 mW m^{-2}) is approximately 8 $x10^{16}$ $s^{-1}cm^{-2}$. In other words, on a typical day in early 2019 there were approximately 8 x 10^{16} (8 followed by 16 zeros) microwave photons passing through any given square cm of air at that location in each and every second. Should be enough?

To summarise, the fact that it is difficult to construct a mathematically tractable model of a particular process is no reason to believe that the process cannot happen. Work on laser light has clearly established the *principle* of multiphoton interaction. There is no particular reason to believe that multiphoton interactions with matter could not also happen at microwave frequencies of radiation, particularly if the microwaves are "noisy" (Spasibko et al 2017).

And, as mentioned above (2.2B.3) the dissociation of ionic compounds in water happens 'spontaneously' without the addition of any particular extra energy – this is called autoionization. When the subject is water itself, the reaction is



The hypothesis that ionic dissociation might be boosted by microwaves is not taken into account at all in the argument above. In fact Vaks et al (1994) claim that in their hands, microwaves do ionize water, and Saitta et al (2012) "observe that the hydrogen-bond length and the molecular orientation [of water] are significantly modified at low-to-moderate [electric] field intensities" and "Fields beyond a threshold of about 0.35 V/Å are able to dissociate molecules".

And even if you don't count dissociation as an example of ionization, as mentioned above the photon model of radiation may be less relevant to the physics of radiation/matter interaction than the wave model anyway.

And biochemistry is replete with examples of metabolic cycles that run on electron transfer between molecules which depends only in an ultimate, not an immediate sense on photon energy.

So overall, a prudent conclusion at this stage must be that microwaves are NOT necessarily 'non-ionizing radiation'.

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CHAPTER 11 APPENDIX I : How do microwave ovens heat water?

In the 21st century there can be few living adults who have never wrapped their hands around a mug of deliciously flavoured water that has been heated in a microwave oven. How do microwaves achieve this feat?

The standard explanation invokes a phenomenon known as 'dielectric heating' (Kappe et al 2012 Ch2). Basically, a single water molecule is composed of one oxygen atom, which carries two negative charges, and two hydrogen atoms, covalently bonded to the oxygen atom at an approximately 104 degree angle from each other and each carrying one positive charge. Thus the water molecule as a whole has a positive side and a negative side. It is an electric dipole.

In liquid water, where water molecules are relatively free to move, introduction of an external electric field forces each water dipole to rotate in space to align with the external field, in accord with the Coulomb force (a fundamental physical force dictating that opposite charges attract and like charges repel). When the external field is an electromagnetic wave instead of a static field, the electric component of the wave oscillates between positive and negative, which means that the water dipole is forced to flip backwards and forwards in order to keep up with the changing field. The faster the oscillations of the electric component of the imposed wave, the faster the water molecule has to flip. At microwave frequencies of oscillation – particularly at the 2.45 GHz frequency used in domestic microwave ovens – the repeated rotations of the water molecules (which at this frequency can almost but not quite follow the oscillations of the imposed field) cause significant between-molecule friction, which results in a temperature rise. To put this in other terms, some of the energy carried by the incoming microwaves is "absorbed" by the water and converted to thermal energy, which eventually manifests as heat. [This is the story for pure water. When the water contains dissolved ions (as does all water in biological organisms) an additional mechanism called 'ionic conduction' is thought to occur, in which ions in solution oscillate in the microwave field, collide with adjacent molecules and ions and again generate thermal or kinetic energy. Indeed, according to Kappe et al (2012), this conductivity principle has a much stronger effect than the dipolar rotation mechanism with regard to the heat-generating capacity of microwaves. But microwaves do still heat pure water].

It must be admitted that a good deal of hand-waving is involved in this dielectric heating explanation, in that in order to rotate into alignment with an externally imposed electric field, a molecule of liquid water has to contend with the network of hydrogen bonds that connect it to its neighboring water molecules in what Marcus (1995) calls "the well known three-dimensional network of liquid water". This is a problem because, although the published bond energies of hydrogen bonds are certainly a hundred times less than the those of the covalent bonds holding individual water molecules together, hydrogen bond energies are still a thousand times higher than the photon energy of microwaves (Kappe et al 2012 page 10). So according to the single-photon model of radiation/matter interaction (Assumption 2.2C.1 in the chapter to which this is an Appendix), microwaves are incapable of breaking hydrogen bonds. Of course it might be that hydrogen bonds have a very short lifetime and incident microwaves just have to wait until enough H bonds break spontaneously at the same instant to allow rotation of the water molecule into alignment with the microwave. But the lifetime of a hydrogen bond is a remarkably contentious matter – Astley et al (1999) say "in general there is no unambiguous or rigorous definition of the mean H-bond lifetime. At a molecular level one can understand this as arising from the difficulty in deciding when fast librational motion breaks an H-bond, and when it merely distorts it. Since the H-bond is a weak bonding interaction, such ambiguous distortions occur frequently, so that the precise definition of when the bond breaks can markedly alter the resulting lifetime". [Libration is a type of reciprocating motion in which an object with a nearly fixed orientation repeatedly rotates slightly back and forth].

It should now be becoming clear that according the 'official' model described in this chapter, even the mechanism by which high intensity microwaves heat water is far from completely understood. But high intensity microwaves clearly CAN heat water. Therefore there must be something wrong with the 'offical' model. Maybe what's wrong is the unsupported assumption that all interactions between radiation and matter have to involve single photons. Maybe it's something else. But *something* is wrong.

And the point of this Appendix is that anyone who tried to claim we must reject the evidence of our own eyes (that microwave ovens do heat water) simply **because we don't fully understand HOW microwave ovens heat water**, would rightly be regarded as an idiot.

The claim that we must reject the mountain of evidence documented in Part II of this book (that low-powered microwaves do damage biology) simply **because we don't fully understand HOW low-powered microwaves damage biology**, is equally idiotic. It beggars belief that people who make such a claim are taken seriously.

CHAPTER 11 APPENDIX 2 If microwave power density is measured at 129 mW per square metre, how many photons per square cm per second are there?

1. Convert power density from mW/m^2 to W/cm^2

$$P = 129 \times 10^{-3}\ W/m^2 = 1.29 \times 10^{-1}\ W/m^2 = 1.3 \times 10^{-5}\ W/cm^2$$

2. Convert the energy per photon from electron volts to Joules (multiply by electronic charge)

$$E = 10^{-3} \times 1.6 \times 10^{-19}\ J = 1.6 \times 10^{-22}\ J$$

3. Divide P by E to get photon flux density (photons/second/cm^2):

$$\frac{1.3 \times 10^{-5}}{1.6 \times 10^{-22}}$$

$$= 8 \times 10^{16}\ s^{-1}\ cm^{-2}$$

Chapter 12

WATER

Life could not exist without water. This is such an obvious fact – and water such a simple molecule (H_2O : just two atoms of hydrogen and one of oxygen) – that one might reasonably assume that everything which can be known about water is known, and indeed was discovered long ago.

Surprisingly, this is not the case. The issue is again that, while liquid water does indeed consist of discrete molecules of H_2O, these molecules are held together in various ways by structures called hydrogen bonds.

Buckingham et al (2008) say of hydrogen bonds "The literature abounds with mystical statements about the hydrogen bond. For example, a well known textbook states: 'Because the bonding depends on orbital overlap, the H-bond is virtually a contact-like interaction that is turned on when XH touches Y and is zero as soon as the contact is broken.' " Unfortunately they then add "for the vast majority of *normal* hydrogen bonds in the vapor and condensed phases, the electrostatic-plus-induction description provides a near-quantitative account of the attractive force responsible for the interaction, and has the virtue of simplicity." – which sounds to the non-expert at least as mystical as the first statement. A very rough summary of a huge number of publications in this area is that hydrogen bonds clearly come in a number of varieties, the details of which are not particularly important in the present context. What is important in the present context is the long-running debate over whether liquid water is basically a continuum of different H-bonding configurations, or whether it consists of a mixture of relatively well-defined species with regard to H-bonds.

This debate started well over a century ago, when Röntgen (1892) proposed that liquid water contains a mixture of two components, one ice-like and one of then-unknown characteristics. Little happened about this suggestion for about 30 years, probably because there did not seem to be any way of testing the idea. Then the technique of spectroscopy became widely available to physical chemists in the 1930s, and naysayers started reporting that the two-state idea of water was not upheld by experiment.

However, spectroscopy involves bouncing various kinds of electromagnetic radiation off the object of interest and looking for peaks in the resulting spectrum, which peaks are inferred to indicate absorption of the radiation by whatever structures are present. Thus, spectroscopy as a technique is always open to the objections that (a) the radiation itself might change whatever it is being used to observe, and (b) the technique can only look at average properties, on a relatively large spatial scale. These objections are particularly cogent when the system being investigated is water constrained in structures themselves as delicate and intricate as biological cells.

However, less potentially destructive techniques to address the question were found, and by the middle of the 20th century Henniker (1949) was able to publish a review of 174 papers suggesting that "vicinal" water (i.e. water found in the vicinity of various kinds of surfaces) has radically different properties from "bulk" water.

Initially this question was interesting only to physical chemists. But soon biologists realised the importance of vicinal water and it became clear that different kinds of surface are surrounded by different kinds of vicinal water.

The answer turned out to be that water comes in two quite different states of density, which critically depend on the characteristics of the hydrogen bonds between water molecules. Much of the evidence for this was obtained by New Zealander Phillipa Wiggins, during her tenure of a Career Fellowship of the late, lamented New Zealand Medical Reseach Council (for summaries see Wiggins 1990; 2001).

High density and low density water

A diagram showing the essential differences between these two states of water is shown in Figure 9.

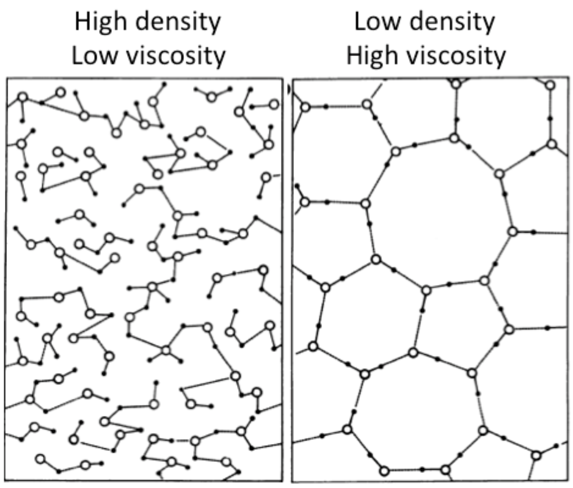

Figure 9: Two states of water (after Fig 6 of Wiggins 1990)

Figure 9 shows that in high density, low viscosity ('thin') water, the intermolecular hydrogen bonds are bent and weak, and there are many unbonded water molecules. Water in this state is very reactive, because it is rich in lone pairs of electrons and free OH^- groups, which are the reactive centres of water molecules (Symons et al 1981). In contrast, high viscosity, 'thick' water contains many ice-like, strong, straight hydrogen bonds and is relatively inert, because there are few reactive centres. Thick water behaves much like a gel.

According to Wiggins (1990), the water inside biological cells tends to be high viscosity, gel-like water. This is transparently explained by the facts that (a) Zheng et al (2006) report an association of charged (aka polar) surfaces with 'exclusion zones' of ordered water that extend out for several hundred microns from the surface, (b) the phospholipid bilayers that make up biological membranes are arranged so that both surfaces of the bilayer are charged (the non-polar, lipid bits being hidden in the inside of the bilayer – see Chapter 15), and (c) Figure 3 in Chapter 5 illustrates the fact that biological cells are essentially stuffed full of internal structures bounded by membranes of one sort or another, which means that pretty much the entire inside of a cell is within a hundred microns of some charged surface. Also DNA, RNA and enzymes all present largely charged surfaces, with the non-polar parts of enzyme molecules again being hidden inside the 3-D shape of the molecule (caused by protein folding due to intramolecular hydrogen bonding, which is essential to the proper functioning of the molecule). Furthermore, Knight et al (2019) measure a decreased density of water that is confined in nano-scale pores.

An interesting sidetrack here is that Wiggins (1990) summarises evidence from her lab that K^+ (potassium ions) preferentially partition into the ordered, viscous, 'thick' water found inside cells, while Na^+ (sodium ions) preferentially partition into the 'thin' water found outside cells. Thus the well known physiological fact that there is a higher concentration of K^+ inside cells and a higher concentration of Na^+ in the extracellular fluid is partially explained without the need for ion pumps[18] – see Appendix I to this chapter.

Effects of microwaves

All of this means that if microwaves were to act by weakening hydrogen bonds and thereby converting viscous 'thick' water to low-viscosity, 'thin' water, multiple biological consequences would be predicted.

Is there any evidence that microwaves do act in this way? Yes, a little.

- Fesenko and Gluvstein (1995) find that 36 GHz radiation (mm waves of the sort used in high band 5G) change the properties of distilled water within 1-10 minutes. They say "the new state is retained for at least tens of minutes, and manifests itself as changes in the power density spectrum of periodic fading voltage fluctuations that are generated during discharge of a capacitor in which water is used as a dielectric." In other words, they took a small plastic tube, 1mm internal diameter, containing 15 µl of distilled water and inserted two gold-plated electrodes into the tube 2 mm apart. The tube was placed in the waveguide of a mm wave generator, positioned at the antinode of the EM field. Rectangular voltage pulses were then passed through the water to allow measurement of the capacitance of the water, both before (control) and after (experimental) irradiaion of the water with 36 GHz waves, at either 50 µW or 5 mW power. Irradiation with mm waves was observed to change the behavior of the water during the period when the large rectangular voltage pulses were fading. Surprisingly, during this period small voltage fluctuations (remarkably similar to those observed in patch clamp experiments on brain tissue, where such fluctuations are universally assumed – e.g. by Fesenko et al (1995) – to represent the opening and closing of membrane channels in neurons) were observed in pure distilled water. Even more surprisingly, these small voltage fluctuations in pure water were more pronounced after irradiation with low power mm waves than after irradiation with the higher power mm waves. The authors conclude, rather conservatively, that mm waves somehow change the state of water and that this new state persists for some time after termination of the mm wave irradiation.

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[18] Bray et al (1976) find that inactivation of the sodium pump which normally ejects Na^+ ions from muscle cells only causes a 25% drop in the resting membrane potential of the cell, indicating that 75% of the high intracellular K^+ concentration that is thought to underpin the resting membrane potential is, indeed, independent of the sodium pump.

- Independently, Bakker and Nienhuys (2002) report that radiation with lower than expected energies can break or at least weaken the hydrogen bonds in liquid water. Specifically they say "the vibrational potential of the O–H stretch vibrations of liquid water shows extreme anharmonicity that arises from the O–H•••O hydrogen bond interaction. We observe that already in the second excited state of the O–H stretch vibration, the hydrogen atom becomes delocalized between the oxygen atoms of two neighboring water molecules. The energy required for this delocalization is unexpectedly low and corresponds to less than 20% of the dissociation energy of the O–H bond of the water molecule in the gas phase."

- Preliminary experiments by Aly et al (2008) find that blood cells following a chemoattractant trail were able to move faster when irradiated by 900 MHz radiation that was too weak to cause any temperature change (Figure 10). One possible explanation for this result is that the radiation reduced the viscosity of the aqueous medium.

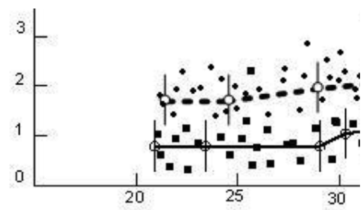

Figure 10: One segment of Fig 3 of Aly et al (2008). Horizontal axis is ambient temperature in degrees C. Vertical axis is speed of cell movement in microns per min. Dashed line and circles: irradiated with 900 MHz RF. Solid line and squares: not irradiated.

- Huang et al (2009) report that the conductivity of an aqueous solution of sodium chloride is changed by non-thermal treatment with 2.45 GHz microwaves, with a temperature change of less than 0.1^{o} C.

- Yakunov et al (2017) treat distilled water with 2.45 GHz microwaves and find long-term changes in water structure which they interpret as a change in the structure of the 'percolation cluster' formed by the network of hydrogen bonds.

- Hinrikus et al (2018) propose on theoretical grounds that microwaves restructure or weaken the hydrogen bonds interconnecting water molecules in such a way that the viscosity of the water is decreased.

Conclusions

1. The wide variety of biological effects caused by microwaves (for documentation see Part II of this book) suggests a common mechanism.

2. Water is involved in everything that goes on in a biological organism.

3. There is evidence that microwaves change the state of water.

4. This makes the state of water a likely candidate for at least one of the factors underpinning all of the multitude of biological effects exerted by low powered microwaves. (Another, possibly related, factor is oxidative stress – see next chapter).

5. Therefore, the effects of microwave irradiation on water *per se* should be an urgent focus of future research.

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CHAPTER 12 APPENDIX I: SOURCE OF THE RESTING MEMBRANE POTENTIAL

It is a central fact of neurophysiology that the inside of nerve and muscle cells is slightly electrically negative compared to the outside. The present author has dutifully taught generations of physiology students the dogma that this situation is caused by a combination of high intracellular potassium ion concentration and a slight permeability of the cell membrane to potassium ions. The idea is that because there is a natural tendency for ions in a watery environment to diffuse from areas where there is a lot of them to areas where there isn't, potassium ions (K^+) tend to diffuse out of the cell. But this removal of positive charges makes the inside of the cell more negative – and because negative attracts positive, the increasing internal negativity eventually stops the outward diffusion of K^+, at an inside potential named the equilibrium potential for potassium (about –90 mV).

It's a good story and could still be true in part, at least with regard to the maintenance of the resting potential. But it has never satisfactorily explained why there is a higher concentration of K^+ inside the cell in the first place. The explanation that intracellular water preferentially accumulates K^+ (Wiggins 1990) certainly makes the whole thing much more understandable.

And now Pollack et al (2009) have tossed another hungry cat among these pigeons by claiming that even pure, ion-free, vicinal a.k.a. interfacial water – water of the sort found near surfaces – carries a negative charge in the complete absence of any added ions at all. True, this claim has been the source of some controversy, with opponents insisting that water cannot store charge (Ovchinnoka & Pollack 2009a; Corti & Colussi 2009; Ovchinnoka & Pollack 2009b). And Pollack does rather go overboard, tossing out altogether the baby of ion pumps and membrane channels with his old bathwater, sans any due consideration of the considerable evidence for the existence of the baby (Pollack 2015). And his idea does rather suggest that the outside of cell membranes should be surrounded by a cloud of negative charge as well as the inside, which is not obviously the case. There is clearly a deal of work still to be done here! But overall, this is a claim that is not readily discounted, and has certainly made life a great deal more interesting.

Chapter 13

OXIDATIVE STRESS

What is oxidative stress?

In the discipline of chemistry, the word "oxidation" has a specific technical meaning. It means loss of electrons. (For further information about electrons, see Chapter 11). When a molecule is said to be oxidised, what is meant is that it has lost ('donated') one or more of its electrons to ... something else. The something else is then called an oxidant (because it has in some sense caused the oxidation) and is itself said to be "reduced" (another technical term, meaning gain of electrons). Hence, this sort of transfer of electrons from one molecular entity to another is known as a redox (reduction-oxidation) reaction.

Electron transfer or redox reactions are the cornerstone of biochemistry. They are involved in pretty much everything that goes on in a biological cell. For just one example, take oxidative phosphorylation. This is the chain reaction occuring in mitochondria (see Figure 4 in Chapter 5 for a diagram including mitochondria), by which ATP (adenosine triphosphate) is formed from ADP (adenosine diphosphate). ATP is essentially the "battery" that cells use to store energy for later use. So oxidative phosphorylation is central to life.

However, there's no such thing as a free lunch and the many electron transfer reactions so essential for life inevitably end up generating, as by-products, molecules (like hydrogen peroxide), or independent parts of molecules (like the superoxide radical or the hydroxyl radical) that are left with outer orbitals populated by only one electron, instead of the preferred two.

Nobody likes an orbital with only one electron (this is of course completely unacceptable anthropomorphism, but hey, a little can't hurt) so these **reactive oxygen species (ROS)** and/or **free radicals** roam the cell looking for an electron to scavenge. In this capacity, they can act as important signalling molecules (Chandel 2015; Shadel & Horvath 2015). But they also have the ability – and the tendency – to cause serious damage to innocent by-standers (for example polynucleotides like DNA and RNA and polypeptides like enzymes, microtubules, membrane channels and others). This tendency to cause damage makes free radicals the keystone of the free radical theory of aging (Cadenas and Davies 2000).

Taking the long view, this destructive tendency of naturally produced free radicals can probably be seen as not entirely a bad thing. After all, if individual humans lived forever, the planet would have been overrun with us long ago. However, such selfless considerations notwithstanding, a wide array of antioxidants (which act to neutralise the free radicals before they do too much collateral damage) and repair mechanisms (which act to fix the various kinds of collateral damage) have evolved to protect animals from their own free oxidants. Some of these antioxidants are made by the body (lipoic acid, glutathione, superoxide dismutase, melatonin). Some are taken in as food (Vitamins C and E, plant polyphenols – and, cheeringly, dark chocolate). But most of them, in turn, can have unpredictable side-effects. So basically, the whole system represents a marvellously complicated and delicate balancing act.

Oxidative stress is the term used to describe a tipping of this balance in favour of oxidants and pro-oxidants (free radicals, Reactive Oxygen Species) over antioxidants and repair mechanisms.

Effect of microwaves

Microwaves cause oxidative stress.

A small, random selection of the many studies showing this is as follows:

- Lai and Singh (1997) found that the free radical scavengers melatonin and PBN (a spin trap compound – see below) protect rats from the DNA breaks caused by microwave exposure (for a great deal of evidence that microwaves cause DNA breaks see Part II Chapter 2).
- Tkalek et al (2013) find that the DNA breakage and damage to proteins and lipids caused by exposure of earthworms to 900 MHz microwaves is accompanied by a rise in catalase and glutathione reductase (natural anti-oxidant enzymes), indicating an involvement of oxidative stress in the original microwave-induced damage
- Yakymenko et al (2015) analyse 100 peer-reviewed studies dealing with oxidative effects of radiofrequency emissions at intensities thousands of times lower than those permitted by ICNIRP guidelines, and report that 93 of the 100 studies confirm that RF radiation induces oxidative effects in biological systems. To quote these authors: "A wide pathogenic potential of the induced ROS and their involvement in cell signaling pathways explains a range of biological/health effects of low intensity RFR, which include both cancer and non-cancer pathologies". They conclude that "low-intensity RFR is an expressive oxidative agent for living cells with a high pathogenic potential and that the oxidative stress induced by RFR exposure should be recognized as one of the primary mechanisms of the biological activity of this kind of radiation."
- Chauhan et al (2017) show that WiFi radiation generates a number of oxidative stress markers in rats.
- Kivrak et al (2017) review papers showing that microwaves cause oxidative stress in the brain, spinal cord, eyes, thyroid, thymus, kidney, liver, spleen, pancreas, testicles, sperm, blood and other human organs and hence contribute to the generation of pretty much all inflammation-related disease conditions.

But how do microwaves generate oxidative stress?

The IARC and their parent agency the WHO, dismiss or at least minimise all of the above evidence, on the grounds that it is not known HOW microwaves cause oxidative stress. If you don't know how something works, they claim, you must disbelieve the evidence that it does work. No particular justification is ever offered for this remarkable contention – which indeed is never even specifically stated (probably because specifically stating it reveals its sheer silliness. But this IS the argument used. "There is no mechanism by which these effects could occur."

In fact, however, there are a number of mechanisms by which microwaves cause oxidative stress. These include:

1. Direct generation of hydrogen peroxide from water. Living animals are mostly composed of water. Vaks et al (1994) report that irradiation of either pure water or an aqueous solution of magnesium salts, by either continuous or pulsed 2.5 GHz or 10 GHz microwaves, produces H_2O_2 (hydrogen peroxide). The authors infer that this is because microwaves increase the autoionization of water to OH^- and H_3O^+, which then recombine to produce H_2O_2. It remains to be seen whether this is an adequate description. But irrespective of how the hydrogen peroxide measured by Vaks and colleagues is generated, it is well accepted that the H_2O_2 generated in mitochondria by natural biochemical reactions (a) has a relatively long half-life compared to free radical oxidants, (b) causes significant damage to mitochondrial DNA and enzymes and thus (c) is a major cause of a variety of age-related, degenerative health conditions (Cadenas and Davies 2000).

2. Prolongation of the lifetime of biochemically generated free radicals. Unlike hydrogen peroxide, most free radical oxidants have extremely short half lives (Phaniendra et al 2015). Irradiation by microwaves – especially pulsed microwaves like those used by the telecommunications industry (see Chapter 1) – increases the lifetime of free radicals by approximately 50-fold (Miura and Wasielewski 2011). This means that the plethora of free radicals generated by natural biochemical pathways last longer, and therefore have more opportunity to do collateral damage, if irradiated by microwaves. And how do microwaves act to increase the lifetime of free radicals? This is not entirely clear, but in all likelihood it has to do with:

3. Interference with spin chemistry. At the very small spatial scales treated by quantum mechanics, particles have a property called spin. QM spin is simply a fundamental property like charge or mass. It is not helpful to try visualising it in terms of anything related to spin in the macroscopic world (the rotating elements in figure skating for example, or the 'orchestrated litany of lies' (Mahon 1981) so frequently encountered in politics). Like charge, QM spin can take one of two states. The two possible states of charge are called positive and negative. The two possible states of spin are called up and down. Usually the spins of the two electrons occupying any given atomic orbital in some sense cancel one another out. But the defining feature of free radicals is that they have outer orbitals populated by only one electron. The spin of an unpaired electron makes it paramagnetic, which means 'very weakly attracted to one or the other pole of a magnet'.

   Radicals formed during the normal electron transfer reactions that underpin all of biology generally come in pairs – one from each of the molecules involved in the electron transfer. In other words, a radical pair is a short-lived reaction intermediate comprising 2 radicals formed in tandem, whose unpaired electron spins may be either antiparallel (one up, one down – called a singlet state) or parallel (either both up, or both down – called a triplet state). It has long been known that external magnetic fields can differentially flip the spins of the members of a radical pair, thereby changing the chemistry of reactions in which the pair is involved (Salikhov et al 1984; Salikhov 2019). In fact, this effect has been used for decades in the widely applied technique of ESR (electron spin resonance) a.k.a. EPR (electron paramagnetic resonance) spectroscopy, in which a static magnetic field combined with a pulsed radiofrequency field is used to investigate the physical structure of radicals.

And this, dear reader, is why those minority members of the 2011 IARC working group who insisted that microwaves be classified as only a 'possible' cause of cancer (see Chapter 5) engineered that the working group's report (IARC 2013) on mechanisms say the group had concluded "it is theoretically implausible for physiological effects (*except for reactions mediated by free radical pairs*) to be induced at exposure intensities that do not cause an increase in tissue temperature" [*italics added*].

To reiterate, the IARC committee which met in 2011 (Chapter 5) well knew about the effects of microwaves on radical pair reactions. They knew (or if they didn't, they were incompetent, because there was plenty of evidence for this available in 2011) that such effects can cause oxidative stress, and that oxidative stress can cause all manner of health harms. But the 2011 IARC committee deliberately glossed over this perfectly well-accepted mechanism by which "physiological effects could be induced at exposure intensities that do not cause an increase in tissue temperature"– purely to maintain the ICNIRP spin (using that word now specifically in the sense of 'politically orchestrated litany of lies') that there is no plausible mechanism by which cellphone emissions can cause cancer.

There unquestionably IS at least one such mechanism, and the IARC committee all knew about it when they signed their report.

Are you shocked, reader? If you're not, you should be. Even in a world as saturated with fake news, relentless propaganda and outright lies told by the very politicians and bureaucrats charged with protecting the public as our world is, this particular small cynical act should retain the capacity to shock. Arguably it has condemned many thousands of people to unnecessary unpleasantness, followed by premature death. If the microwaves emitted by cellphone technology were correctly classified as carcinogenic to humans, SURELY the governments of the world would have seen fit a decade ago to restrict the involuntary exposure of all life to this carcinogen. Well, you'd think so ....

So are the anonymous minority members of the 2011 IARC committee who did this consumed with guilt? No, almost certainly not. Denial is a wonderful psychological escape mechanism – and anyway, psychopaths

(Skeem et al 2011) apparently do not feel even the normal animal urge for self-preservation, let alone empathy for others.

As Shakespeare (1623) put it "Such men [and women] are dangerous". We the people urgently need to take action to protect ourselves.

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Chapter 14

BRILLOUIN PRECURSORS

It has been known for a over century (Brillouin 1914; Brillouin 1960) that when a very fast-onset pulse of electromagnetic radiation enters a "dispersive" or "lossy" medium (that is to say, a medium that 'absorbs' the radiation: in the case of microwaves this means water, or materials containing it) a very strange phenomenon occurs. Slesin (2002a) puts it as follows: "When a very fast pulse of radiation enters the human body, it generates a burst of energy that can travel much deeper than predicted by conventional models" and "Once generated, the new pulses propagate without significant attenuation".

These induced radiation pulses are known to physicists as Brillouin precursors.

What generates such a pulse, and why is it called a "precursor"?

The fact that Brillouin precursors have until now been known (or at least known under that name) only by theoretical physicists has led to a number of claims about them which seem to lay people uncomfortably mystical. For example, Gehring et al (2006) begin their article in the respected journal Science with the statement: "Researchers have long been intrigued by the wide range of phenomena that can occur in the propagation of optical pulses through highly dispersive media (1–21). Some of the most exotic of these effects occur for a medium with a negative value of the group velocity. In such a situation, theory predicts that the peak of the transmitted pulse will exit the material before the peak of the incident pulse enters the material, and furthermore that the pulse will appear to propagate in the backward direction within the medium".

Well then! In order to feel comfortable with this sort of statement, it is probably necessary to have at least an undergraduate degree in physics, followed by a specific tutorial on the meaning and modelling of 'group velocity' – and on top of that (it is suggested by Oughstun and Slesin 2002), an understanding of mathematics surpassing even than that of the great Robert K Adair (he whose mathematical modelling of the interaction between microwaves and DNA was so heavily relied upon by the IARC to justify their 2011 classification of microwaves as only a 'possible' cause of cancer: see Chapter 5).

It therefore came as something of a relief to the present author, a mere lapsed neurophysiologist, to read the paper by Albanese et al (1994) and realise that actually, Brillouin precursors are nothing more exotic than the entities known in the neurophysiology trade as 'on-off transients' or 'stimulus artefacts'. Working neurophysiologists take it for granted that whenever a square pulse of current is injected into tissue – usually for the purpose of stimulating the neurons – the main bulk of the pulse is absorbed to a greater or lesser extent by the aqueous medium, but however far from the stimulation site you record, the transients that appear at both the leading and trailing edges of the injected pulse remain large enough to be annoying. And lo, 'Brillouin precursors' turns out to be simply the name physicists give to these on-off transients.

Figure 11 illustrates this. Figure 11A shows a very short pulse of 10 GHz microwaves injected into a container of water by Albanese et al (1994). Figure 11B shows the same pulse recorded after passage through 1 cm of water. It can be seen that the oscillations making up the main body of the pulse are reduced from ±1 volt per metre at the injection site (Fig. 11A) to approximately ± 0.005 volts per metre after passage through 1 cm of pure water (Fig. 11B). In contrast, after passage through 1 cm of water large transients have appeared at the leading and trailing edges of the pulse, which have amplitudes of ± 0.035 volts per metre (note the different scales on the vertical axes in Figs 11A and 11B).

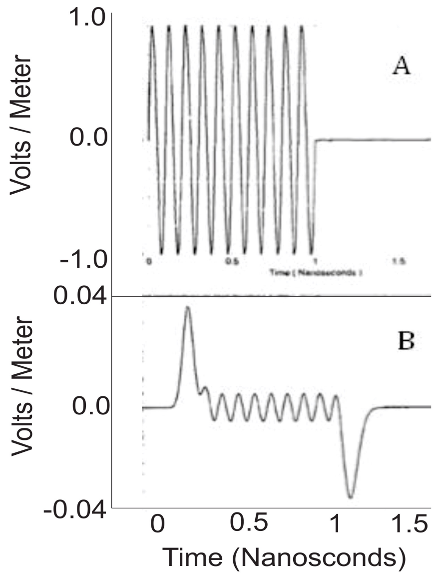

Figure 11: (After Albanese et al 1994) A: Injected pulse
B: Same pulse after passage through 1 cm water
F

According to Albanese and colleagues, Brillouin precursors are these leading and trailing edge transients. The 'Brillouin' part of the name honors the French physicist who first described them and the 'precursors' part presumably refers to the fact that the leading-edge transient is in some sense a precursor to the main body of the pulse. According to Albanese and colleagues, the transients "represent radiation from the initial and terminal transient movements of charged particles in the water as the pulse first strikes and then leaves the local region in the medium. The charged entities in pure water that are reacting to the field are the small charge separations in each water molecule associated with the 108^{o} chemical H-O-H bond." Which does not exactly make it clear why such movements of charged particles should occur only at the beginning and end of the pulse, but does suggest that the transients are likely to be larger in water containing dissolved salts, as all biological water does.

In any case, the idea that these transients are rare and have been observed only in classified experiments by secret USAF labs is far from correct. Every working cellular neurophysiologist sees thousands of such entities every day. We call them stimulus artefacts and do our best to minimise them, because they get in the way of measurements of genuine biological responses to imposed stimuli (Pockett 2006).

Technological effects of Brillouin precursors

Brillouin precursors are formed whenever EM pulses of any duration (or any intra-pulse oscillation frequency) impact a lossy material like water – or the biological organisms that are largely made up of water, or even wet earth. Obviously there will be more such transients per unit time when the pulses are shorter and more frequent. But even relatively long pulses of relatively low-frequency radiation come with these short, sharp spikes at the beginning and end of each pulse. Brillouin precursors are therefore very likely to be a major explanation of the now well-accepted fact that pulsed microwave radiation, like that used by mobile phones and WiFi (see Chapter 1) is much more biologically damaging than continuous radiation (Panagopoulos et al 2019).

Even more worryingly in the present context, Figure 12B shows that the Brillouin precursors generated by pulses of mm-wave radiation (high frequency radiation with wavelengths in the range 1 to 10 mm) penetrate much further into dispersive (watery) materials than does continuous mm-wave radiation. Xiao and Oughstun (1999) describe mathematically how and why the standard analysis of microwave propagation through dispersive or lossy media fails to describe what happens when ultrashort pulses of ultrawideband radiation enter the picture. Basically, the assumption that group velocity is the main determinant of what happens – that the frequency of the carrier wave (see Chapter 1) dominates – breaks down when the pulse frequency is high enough for Brillouin precursors to become a major factor. In that case, the interaction between the Brillouin precursors at the leading and trailing edges of the pulses of radiation becomes increasingly complicated, until mathematics described as an "invention of the devil" are needed to describe them (Oughstun 2017). But basically the frequency of the pulsed signal that modulates the carrier wave takes precedence over the frequency of the carrier wave.

This realization completely explodes the myth that 5G radiation with a mm wave carrier can not penetrate skin, or leaves, or walls. Certainly, the main bulk of each pulse of mm wave radiation does not penetrate far through a watery material (Figure 12B). But the transients at the beginning and end of the pulses are much less attentuated – to the extent that the US Air Force can use airborne pulsed mm-wave radar to detect metal objects concealed beneath leaves, or even buried in the earth (Oughstun and Slesin 2002). Indeed Section 17 of Volume 2 of a magisterial book by Oughstun (2017) considers, among other things, existing and proposed uses of pulsed mm-wave radiation in "applications to bioelectromagnetics, remote sensing, ground and foliage penetrating radar, and undersea communications."

In this latter regard, the politics of the situation with regard to the PAVE PAWS radar installation on Cape Cod (Slesin 2002b; 2003 and see below) calls to mind Frey's revelations about an earlier USAF-funded dirty-tricks campaign designed to discredit his 1975 research on the blood-brain-barrier-damaging effects of less advanced radar technology (Frey 2012). In both cases, scientific honesty and the protection of public health appear to have been comprehensively over-ridden by military considerations. And of course, the telecommunications industry's present huge financial interest in maintaining the position that mm-wave 5G is harmless is already the stuff of legend.

The inconvenient truth is that pulsed mm-wave radiation is NOT stopped by leaves, or walls, or water in the air, or distance. If it were, satellite-borne mm-wave radar would not work. It is therefore NOT necessary to install thousands of new transmitters in suburbia – unless the real objective is simply to provide hugely increased bandwidth to accommodate the thousands of new clients projected to make up the "internet of things". This IoT is a dystopian and generally unwanted scenario in which it is envisaged that all household appliances will chatter away wirelessly to each other, so that ... well actually the reason for this lunatic scheme appears not to be clear even to the telcos, as evidenced by the fact that, at least in New Zealand, they repeatedly employ expensive advertising agencies to plead for someone – anyone – to tell them why the internet of things will be the best thing since sliced bread.

As pointed out in the Introduction to this book, Eisenhower (1961) in his farewell address as outgoing US president said "In the councils of government, we must guard against the acquisition of unwarranted influence, whether sought or unsought, by the military–industrial complex. The potential for the disastrous rise of misplaced power exists, and will persist.

We must never let the weight of this combination endanger our liberties or democratic processes. We should take nothing for granted. Only an alert and knowledgeable citizenry can compel the proper meshing of the huge industrial and military machinery of defense with our peaceful methods and goals so that security and liberty may prosper together. "

The modern version of the military industrial complex comprises the US military and the global telecommunications industry. At present, let nobody be in any doubt that the weight of this combination is not just endangering, but actively squashing flat our liberties, our democratic processes and even our health.

Biological effects of Brillouin precursors

A 2005 review on the potential effects of the PAVE PAWS radar installation at Cape Cod, commissioned by the US Air Force at the request of Senator Robert Kennedy (National Research Council 2005) says "The effect of the RF fields on the biological system may take place by changing chemical reaction rates or the binding of molecules to a membrane surface. This could occur in at least five ways (Barnes 1996). First, it may affect the transport of ions or charged molecules and thus the probability of the two particles coming close enough to each other to react. Second, it may affect the energy with which they collide. Third, it may affect the orientation or configuration of the colliding particles. Fourth, it may change the energy state of one of the molecules. Fifth, it may affect the average temperature of the environment. Of these effects, only those related to changes in the average temperature are well studied and are generally accepted by the scientific community at large, as described in a review article by Adair (2003).

The Adair referred here to is the same individual upon whose mathematical calculations the 2011 IARC Working Group relied for their conclusion that it is theoretically impossible for microwaves to damage DNA (and therefore that all the empirical evidence detailed in Chapters 5 and 6 should be disregarded). The USAF review of the radar installation at Cape Cod concluded that (a) there was no point in attempts to mitigate the exposure of local residents to the radiation, since planting trees or even erecting walls of earth around the installation would have no effect (proving that they knew pulsed microwave radiation is not stopped after a couple of cm by leaves, earth, or any material that contains water), but (b) there was no proven mechanism by which the radiation could cause biological harm, so all evidence that it did so in areas of Cape Cod around the radar installation could be rejected, on the (undocumented) grounds that the obvious cancer cluster in the area had started before the radar was installed.

The Adair referred to in this USAF report is also the same individual who reportedly characterised Brillouin precursors as "strange pulse effects that simply don't exist" (Oughstun and Slesin 2002). When asked how a physicist with a chair at Yale university could hold such a view, Oughstun is said to have replied "I can only guess what any person says or believes. Perhaps it is because the math used to model the behavior of Brillouin precursors—which is known as asymptotic analysis—can be very complicated. The asymptotic description of pulse behavior has been completely verified by independent numerical solutions and by carefully designed experiments. But in spite of this incontrovertible evidence, many researchers continue to cling to the group velocity description".

At any rate, Albanese et al (1994) offer as a "tentative starting point for scientific thought and deliberation", a choice of four mechanisms by which pulsed microwaves and their associated Brillouin precursors could affect biology:
1. Molecular conformation changes
2. Alterations in chemical reaction rates
3. Membrane effects
4. Thermal damage

Factors 1 and 2 are considered briefly below. Re: thermal effects, focussed hot-spots are much more likely when several concentrated beams of radiation employed by 5G technology intersect. Membrane effects are the subject of the next chapter.

1. Molecular conformation changes

Molecular conformation basically means the 3-dimensional shape of molecules. The precise three dimensional shapes of enzyme molecules for example are vital to their function. The 3-D shape of any large molecule is determined by the detail of how the molecule folds : the origami of biology.

Molecular folding is largely caused by the formation of hydrogen bonds between atoms in different parts of the molecule. Therefore, anything that has the capacity to break, or even weaken hydrogen bonds will have far-reaching effects. Microwaves are known to have the capacity to break, or at least weaken, hydrogen bonds (Chapters 11 and 12).

One documented (Li et al 2005) effect of pulsed EM fields on molecular conformation is the production of a conformation change in the insulin molecule, reducing its capacity to bind to its receptors and thus contributing to the current pandemic of Type 2 diabetes (Chapter 8).

Microwave mediated conversion of gel-like, 'thick' intracellular water to 'thin' water (Chapter 12) also has the capacity to cause unfolding of proteins (Wiggins 1990).

2. Alterations in chemical reaction rates

Chemical reactions generally go faster at higher temperatures. As mentioned above, positive interference (as in, the addition as opposed to subtraction of differently phased EM fields), particularly between the Brillouin precursors associated with the directed beams of pulsed microwave radiation employed by 5G technology (Chapter 1) has the capacity to produce very localised 'hot spots' of radiation. The technology for detecting such very localised hot spots does not currently exist.

Additionally, microwave-mediated conversion of gel-like, low density water to more fluid and reactive high density water (Chapter 12) promises to increase chemical reaction rates. The technology to detect the detail of this transition does not currently exist either.

The entirely proven ability of any sort of microwaves to damage membranes is discussed in the next chapter.

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Chapter 15

MEMBRANE EFFECTS

Both biological cells and the smaller organelles inside them (e.g. mitochondria and the cell nucleus) are bounded and held together by biological membranes. These membranes are basically bilayers of phospho–lipid molecules, arranged with the water-loving phosphate parts on the two outer surfaces of the membrane and the water-repelling lipid (fat) parts on the inside of the membrane (Figure 12).

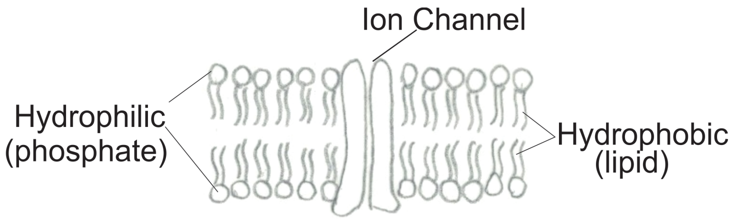

Figure 12: Diagram of generic biological membrane

This arrangement means that water is unable to get through the inner, lipid part of cell membranes, which in turn means that functionally, the water on the inside of the cell is separated from water on the outside of the cell. In other words, membranes stop cells from leaking. Thus, anything that punches holes in membranes obviously has the potential to cause a myriad of biological problems.

Pulsed microwaves punch holes in membranes.

Electroporation

It has been known for many years that electric fields can not only punch holes in cell membranes (Coster 1965; Kinosita and Tsong 1977a,b,c; Neumann et al 1989) but even cause the membranes of different cells to fuse together (Sowers 1985). Under the labels *electroporation* and *electrofusion*, the fact that electric fields – particularly pulsed, radiofrequency fields (Chang 1988, 1989) – can achieve these feats has been much used as a means of introducing large substances like drugs and foreign DNA into living cells (Neuman et al 1989; Tsong, 1991). Because of the usefulness of these processes in medicine, agricultural research and genetic engineering, there is now a large scientific literature on the ways in which microwaves affect cell membranes. Unfortunately however, this literature remains largely unknown to scientists who are not directly working in the relevant areas of science: a situation which is increasingly common as the sheer volume of scientific knowledge forces individual scientists to become ever more specialised[19], and plays a large part in making it ever more difficult for lay people to know which 'experts' to trust.

The structural processes by which electroporation punches holes in membranes

[19] The old joke springs to mind about the definition of an expert as someone who knows more and more about less and less, until eventually they know everything about nothing.

were revealed thirty years ago, using the then-new technique of freeze-fracture electron microscopy (Chang and Reese 1990). When a short pulse of microwaves is applied to a cell, a number of small, "volcano-like" areas appear in the cell membrane within 3 ms (3 thousandths of a second). These volcanos only appear after a pulse of microwaves, and almost certainly represent the pores that are observed functionally (by monitoring the entry of fluorescent molecules into the cell, for example). The 'volcanos' sometimes resolve and the pores start sealing up again a few seconds after the electric pulse stops. But when the pulses are long enough – or repetitive enough – for the pores to reach the size of the natural gaps in the cytoskeleton (a network of filaments which fills the interior of all cells, particularly densely near the membrane), the membrane holes can become permanent.

One example of the biological effects of electroporation – and the general response of the military-industrial complex to inconvenient findings – may be the microwave-induced leaks in the blood brain barrier reported by Frey et al (1975). These authors published a series of impeccably double-blinded experiments showing with high statistical probability that exposing rats' heads to pulsed microwaves created leaks in the blood-brain barrier, which normally acts to protect the brain from blood-borne toxins. The US Air Force (then in the process of brushing off objections from the local citizenry to the unheralded appearance of a radar installation in their neighborhood) responded by hiring a contractor to claim he had been unable to repeat Frey's results. As Frey (2012) describes this situation:

"... after my colleagues and I published in 1975 that exposure to very weak microwave radiation opens the regulatory interface known as the blood brain barrier (bbb), a critical protection for the brain, the Brooks AFB group selected a contractor to supposedly replicate our experiment. For 2 years, this contractor presented data at scientific conferences stating that microwave radiation had no effect on the bbb. After much pressure from the scientific community, he finally revealed that he had not, in fact, replicated our work. We had injected dye into the femoral vein of lab rats after exposure to microwaves and observed the dye in the brain within 5 minutes. The Brooks contractor had stuck a needle into the animals' bellies and sprayed the dye onto their intestines. Thus it is no surprise that when he looked at the brain 5 minutes later, he did not see any dye; the dye had yet to make it into the circulatory system."

Within the blood itself, Kinosita and Tsong (1977b,c) and Chang and Reese (1990) both demonstrate that human red blood cells can be ruptured and destroyed by a pulsed radiofrequency field.

Effects on membrane proteins

A second mechanism by which microwaves may affect membranes is by affecting proteins embedded in the membrane – perhaps by way of oxidative stress (see Chapter 13) or perhaps by a direct action on the protein.

For one thing, enzymes tend to come embedded in membranes. Combining the two potential mechanisms above, Tsong (1990) points out that, just as the energy required for ATP synthesis in plant chloroplasts is provided by natural sunlight, the energy required for ATP synthesis in animal mitochondria, normally provided by the electron transfer reactions that generate pro-oxidants (see Chapter 13), can be boosted by artificially imposed oscillating electric fields.

But probably the most well-publicised work in this area relates to the postulated effect of microwaves on voltage gated calcium channels (Pall 2013, 2015; Buckner et al 2015). Since voltage-gated calcium channels occur in all types of excitable cell (Dolphin 2006) and thus participate in virtually everything that goes on in the body, any effect of microwaves on calcium channels would certainly have wide-spread effects. However, this also makes the well-documented fact that the effects of microwaves are blocked by calcium channel blockers less than secure evidence that the original effect of the microwaves was on calcium channels. Calcium channels would participate in the downstream effects of virtually anything microwaves did.

The only clearcut conclusion here is that weak microwaves definitely have biological effects on membranes, which can be either beneficial or harmful depending on the circumstances.

If this is not an indication that the precautionary principle needs to be applied with respect to the universal microwave pollution that increasingly pervades the world, I don't know what is.

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