The Big Book of EMFs

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

John Mauremootoo, PhD

What are native & non-native EMFs?

How do EMFs affect your body-mind?

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

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Figures & Tables

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

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

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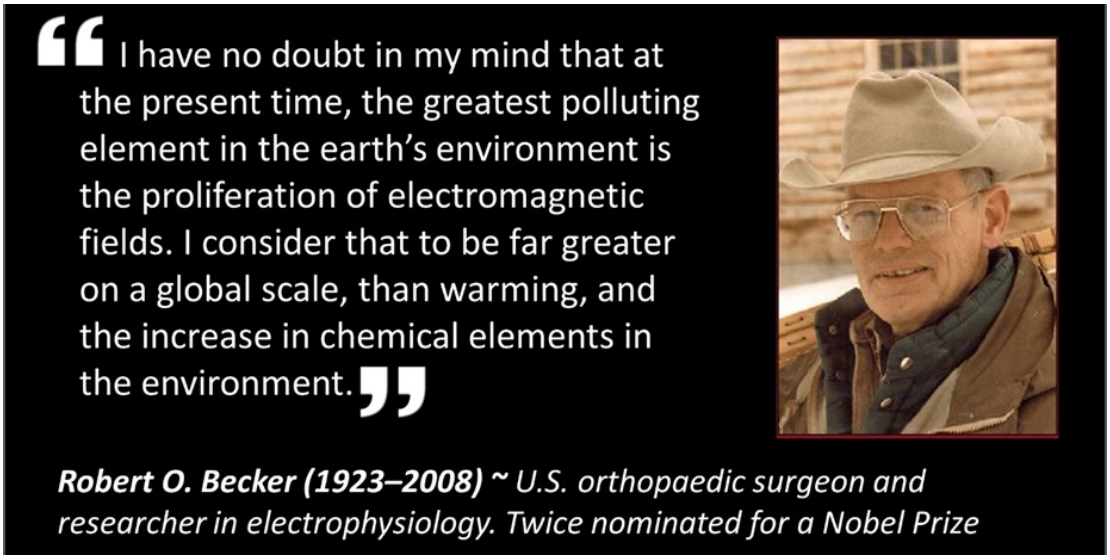

Chapter 1. Setting the Scene: Light in the Absence of Eyes Illuminates Nothing

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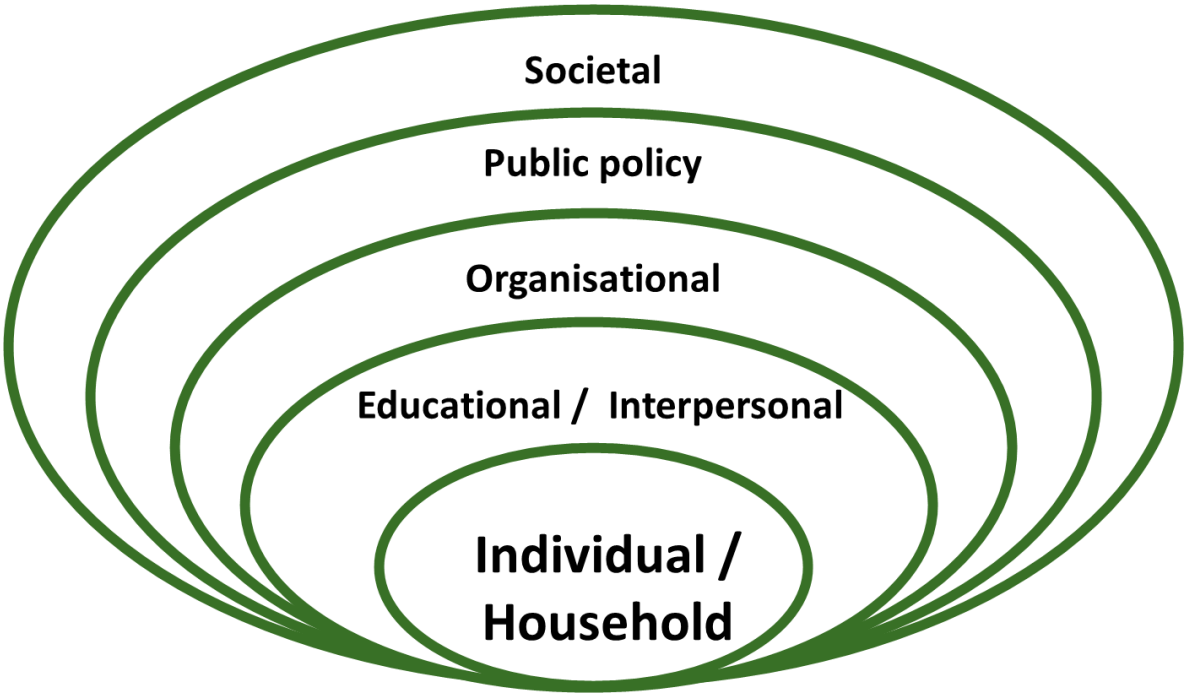

Figure 1.1: *A nested hierarchy of intervention opportunities. This book focuses on the individual/household level. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

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

What is an EMF?

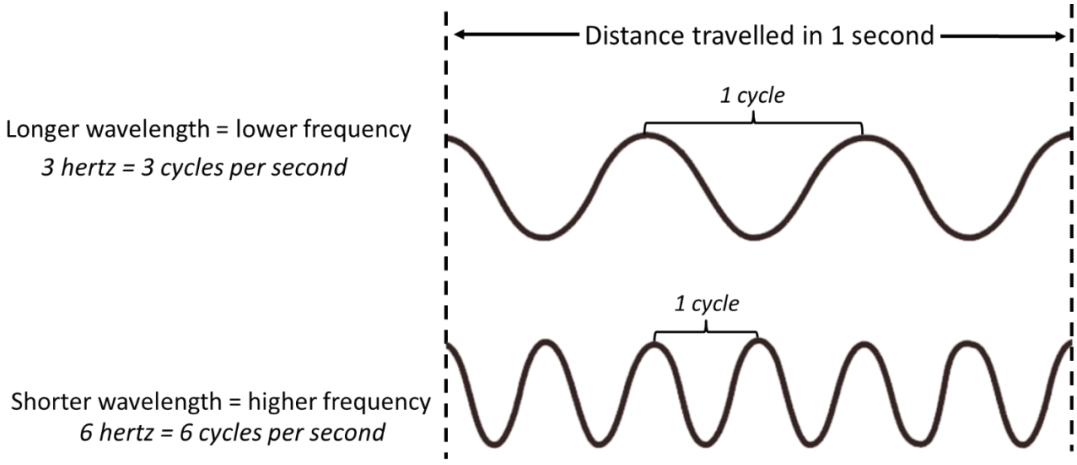

Figure 2.1: *A wave with a longer wavelength (top) has a lower frequency because fewer waves pass a given point per unit of time. A wave with a shorter wavelength (bottom) has a higher frequency. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

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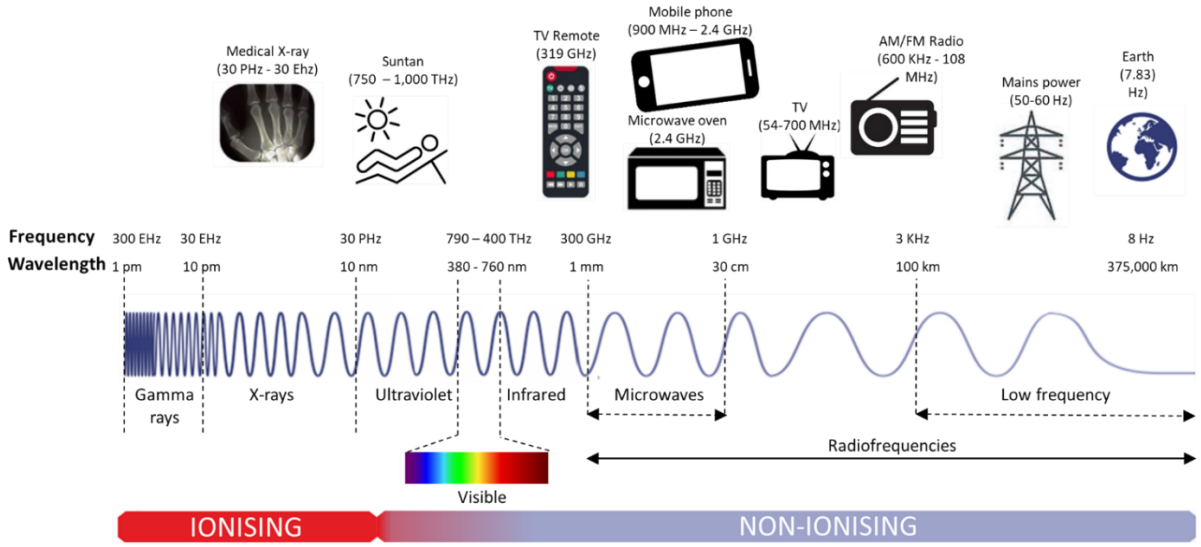


Figure 2.2: *Natural and non-native EMFs along the electromagnetic spectrum. Ionising radiation (IR) dislodges electrons from atoms and molecules, causing them to become charged (ionised). Non-ionising radiation (NIR) does not have enough energy to directly dislodge electrons. There are no sharp, well-defined boundaries in the electromagnetic spectrum, so you will see some variation in the values quoted in the literature for the various EMF categories. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

The rise of non-native EMFs in the modern world

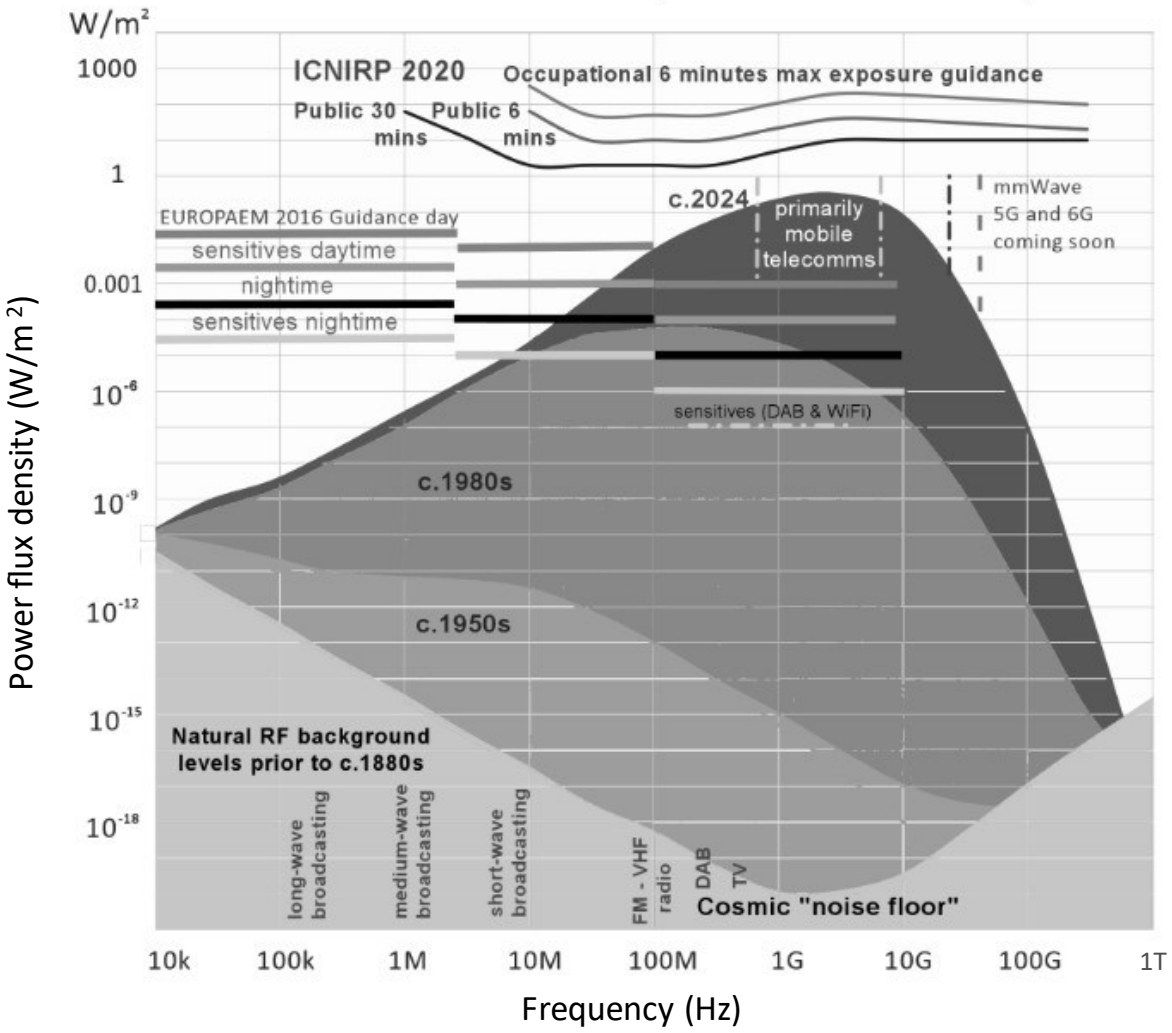


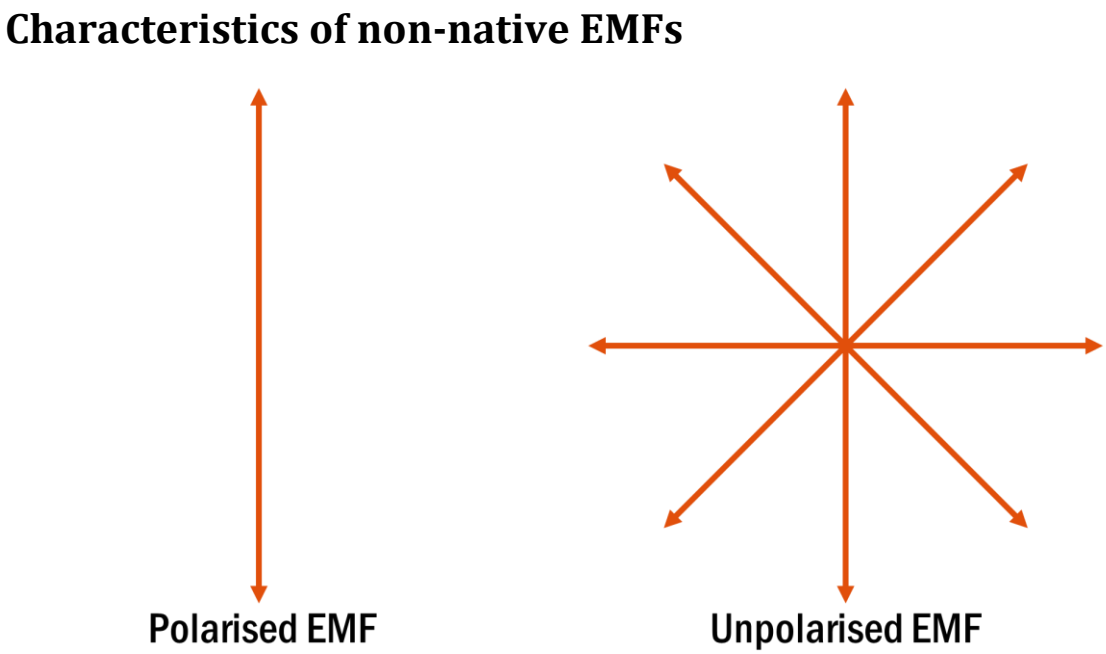
Figure 2.3: *Typical maximum daily exposure to radio frequency electromagnetic radiation from non-native and natural power flux densities compared to exposure guidelines. The shaded areas show common exposure levels in different periods. Updated from Philips & Lamburn 2012. Used with the permission of the authors.*

Philips, A., Lamburn, G. Natural background Electromagnetic Field (EMF) Levels on Earth. at <bemri.org/publications/natural-fields/427-natural-and-human-activity-generated-electromagnetic-fields-on-earth/file> (2012).

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

Type of EMF	Background EMF levels[1]	Modern EMF levels	Increase
Radio Frequency (RF)	<0.000001 μW/m^2	660 μW/m^2 (outdoors in a city)[5]	660 million x
Magnetic Field (MF)	0.0000002 μT	0.085 μT (in homes)[3]	422,500x
Electric Field (EF)	0.0001 V/m	7.5 V/m (in homes)[4]	75,000x

1. International guidance levels. *Powerwatch*. at <https://powerwatch.org.uk/science/intguidance.asp>.
2. Urbinello, D., Joseph, W., Verloock, L., Martens, L., Röösli, M. Temporal trends of radio-frequency electromagnetic field (RF-EMF) exposure in everyday environments across European cities. *Environmental Research*. **134**, 134–142, doi: 10.1016/j.envres.2014.07.003 (2014).
3. Halgamuge, M.N., McLean, L. Measurement and analysis of power-frequency magnetic fields in residences: Results from a pilot study. *Measurement*. **125**, 415–424, doi: 10.1016/j.measurement.2018.05.007 (2018).
4. National Research Council (US) Committee on the Possible Effects of Electromagnetic Fields on Biologic Systems *Possible Health Effects of Exposure to Residential Electric And Magnetic Fields*. at <http://www.ncbi.nlm.nih.gov/books/NBK232736/>. National Academies Press (US). Washington (DC). (1997).
5. Sagar, S. *et al.* Radiofrequency electromagnetic field exposure in everyday microenvironments in Europe: A systematic literature review. *Journal of Exposure Science & Environmental Epidemiology*. **28** (2), 147–160, doi: 10.1038/jes.2017.13 (2018).



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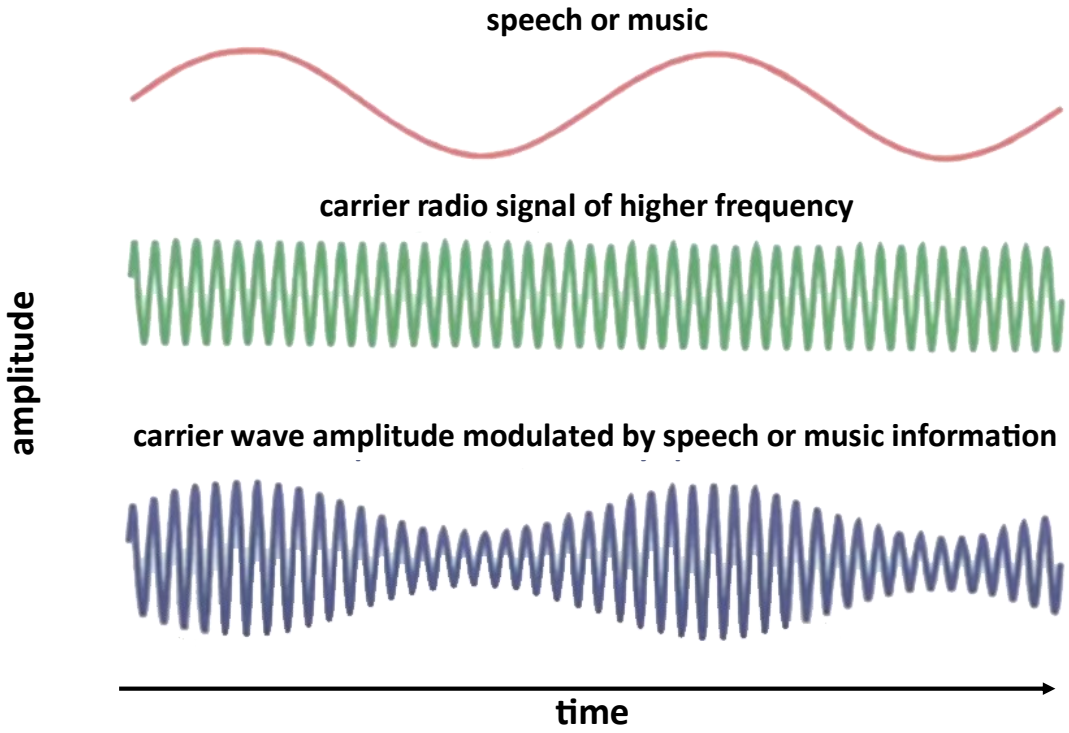


Figure 2.5: *Theoretical mobile phone signal. Adapted from Panagopoulos (2018).*

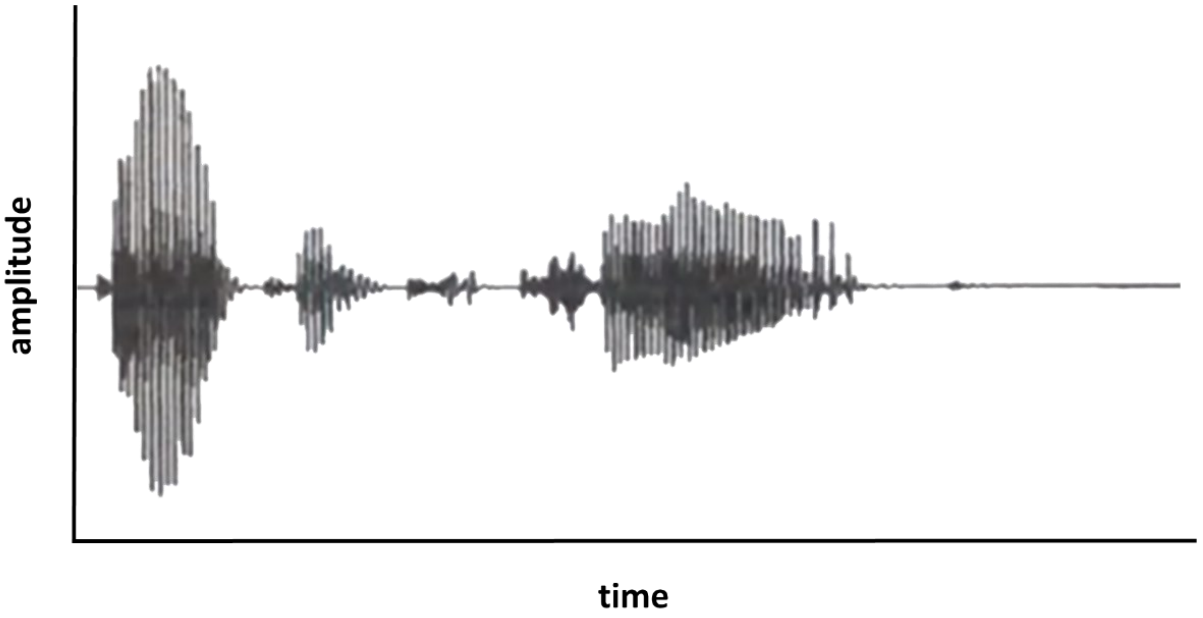


Figure 2.6: *Real-life example of mobile phone signal. Source: Panagopoulos (2018).*

Dr. Dimitris Panagopoulos: Electromagnetic Fields - Health Effects - Mechanism of Action. at <https://www.youtube.com/watch?v=adGtb0kxsDM>. (2018).

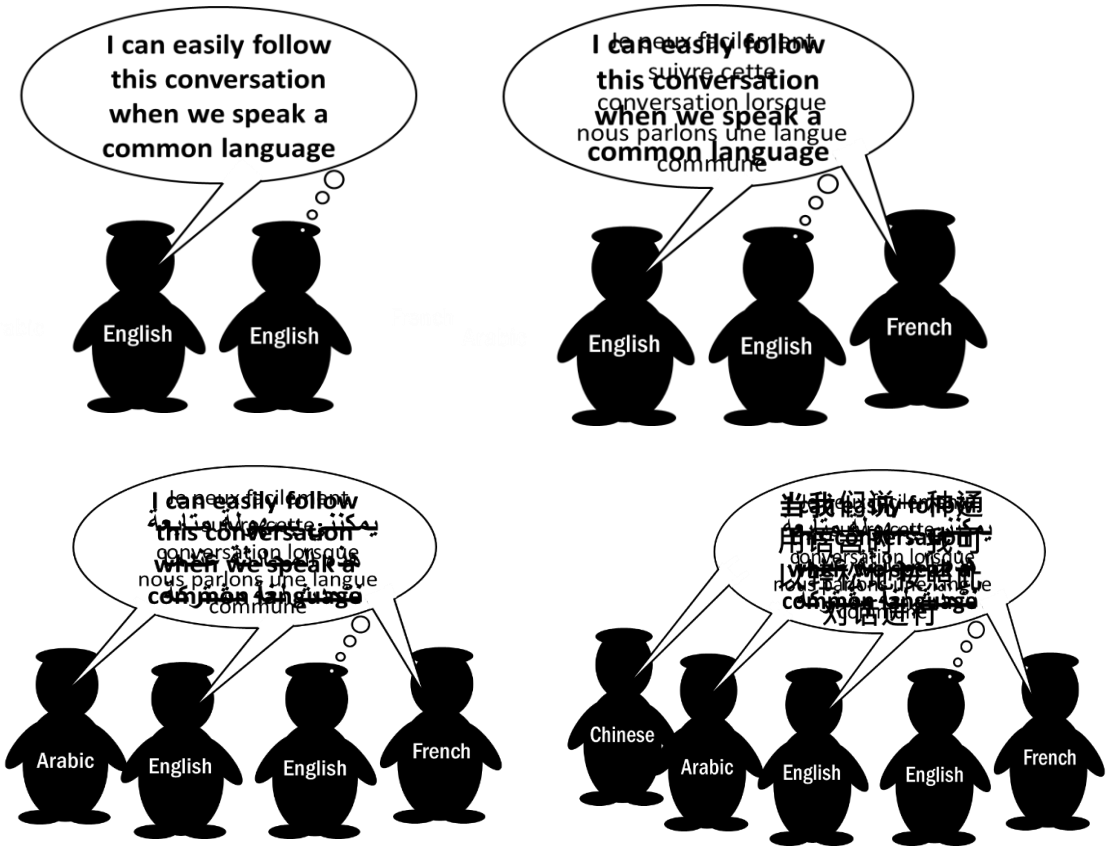
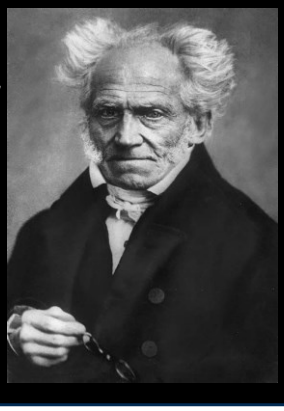


Figure 2.7: *Man-made EMFs: Jamming Nature's Signals. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

Chapter 3. EMFs – Perspectives on Health Impacts

The Schopenhauer Sequence – the road to truth

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



Arthur Schopenhauer (1788–1860)

~ German philosopher.

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

Issue	Date of first Early Warning	Date of Risk Reduction Action	Years of substantial inaction
Over-fishing	1376	1995–2008 "responsible" management: which is not very effective	c.600
Asbestos	1898	1999 EU ban by 2005	101
PCBs (polychlorinated biphenyls)	1899	1970–80s: EU and US restrictions; banned for most uses in most countries	c.90
Benzene	1897	1978 Benzene voluntarily withdrawn from most consumer products in the US	81
Radiation (ionising)	1896	1961–1996 UK, etc., then EU laws	65
MTBE (methyl tert-butyl ether) octane booster in petrol	1960 taste /odour/ persistence in water	2000 undesirable in Denmark/California: permitted elsewhere	c.40
DES (Diethylstilbestrol) a nonsteroidal oestrogen medication	1938	1971–1985 US, EU, global ban	30–50
Antibiotics as livestock growth promoters	1969	1999 EU ban	30
Sulphur dioxide (SO_2), lung disease and lake water pollution	1952 (lung) 1968 (lakes)	1979–2001 increasing EU etc restrictions leading to c 90% reduction on 1975 levels by 2010	25–55
Halocarbons (CFCs and other ozone depleters)	1974	1987 global ban on CFCs + other ozone depleters	10-30
Hormones as cattle growth promoters	1972/3 Oestrogen effects on wildlife	1988 EU ban, US continues	16+
DDT insecticide	1962/3	1970s DDT banned in N. America & EU.	10+
French oyster fisheries collapse	1976–81	1982–7 French, UK then NE Atlantic ban; 2008 global ban	5–30

Gee, D. Late Lessons from Early Warnings: Towards realism and precaution with EMF? Pathophysiology. **16** (2–3), 217–231, doi: 10.1016/j.pathophys.2009.01.004 (2009).

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

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

Anguera, J., Andújar, A., Huynh Minh, C., Orlenius, C., Picher, C., Puente Baliarda, C. Advances in Antenna Technology for Wireless Handheld Devices. International Journal of Antennas and Propagation. 2013, doi: 10.1155/2013/838364 (2013).

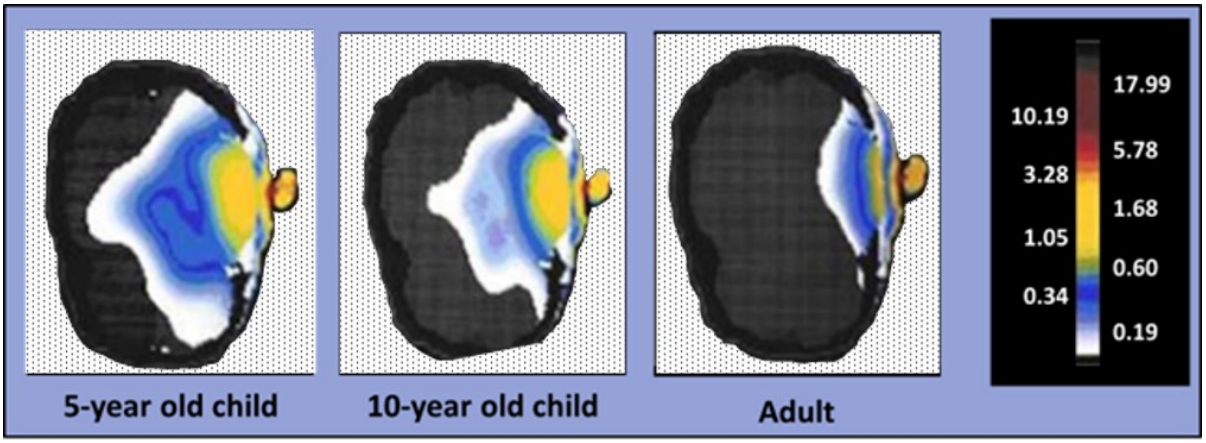
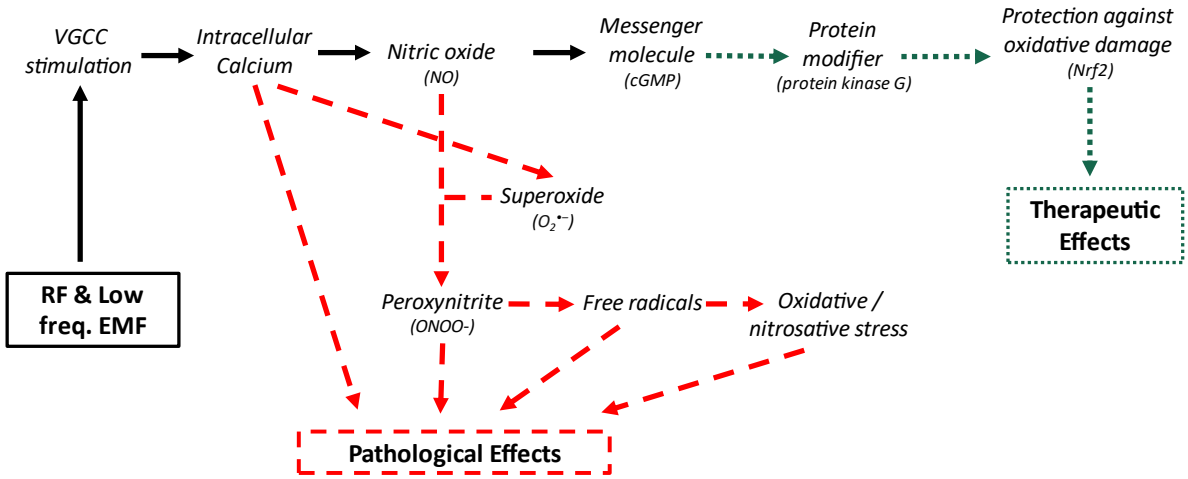


Figure 3.2: *Depth of absorption of mobile phone radiation in a 5-year-old child, a 10-year-old child, and an adult from GSM mobile phone radiation at 900 MHz. The colour scale on the right shows the SAR in watts per kilogram. Adapted from Gandhi* et al. *(1996). Used with the permission of the Institute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

Gandhi, O.P., Lazzi, G., Furse, C.M. Electromagnetic absorption in the human head and neck for mobile telephones at 835 and 1900 MHz. IEEE Transactions on Microwave Theory and Techniques. **44** (10), 1884–1897, doi: 10.1109/22.539947 (1996).

Chapter 4. Health Impacts of Non-Native EMFs

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



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Pall, M.L. Wi-Fi is an important threat to human health. *Environmental Research*. **164**, 405–416, doi: 10.1016/j.envres.2018.01.035 (2018).

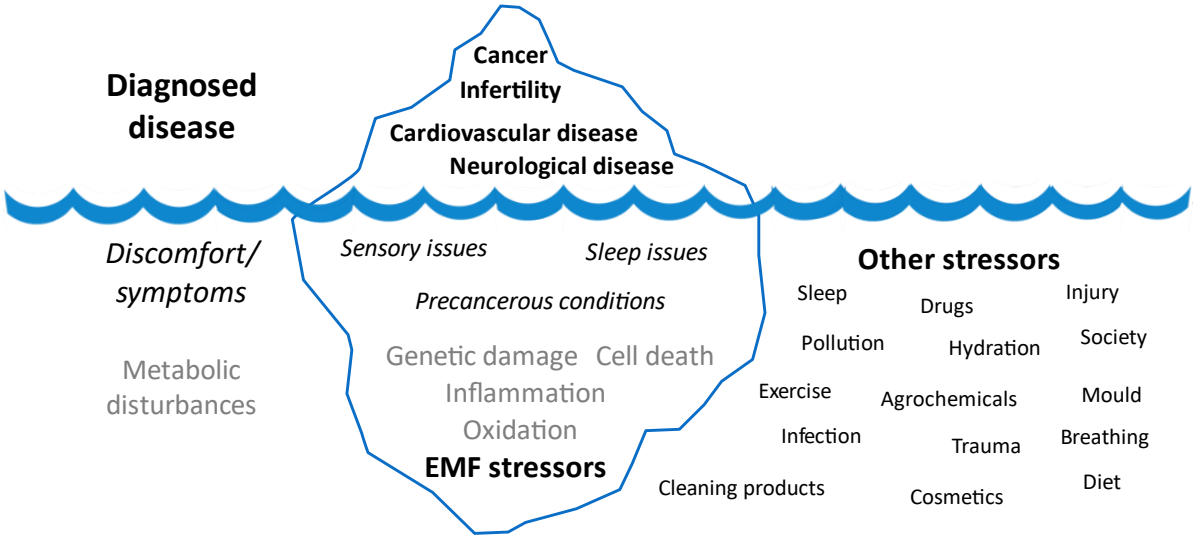


Figure 4.2: *Some adverse effects of non-native EMFs on humans. The tip of the iceberg in a sea of stressors. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

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

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

The stress bucket/total body burden model of chronic disease

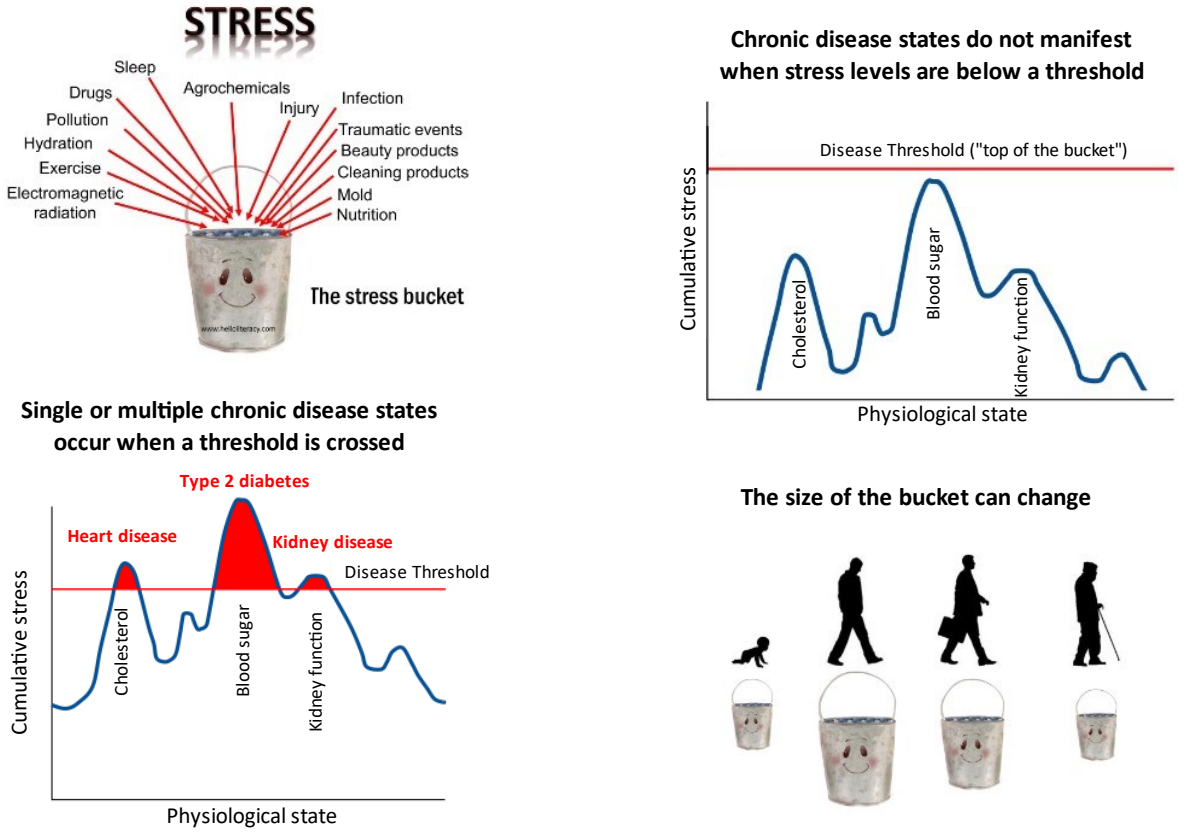


Figure 4.4: *Schematic representation of the stress and disease threshold model of chronic disease. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

Electro Hypersensitivity – the Canary in the Coal Mine

EHS triggers, symptoms, and progression

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

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

Belpomme, D., Hardell, L., Belyaev, I., Burgio, E., Carpenter, D.O. Thermal and non-thermal health effects of low intensity non-ionizing radiation: An international perspective. *Environmental Pollution (Barking, Essex: 1987)*. **242** (Pt A), 643–658, doi: 10.1016/j.envpol.2018.07.019 (2018).

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

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

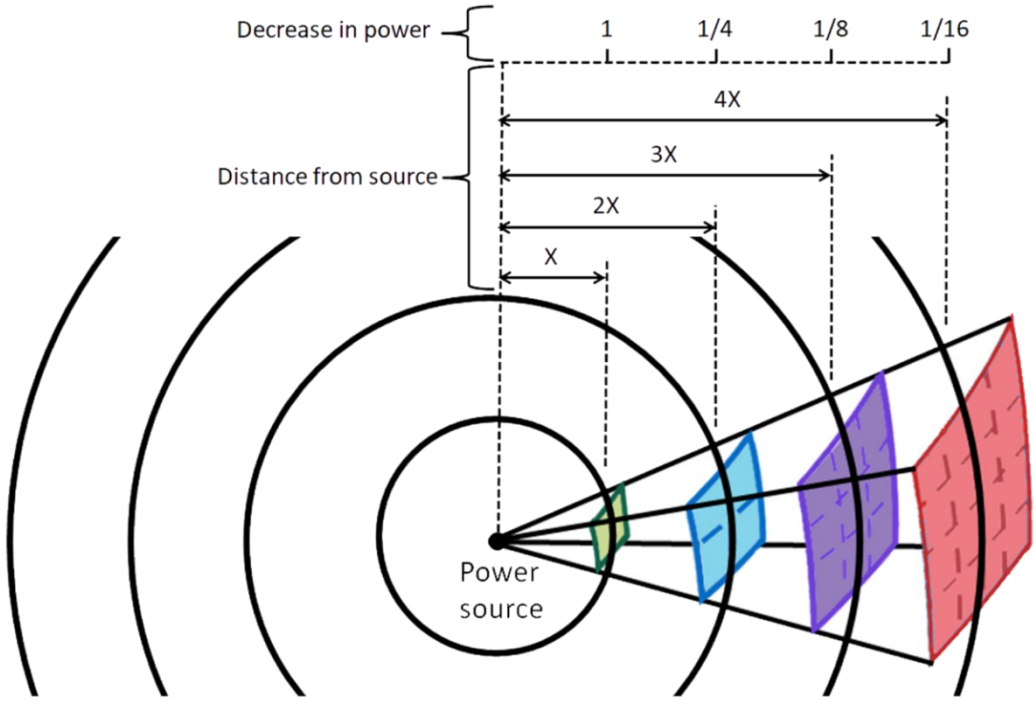


Figure 5.1: Reduction in power with distance from source. *By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

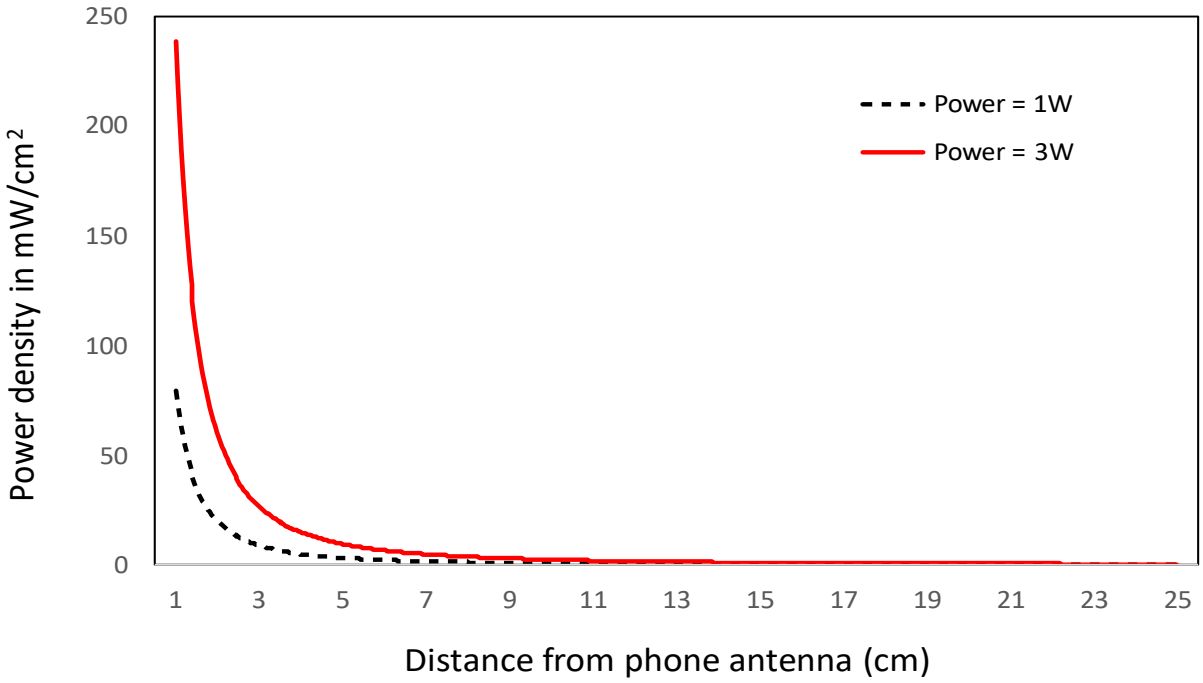


Figure 5.2: *Power densities of mobile phones, transmitted power and distance from the antenna. Derived from data from Saeid 2012 (https://archive.aessweb.com/index.php/5003/article/view/3349/5360). By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

Saeid, S.H. Human exposure assessment in the near-field of antennas used by mobile phone devices. Journal of Asian Scientific Research. **2** (5), 10 (2012).

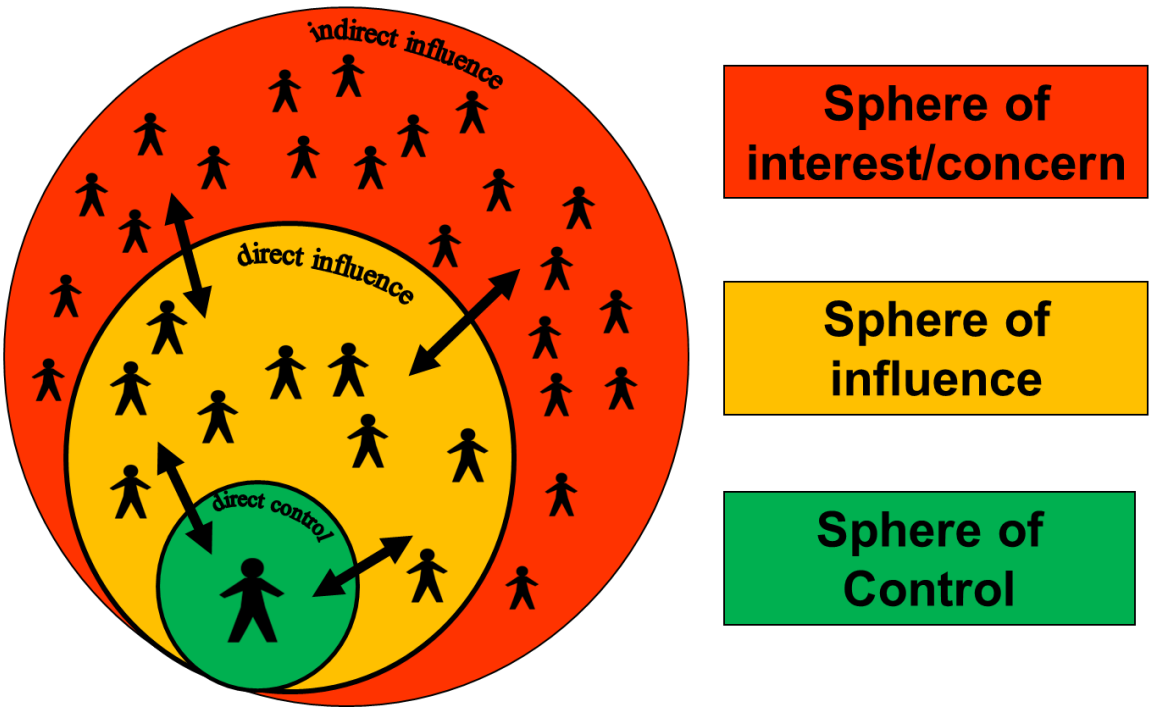
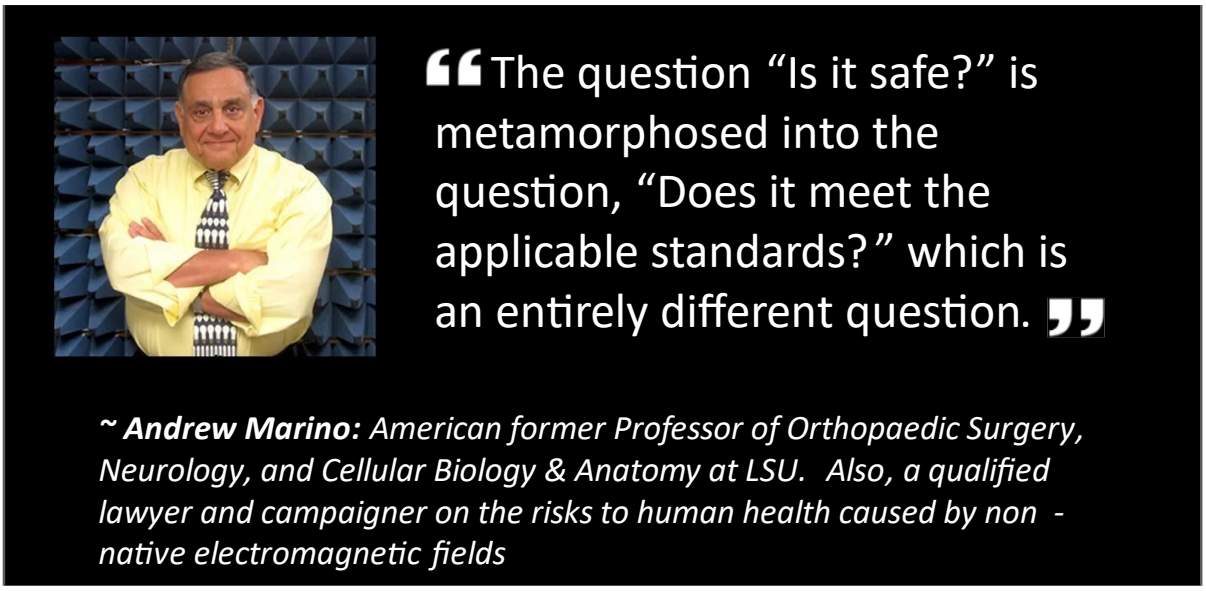


Figure 5.3: *Schematic representation of Stephen Covey's circles of control, influence, and interest/concern. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

Part 2. Electricity – Fallout from Tesla's Triumph



Chapter 6. Extremely Low Frequency EMFs (ELFs) – Electric Fields (EFs) and Magnetic Fields (MFs)

What is ELF-EMF?

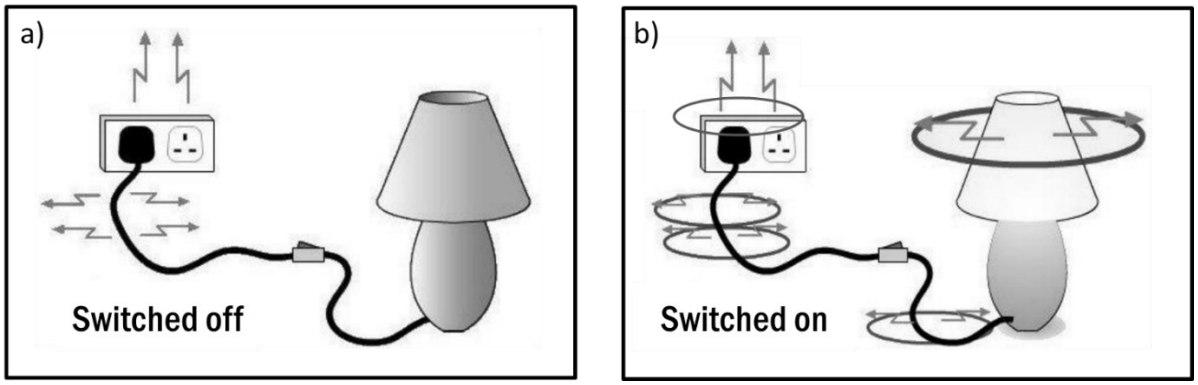


Figure 6.1: *Electric and magnetic fields: a) when a lamp is switched off, and b) when a lamp is switched on. Electric fields are represented as arrows, and magnetic fields as ellipses. Adapted from Philips and Philips 2017 (https://www.powerwatch.org.uk/library/downloads/low-emf-home-1-house-wiring-2017-11.pdf).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

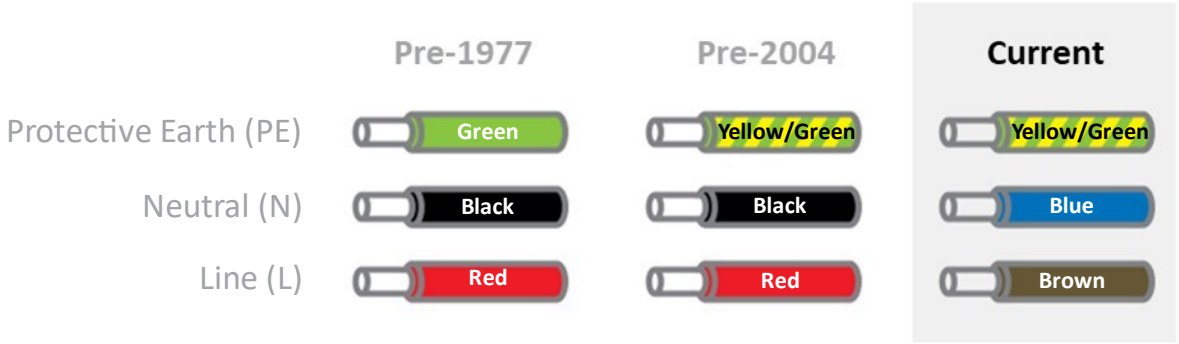


Figure 6.2: *UK electric wire colour coding. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

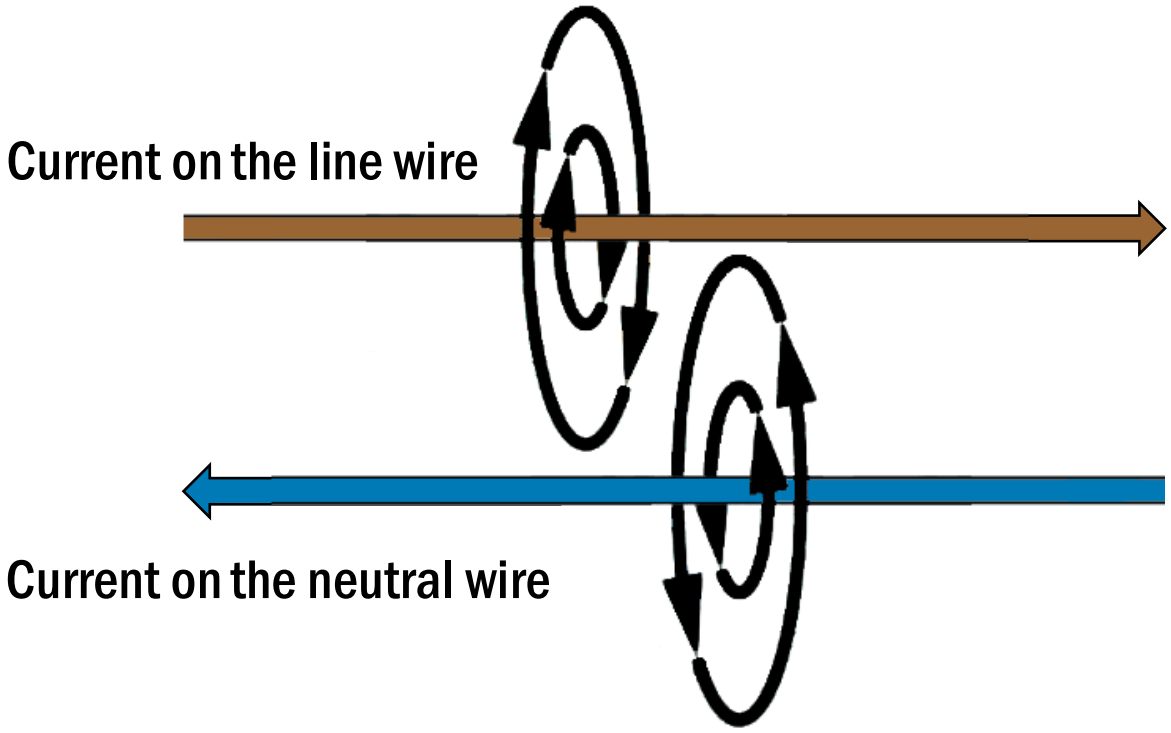


Figure 6.3: *The current on the line wire creates a magnetic field that flows around in one direction, while the current from the neutral wire flows in the opposite direction. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

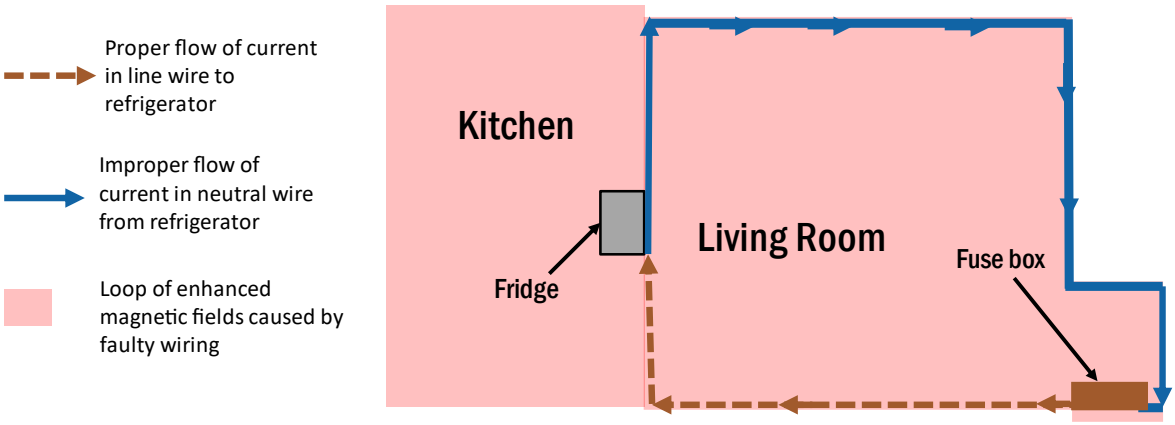


Figure 6.4: *High magnetic field caused by unpaired wires resulting in a current "loop". By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

Health effects of ELF-EMFs

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

A spotlight on low frequency electromagnetic fields and childhood leukaemia

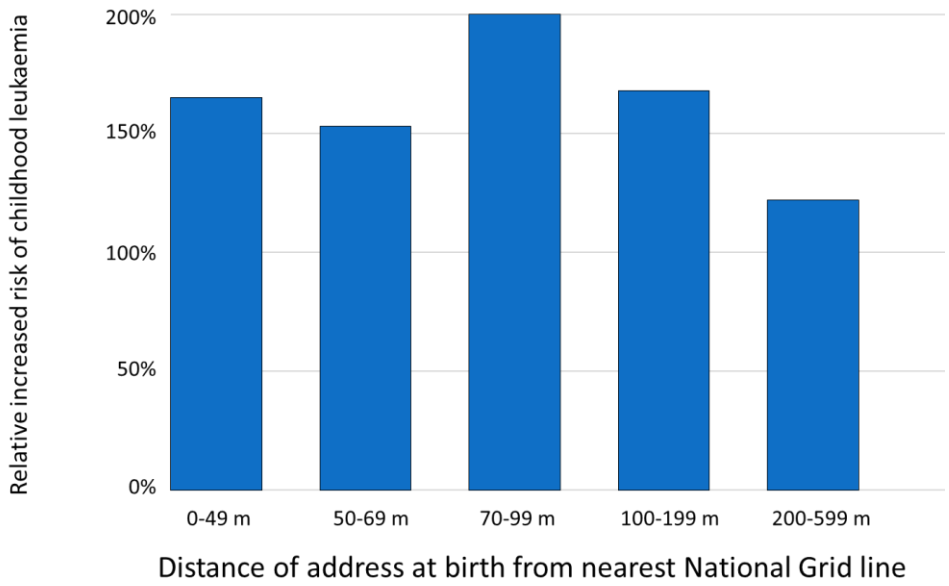


Figure 6.6: *Distance of address at birth from nearest National Grid line and estimated percentage increase in relative risk of leukaemia in England and Wales. The risk is relative to a baseline value for those living more than 600 m from a powerline. Derived from data from Draper et al. (2005). By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

Draper, G., Vincent, T., Kroll, M.E., Swanson, J. Childhood cancer in relation to distance from high voltage power lines in England and Wales: a case-control study. *BMJ (Clinical research ed.)*. **330** (7503), 1290, doi: 10.1136/bmj.330.7503.1290 (2005).

Safety limits for low-frequency electric and magnetic fields

Table 6.1: Different magnetic field safety guidelines around the world

Country/authority	Safety Limit (μT)
European Academy for Environmental Medicine (EUROPAEM)	0.01 (day & night), 0.003 (Sensitive Populations)
Bioinitiative Report	0.1
Switzerland	1.0
UK	3.6
International Commission on Non-Ionizing Radiation Protection (ICNIRP)	200 (general), 1,000 (occupational)

Sources: Pineault (2017),[1] Swanson (2016),[2] Belyaev et al. (2016).[3]

Table 6.2: Different low-frequency electric field safety guidelines around the world

Country/authority	Safety Limit (V/m)
European Academy for Environmental Medicine (EUROPAEM)	1 (night), 10 (day), 0.3 (Sensitive Populations)
Russia	500
Poland	1,000
International Commission on Non-Ionizing Radiation Protection (ICNIRP)	5,000 (general), 10,000 (occupational)
UK	9,000

Sources: Pineault (2017),[1] Swanson (2016),[2] Belyaev et al. (2016).[3]

1. Pineault, N. *The Non-Tinfoil Guide to EMFs: How to Fix Our Stupid Use of Technology*. CreateSpace Independent Publishing Platform. (2017).
2. Swanson, J. *Electric and magnetic fields and health*. at <http://www.emfs.info/wp-content/uploads/2015/07/standards-table-August-2016.pdf>. EMFs.info. (2016).
3. Belyaev, I. *et al.* EUROPAEM EMF Guideline 2016 for the prevention, diagnosis and treatment of EMF-related health problems and illnesses. *Reviews on Environmental Health*. **31** (3), doi: 10.1515/reveh-2016-0011 (2016).

Common ELF-EMF sources

Powerlines

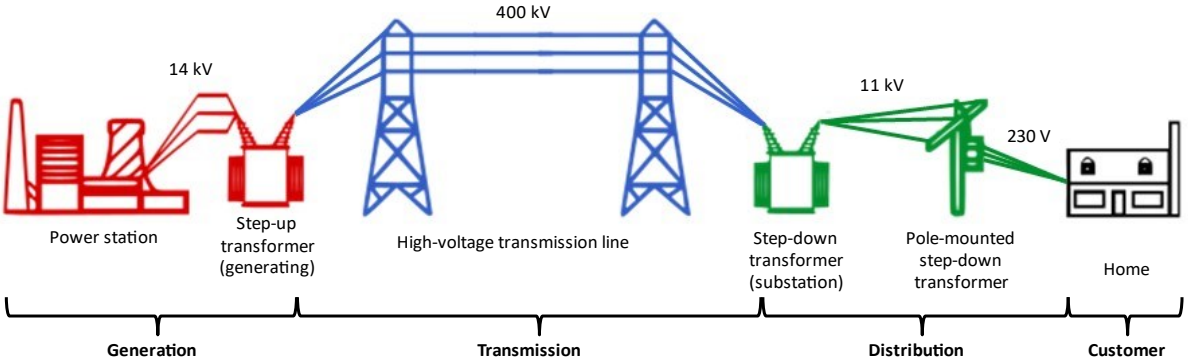


Figure 6.7: *Electricity distribution simplified – from the power station to our homes. CC 4.0 Derivative of Public Domain work by US DOE.*

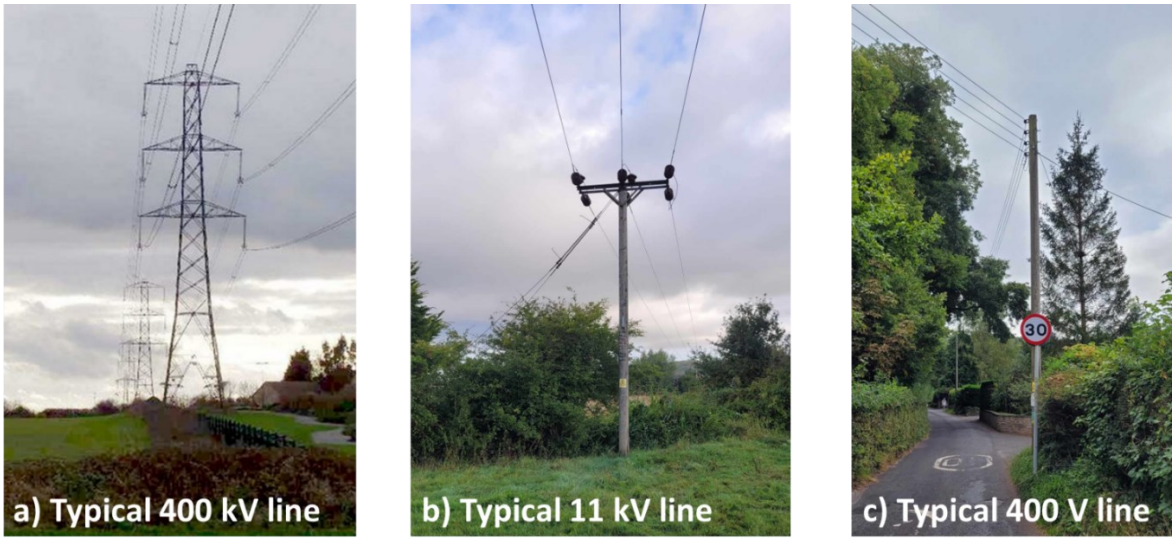


Figure 6.8: *A range of UK overhead powerline types. a) By Frank Skinner CC BY-SA 2.0 creativecommons.org/licenses/by-sa/2.0. b) & c) By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

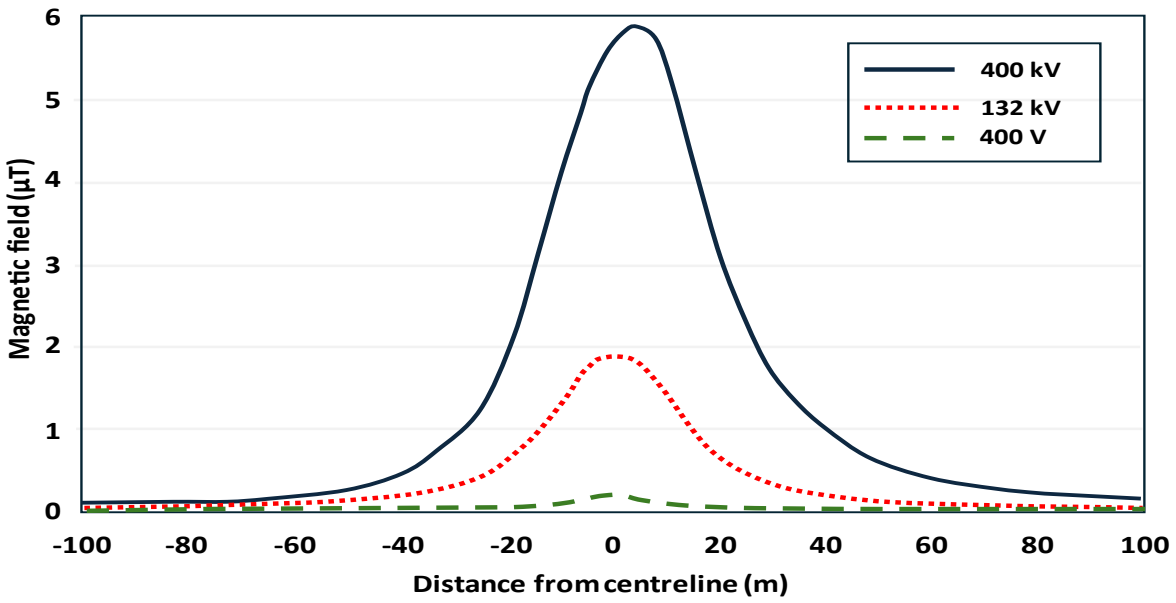


Figure 6.9: *Typical magnetic fields produced by various voltages of overhead lines. Adapted from SAGE 2010 (https://www.powerwatch.org.uk/pdfs/SAGE%20Second%20Interim%20Assessment%202010%20-%20final.pdf).*

SAGE *Second Interim Assessment 2009 – 2010. Electricity Distribution (including low-voltage and intermediate-voltage circuits and substations) and Report on Discussions on Science.* at <https://www.powerwatch.org.uk/pdfs/SAGE%20Second%20Interim%20Assessment%202010%20-%20final.pdf>. Stakeholder Advisory Group on ELF EMFs. (2010).

Table 6.3: Breakdown of magnetic field sources in 102 homes with average fields of greater than 0.2 μT and 21 homes with average fields of greater than 0.4 μT. Source: Maslanyj et al. (2007).

Category	102 homes > 0.2 μT	21 homes > 0.4 μT
High voltage	23%	43%
Low voltage	77%	57%
Outside Home		
High voltage overhead power lines	20%	43%
High voltage underground cables	2%	~
High voltage electrified railway	1%	~
Low voltage overhead power lines	4%	~
Low voltage underground cables	16%	5%
Total outside	**43%**	**48%**
Inside Home		
Internal wiring/net currents	32%	33%
Appliances	3%	~
Total Inside	**35%**	**33%**
Combination of low voltage sources		
	22%	19%

Maslanyj, M.P. *et al.* Investigation of the sources of residential power frequency magnetic field exposure in the UK Childhood Cancer Study. *Journal of Radiological Protection: Official Journal of the Society for Radiological Protection*. **27** (1), 41–58, doi: 10.1088/0952-4746/27/1/002 (2007).

Household wiring

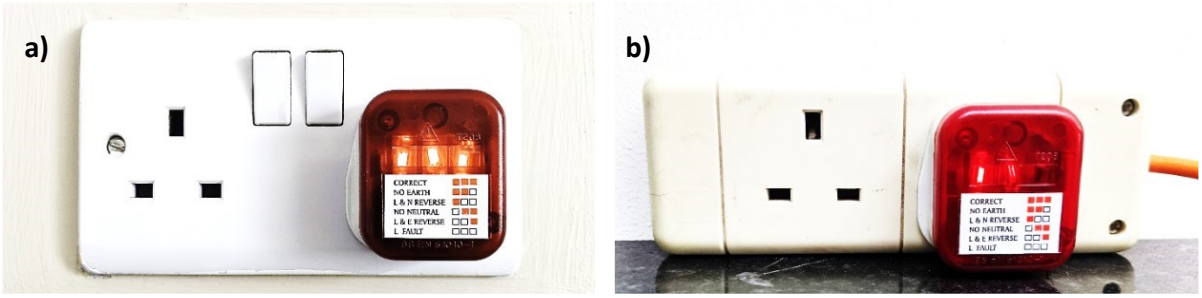


Figure 6.10: *A plug-in socket tester showing wiring status based on LED indicators. a) Correct - wall socket; b) Missing earth on extension lead. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

Household devices and appliances

Table 6.4: Median magnetic field emissions in μT from common household appliances with the highest and lowest readings in brackets. The dash (—) indicates that the magnetic field measurement at this distance from the operating appliance could not be distinguished from background measurements taken before the appliance had been turned on. Source: US EPA, 1992.

Appliance	Distance from appliance & MF emissions in μT			
	6 inches (15 cm)	**1 foot (30.5 cm)**	**2 feet (61 cm)**	**4 feet (1.22 m)**
Electric can openers	**60** (50 to 150)	**15** (4 to 30)	**2** (0.3 to 2)	0.2 (— to 0.4)
Vacuum cleaners	**30** (10 to 70)	**6** (2 to 20)	**1** (0.4 to 5)	**0.1** (— to 1)
Electric pencil sharpeners	**30** (2 to 10)	**9** (0.8 to 9)	**3** (0.5 to 3)	**0.2** (— to 3)
Hair dryers	**30** (0.1 to 70)	**0.1** (— to 7)	**—** (— to 1)	**—** (— to 0.1)
Microwave ovens	**20** (10 to 30)	**4** (0.1 to 20)	**1** (0.1 to 3)	**0.2** (— to 2)
Electric drills	**15** (10 to 20)	**3** (2 to 4)	**0.4** (0.3 to 0.6)	**—** (— to —)
Electric razors	**10** (0.1 to 60)	**2** (— to 10)	**—** (— to 1)	**—** (— to 0.1)
Portable heaters	**10** (0.5 to 15)	**2** (0.1 to 4)	**0.4** (— to 0.8)	— (— to 0.1)
Fluorescent lights	**4** (2 to 10)	**0.6** (— to 3)	**0.2** (— to 0.8)	**—** (— to 0.4)
Dishwashers	**2** (1 to 10)	**1** (0.6 to 3)	**0.4** (0.2 to 0.7)	— (— to 0.1)
Washing machines	**2** (0.4 to 10)	**0.7** (0.1 to 3)	**0.1** (— to 0.6)	**—** (— to —)
Toasters	**1** (0.5 to 20)	**0.3** (— to 0.7)	**—** (— to —)	**—** (— to —)
Electric ovens	**0.9** (0.4 to 2)	**0.4** (0.1 to 0.5)	**—** (— to 0.1)	**—** (— to —)
Refrigerators	**0.2** (— to 4)	**0.2** (— to 2)	**—** (0.1 to 1)	**—** (— to 1)
Tumble dryers	**0.3** (0.2 to 1)	**0.2** (— to 0.3)	**—** (— to —)	**—** (— to —)
Ceiling fans	Not reported	**3** (– to 5)	— (— to 0.6)	**—** (— to 0.1)
Window air conditioners	Not reported	**0.3** (— to 2)	**0.1** (— to 0.6)	**—** (— to 0.4)
Digital clocks	Not reported	**0.1** (– to 0.8)	**—** (— to 0.2)	**—** (— to 0.1)

EMF In Your Environment: Magnetic Field Measurements of Everyday Electrical Devices. United States Environmental Protection Agency, Office of Radiation and Indoor Air. (1992).

Measuring EMFs

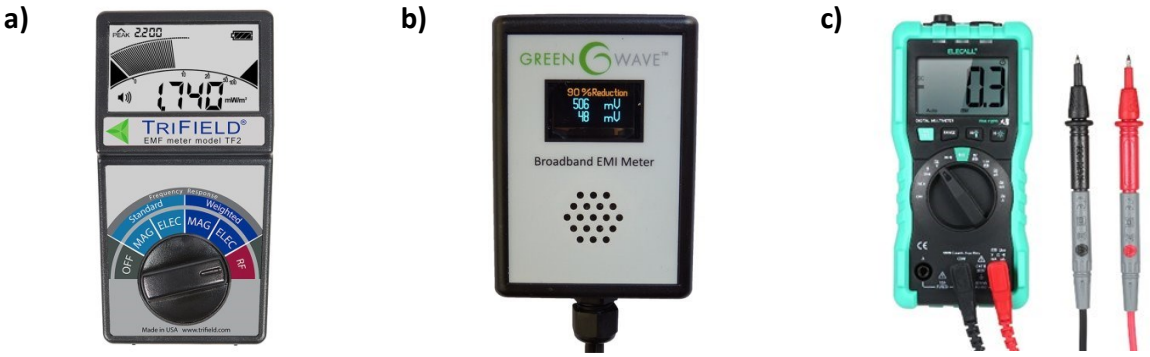


Figure 6.11: *Some different types of EMF meter: a) A single meter to detect radio frequency, electric and magnetic fields, b) A dirty electricity meter, c) A multimeter used to measure body voltage. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

Chapter 7. Dirty Electricity

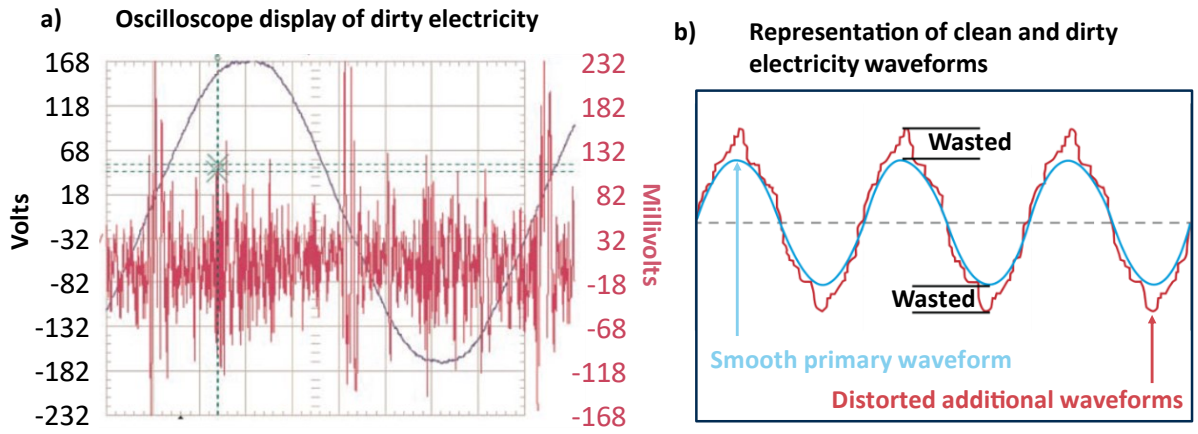


Figure 7.1: *a) Dirty electricity example – the normal AC frequency wave (60 Hz in this US example) is a smooth line with the dirty electricity jagged line. Note the different scales used so that both curves fit on the same graph. Source Milham & Morgan 2008, b) Representation of clean electricity (smooth line) and the superimposition of dirty electricity, which makes the line jagged. Source: SATIC Inc (2024).*

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

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

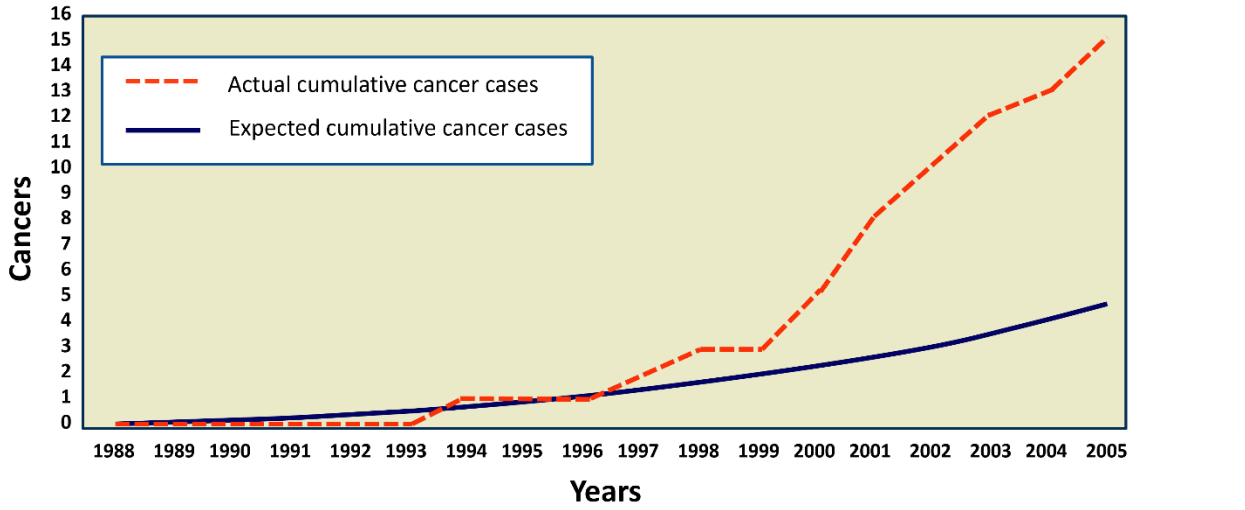


Figure 7.2: *Expected cancers versus actual cancers for LQMS teachers from 1988–2005. Adapted from Milham 2010 (http://www.sammilham.com/).*

Milham, S. Dirty Electricity: Electrification and the Diseases of Civilization. iUniverse Inc. Bloomington. (2010).

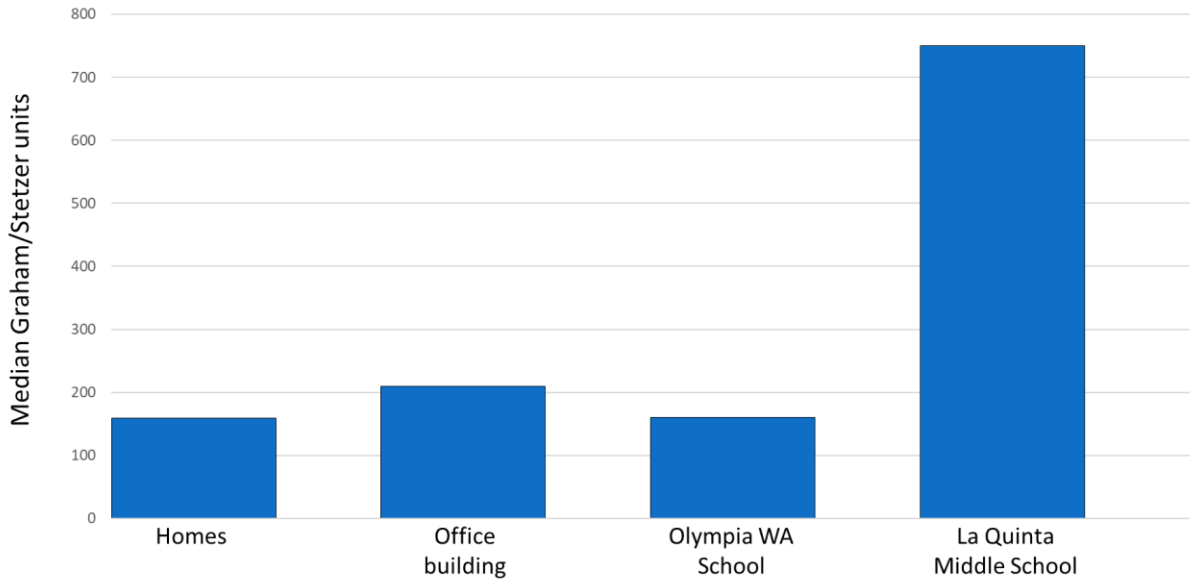


Figure 7.3: *Median dirty electricity values in LQMS compared with another school, homes and an office building. Data from Milham & Morgan 2008.*

Milham, S., Morgan, L.L. A new electromagnetic exposure metric: high frequency voltage transients associated with increased cancer incidence in teachers in a California school. *American Journal of Industrial Medicine*. **51** (8), 579–586, doi: 10.1002/ajim.20684 (2008).

Chapter 8. Electricity Solutions

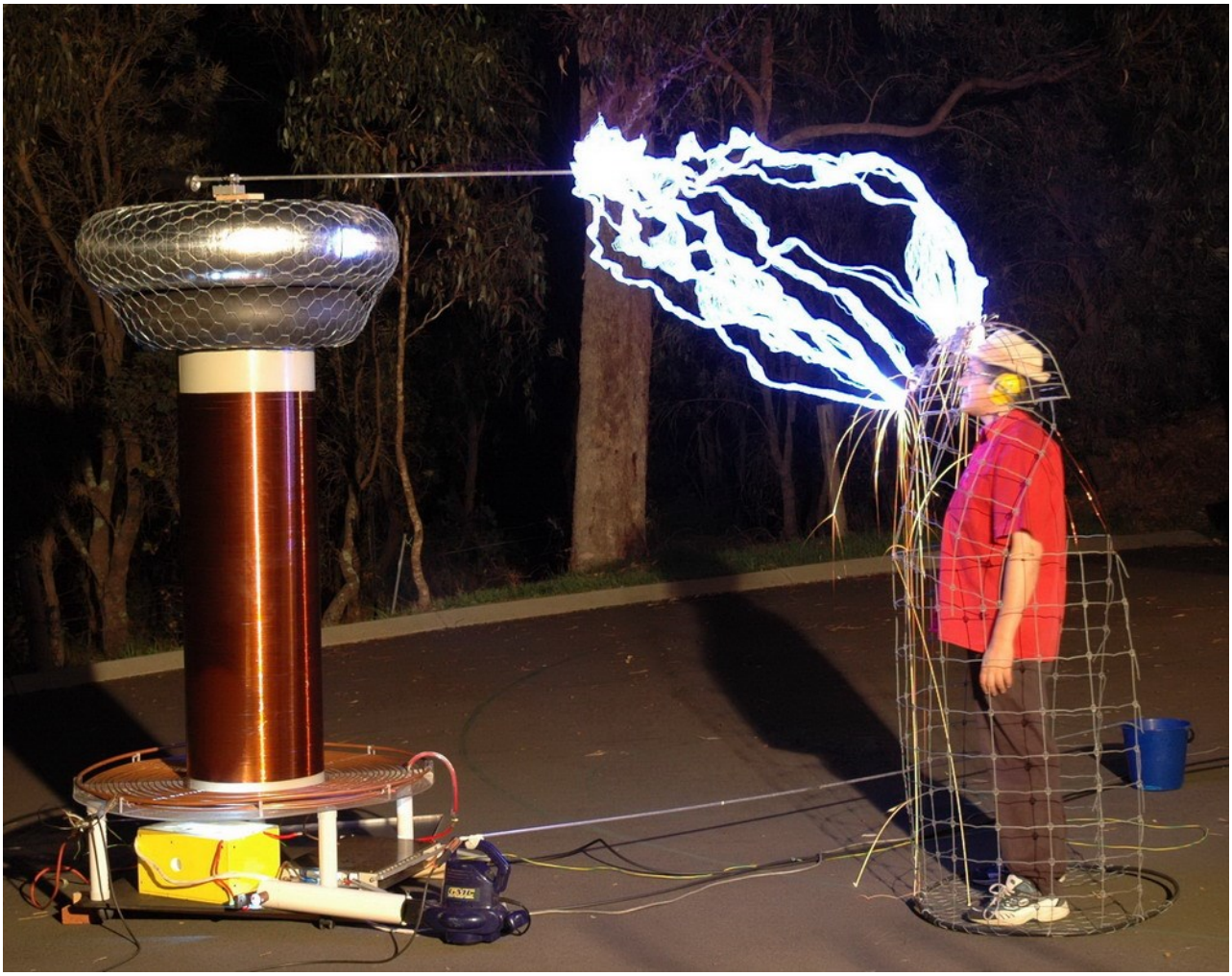
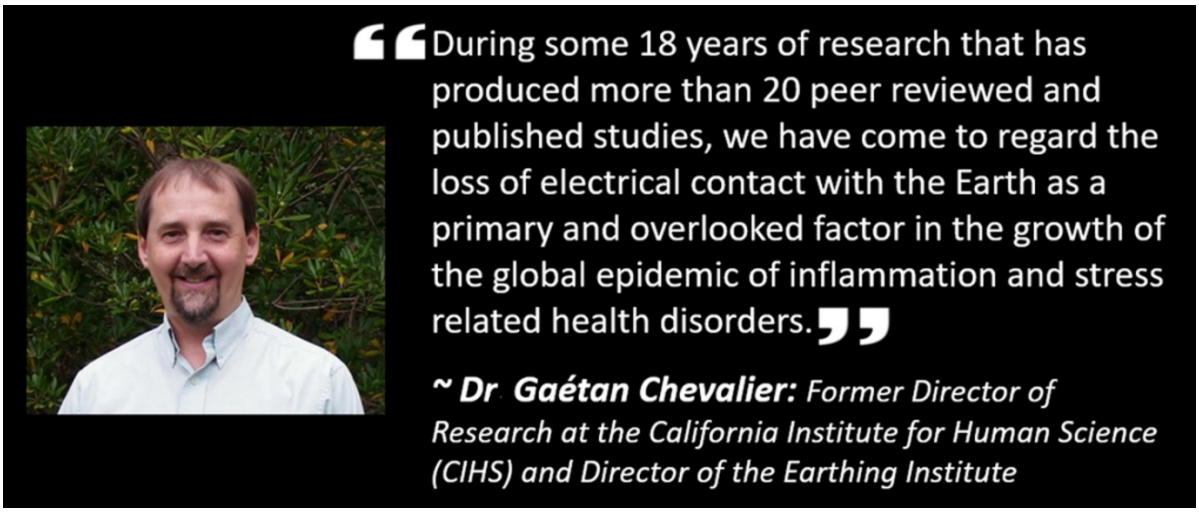


Figure 8.1: *Man in a Faraday cage protected from a high voltage electric current. Please don't try this at home. by Tesla Downunder (https://tesladownunder.com/Tesla18Dalek10003Ft.jpg) CC BY-SA 2.5 creativecommons.org/licenses/by-sa/2.5.*

Chapter 9. Grounding: "The Most Important Health Discovery Ever!"



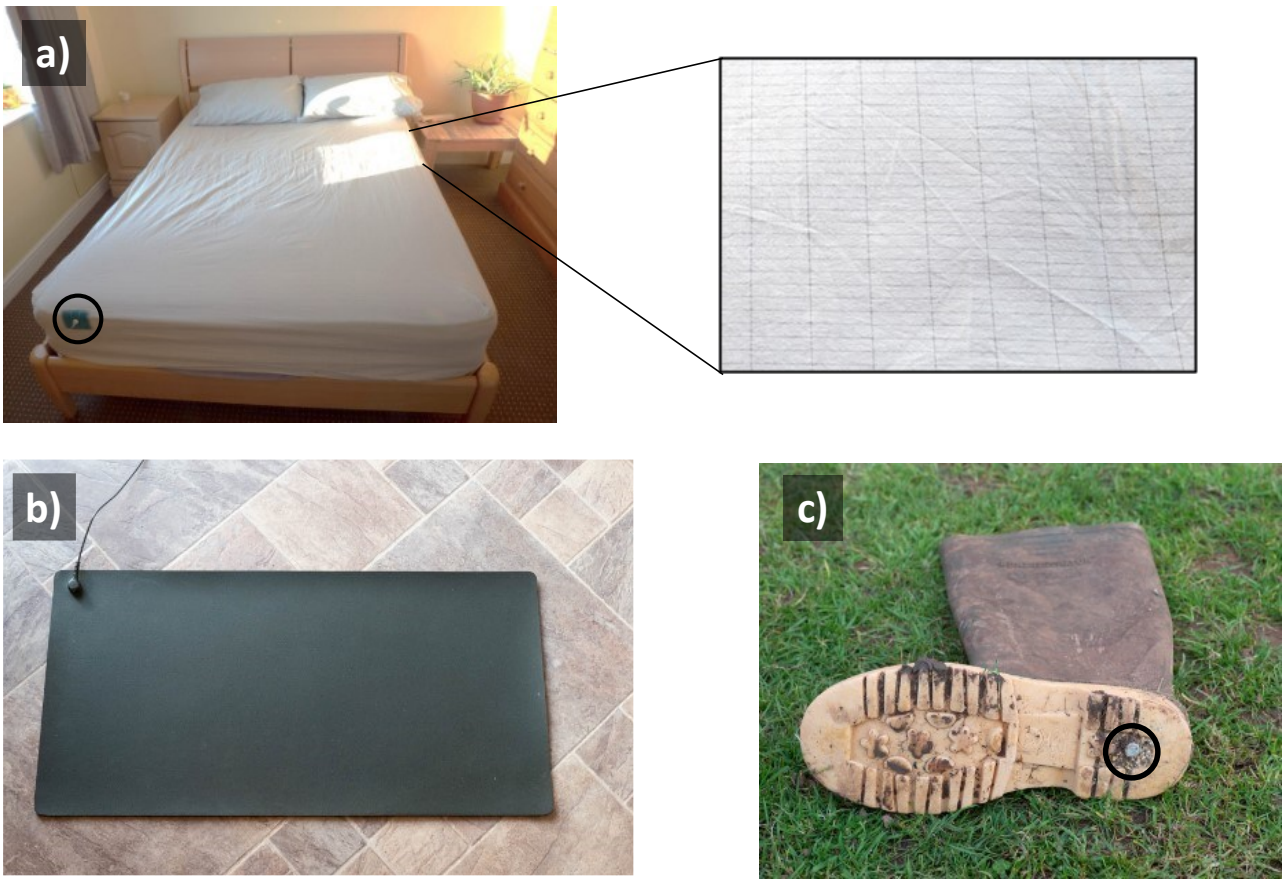


Figure 9.1: *Examples of commercially available and homemade grounding products: a) Fitted grounding bedsheet. The inset shows the conductive silver fibres woven throughout the cotton. The connection stud where the connection cord fits is circled. b) Grounding mat for use while sitting or standing, while at a desk, watching television, etc. c) grounded Wellington boot with a bolt inserted through the sole (circled). By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

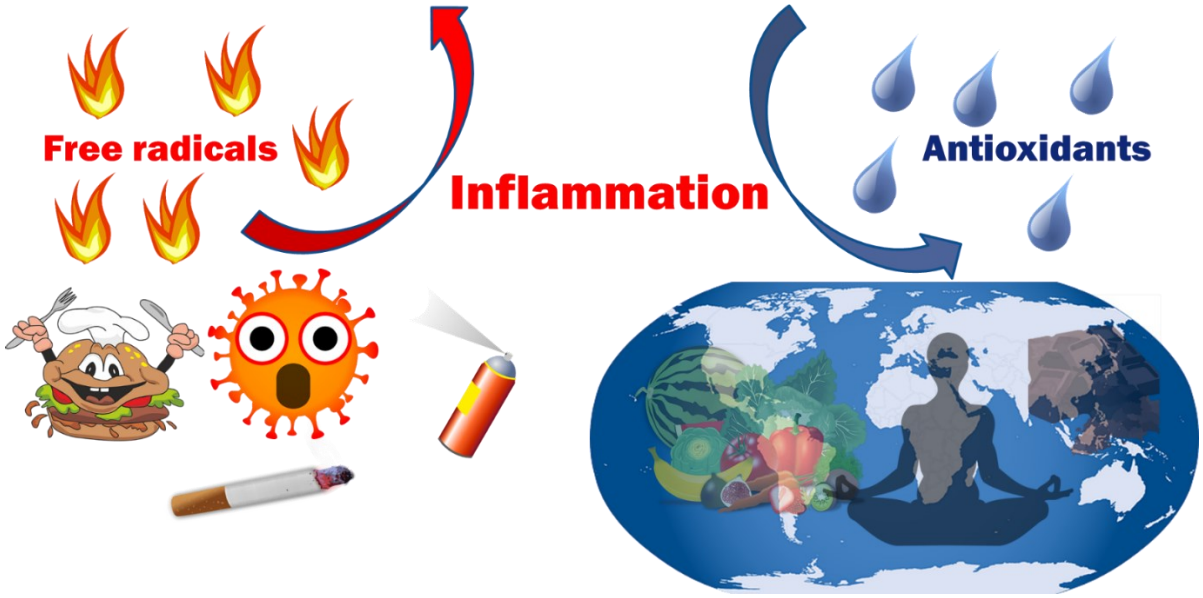


Figure 9.2: *Fresh fruit and vegetables, dark chocolate, and breathing and relaxing exercises help provide antioxidants, but the ultimate source of antioxidants is the surface of the Earth itself. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

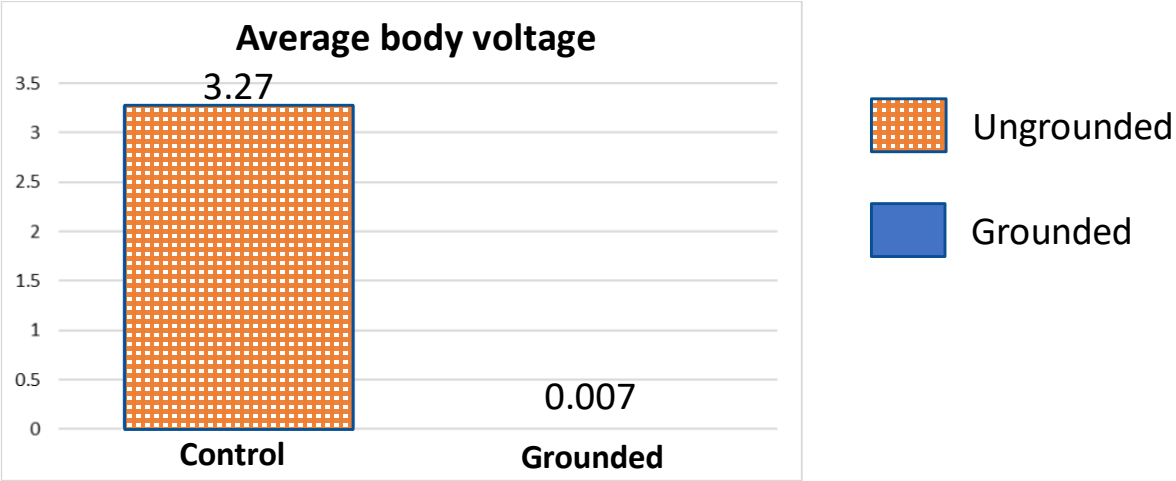


Figure 9.3: *Average body voltage before and during grounding. Source: Ghaly & Teplitz 2004 (doi:10.1089/acm.2004.10.767). The publisher for this copyrighted material is Mary Ann Liebert, Inc. publishers. Used with the permission of Mary Ann Liebert, Inc.*

Ghaly, M., Teplitz, D. The biologic effects of grounding the human body during sleep as measured by cortisol levels and subjective reporting of sleep, pain, and stress. *Journal of Alternative and Complementary Medicine (New York, N.Y.).* **10** (5), 767–776, doi: 10.1089/acm.2004.10.767 (2004).

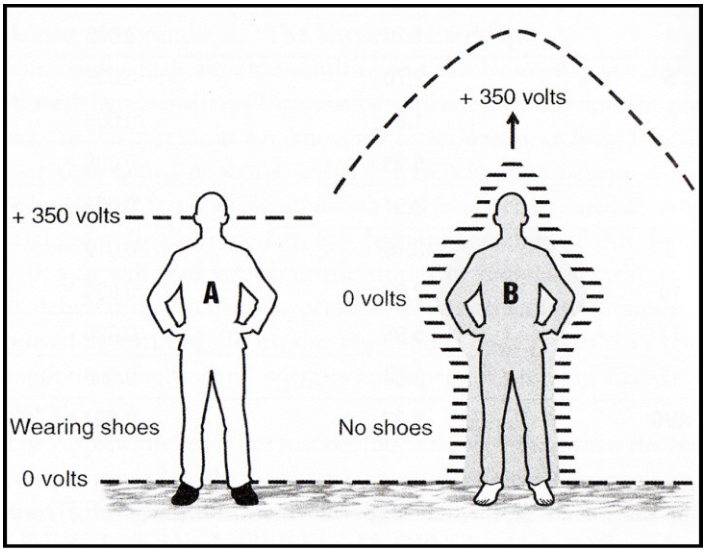


Figure 9.4: *The umbrella effect of grounding. Source: Ober et al. 2014 (https://www.earthing.com/). Used with the permission of Turner Publishing Company, LLC.*

Ober, C., Sinatra, S.T., Zucker, M. Earthing: The Most Important Health Discovery Ever! Basic Health Publications Inc. (2014).

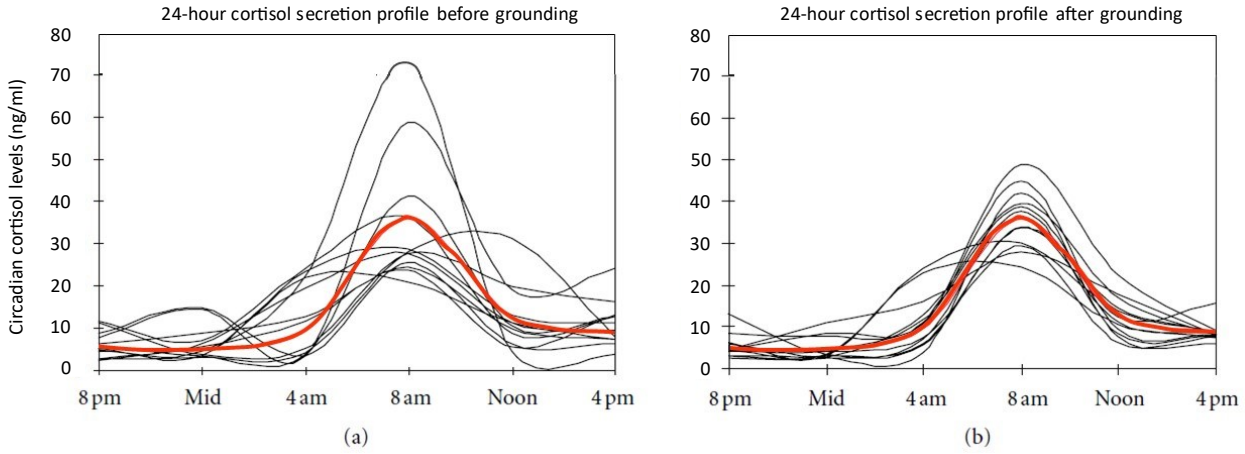
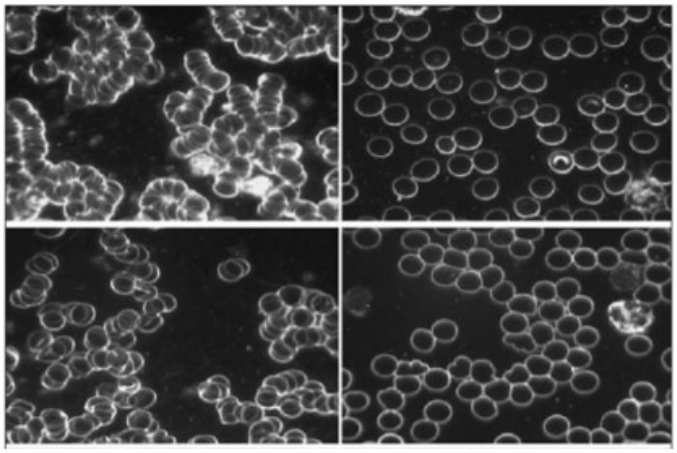


Figure 9.5: *Cortisol levels before and after grounding. The thick line indicates an optimal cortisol secretion pattern. Adapted from Ghaly & Teplitz 2004 (doi:10.1089/acm.2004.10.767). The publisher for this copyrighted material is Mary Ann Liebert, Inc. publishers. Used with the permission of Mary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

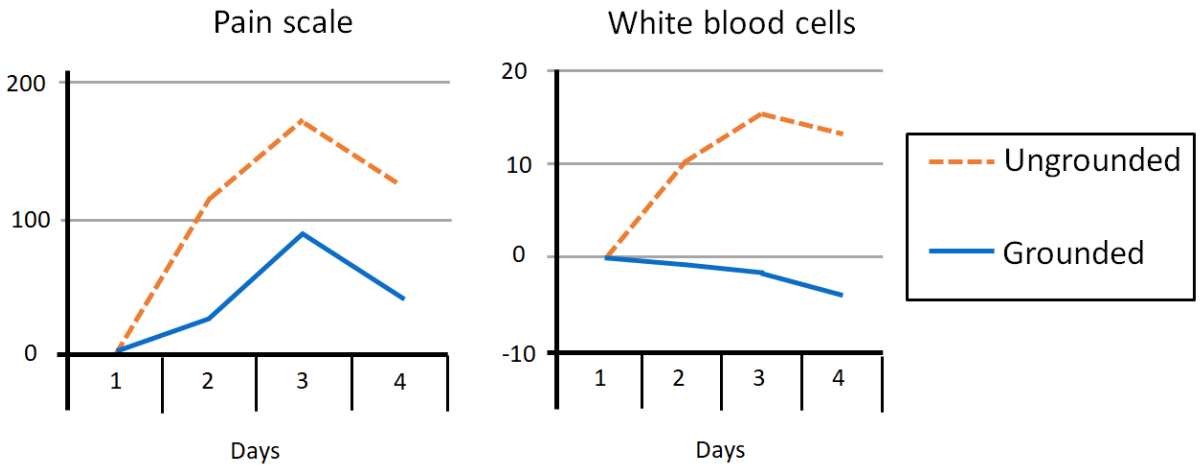
Ghaly, M., Teplitz, D. The biologic effects of grounding the human body during sleep as measured by cortisol levels and subjective reporting of sleep, pain, and stress. *Journal of Alternative and Complementary Medicine (New York, N.Y.).* **10** (5), 767–776, doi: 10.1089/acm.2004.10.767 (2004).



Microscope images of blood taken before (left) and after (right) 40 minutes of grounding.

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

Ober, C., Sinatra, S.T., Zucker, M. Earthing: The Most Important Health Discovery Ever! Basic Health Publications Inc. (2014).



Grounded subjects expressed less pain perception and a muted white blood cell response indicating less inflammation.

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

Brown, R., Chevalier, G., Hill, M. Pilot study on the effect of grounding on delayed-onset muscle soreness. *The Journal of Alternative and Complementary Medicine*. **16** (3), 265–273, doi: 10.1089/acm.2009.0399 (2010).

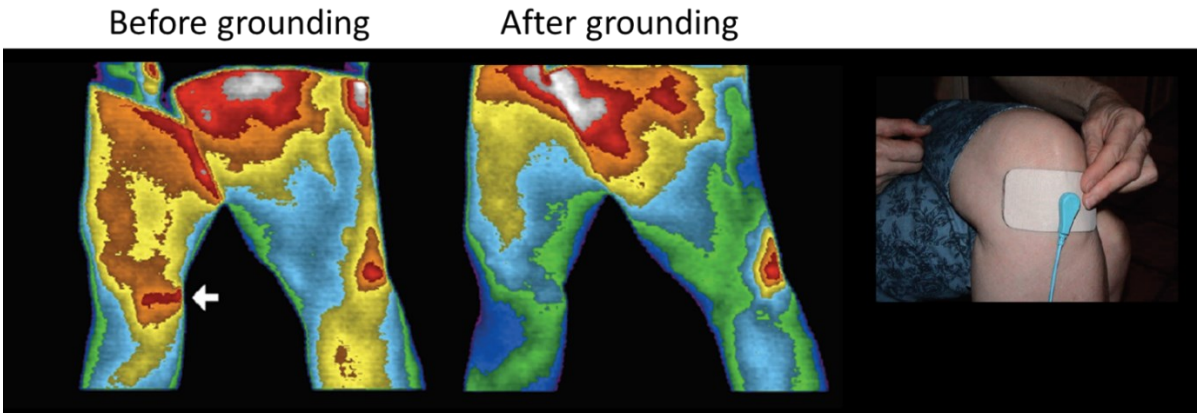


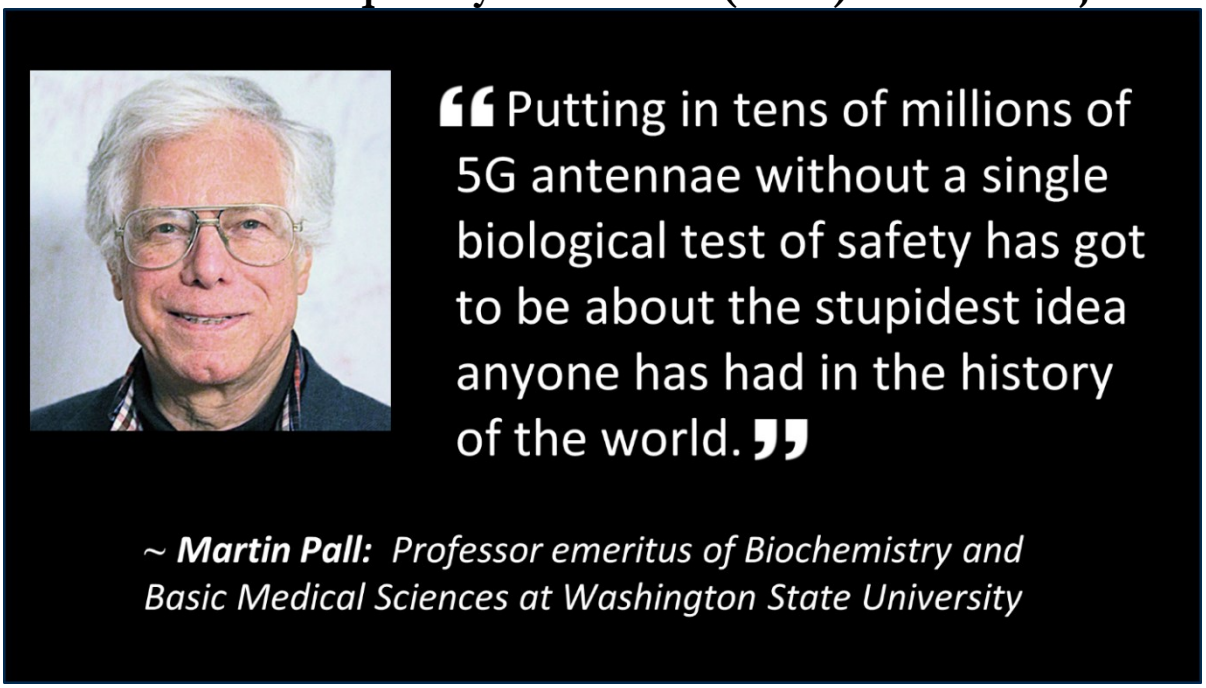
Figure 9.8: *Infrared images of the leg of a 33-year-old woman with chronic right knee pain. Abnormally hot areas (red) indicate inflammation. The photos were taken 30 minutes apart. The inset shows the clinical grounding patch system – a peel-away strip over a conductive connected with the Earth via a grounding rod. Source: Oschman 2007 (doi:10.1089/acm.2007.7048). The publisher for this copyrighted material is Mary Ann Liebert, Inc. publishers. Used with the permission of Mary Ann Liebert, Inc.*

Oschman, J.L. Can electrons act as antioxidants? A review and commentary. *Journal of Alternative and Complementary Medicine (New York, N.Y.).* **13** (9), 955–967, doi: 10.1089/acm.2007.7048 (2007).

Table 9.1: Common criticisms of grounding and responses

Criticism	Response
Grounding turns you into an antenna, thus drawing EMFs into your body and harming it.	A grounded antenna no longer works as an antenna. The metal structures that house TV, radio, or mobile phone antennas are grounded to protect property against lightning, but the antennas themselves are not grounded.
Using grounding products indoors in the presence of EMFs is harmful to health and should be avoided because dangerous currents will circulate in your body.	You do not become a target of electric fields because of the Umbrella Effect. The claim is the opposite of the reality that EMFs are reflected away from you when grounded, thus dropping your body voltage to nearly zero. This is true for frequencies below 100 kHz. For higher frequencies, more research is needed.
If you ground yourself indoors by connecting to a wall outlet, dirty electricity comes through the ground cord, the grounding product you are using, and through your body, and is dangerous.	All the published evidence indicates that dirty electricity does not penetrate a grounded body.
Grounding amid high electric fields in your home puts you at risk of a shock.	There is no possibility of an electric shock because electric shocks are caused by electric currents, and electric fields carry no current.
It is best not to ground yourself if you live in a city or suburb because of the presence of "stray voltage" or ground currents, which result from our electrical system feeding AC electricity into the ground.	Significant voltage in the ground is exceedingly rare and limited to specific areas, such as immediately next to power stations and electric trains.

Part 3. Radio Frequency Radiation (RFR) — It's not just 5G



Chapter 10. Radio Frequency Radiation

What is radio frequency radiation (RFR)?

Table 10.1: Subcategories of radio frequencies, their propagation characteristics, and examples of use. Sources[1–11].

Radio Frequency	Propagation characteristics	Examples of use
Very low frequency (VLF) *Myriametre wave* Frequency: 3–30 kHz Wavelength: 100–10 km	With their long wavelengths, VLF radio waves can diffract (bend) over and around large obstacles, so they are not blocked by mountain ranges, and they can follow the curvature of the Earth and so are not limited by the horizon. VLF waves experience little of the attenuation or "fading" that afflicts higher frequencies. Propagation distances of 5,000–20,000 km have been recorded. VLF waves can penetrate seawater to a depth of at least 10–40 m. The longer the wavelength, the greater the size of the antenna required for transmission, so high-power transmitting antennas for VLF frequencies need to be up to several kilometres long.	A small number of radio navigation services and military communication with submarines use this band. It was used for long-distance transoceanic radio communication during the wireless telegraphy era between about 1905 and 1925. Early attempts were made to use a radiotelephone within this band, but the available bandwidth was insufficient.
Low frequency (LF) *Kilometre wave* Frequency: 30–300 kHz Wavelength: 10–1 km	Low-frequency radio waves can diffract over obstacles like mountain ranges and travel beyond the horizon. The attenuation of signal strength with distance by absorption in the ground is lower than at higher frequencies, and LF waves can be received up to 2,000 km from the transmitting antenna.	AM broadcasting ("longwave" band), information and weather systems, amateur radio, and military communication with submarines.
Medium frequency (MF) *Hectometre wave* Frequency: 300 kHz–3 MHz Wavelength: 1 km–100 m	MF radio waves can diffract over hills and beyond the visual horizon, although mountain ranges may block them. Typical MF radio stations can cover a radius of several hundred kilometres from the transmitter.	AM broadcasting ("medium wave" band), some coast guard and other ship-to-shore frequencies, amateur radio, and used for early portable or cordless home phones.
High frequency (HF) *Decametre wave* Frequency: 3–30 MHz Wavelength: 100–10 m	The HF band is a major part of the shortwave band of frequencies, so communication at these frequencies is often called shortwave radio. Because HF radio waves can be reflected back to Earth by the ionosphere – "skip" or "skywave" propagation – these frequencies are suitable for long-distance communication across intercontinental distances and for mountainous terrains, which prevent line-of-sight (LOS) communications.	International shortwave radio broadcasting, aviation communication, weather stations, and amateur radio.
Very high frequency (VHF) *Metre wave* Frequency: 30–300 MHz Wavelength: 10 m–1 m	Travel mainly by LOS and ground-bounce paths. They do not follow the contour of the Earth and so are blocked by hills and mountains but can travel somewhat beyond the visual horizon to about 160 km from the transmitter. Can penetrate buildings, although in urban areas, reflections from buildings can interfere with television reception. Atmospheric radio noise and interference (RFI) from electrical equipment is less of a	Digital Audio Broadcasting (DAB) and FM radio broadcasting, television broadcasting, two-way land mobile radio systems, long-range data communication with radio modems, amateur radio and marine communications, and air traffic control communications and air navigation systems.

Radio Frequency	Propagation characteristics	Examples of use
	problem in this and higher frequency bands than at lower frequencies. The VHF band is the first band in which efficient transmitting antennas are small enough to be mounted on vehicles and portable devices.	
Ultra high frequency (UHF) *Decimetre wave* Frequency: 300 MHz–3 GHz Wavelength: 1 m–10 cm	Travel almost entirely by LOS and ground reflection paths. Blocked by hills and cannot travel beyond the horizon but can penetrate foliage and buildings for indoor reception. UHF TV signals are generally more degraded by moisture than lower bands, such as VHF TV signals. As UHF transmission is limited by the visual horizon and local terrain, it allows the same frequency channels to be reused by other users in neighbouring geographic areas (frequency reuse).	Television broadcasting, mobile phones, satellite communication including GPS, Wi-Fi and Bluetooth, walkie-talkies, cordless phones, radar, and numerous other applications.
Super high frequency (SHF) *Centimetre wave* Frequency: 3–30 GHz Wavelength: 10–1 cm	Travel solely by LOS paths. In some cases, they can penetrate building walls enough for useful reception. Wavelengths are small enough that the antenna can be much larger than a wavelength, which allows highly directional ("high gain") antennas which can produce narrow beams, which allow frequency reuse by nearby transmitters. SHF waves create strong reflections from metal objects the size of cars, aircraft, and ships. This, along with high gain antennas and the low atmospheric attenuation compared with higher frequencies, make SHF the main frequencies used in radar.	The frequency range used for most radar transmitters, wireless LANs, satellite communication, microwave radios, and short-range terrestrial data links. Also used for heating in industrial microwave heating, and in microwave ovens. 0.5–10 GHz beams aimed at the US Embassy Moscow from 1953–1979 (the "Moscow signal") allegedly for behavioural /physiological interference.[10]
Extremely high frequency (EHF) *Millimetre wave (mmWave)* Frequency: 30–300 GHz Wavelength: 1 cm–1 mm	Travel solely by LOS paths. At typical power densities, they are blocked by walls and suffer significant attenuation when passing through foliage. Absorption by atmospheric gases is a significant factor and increases with frequency. This absorption is at its maximum at a few specific absorption lines, mainly those of oxygen at 60 GHz and water vapour at 24 GHz and 184 GHz. At frequencies in the "windows" between these absorption peaks, millimetre waves have much less atmospheric attenuation and greater range, so many applications use these frequencies. Millimetre wavelengths are the same order of size as raindrops, so precipitation causes additional attenuation. Useful propagation is limited to a few kilometres. Therefore, they are useful for densely packed communications networks that improve spectrum utilisation through frequency reuse.	Commonly used in radio astronomy and satellite-based remote sensing. Remote sensing is used for atmospheric monitoring in meteorological and climate sensing applications. Uses of millimetre wave bands include point-to-point communications, intersatellite links, and point-to-multipoint communications. The use of millimetre wave bands by 5G mobile phones is likely to become commonplace. The use of millimetre wave bands to support self-driving vehicles is being intensively pursued. Non-lethal directed energy weapons using mmWave EMF have been developed, e.g. the US active denial system (ADS).[11]

1. Wikipedia contributors Radio frequency. *Wikipedia, The Free Encyclopedia*. at <https://en.wikipedia.org/w/index.php?title=Radio_frequency&oldid=1006176178> (2021).

2. Wikipedia contributors Very low frequency. *Wikipedia*. at <https://en.wikipedia.org/w/index.php?title=Very_low_frequency&oldid=1009920399> (2021).

3. Wikipedia contributors Low frequency. *Wikipedia*. at <https://en.wikipedia.org/w/index.php?title=Low_frequency&oldid=1009054345> (2021).

4. Wikipedia contributors Medium frequency. *Wikipedia*. at <https://en.wikipedia.org/w/index.php?title=Medium_frequency&oldid=1002816816> (2021).

5. Wikipedia contributors High frequency. *Wikipedia*. at <https://en.wikipedia.org/w/index.php?title=High_frequency&oldid=1004414446> (2021).

6. Wikipedia contributors Very high frequency. *Wikipedia*. at <https://en.wikipedia.org/w/index.php?title=Very_high_frequency&oldid=1012331081> (2021).

7. Wikipedia contributors Ultra high frequency. *Wikipedia*. at <https://en.wikipedia.org/w/index.php?title=Ultra_high_frequency&oldid=1010626922> (2021).

8. Wikipedia contributors Super high frequency. *Wikipedia*. at <https://en.wikipedia.org/w/index.php?title=Super_high_frequency&oldid=1008870950> (2021).

9. Wikipedia contributors Extremely high frequency. *Wikipedia*. at <https://en.wikipedia.org/w/index.php?title=Extremely_high_frequency&oldid=1006524393> (2021).

10. Martínez, J.A. The "Moscow signal" epidemiological study, 40 years on. *Reviews on Environmental Health*. **34** (1), 13–24, doi: 10.1515/reveh-2018-0061 (2019).

11. Zohuri, B. Millimeter-wave energy as weapon. *Directed-Energy Beam Weapons*. 377–396, doi: 10.1007/978-3-030-20794-6_7 (2019).

Health effects of radio frequency EMFs

Cancers

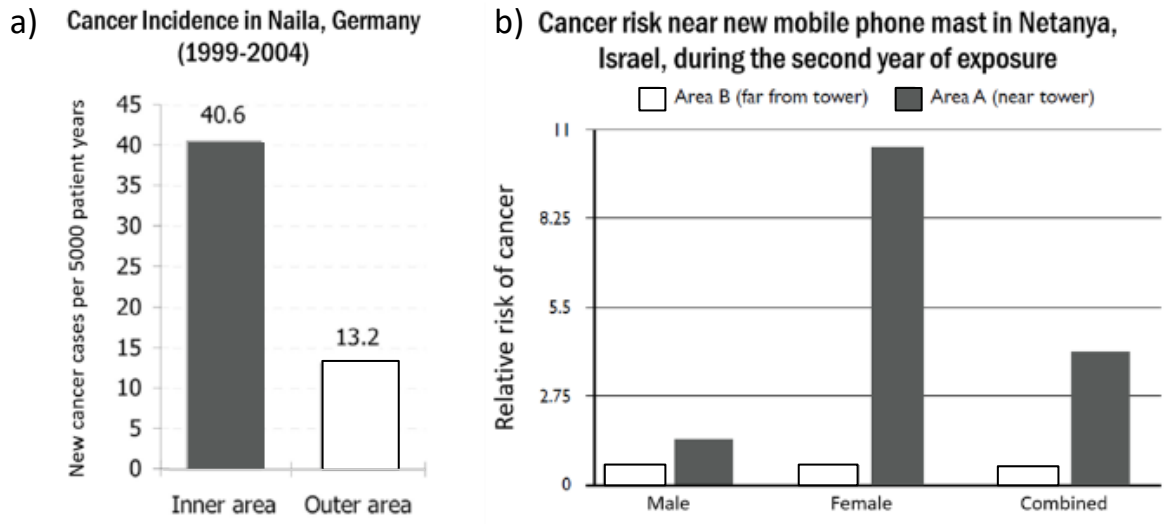


Figure 10.1: *Associations between proximity to cell towers and incidence of cancer. Sources: a) Eger et al. (2004)[1] and b) Wolf & Wolf (2004).[2]*

a) Derived from data from Eger et al. 2004 (https://fliphtml5.com/btup/mtll/basic#google_vignette). By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

b) Source: Wolf & Wolf 2004 (www.emf-portal.org/en/article/19820).

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Table 10.2: A comparison of radio frequency exposure guidelines, emissions from RFR emitting devices and impacts. Adapted from the BioInitiative Report.[1]

RFR exposure (μW/m²)[a]	Exposure Guidelines, Emissions, & Adverse Biological Effects	Source	Year	Country/ Countries
10,000,000	**FCC Public Exposure Guidelines[b]**	**FCC[2]**	**1986**	**USA**
9,000,000	**ICNIRP Public Exposure Guidelines (adopted by the UK, most other countries, and WHO)[b]**	**ICNIRP[3]**	**1998**	**Most**
1,000,000	24% drop in testosterone after 6 hours exposure	Navakatikian[4]	1994	Russia
500,000	Pathological leakage of blood-brain barrier in one hour	Salford[5]	2003	Sweden
100,000	**Russia, Italy & China Public Exposure Guidelines**			
100,000	Increased cancer risk for radar operators; very short latency period. Dose-response to exposure level of RFR (100,000–1,000,000 μW/m²)	Richter[6]	2000	Israel
95,000	**Close to Wi-Fi hotspots in dense urban spaces**	**Hardell[7]**	**2016**	**Sweden**
60,000	DNA damage	Phillips[8]	1998	USA
52,500	Cell stress response	Kwee[9]	2001	Denmark
50,000	Impaired nervous system activity	Dumansky[10]	1974	Russia
50,000	Drop in natural killer white blood cells (immune function decreased)	Boscol[11]	2001	Italy
40,000	Changes in hippocampus (component of the brain involved in memory, among other functions)	Tattersall[12]	2001	UK
27,000	**Representative mobiles phones at 4 cm**	**Wall[13]**	**2019**	**USA**
20,000	Double-stranded DNA damage	Kesari[14]	2008	India
17,000	**Average max power levels for representative smart meters at 0.5 m**	**Peyman[15]**	**2017**	**Great Britain**
15,000	Reduced memory function	Nittby[16]	2008	Sweden
13,000	Twice the rate of leukaemia in adults	Dolk[17]	1997	UK
12,500	Kidney development affected	Pyrpasopoulou[18]	2004	Greece
10,000	Immune system functions affected	Novoselova[19]	1999	Russia
8,000	**Typical at 1 m from a Wi-Fi router**	**Mauremootoo (pers. observation)**	**2025**	**Various**

RFR exposure ($\mu W/m^2$)[a]	Exposure Guidelines, Emissions, & Adverse Biological Effects	Source	Year	Country/ Countries
8,000	Emotional behaviour changes, free radical damage	Akoev[20]	2002	Russia
3,800	Calcium metabolism affected in heart cells	Schwartz[21]	1990	Canada
2,500	**Typical laptop at hand position**	**Mauremootoo (pers. observation)**	**2025**	**UK**
2,000	Twice the rate of leukaemia in children	Hocking[22]	1996	Australia
1,600	Negatively affected memory, attention, motor function of schoolchildren (9 to 18 yrs)	Kolodynski[23]	1996	Latvia
1,700	Irreversible infertility in mice after 5 generations of exposure	Magras[24]	1997	Greece
1,490	**Typical levels inside public transportation**	**Sagar[25]**	**2018**	**Europe**
1,000	**Salzburg Resolution Target**	**Sage[1]**	**2000**	**Austria**
700	Sperm abnormalities in mice	Otitoloju[26]	2010	Nigeria
660	**Typical outdoor average levels in cities**	**Sagar[25]**	**2018**	**Europe**
500	Adverse neurological, cardiovascular symptoms and cancer risk	Khurana[27]	2010	Australia
500	Headaches, fatigue, cardiovascular conditions	Kundi[28]	2009	Austria
165	**Typical levels inside homes**	**Sagar[25]**	**2018**	**Europe**
100	Fatigue, headaches, sleeping problems	Navarro[29]	2003	Spain
100	Headaches, concentration problems, sleeping problems	Hutter[30]	2006	Austria
90	**Typical outdoor average levels in rural locations**	**Sagar[25]**	**2018**	**Europe**
48	**Median level, 15 US cities 1977 (mainly VHF & TV)**	**Powerwatch[31]**	**No date**	**USA**
30	**BioInitiative Report, 2012 – lowest observed effect level (LOE) for RFR[c]**	**Sage[1]**	**2012**	
30	Behavioural problems in school (8 to 17 yrs)	Thomas[32]	2010	Germany
30	Headaches, irritation, concentration difficulties in school (8 to 17 yrs)	Heinrich[33]	2010	Germany
12	**Typical (non-smart) TV & FM radio at 2 m**	**Mauremootoo (pers. observation)**	**2025**	**UK**

RFR exposure ($\mu W/m^2$)[a]	Exposure Guidelines, Emissions, & Adverse Biological Effects	Source	Year	Country/ Countries
6	**BioInitiative Report, 2012 Upper precautionary action level[c]**	**Sage[1]**	**2012**	
6	Fatigue, depressive tendency, sleeping disorders, concentration difficulties, cardiovascular problems	Oberfeld[34]	2002	Austria
5	Decreased cell proliferation	Velizarov[35]	1999	Bulgaria
3	**BioInitiative Report, 2012 Lower precautionary action level[c]**	**Sage[1]**	**2012**	
0.000002	**Mobile phone handsets can work down to about these RFR levels**	Powerwatch[31]	No date	
0.000001	**Natural background level**	Powerwatch[31]	No date	Global

a. The exposure figure refers to power flux density (PFD), which relates to average power. This is a simple but not wholly adequate representation of RFR (see Chapter 2 for details). One milliwatt per metre squared (mW/m^2) is equivalent to 1,000 microwatts ($\mu W/m^2$). To standardise the units, some of the figures have been converted from volts per meter (V/m).

b. The ICNIRP and FCC maximum exposure guidance levels vary with frequency and other criteria. They have been set to protect against direct effects such as electric shock and body tissue heating. The figures provided in this table refer to 1800 MHz Public Exposure Guidelines. For precautionary levels that take into account non-thermal effects, there is no need for different values for different frequencies.[31]

c. A scientific benchmark of 30 $\mu W/m^2$ for the 'lowest observed effect level' for RFR is based on mobile phone base station-level studies. Applying a five–ten-fold reduction to compensate for the lack of long-term exposure (to provide a safety buffer for chronic exposure) or for sensitive subpopulations (including babies, children, the elderly, those with pre-existing chronic diseases, and those with electrical hypersensitivity (EHS)) gives the 30 to 60 $\mu W/m^2$ precautionary action level. As stated by the BioInitiative Working Group, "These levels may need to change in the future, as new and better studies are completed."

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Table 10.3: Radio frequency exposure guidelines. Extracted from Table 10.2.

RF Radiation exposure ($\mu W/m^2$)	Exposure Guidelines	Source	Year
10,000,000	**FCC Public Exposure Guidelines (USA)**	**FCC**[1]	**1986**
9,000,000	**ICNIRP Public Exposure Guidelines (adopted by the UK, most other countries, and WHO)**	**ICNIRP**[2]	**1998**
100,000	**Russia, Italy & China Public Exposure Guidelines**	**Powerwatch**	**No date**
1,000	**Salzburg Resolution Target**	**Sage**[3]	**2000**
6	**BioInitiative Report, 2012 Upper precautionary action level**	**Sage**[3]	**2012**
3	**BioInitiative Report, 2012 Lower precautionary action level**	**Sage**[3]	**2012**

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2. International Commission on Non-Ionizing Radiation Protection Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). International Commission on Non-Ionizing Radiation Protection. *Health Physics*. **74** (4), 494–522 (1998).

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Table 10.4: Typical Radio frequency exposure in a variety of situations. Extracted from Table 10.2.

RF Radiation exposure ($\mu W/m^2$)	Exposure Guidelines, Emissions, & Adverse Biological Effects	Source	Year
95,000	**Close to Wi-Fi hotspots in dense urban spaces**	**Hardell**[1]	**2016**
27,000	**Representative mobile phones at 4 cm**	**Wall**[2]	**2019**
17,000	**Average max power levels for representative smart meters at 0.5 m**	**Peyman**[3]	**2017**
8,000	**Typical at 1 m from a Wi-Fi router**	**Mauremootoo**	**2025**
2,500	**Typical laptop at hand position**	**Mauremootoo**	**2025**
1,490	**Typical levels inside public transportation**	**Sagar**[4]	**2018**
660	**Typical outdoor average levels in cities**	**Sagar**[4]	**2018**
165	**Typical levels inside homes**	**Sagar**[4]	**2018**
90	**Typical outdoor average levels in rural locations**	**Sagar**[4]	**2018**
48	**Median level, 15 US cities 1977 (mainly VHF & TV)**	**Powerwatch**[5]	**No date**
12	**Typical (non-smart) TV & FM radio at 2 m**	**Mauremootoo**	**2025**
0.000001	**Natural background level**	**Powerwatch**[5]	**No date**

1. Hardell, L., Koppel, T., Carlberg, M., Ahonen, M., Hedendahl, L. Radiofrequency radiation at Stockholm Central Railway Station in Sweden and some medical aspects on public exposure to RF fields. *International Journal of Oncology*. **49** (4), 1315–1324, doi: 10.3892/ijo.2016.3657 (2016).

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Chapter 11. Common Radio Frequency Radiation Sources

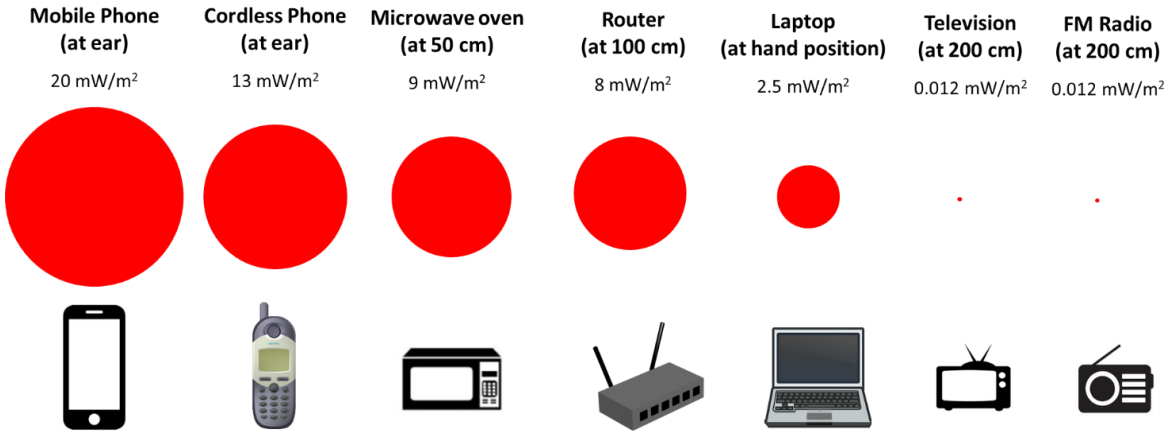


Figure 11.1: *Typical exposure levels from common RFR sources. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

The mobile phone network: From Brick Phone to the Internet of Things

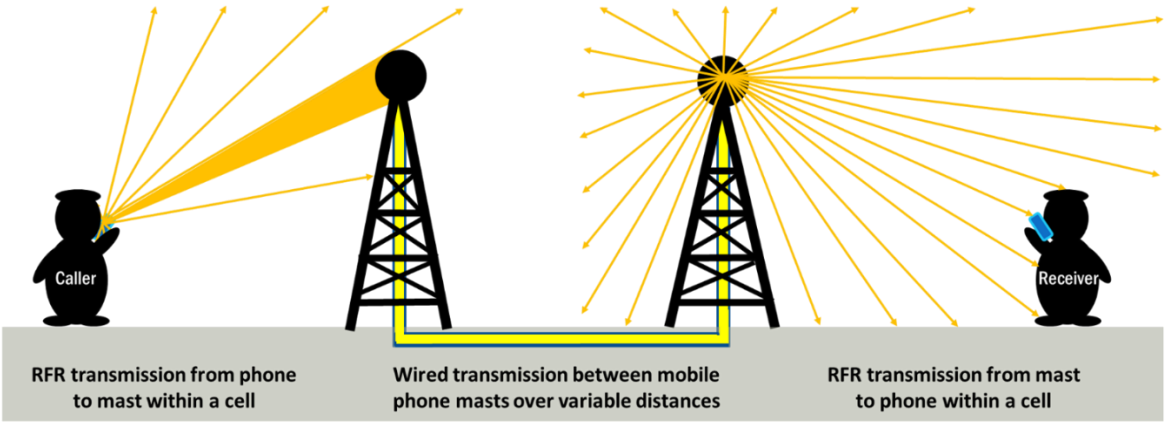


Figure 11.2: *Simplified representation of how mobile phone signals are transmitted and received. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

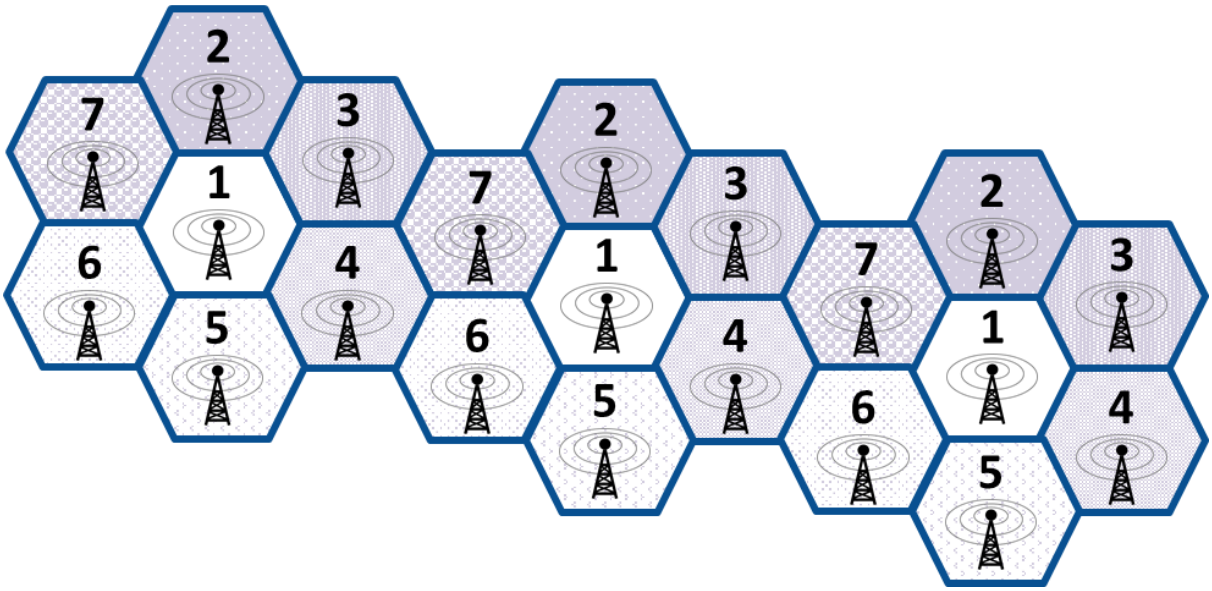


Figure 11.3: *Frequency reuse. Cell antennas at the centre of each cell and neighbouring cells using different frequencies. Each number indicates a specific set of frequencies. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

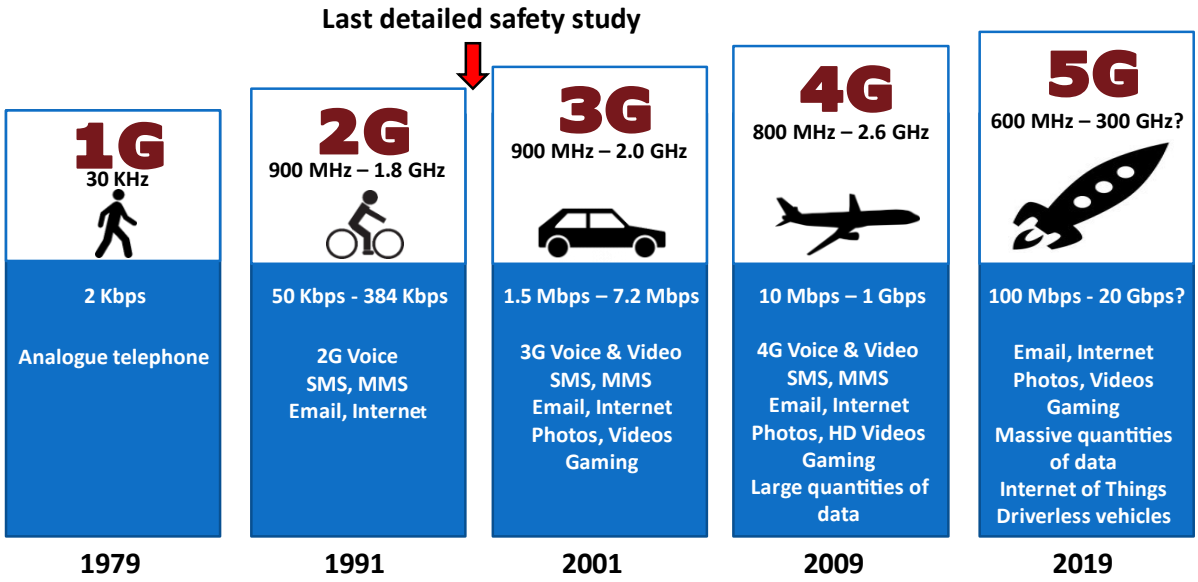


Figure 11.4: *1G–5G: From Brick Phone to the Internet of Things – The evolution of wireless technology. The safety study, which looked at frequencies commonly used in 2G and 3G, finally released its peer-reviewed findings in 2018.*[1] *By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

1. National Toxicology Program *Peer Review of the Draft NTP Technical Reports on Cell Phone Radiofrequency Radiation. Peer-Review Report.* at <https://ntp.niehs.nih.gov/ntp/about_ntp/trpanel/2018/march/peerreview20180328_508.pdf>. National Institute of Environmental Health Sciences. Research Triangle Park, NC. (2018).

Energy consumption

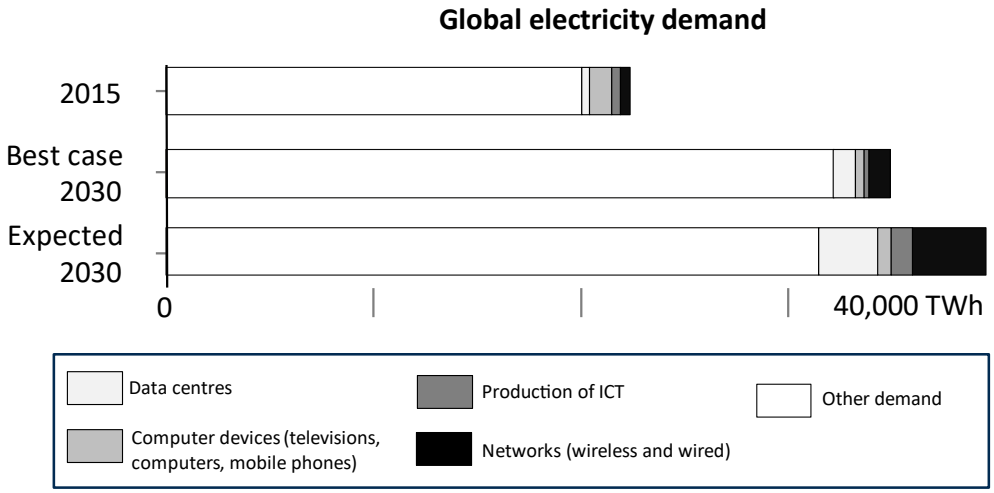


Figure 11.5: *The contribution of ICT to the forecasted growth in demand for electricity. Data from: Andrae & Edler (2015).*

Andrae, A.S.G., Edler, T. On global electricity usage of communication technology: trends to 2030. *Challenges*. **6** (1), 117–157, doi: 10.3390/challe6010117 (2015).

Impacts on plants and animals

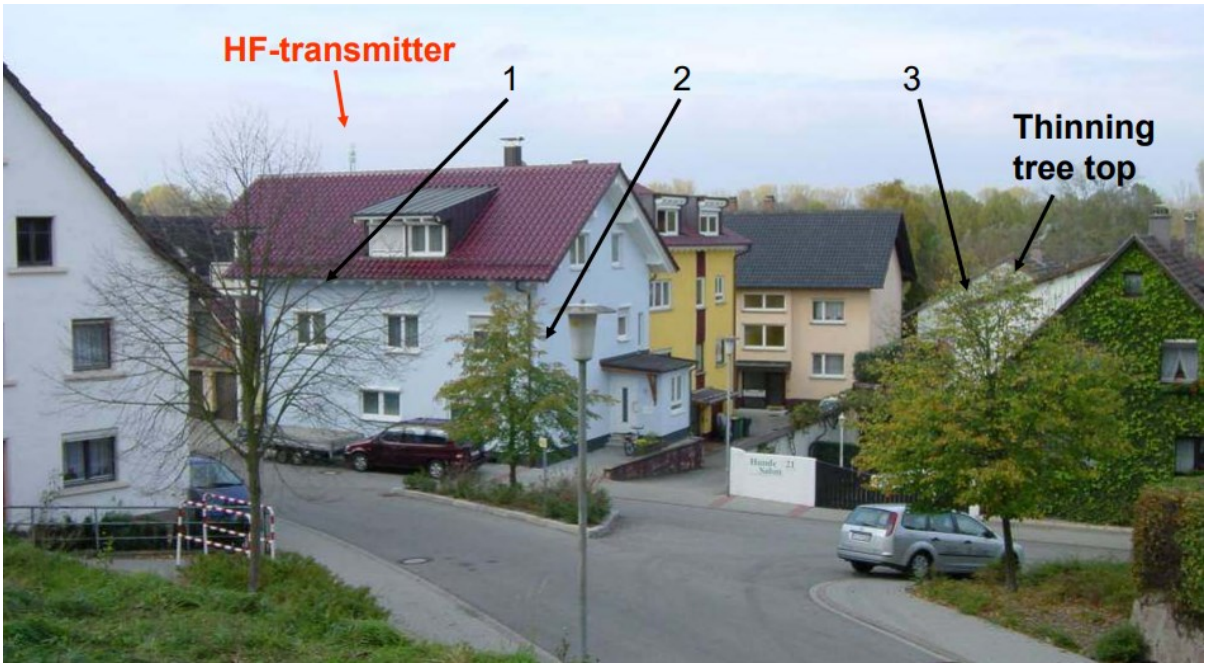


Figure 11.6: *Three lime trees under three different high frequency (HF) exposure conditions exhibit different damage patterns. 1) Tree with the most exposure and greatest damage, 2) Tree fully shielded with minimal damage, 3) tree mostly shielded with damage to the topmost leaves. Source: Schorpp 2007.*

Schorpp, V. Tree Damage from Chronic High Frequency Exposure? Mobile Telecommunications, Radar, Point-to-point Transmission Systems, Terrestrial Radio and TV etc. Timeline Sequence: "The Three Lime Trees." at <http://www.puls-schlag.org/download/ThreeLimeTrees%2096dpi0704ebook.pdf> (2007).

Satellite phones and Internet

Figure 11.7: *Starlink satellites, photographed soon after launch, pass overhead near Carson National Forest, New Mexico. Source: M. Lewinsky.*

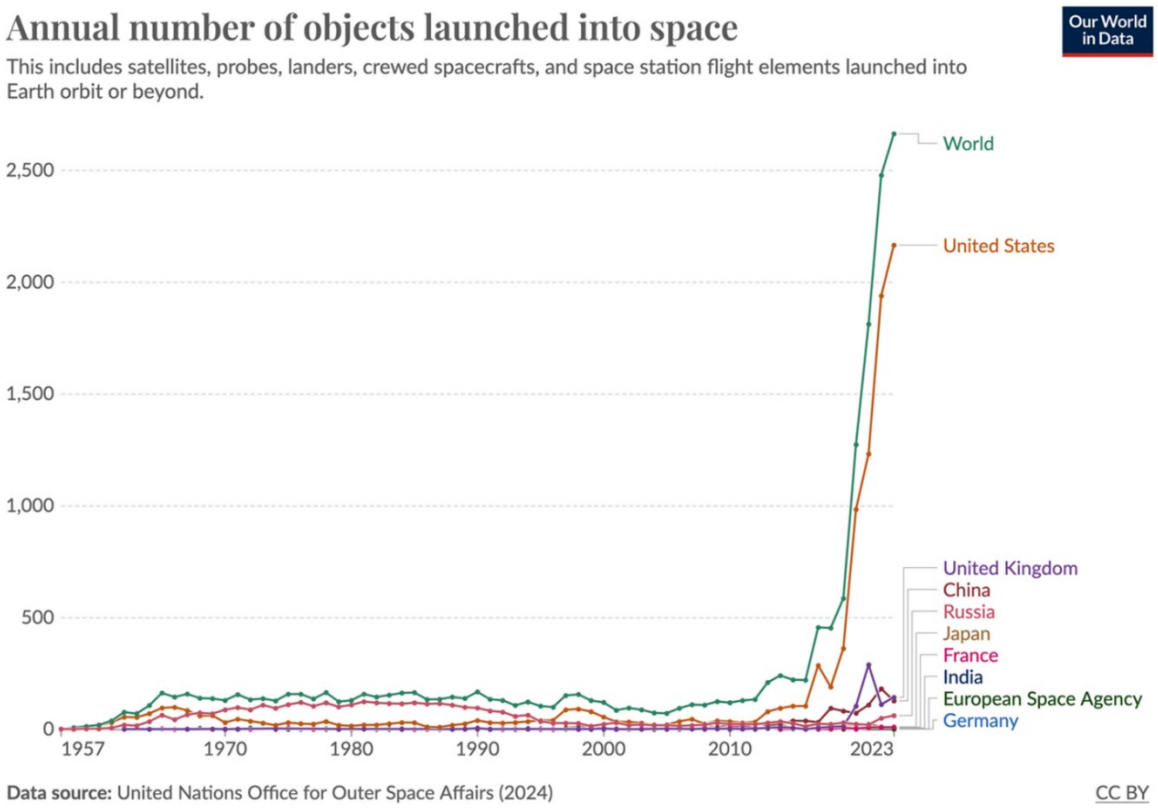


Figure 11.8: *An illustration of the massive recent increases in objects launched into space. Source: United Nations Office for Outer Space Affairs (2024) – with major processing by Our World in Data. Part of the following publication: Edouard Mathieu and Max Roser (2022) - "Space Exploration and Satellites". Data adapted from United Nations Office for Outer Space Affairs. Retrieved from https://ourworldindata.org/grapher/yearly-number-of-objects-launched-into-outer-space [online resource].CC BY*

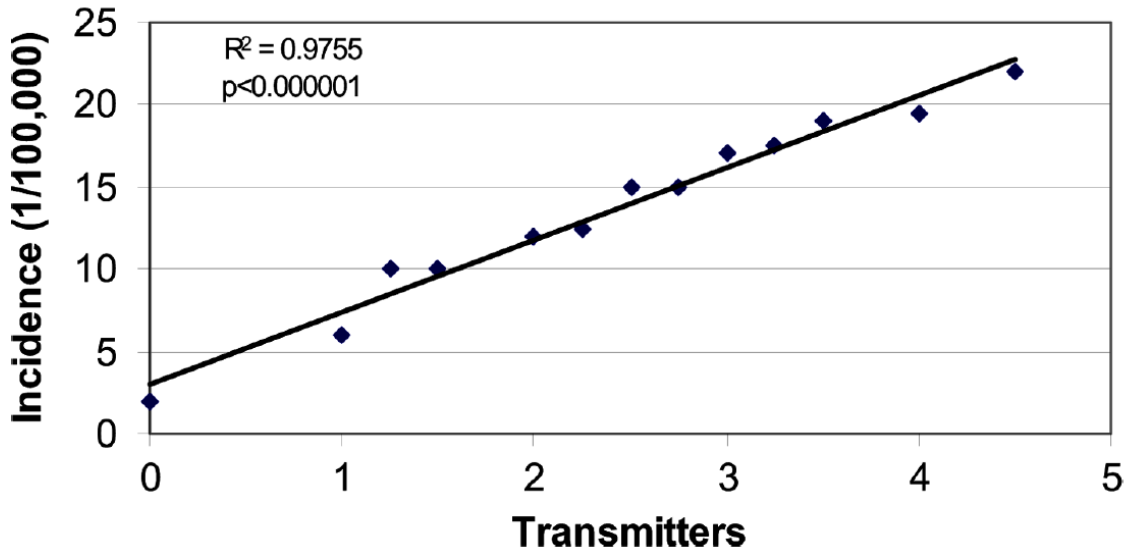


Figure 11.9: *Median malignant melanoma incidence versus the average number of FM transmitters in each municipality in Sweden. Source: Hallberg & Johansson 2005 (doi:10.1081/JBC-200054260). Used with the permission of Taylor & Francis.*

Hallberg, Ö., Johansson, O. FM Broadcasting Exposure Time and Malignant Melanoma Incidence. *Electromagnetic Biology and Medicine.* **24** (1), 1–8, doi: 10.1081/JBC-200054260 (2005).

Bluetooth

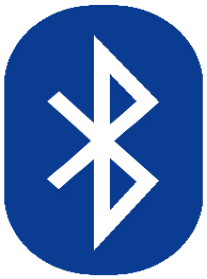


Figure 11.10: *The Bluetooth logo (https://cdn.pixabay.com/photo/2015/03/12/12/22/bluetooth-670069_640.png). Public Domain.*

Television and radio

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

GPS

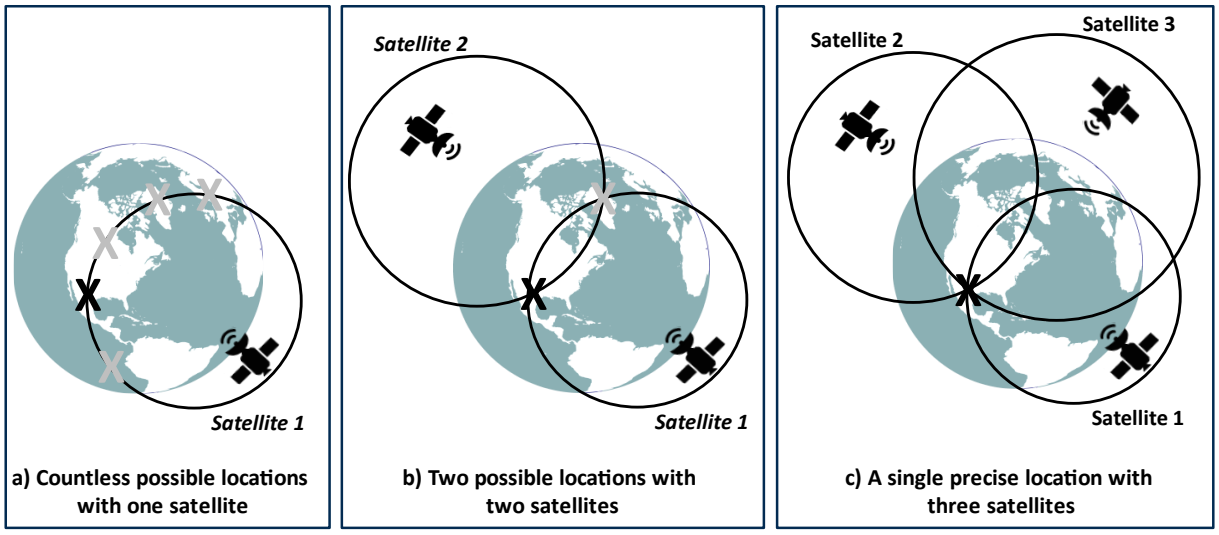


Figure 11.12: *How a GPS system works through trilateration. The actual location is marked with a black X. The possible locations with one satellite are marked as discrete points but represent many locations in practice. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

Motor vehicles

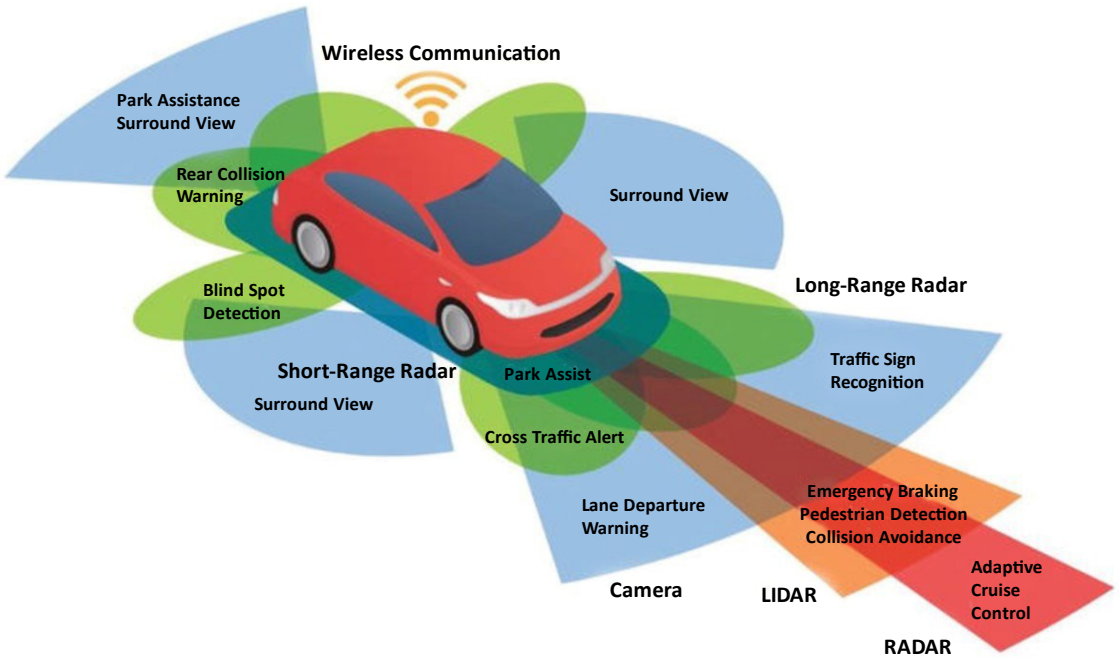


Figure 11.13: *Wireless Communication and Sensors in Self-Driving Cars. Source: Pisarov & Mester 2020 (doi: 10.5937/fme2101029P). CC BY 4.0 creativecommons.org/licenses/by-sa/4.0.*

Pisarov, J., Mester, G. The future of autonomous vehicles. *FME Transactions*. **49** (1), 29–35, doi: 10.5937/fme2101029P (2021).

Smart meters

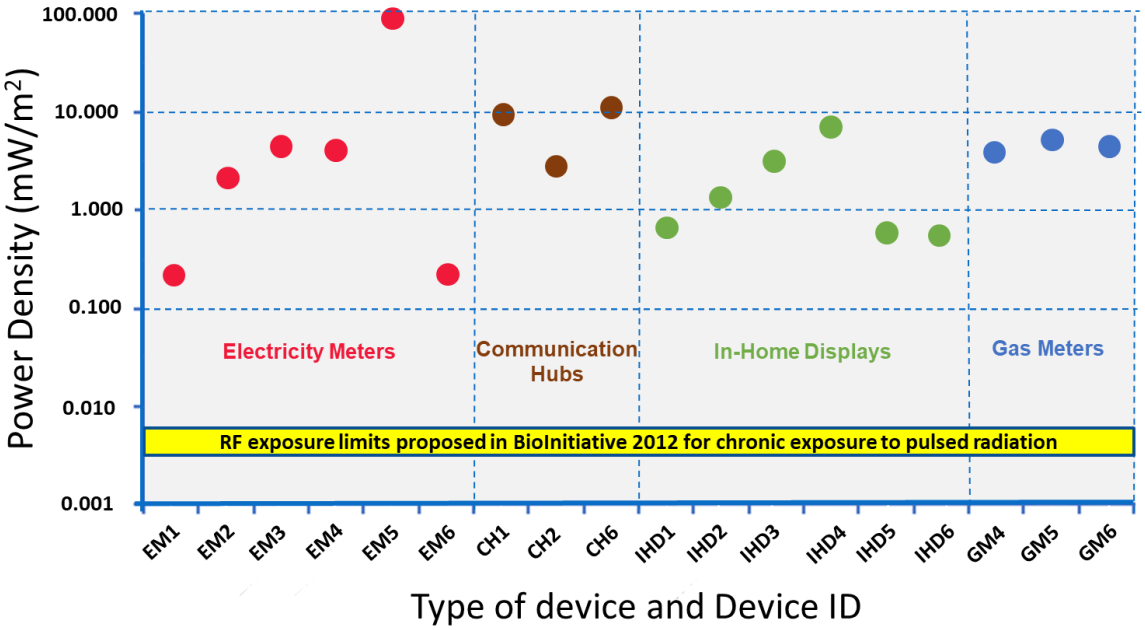


Figure 11.14: *Maximum recorded power density values for examples of smart meter devices used in Great Britain. Adapted from Peyman et al. (2017). EM – Electricity Meters, CH – Communication Hubs, IHD – In-Home Displays, GM – Gas Meters. Note the non-linear scale. (doi:https://doi.org/10.1002/bem.22044). Wiley CC-BY-4.0 creativecommons.org/licenses/by-sa/4.0.*

Peyman, A., Addison, D., Mee, T., Goiceanu, C., Maslanyj, M., Mann, S. Exposure to electromagnetic fields from smart utility meters in GB; part I) laboratory measurements. *Bioelectromagnetics*. **38** (4), 280–294, doi: https://doi.org/10.1002/bem.22044 (2017).

Chapter 12. Radio Frequency Radiation Solutions

Increase Distance

Don't keep Wi-Fi-enabled devices next to your body

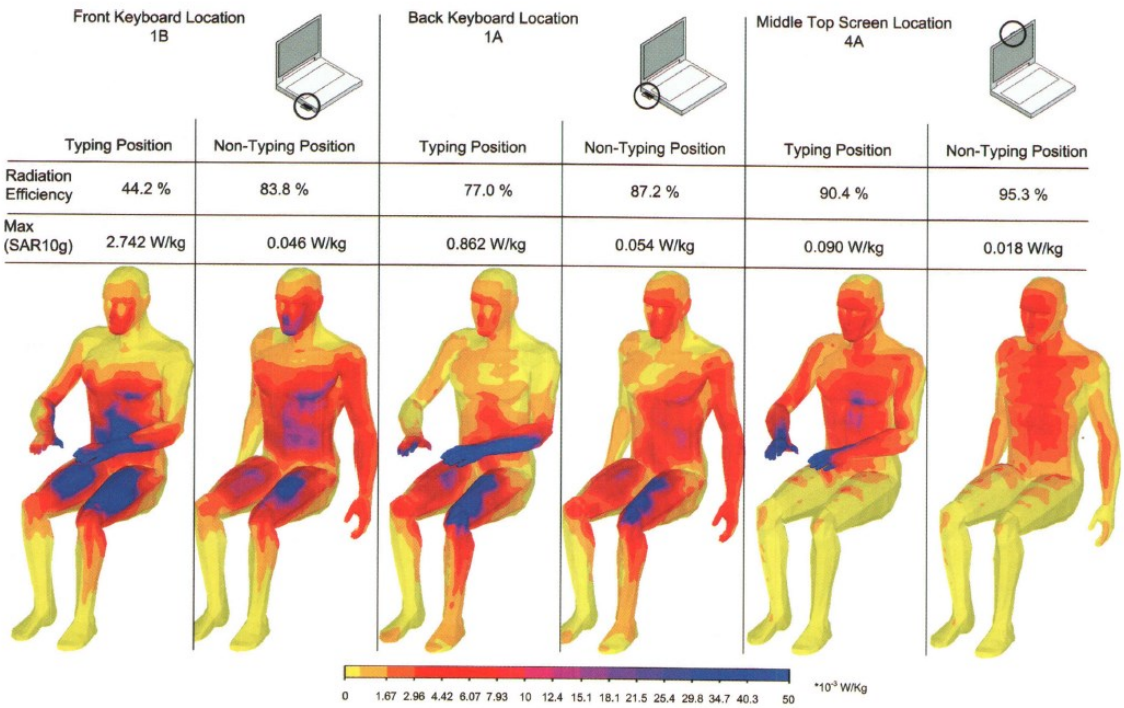


Figure 12.1: *Absorption of RFR in human tissue in relation to typing antenna radiation position. Source: Guterman et al. 2009 (doi:10.1109/MAP.2009.5338680). Used with the permission of IEEE.*

Guterman, J., Moreira, A.A., Peixeiro, C., Rahmat-Samii, Y. Wrapped microstrip antennas for laptop computers. *IEEE Antennas and Propagation Magazine*. **51** (4), 12–39, doi: 10.1109/MAP.2009.5338680 (2009).

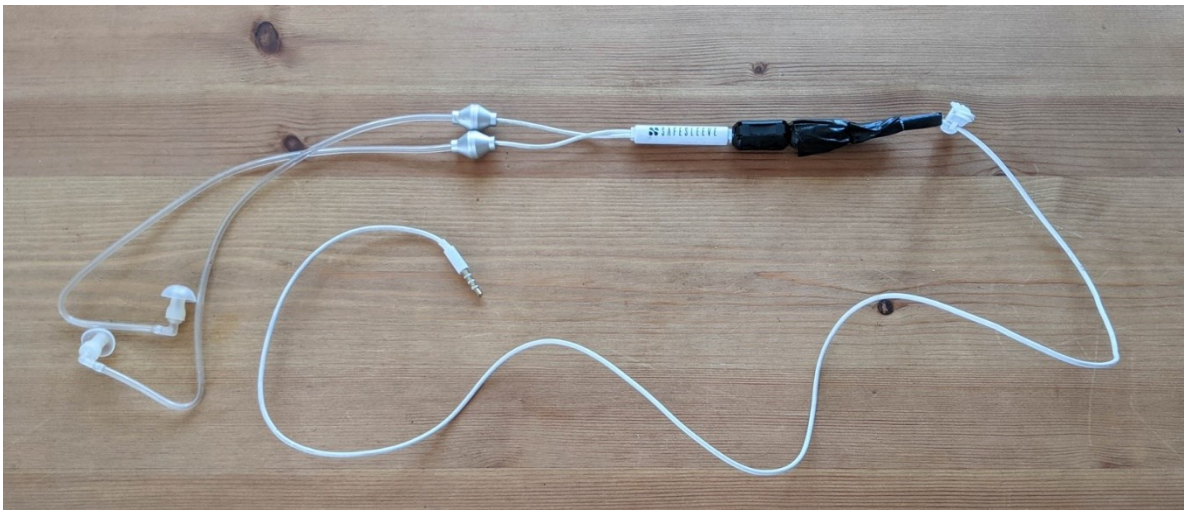
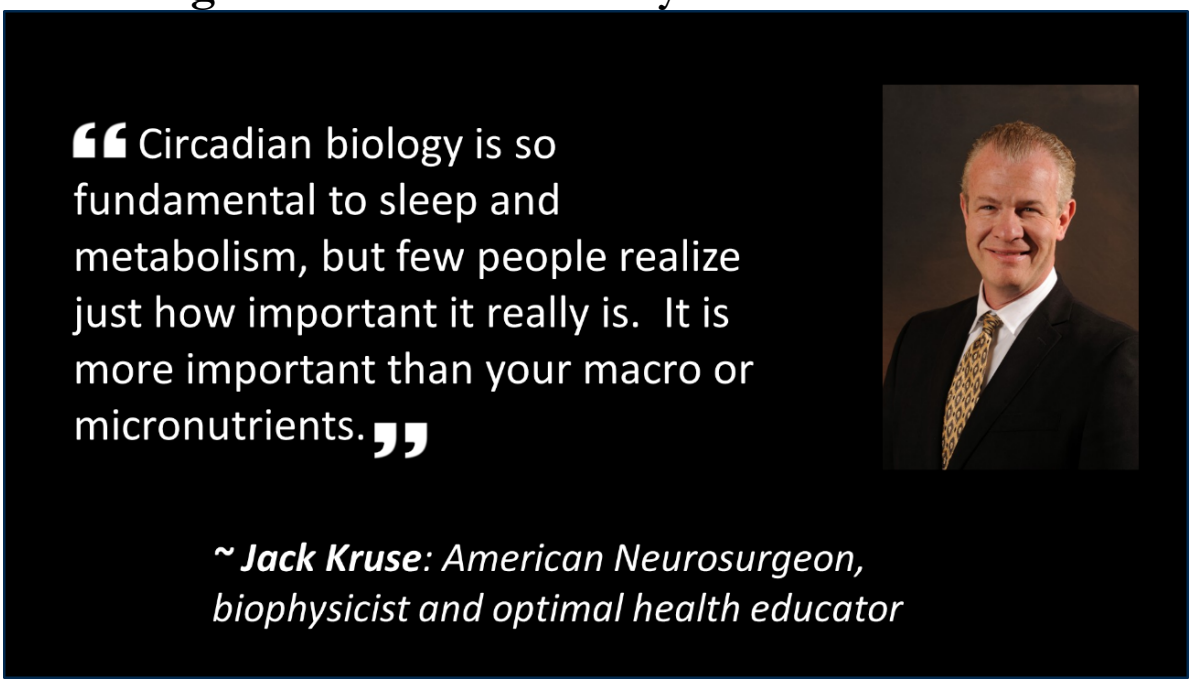


Figure 12.2: *Ferrite beads fitted to an air-tube headset. Duct tape has been used to stop the beads from slipping. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

Part 4. Light – More Than the Eye Can See



Chapter 13. Light – Hidden Health Impacts

Introduction: A history of light

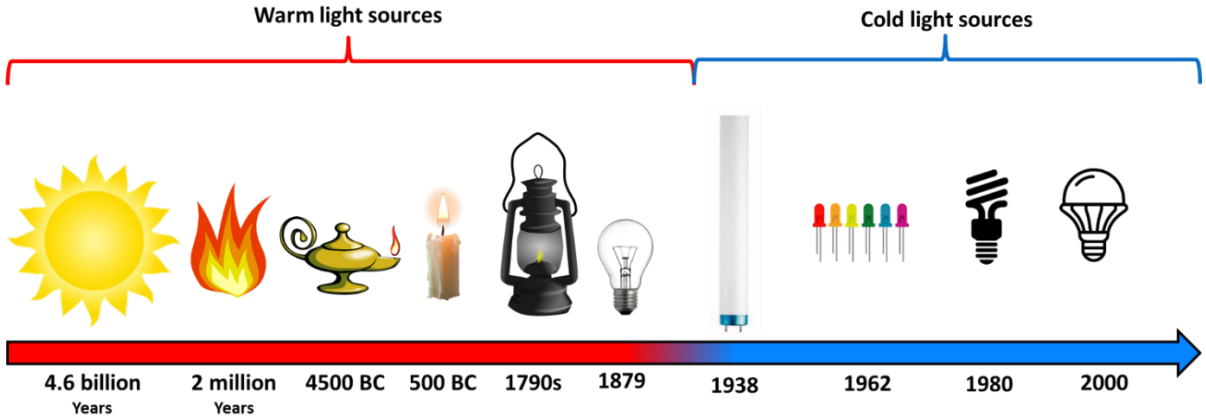


Figure 13.1: *Evolution of light sources from sunlight to LEDs. Adapted from Wunsch 2018. The two-million-year figure for fire refers to the use of fire by the ancestors of modern humans. Obviously, fire in nature has been around for considerably longer. Used with the permission of Alexander Wunsch.*

Artificial Light, Chronobiology and LED Hazards. at <https://vimeo.com/301352213>. (2018).

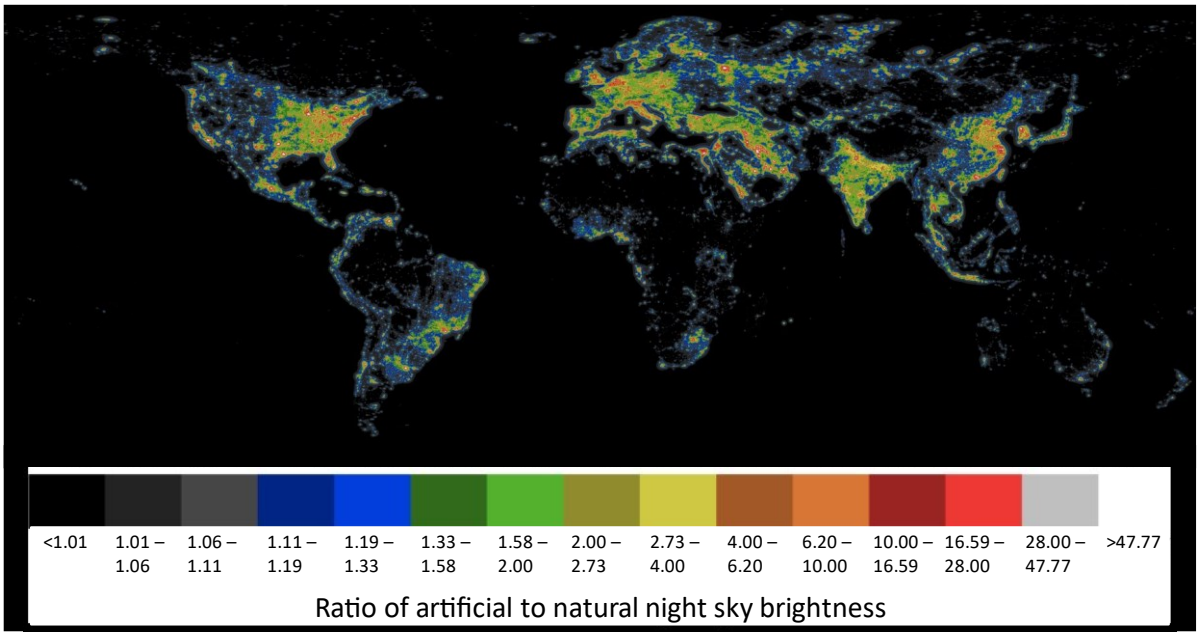


Figure 13.2: *Our night-shifted World. The units are the ratio of artificial to natural night sky brightness (e.g., a value of 2 means that the artificial sky brightness is twice as bright as natural). Source: Lorenz 2022 (https://djlorenz.github.io/astronomy/lp2022/).*

Circadian rhythms

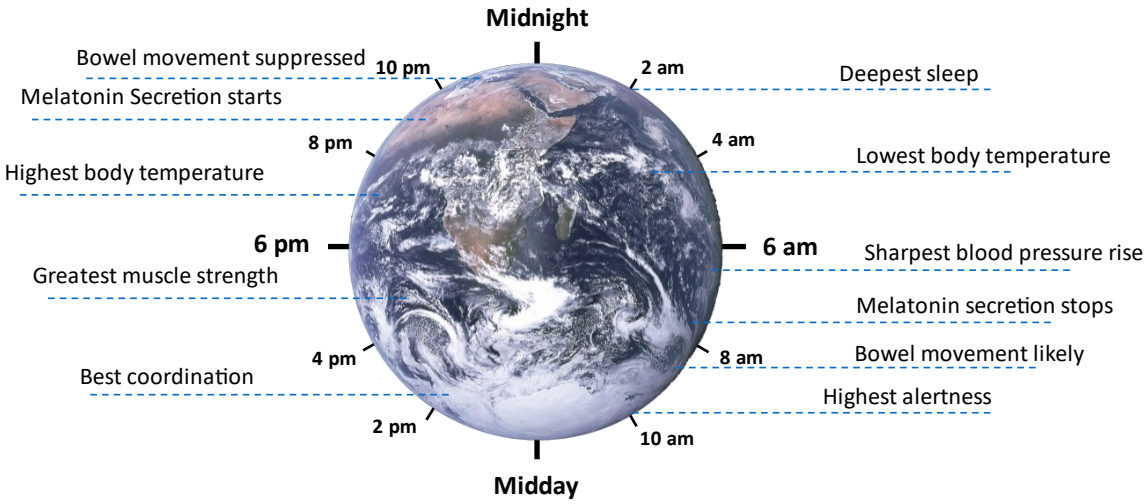


Figure 13.3: *Practically all of our biological functions are influenced by circadian rhythms. Adapted from Wunsch 2018. The two-million-year figure for fire refers to the use of fire by the ancestors of modern humans. Obviously, fire in nature has been around for considerably longer. Used with the permission of Alexander Wunsch.*

Artificial Light, Chronobiology and LED Hazards. at <https://vimeo.com/301352213>. (2018).

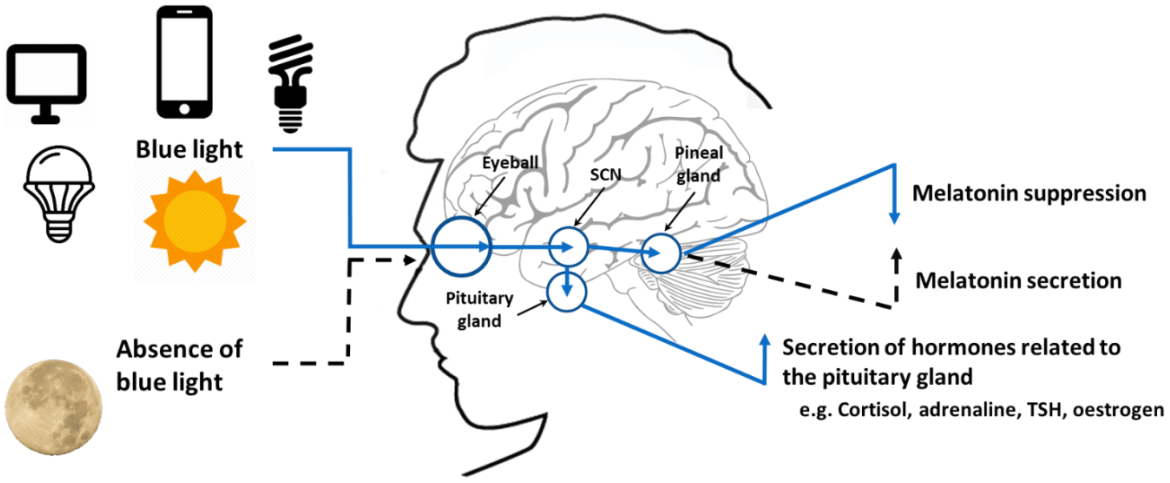


Figure 13.4: *Blue light, via nonimage-forming cells in the retina, affects melatonin levels and pituitary gland activity. TSH = Thyroid-stimulating hormone. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

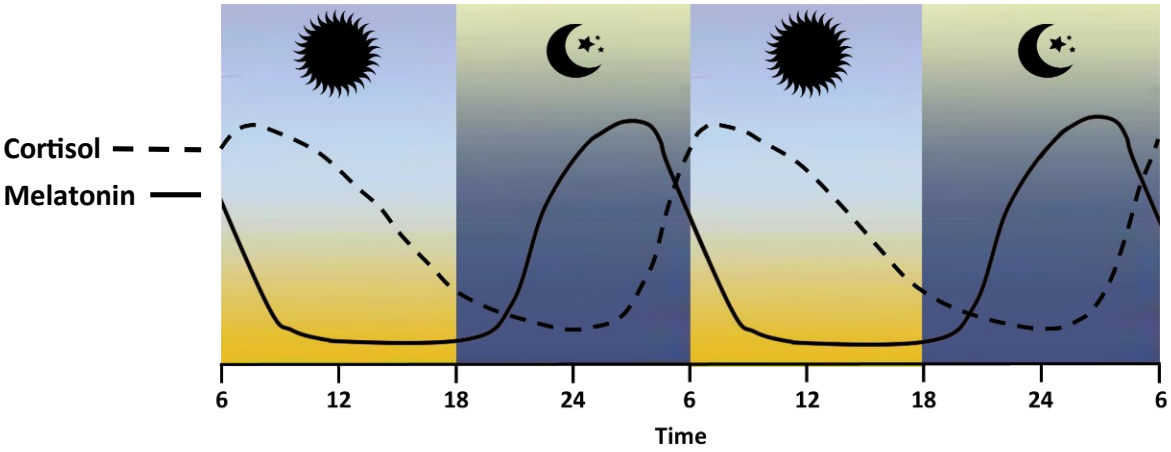


Figure 13.5: *Ideal day-night fluctuations in circulating cortisol and melatonin levels under close-to-natural conditions. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

What is light?

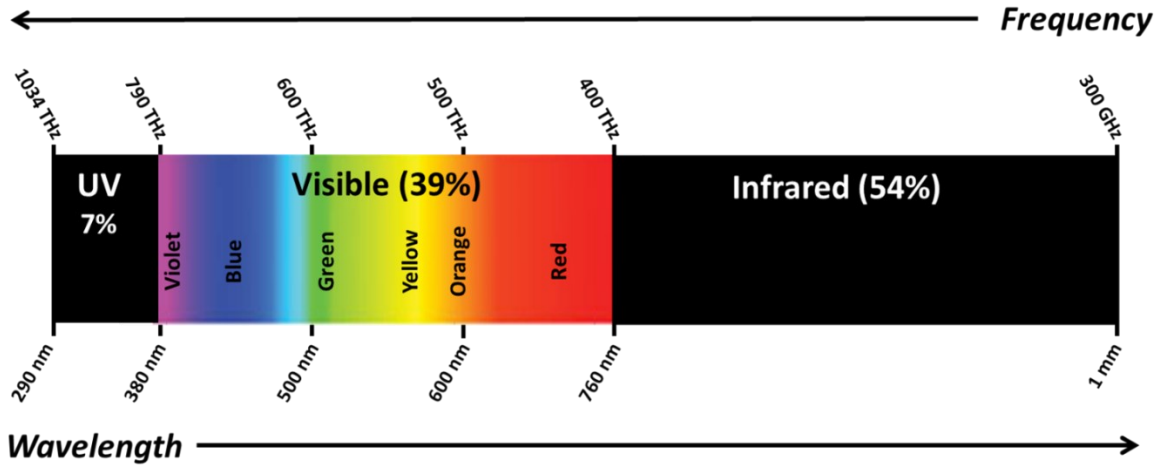


Figure 13.6: *Percentages of light energy in different wavelengths received at the Earth's surface. The precise proportions will vary with factors such as time of day, latitude, altitude, season, and cloudiness. There are no sharp, well-defined boundaries in the electromagnetic spectrum, so you will see variations in the values quoted in the literature for the various optical spectra. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

Table 13.1: Some health costs and benefits and therapeutic uses of different parts of the light spectrum

Light Spectrum	Health benefits	Health costs	Therapeutic use
Infrared (IR) 760 nm to 1 mm	• Promotion of mitochondrial health.[1] • Subcellular melatonin is produced in response to near-infrared light.[2] • Induces improved tissue hydration – exclusion-zone (EZ) water activation[3] (more on EZ water later in this chapter). • Reduced vulnerability to sunburn through preconditioning against upcoming UVB exposure (photoprevention) and enhanced tissue repair post–UVB exposure.[4] • Reduction of fine lines, wrinkles, skin roughness, and intradermal collagen density increase.[5]	• Thermal skin burns.[6]	• Infrared saunas.[7] • Infrared thermal imaging.[8] • Photobiomodulation or low-level light therapy – using light of 500–1000 nm for the treatment of soft tissues.[9] • Use of lasers in diagnostics, therapy, and surgery.[10]
Visible light (Vis) 380–760 nm	• Sight! • Antioxidant effects of red light. • Visible light spectra for accelerated wound healing.[11] • Blue light as a stimulant for the production of "hormones of daylight" – cortisol, ATCH, adrenaline, etc.[12] • Red light for reduction of fine lines, wrinkles, skin roughness, and intradermal collagen density increase.[5]	• Artificial blue light alters blood sugar metabolism and sleep cycles.[13] • Blue light can cause retinal damage (*the blue light hazard*).[14] • Visible radiation, especially blue light, is associated with age-related macular degeneration (ARMD).[15]	• Red light therapy.[16] • Photobiomodulation.[9] • Various forms of colour therapy, including the Spectro-Chrome system.[17] • Use of lasers.[10] • Treatment of seasonal affective disorder (SAD).[18]
Ultraviolet A (UVA) 320–400 nm	• Increased levels of nitric oxide and reduced blood pressure.[19]	• Premature skin ageing (photoaging).[20] • Skin cancer.[21] • DNA mutation.[22]	• Phototherapy including PUVA therapy to treat skin conditions.[23] • UV therapy for a range of health conditions.[24]
Ultraviolet B (UVB) 290–320 nm	• Vitamin D synthesis.[25] • Adaptation to chronic UV exposure by inducing a range of protective mechanisms, notably tanning (more on safe tanning in Chapter 14).[26]	• Sunburn, sunstroke, and skin cancer.[27] • DNA mutation.[23] • Cataracts.[15] • Immune system suppression.[23]	• UV therapy for a range of health conditions.[24] • Use of lasers.[10]
Ultraviolet C (UVC) 200–290 nm	Virtually no UVC radiation reaches the Earth's surface due to scattering in the ozone layer.[6]		• Germicidal lamps.[28]

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2. Zimmerman, S., Reiter, R.J. Melatonin and the optics of the human body. *Melatonin Research*. **2** (1), 138–160, doi: 10.32794/mr11250016 (2019).

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Light spectra

Figure 13.7: *Changes in natural light spectra of the day. Adapted from Wunsch 2018. The two-million-year figure for fire refers to the use of fire by the ancestors of modern humans. Obviously, fire in nature has been around for considerably longer. Used with the permission of Alexander Wunsch.*

Artificial Light, Chronobiology and LED Hazards. at <https://vimeo.com/301352213>. (2018).

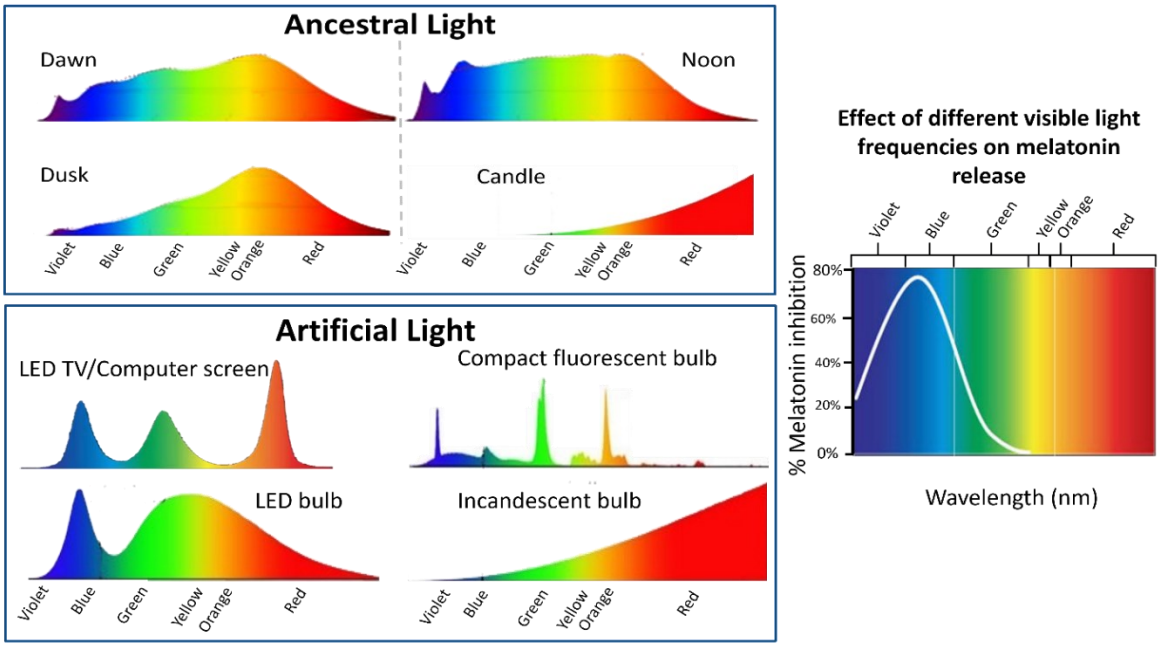

Figure 13.8: *Natural and artificial light spectra, and melatonin suppression. Adapted from Brainard et al. 2001 (10.1523/JNEUROSCI.21-16-06405.2001). Copyright 2001 Society for Neuroscience.*

Brainard, G.C. *et al.* Action spectrum for melatonin regulation in humans: evidence for a novel circadian photoreceptor. *The Journal of Neuroscience.* **21** (16), 6405–6412, doi: 10.1523/JNEUROSCI.21-16-06405.2001 (2001).

Table 13.2: Phase-shift potential of different light sources from f.luxometer®.

Light Source	Phase shift
Night with no light pollution (natural)	0 minutes
Candle	0 minutes
Streetlights (high-pressure sodium)	0 minutes
Kindle Blue Shade	0 minutes
Streetlights (Lumican LED)	4 minutes
Kindle Paperwhite	10 minutes
Himalayan salt lamp	17 minutes
Streetlights (Chips and Wafers Cool White CW7)	44 minutes
Incandescent lightbulb (GE)	55 minutes
Macbook Air 2012	59 minutes
Standard indoor lighting (type not specified)	62 minutes
Surface Pro 3	63 minutes
iPhone 6	67 minutes
LED lightbulb 5000K	85 minutes
iPad Pro	96 minutes
iPhone X	103 minutes
Daylight (natural)	159 minutes

Welcome to f.luxometer™. at <https://justgetflux.com/news/pages/fluxometer/home/>.

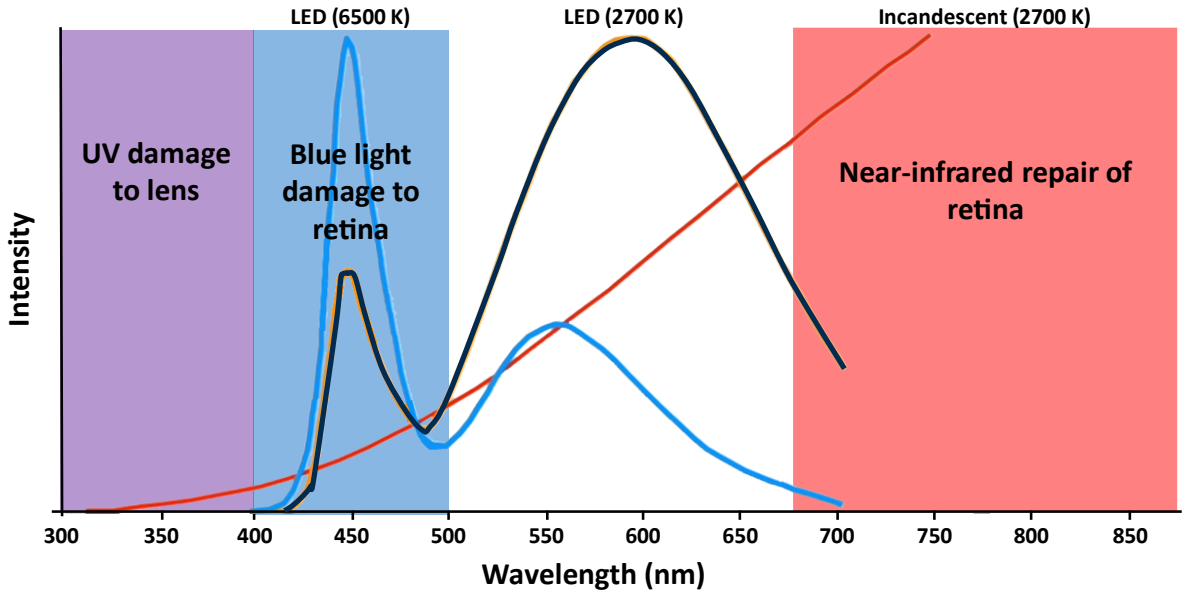

Figure 13.9: *Spectral distribution of different artificial light sources and effects of different wavelengths on the eye. Adapted from Wunsch 2018. The two-million-year figure for fire refers to the use of fire by the ancestors of modern humans. Obviously, fire in nature has been around for considerably longer. Used with the permission of Alexander Wunsch.*

Artificial Light, Chronobiology and LED Hazards. at <*https://vimeo*.com/301352213>. (2018).

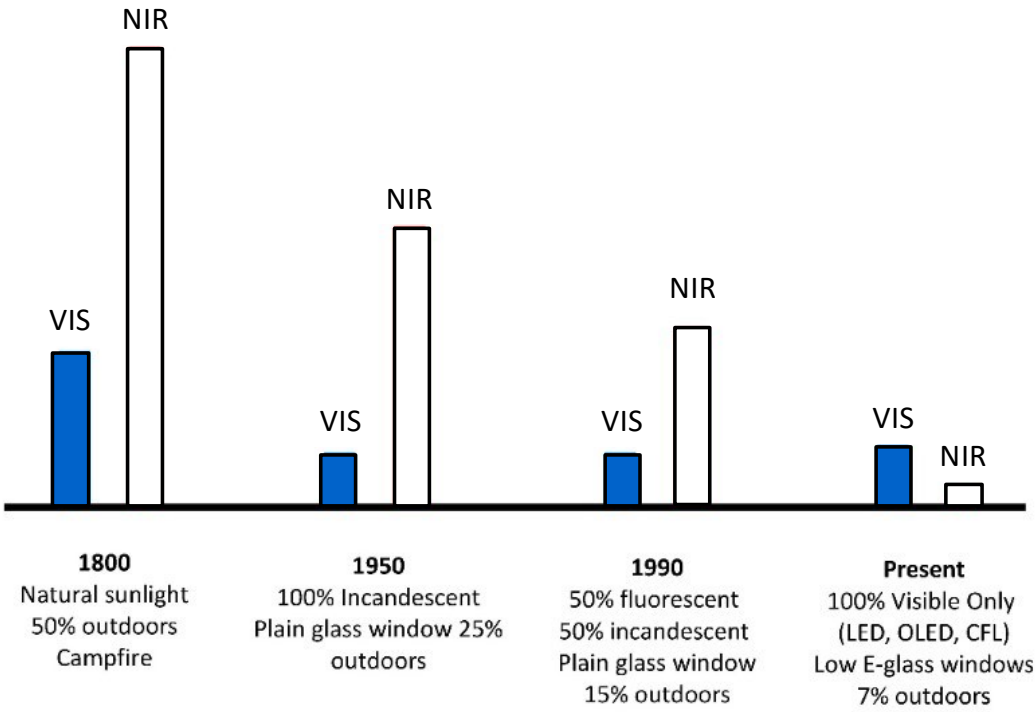

Figure 13.10: *Comparison of near-infrared to visible light exposure levels from 1800 to Present. Adapted from Zimmerman & Reiter 2019 (doi: 10.32794/mr11250016 (Supplemental Materials)). CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

Zimmerman, S., Reiter, R.J. Melatonin and the optics of the human body. *Melatonin Research.* **2** (1), 138–160, doi: 10.32794/mr11250016 (2019).

Colour temperature

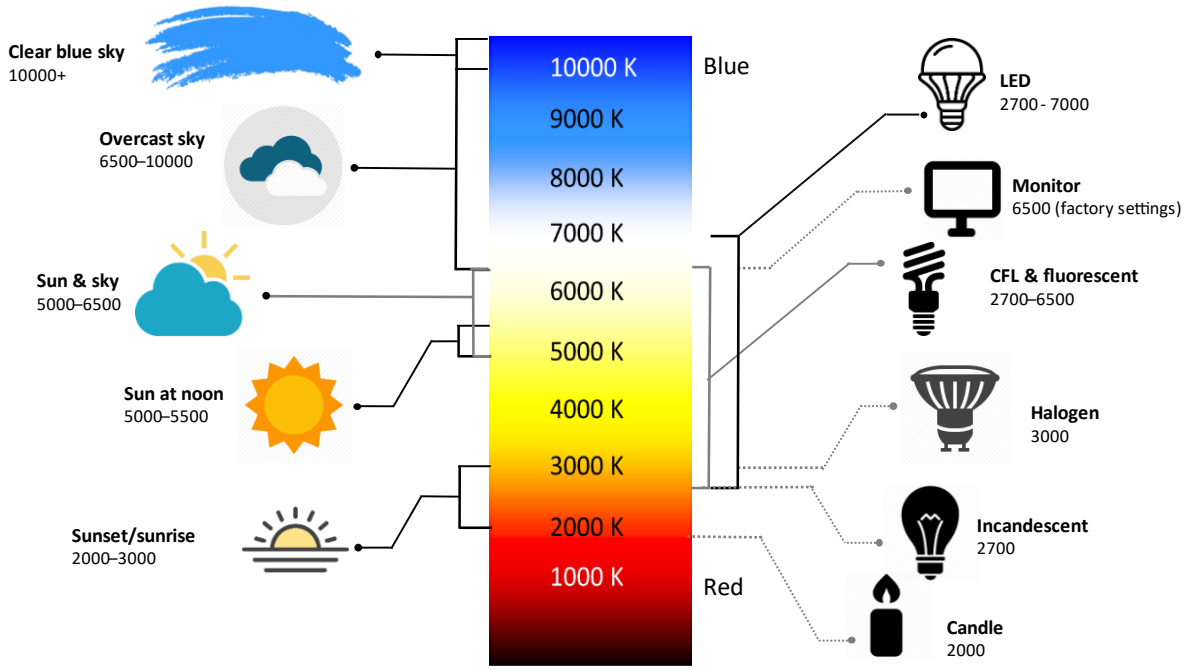

Figure 13.11: *Colour temperatures of typical natural light at different times of day and typical artificial light sources on the Kelvin scale. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

Light intensity

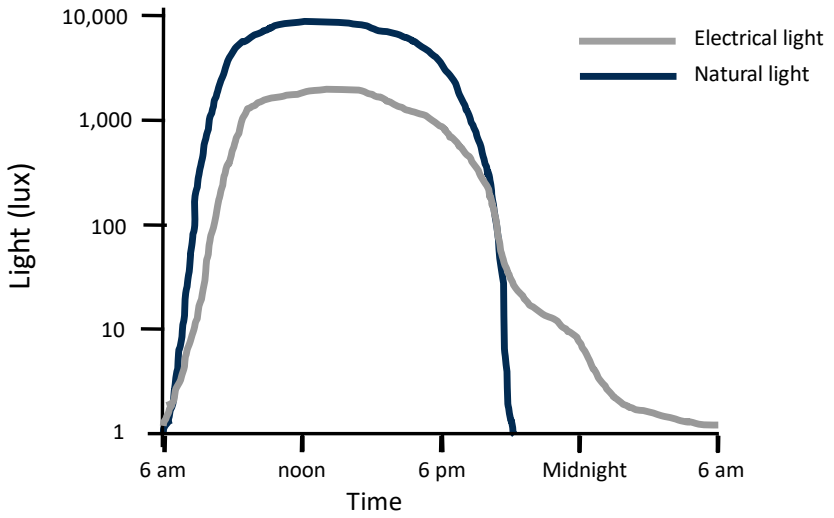

Figure 13.12: *Representation of light intensity over 24 hours in a city compared with an environment with limited artificial light. The lux is a measure of light intensity as perceived by the human eye.By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

Table 13.3: Common light sources and lux values. Adapted from Lauritzen (2017).

Source – surfaces illuminated by	Typical light intensity (measured in lux)
Moonless, overcast night sky	0.0001 lux
Moonless, clear night sky	0.002 lux
Full moon on a clear night	0.2–1.0 lux
Dark limit of twilight under a clear sky	3.4 lux
Family living room lights	50 lux
Office building hallway/toilet lighting	80 lux
Very dark overcast day	100 lux
Office lighting	320–500 lux
Sunrise or sunset on a clear day	400 lux
Overcast day	1,000 lux
Typical TV studio lighting	1,000 lux
Full daylight (not direct sun)	10,000–25,000 lux
Direct sunlight	32,000–100,000 lux

Lauritzen, J. What You Need to Know About Blue Light and Health. at <https://www.jasonlauritzen.com/what-you-need-to-know-about-blue-light-and-health/> (2017).

Flicker

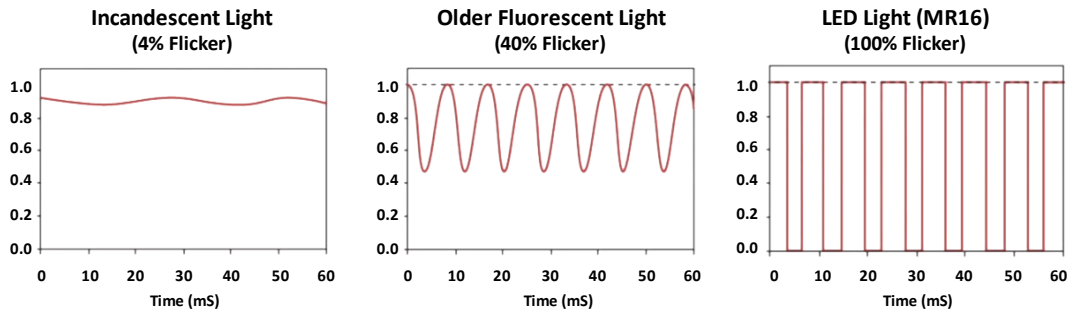

Figure 13.13: *Flicker characteristics of different electric light sources. From Wunsch 2018. The two-million-year figure for fire refers to the use of fire by the ancestors of modern humans. Obviously, fire in nature has been around for considerably longer. Used with the permission of Alexander Wunsch.*

Artificial Light, Chronobiology and LED Hazards. at <https://vimeo.com/301352213>. (2018).

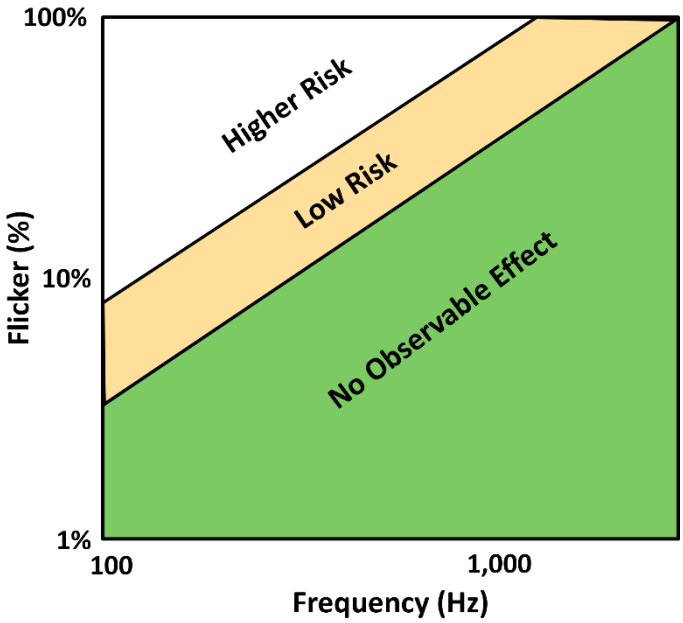

Figure 13.14: *Acceptable and unacceptable limits of flicker. Note the logarithmic axes. Adapted from Lehman and Wilkins 2010 (doi:10.1109/MPEL.2014.2330442). Used with the permission of IEEE.*

Wilkins, A., Veitch, J., Lehman, B. LED lighting flicker and potential health concerns: IEEE standard PAR1789 update. *2010 IEEE Energy Conversion Congress and Exposition*. 171–178, doi: 10.1109/ECCE.2010.5618050 (2010).

Artificial light sources

Light filtered through windows

Figure 13.15: *Accelerated skin ageing on one side of the face of a man who had spent 28 years as a driver, clearly not in the UK. Source: Gordon & Brieva 2012 (10.1056/NEJMicm1104059). Used with the permission of the Massachusetts Medical Society.*

Health effects of unnatural light regimes – ocular, dermal, and systemic effects

Ocular effects

Age-Related Macular Degeneration (ARMD)

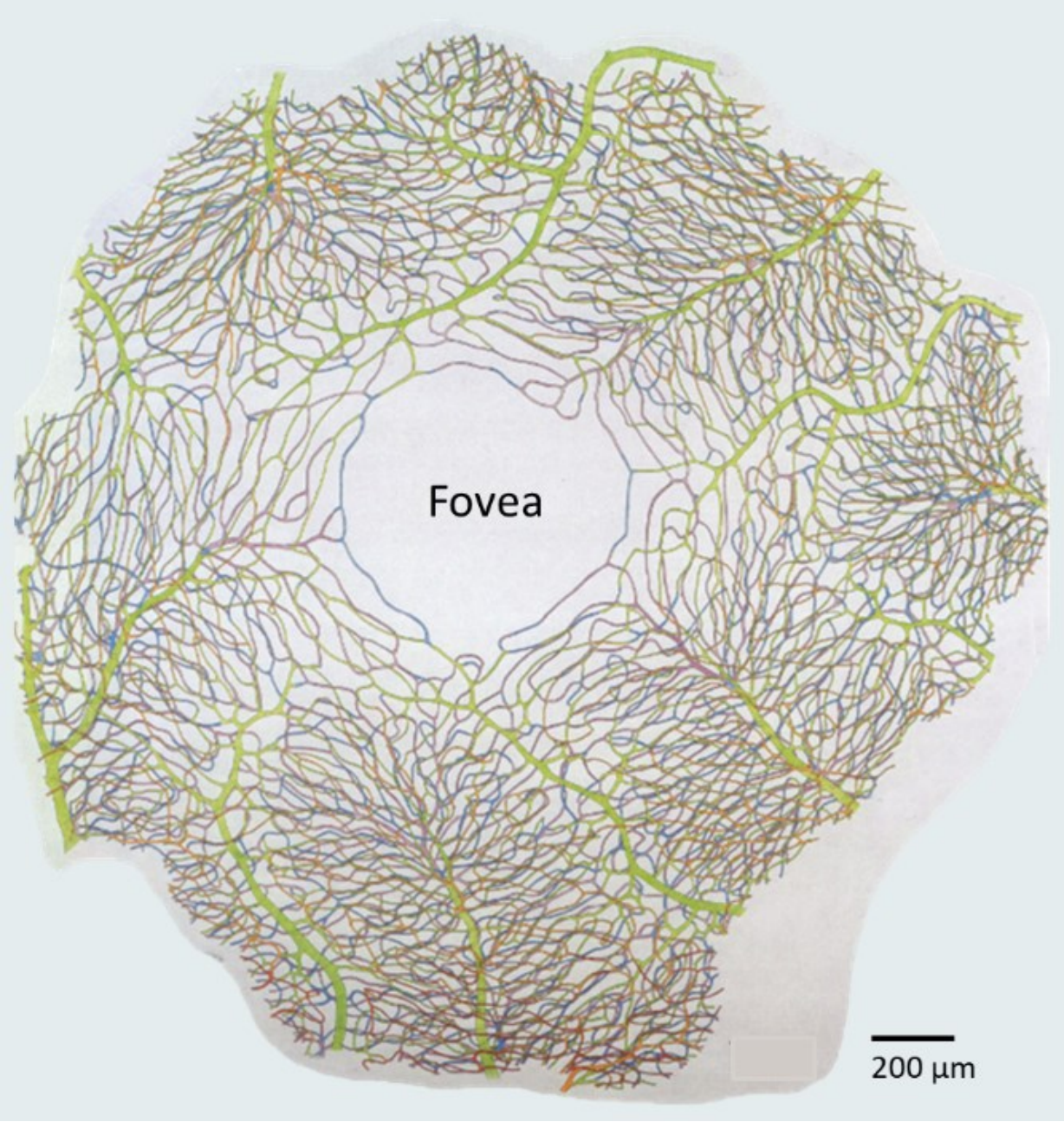

Figure 13.16: *Blood vessels within the macula. Source: Snodderly et al. 1992 (10.1523/JNEUROSCI.12-04-01169.1992). Copyright 1992 Society for Neuroscience.*

Snodderly, D.M., Weinhaus, R.S., Choi, J.C. Neural-vascular relationships in central retina of macaque monkeys (*Macaca fascicularis*). *The Journal of Neuroscience*. **12** (4), 1169–1193, doi: 10.1523/JNEUROSCI.12-04-01169.1992 (1992).

Vitamin D

A pandemic of vitamin D deficiency

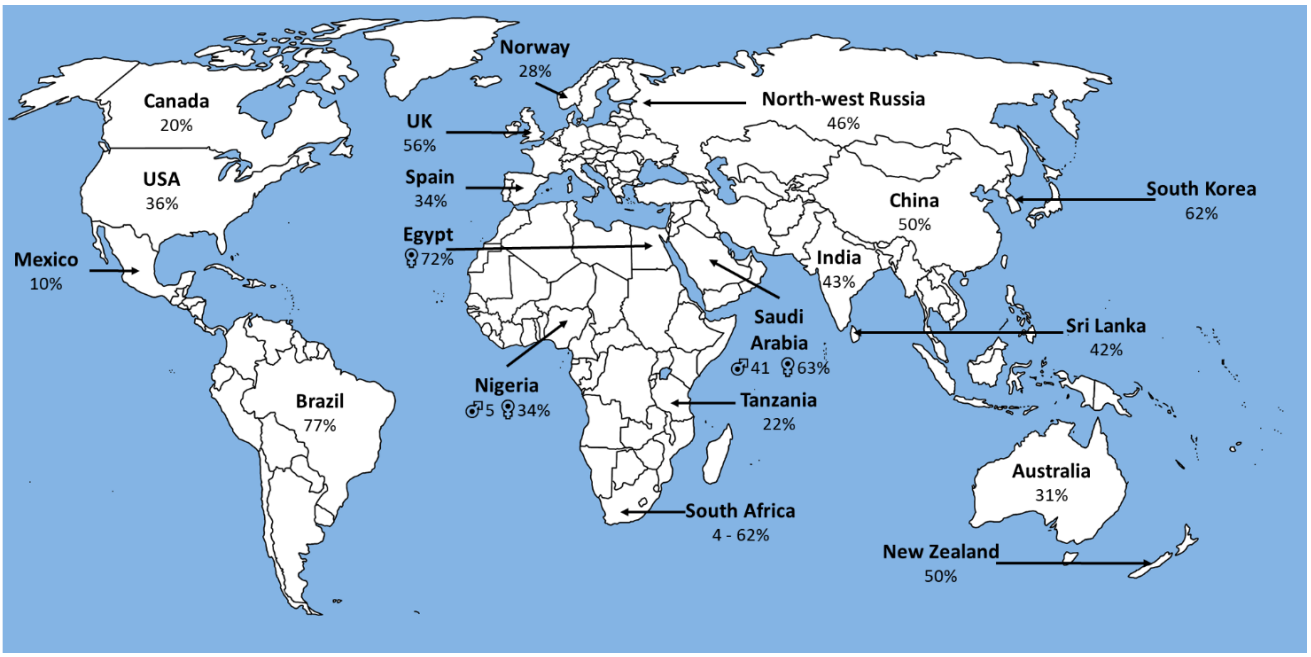

Figure 13.17: *Percentage of people in different parts of the world with vitamin D deficiency (below a 25(OH)D reference value of less than 50 nmol/l). Sources: Canada,*[1] *USA,*[2] *Mexico,*[3] *Brazil,*[4] *Norway,*[5] *UK,*[6] *Spain,*[7] *Egypt,*[8] *Saudi Arabia,*[9] *Nigeria,*[10] *Tanzania,*[11] *South Africa,*[12] *North-west Russia,*[13] *South Korea,*[14] *China,*[15] *India,*[16] *Sri Lanka,*[17] *Australia,*[18] *New Zealand.*[19]. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.

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What is vitamin D?

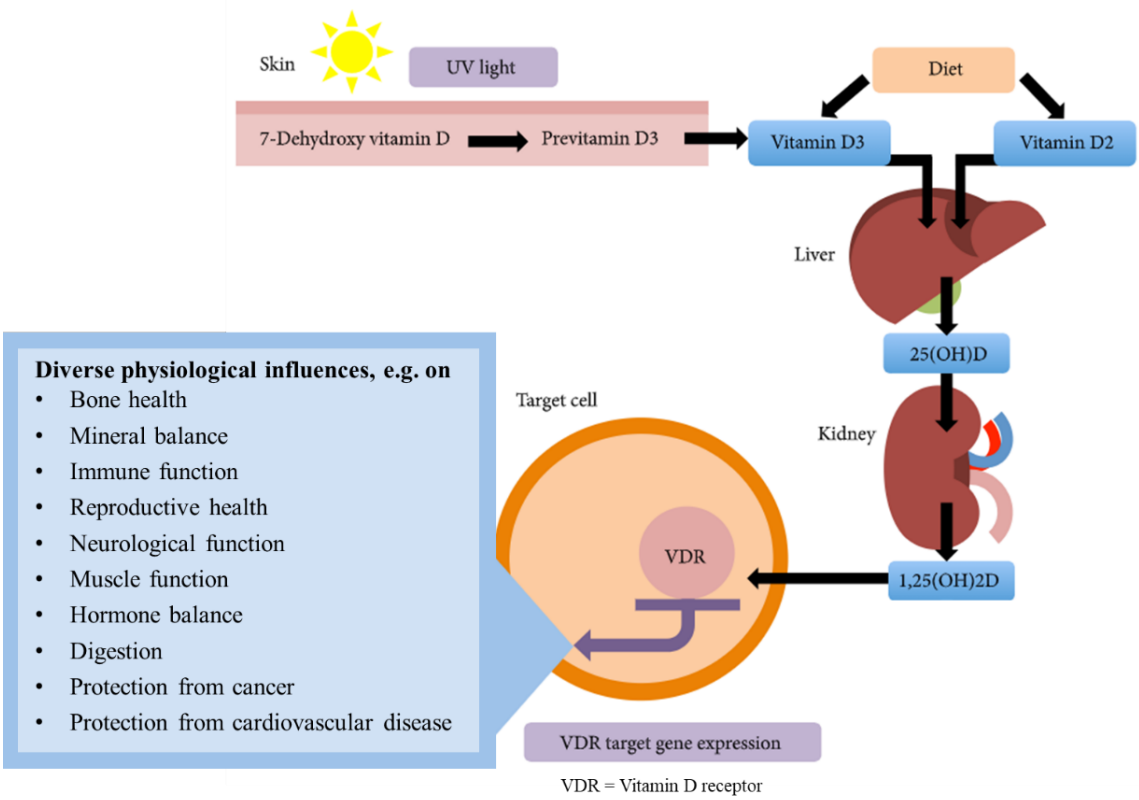

Figure 13.18: *Vitamin D metabolism and the vitamin D receptor. Adapted from Lugg et al. 2015 (doi:10.1155/2015/864370). Wiley CC BY-SA 3.0 creativecommons.org/licenses/by-sa/3.0.*

Lugg, S.T., Howells, P.A., Thickett, D.R. Optimal vitamin D supplementation levels for cardiovascular disease protection. *Disease Markers*. **2015**, e864370, doi: 10.1155/2015/864370 (2015).

Optimal vitamin D levels

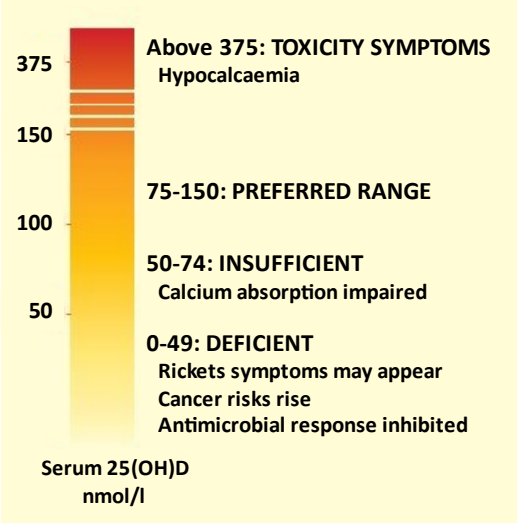

Figure 13.19: Changing impacts of vitamin D levels. Adapted from Tavera-Mendoza and White 2007 (doi:10.1038/scientificamerican1107-62). Used with the permission of Springer Nature America.

Tavera-Mendoza, L.E., White, J.H. Cell defenses and the sunshine vitamin. *Scientific American*. **297** (5), 62–65, 68–70, 72, doi: 10.1038/scientificamerican1107-62 (2007).

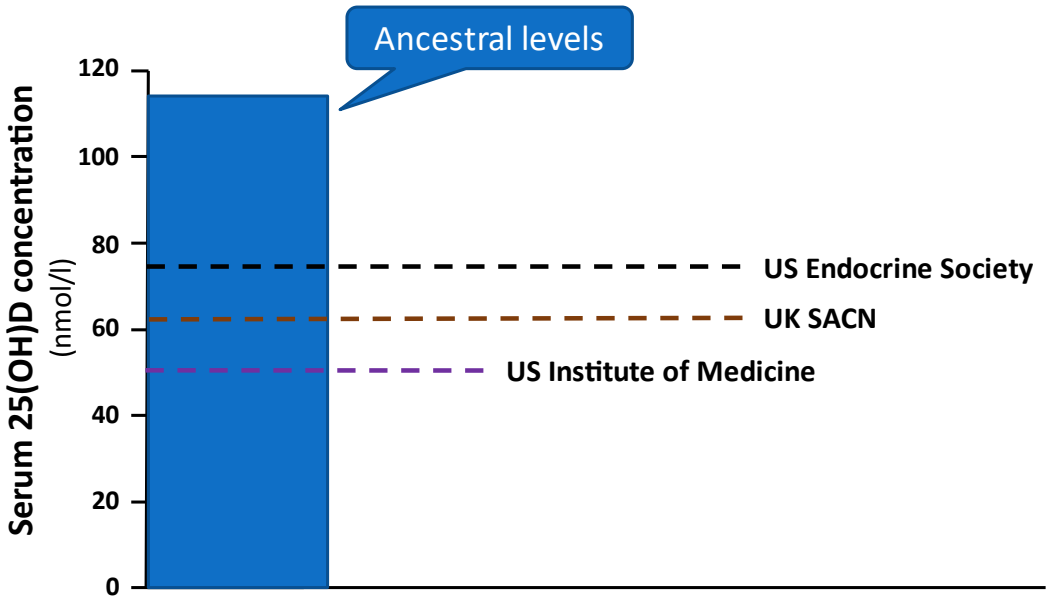

Figure 13.20: *Ancestral levels of vitamin D in the blood in comparison with recommended minimum levels. Sources*[1–4]*.By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

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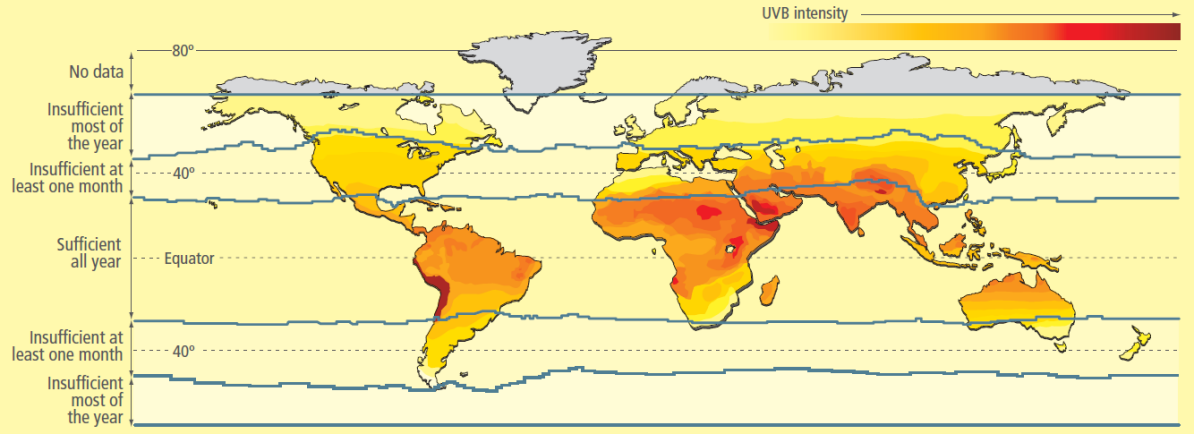

Figure 13.21: The effect of latitude on UVB intensity available for the synthesis of vitamin D. Source: Tavera-Mendoza and White 2007 (doi:10.1038/scientificamerican1107-62). Used with the permission of Springer Nature America.

Tavera-Mendoza, L.E., White, J.H. Cell defenses and the sunshine vitamin. *Scientific American*. **297** (5), 62–65, 68–70, 72, doi: 10.1038/scientificamerican1107-62 (2007).

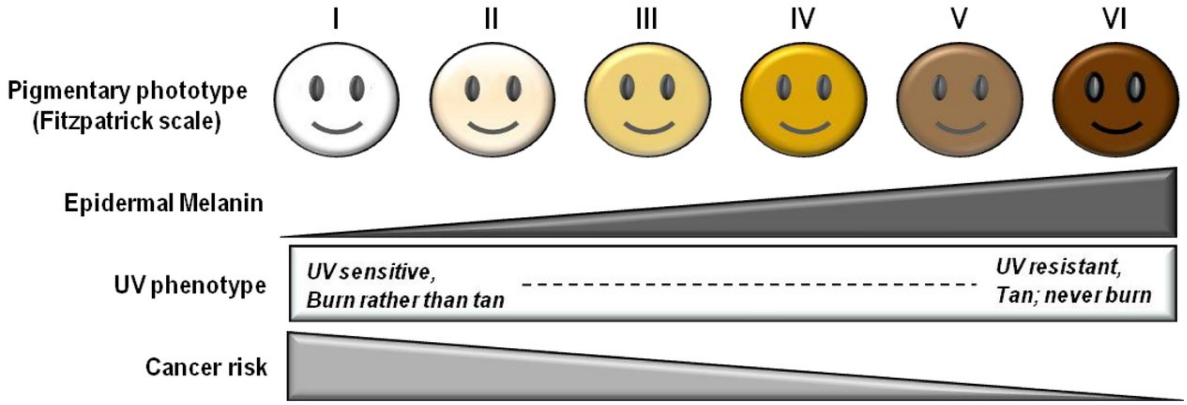

Figure 13.22: *The Fitzpatrick scale. Source: : D'Orazio, et al. 2013 (doi:10.3390/ijms140612222). MDPI CC BY 3.0 creativecommons.org/licenses/by-sa/3.0.*

D'Orazio, J., Jarrett, S., Amaro-Ortiz, A., Scott, T. UV Radiation and the Skin. *International Journal of Molecular Sciences*. **14** (6), 12222–12248, doi: 10.3390/ijms140612222 (2013).

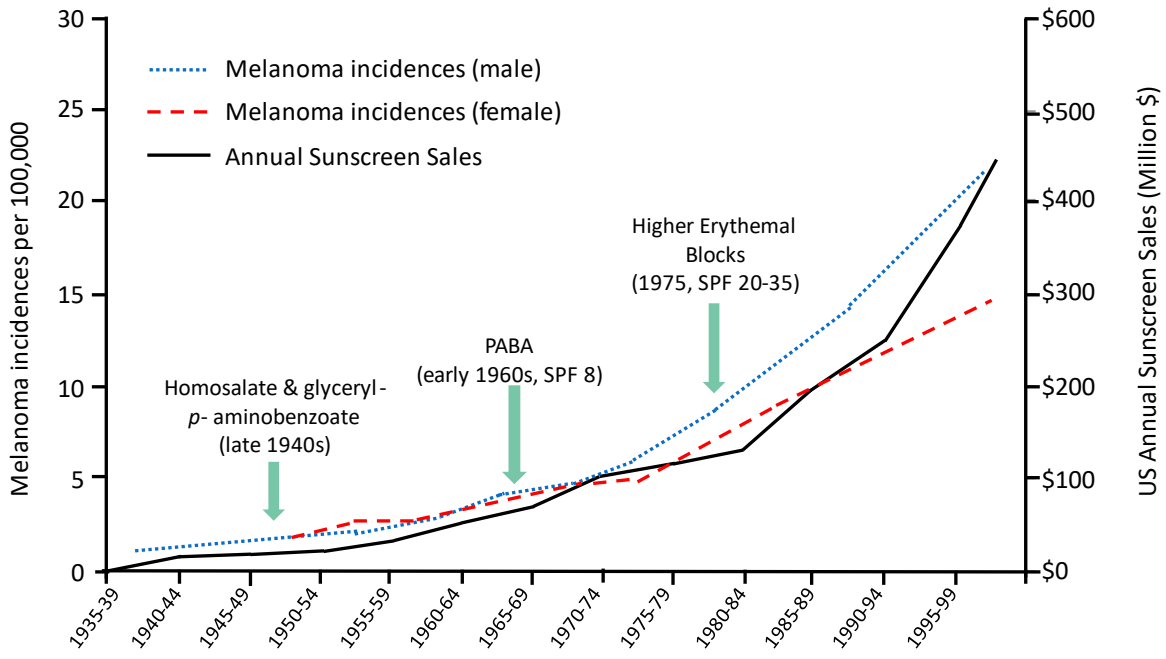

Figure 13.23: *Sunscreen sales and age-adjusted melanoma incidence rates per 100,000. Melanoma data from the Connecticut Tumor Registry and sales data for the USA. Adapted from Gorham 2010 (https://www.youtube.com/watch?v=-vt9Lc_PcWM).*

Vitamin D toxicity and skin cancer: two big elephants in the UVB room

Sun exposure and skin cancer – a complex relationship

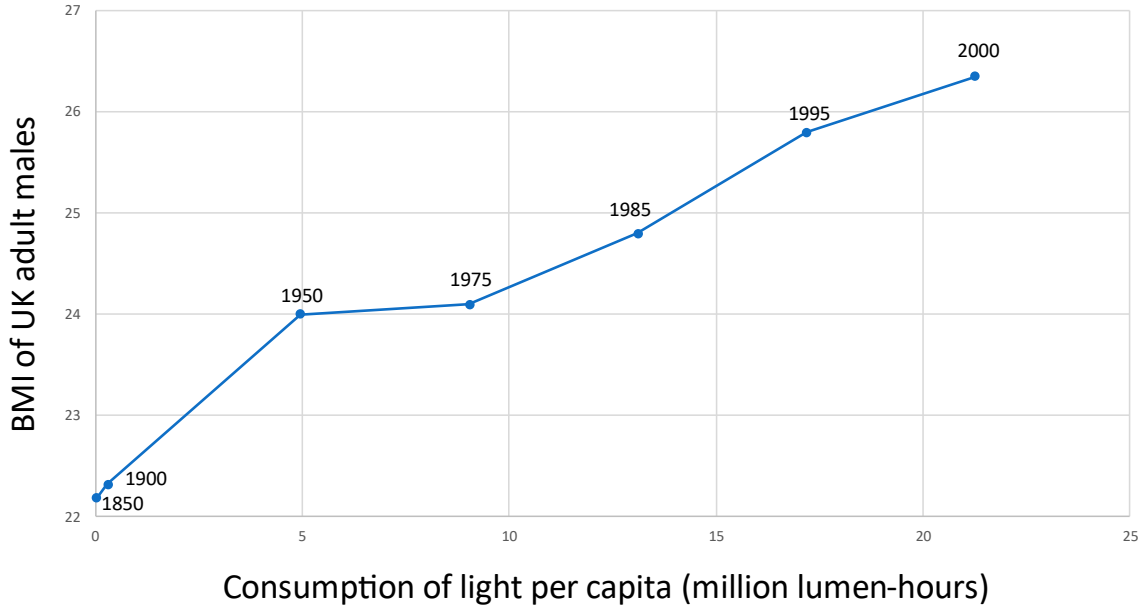

Figure 13.24: *Body mass index (BMI) in the UK and artificial light exposure over a 150-year period. Data on BMI from Floud (1998)[280] & Anon (2016).[281] Data on light exposure from Fouquet & Pearson (2006).[282] Light data for 1975, 1985 and 1995, and BMI data for 2000 estimated by linear interpolation.*

Vitamin D: UV, The Original Source! How to Use It. at <https://www.youtube.com/watch?v=-vt9Lc_PcWM>. (2010).

Chapter 14. Light Solutions

Seek Sensible Sun-Like Exposure

Get Out in Natural Sunlight – red balanced with blue, infrared and UV

Consider supplementing with vitamin D and K2

Table 14.1: Vitamin D recommendations by the Institute of Medicine and Dr Holick. Source: Holick (2011).

	Institute of Medicine Recommendations (IU/day)				Dr Holick's Recommendations for Patients at Risk for Vitamin D Deficiency (IU/day)	
Life Stage Group	**AI**	**EAR**	**RDA**	**Tolerable UL**	**Daily Allowance**	**Therapeutic use**
Infants: 0–6 months	400	–	–	1000	400–1000	2000
Infants: 6–12 months	400	–	–	1500	400–1000	2000
Children: 1–3 years	–	400	600	2500	600–1000	4000
Children: 4–8 years	–	400	600	3000	600–1000	4000
Males: 9–13 years	–	400	600	4000	1500–2000	4000
Males: 14–18 years	–	400	600	4000	1500–2000	4000
Males: 19–30 years	–	400	600	4000	1500–2000	10,000
Males: 31–50 years	–	400	600	4000	1500–2000	10,000
Males: 51–70 years	–	400	600	4000	1500–2000	10,000
Males: >70 years	–	400	800	4000	1500–2000	10,000
Females: 9–13 years	–	400	600	4000	1500–2000	4000
Females: 14–18 years	–	400	600	4000	1500–2000	4000
Females: 19–30 years	–	400	600	4000	1500–2000	10,000
Females: 31–50 years	–	400	600	4000	1500–2000	10,000
Females: 51–70 years	–	400	600	4000	1500–2000	10,000
Females: >70 years	–	400	800	4000	1500–2000	10,000
Pregnancy: 14–50 years	–	400	600	4000	1500–2000	10,000
Lactation: 14–50 years	–	400	600	4000	4000*	10,000

AI indicates recommended adequate intake; EAR estimated average requirement; RDA recommended dietary allowance. *The table in Holick (2011) states a daily allowance of 1500–2000 IU, but in the text, Holick states that "Lactating women need to ingest 4000 IU/day to put enough vitamin D in their milk."

Holick, M.F. Vitamin D: A D-Lightful Solution for Health. *Journal of Investigative Medicine*. **59** (6), 872–880, doi: 10.2310/JIM.0b013e318214ea2d (2011).

Part 5. Ionising Radiation – Something We Can All Agree Upon?

"Ionising radiation might be an overlooked toxin that contributes to significant health issues. People with chronic illnesses who can't get well or progress past a certain point in their health recovery may be experiencing immune system suppression and other challenges from radiation toxicity."

~ Jay Davidson: *American chiropractor, natural medicine practitioner, speaker and author*

Figure 15.1: *Advertisement for "Undark" from 1921. Public domain, via Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Undark_(Radium_Girls)_advertisement,_1921,_retouched.png..*

What is ionising radiation?

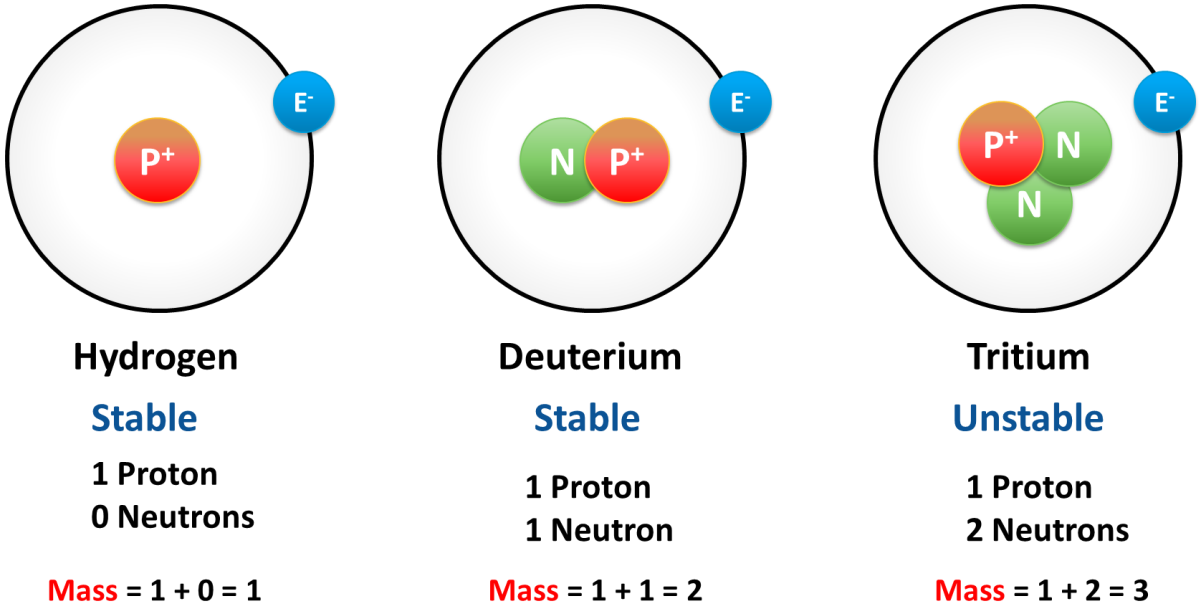

Figure 15.2: *Nuclides of hydrogen. This diagram is not remotely to scale, with the actual protons and neutrons about 2000 times the mass of an electron, while all the subatomic particles take up only about one trillionth of the volume of the atom. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

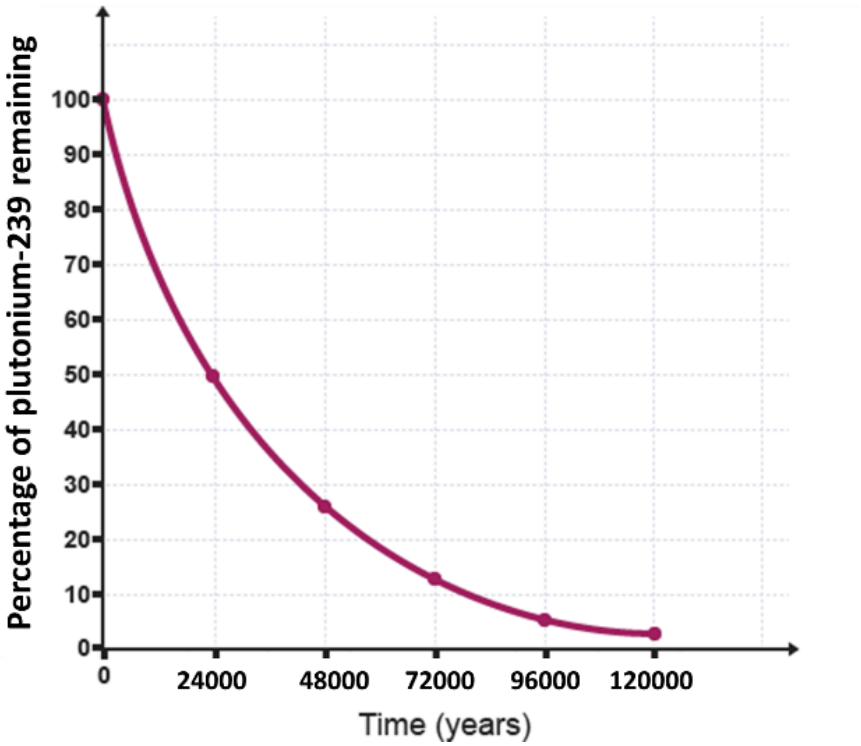

Figure 15.3: *How the percentage of radionuclide atoms in a sample changes over time illustrated by plutonium-239 (half-life of 24,000 years). By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

How ionising radiation can harm us

Table 15.1: Effects of acute whole-body radiation doses on the human body. Adapted from Craig and Jungerman, 1990.[12]

Dose (sievert)	Effects
0.05–0.2	Possible late effects; possible chromosomal damage.
0.2–1	Temporary reduction in white blood cells.
1–2	Mild radiation sickness within a few hours: vomiting, diarrhoea, fatigue; reduced resistance to infection.
2–3	Severe radiation sickness effects and haemorrhage; exposure is a lethal dose to 10–35% of the population after 30 days.
3–4	Severe radiation sickness; marrow and intestine destruction; exposure is a lethal dose to 50–70% of the population after 30 days.
4–10	Acute illness, early death; exposure is a lethal dose to 60–95% of the population after 30 days.
10–20	Acute illness, early death in days; exposure is a lethal dose to 100% of the population after 10 days.

Craig, P.P., Jungerman, J.A. *The nuclear arms race: technology and society*. McGraw-Hill Pub. Co. New York. (1990).

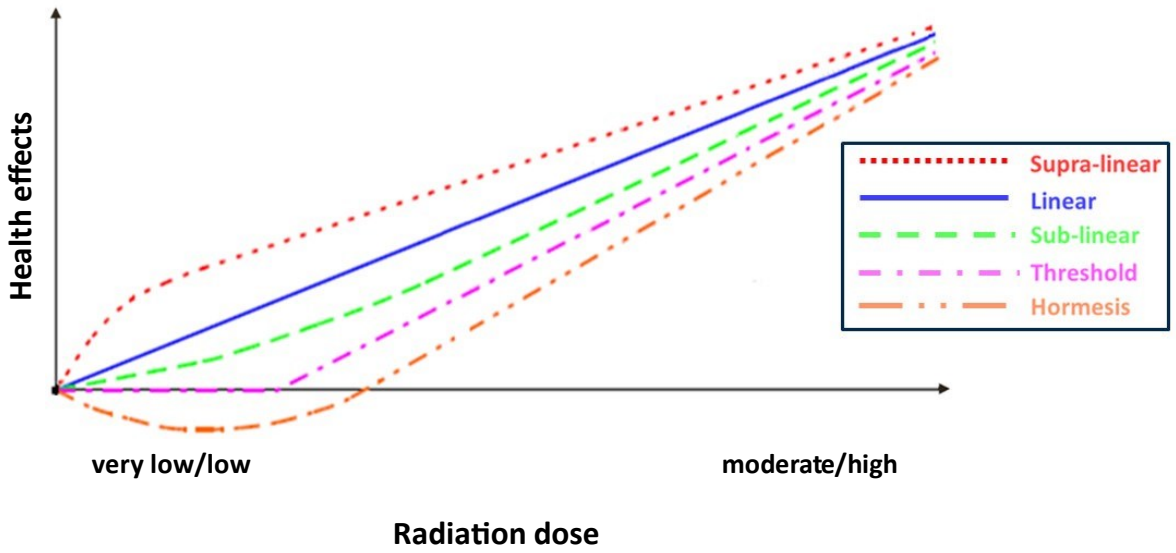

Figure 15.4: *Some possible dose-response curves describing the risk of health effects at different radiation doses. Adapted from Belli & Indovina 2020 (doi: 10.3389/fpubh.2020.601711). CC BY 4.0. creativecommons.org/licenses/by/4.0.*

Belli, M., Indovina, L. The response of living organisms to low radiation environment and its implications in radiation protection. *Frontiers in Public Health*. **8**, doi: 10.3389/fpubh.2020.601711 (2020).

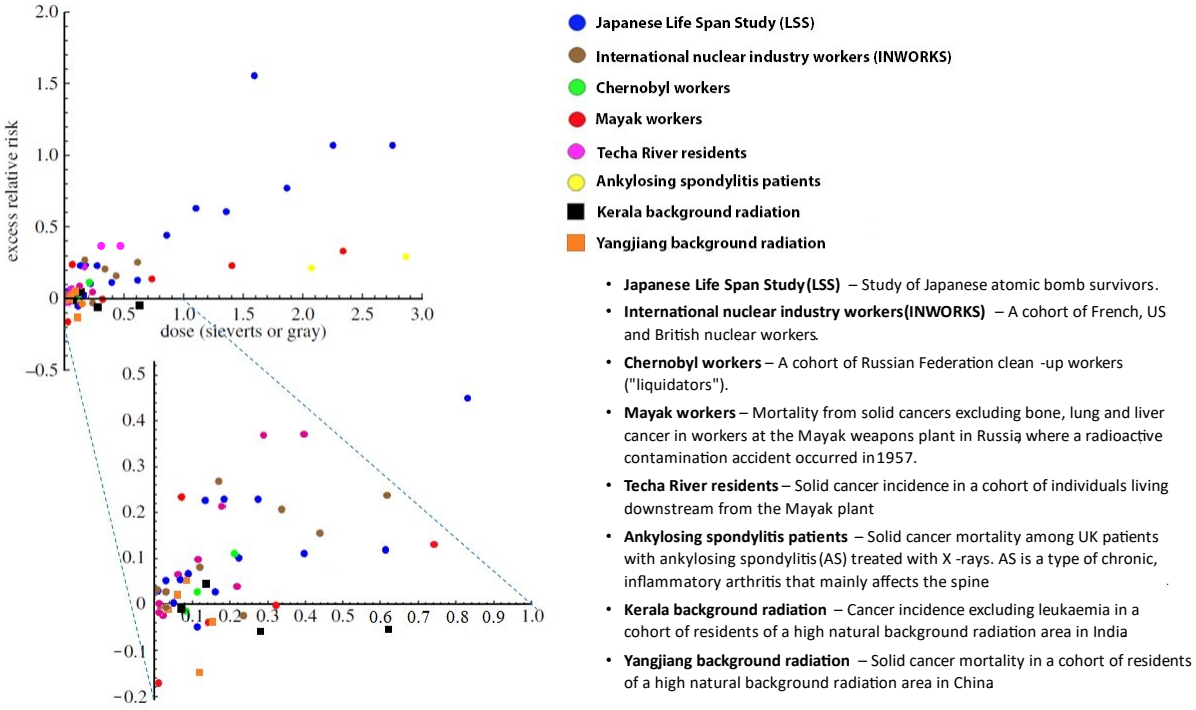

Figure 15.5: *The relationship between radiation dose and the incidence of non-leukaemia cancers. Adapted from McLean et al. 2017 (doi:10.1098/rspb.2017.1070). The Royal Society Publishing CC BY 4.0 creativecommons.org/licenses/by-sa/4.0.*

McLean, A.R. *et al.* A restatement of the natural science evidence base concerning the health effects of low-level ionizing radiation. *Proceedings of the Royal Society B: Biological Sciences*. **284** (1862), 20171070, doi: 10.1098/rspb.2017.1070 (2017).

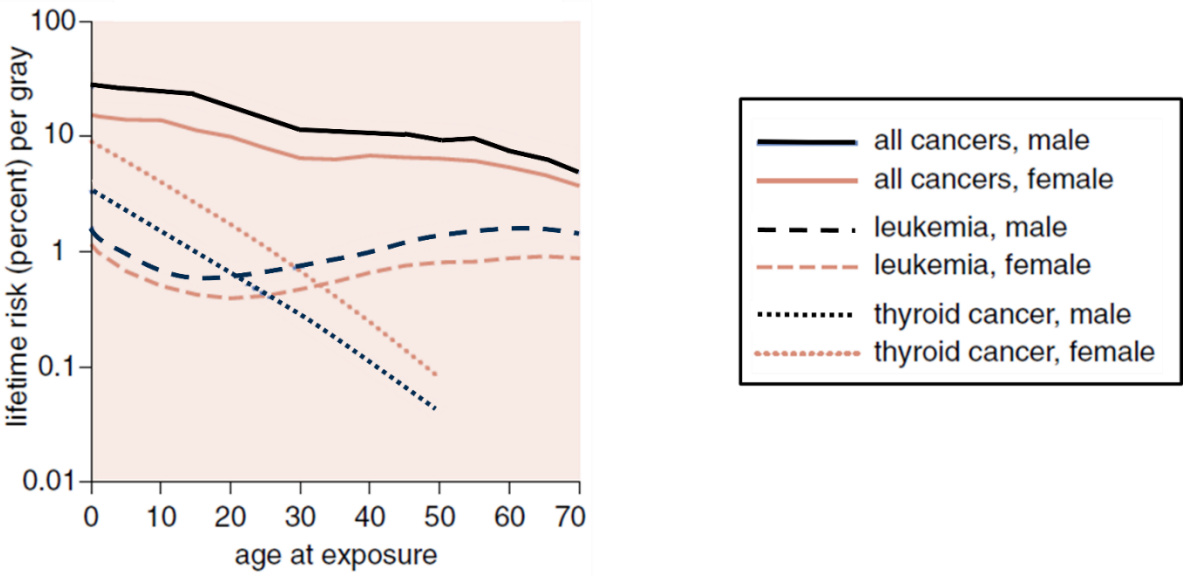

Figure 15.6: *Lifetime risk of cancers per gray of absorbed radiation and age at exposure. The curves for leukaemia refer to the absorbed doses to red bone marrow, the curves for thyroid cancer refer to the absorbed doses to the thyroid gland, and the curves for all cancers refer to whole-body absorbed doses. Source: Simon et al. 2006 (doi: 10.1511/2006.57.982). Used with the permission of Sigma Xi.*

Simon, S.L., Bouville, A., Land, C.E. Fallout from nuclear weapons tests and cancer risks: exposures 50 years ago still have health implications today that will continue into the future. *American Scientist*. **94** (1), 48–57 (2006).

Table 15.2: Exposure of the UK population in 2010 from all sources of ionising radiation. Adapted from PHE (2016).[24]

Source of exposure	Per capita dose (mSv) per year
Ubiquitous radiation in the environment	
Radon	1.3
Intake of natural radionuclides (excluding radon)	0.27
Terrestrial gamma radiation	0.35
Cosmic radiation	0.33
Weapons fallout	0.005
Other anthropogenic reactivity in the environment*	0.0008
Total dose from ubiquitous radiation in the environment	2.3
Exposure from the use of radiation	
Patient exposure from the medical use of radiation	0.44
Occupational exposure from the use of radiation**	0.0004
Total dose from the use of radiation	**0.44**
TOTAL DOSE FROM ALL SOURCES OF RADIATION	**2.7**

* Includes exposure to radionuclides routinely discharged or accidentally released into the environment.

** Includes occupational exposure to radiation not ubiquitous in the environment within the nuclear fuel cycle and during nuclear power production, application of radiation within medicine, and use of radiation in general industry and research. The contributions to the collective dose to the UK population from occupational exposure to radon and cosmic radiation are included within the 'radon' and 'cosmic radiation' sources, respectively.

Ionising Radiation Exposure of the UK Population: 2010 Review. at <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/518487/PHE-CRCE-026_-_V1-1.pdf>. Public Health England. Chilton, Didcot, Oxfordshire. (2016).

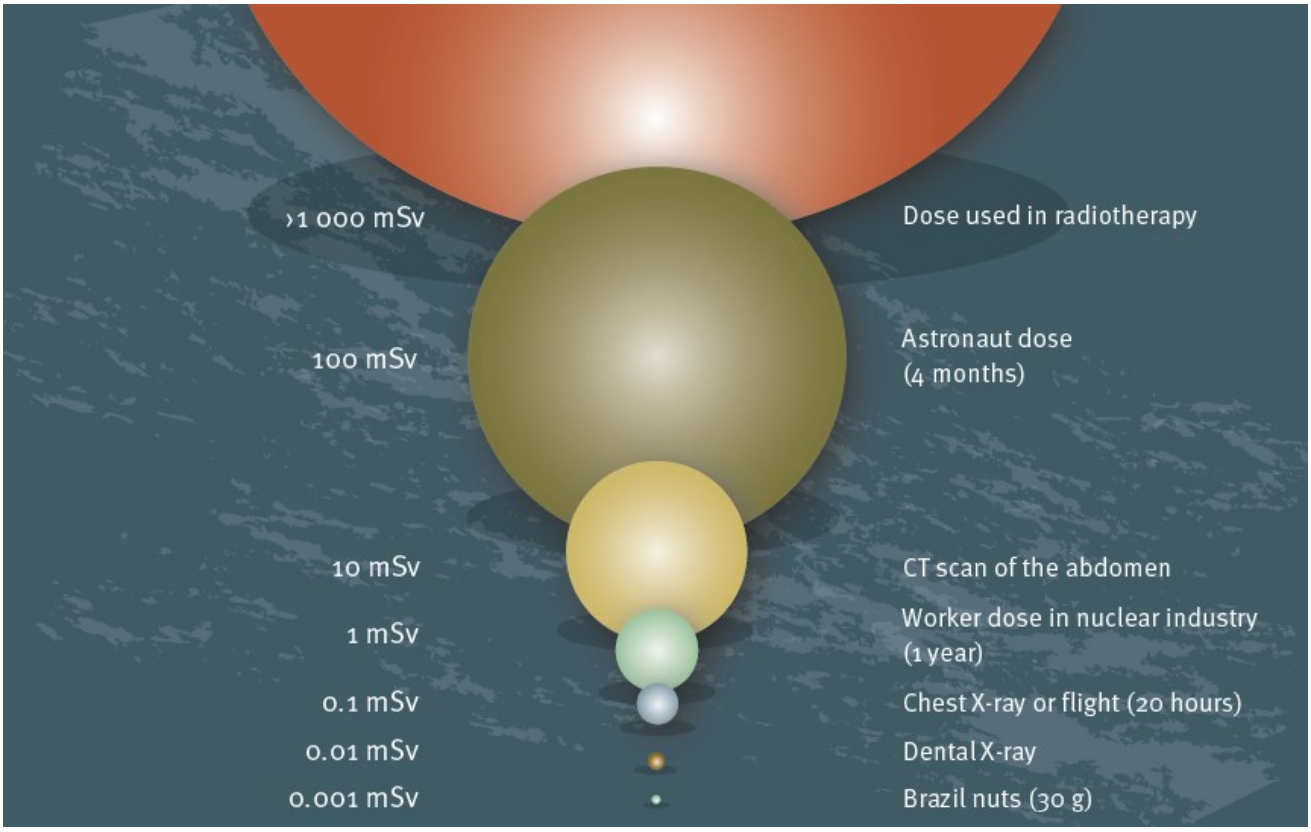

Figure 15.7: *Relative doses of different ionising radiation sources. From UNEP 2016 (http://www.unep.org/resources/report/radiation-effects-and-sources), Nairobi. Used with the permission of UNEP.*

Radiation: Effects and sources. at <http://www.unep.org/resources/report/radiation-effects-and-sources>. United Nations Environment Programme. Nairobi, Kenya. (2016).

Natural sources of ionising radiation

Radon

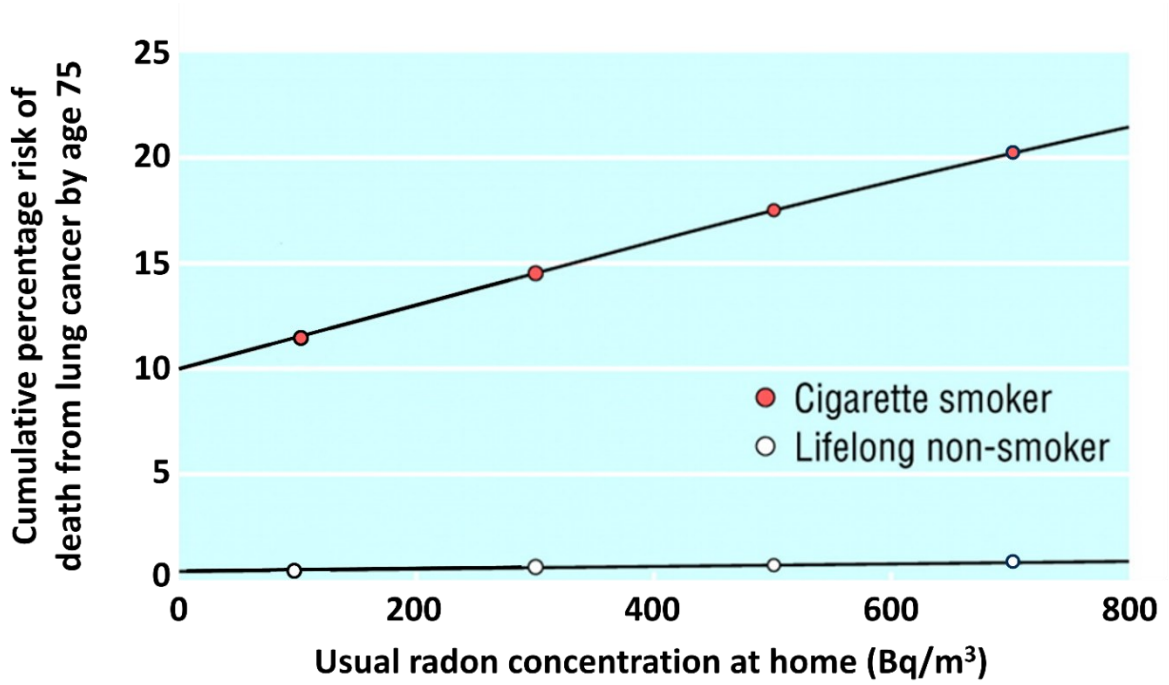

Figure 15.8: *Cumulative absolute risk of death from lung cancer by age 75 years versus usual radon concentration at home for cigarette smokers and lifelong non-smokers. Source: Darby et al. 2005 (doi:10.1136/bmj.38308.477650.63). Used with the permission of BMJ Publishing Group Ltd.*

Darby, S. *et al.* Radon in homes and risk of lung cancer: collaborative analysis of individual data from 13 European case-control studies. *BMJ*. **330** (7485), 223, doi: 10.1136/bmj.38308.477650.63 (2005).

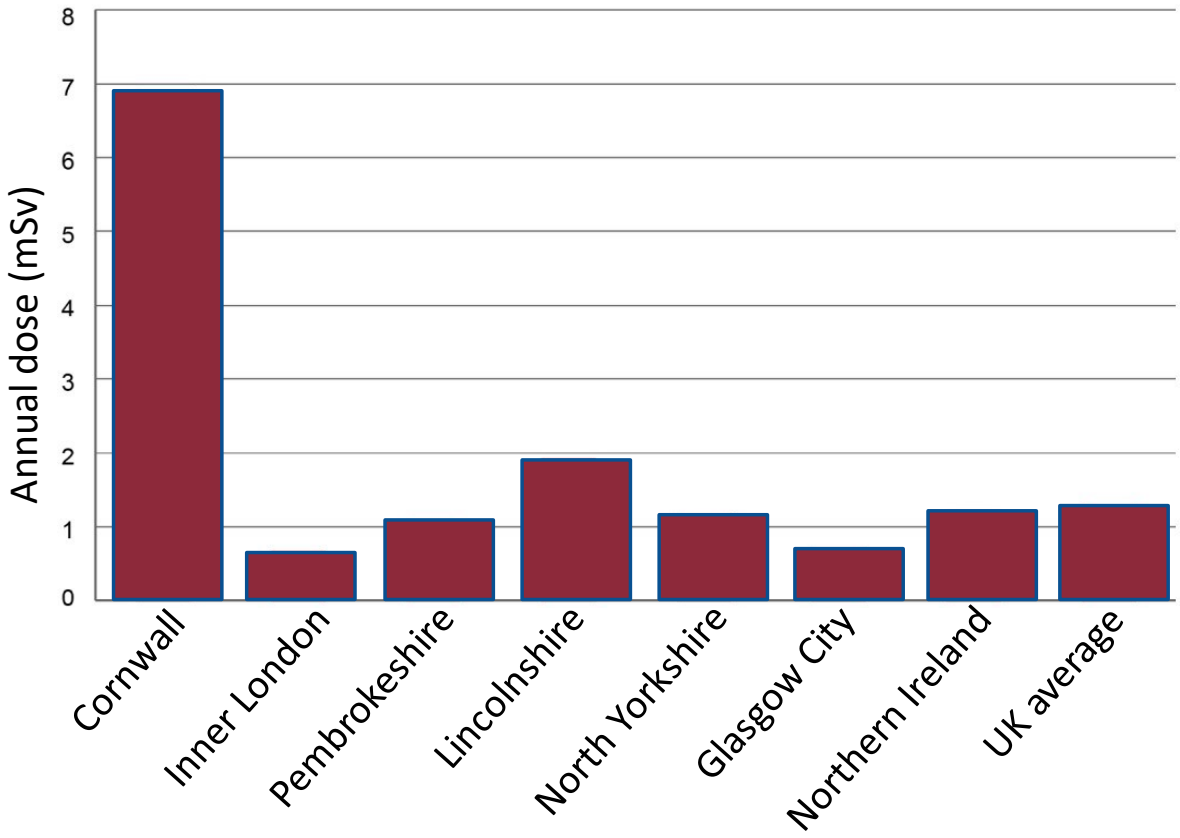

Figure 15.9*: Illustrative annual doses from inhaling radon in different parts of the UK. The high radon levels in properties in Cornwall are due to the large amounts of uranium 238-containing granite found there. Similarly, properties in other areas of the UK are exposed to relatively high radon levels because of the prevailing soil and rock types. Source: PHE 2016 (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/518487/PHE-CRCE-026_-_V1-1.pdf). Contains public sector information licensed under the Open Government Licence v3.0 (www.nationalarchives.gov.uk/doc/open-government-licence/version/3).*

Ionising Radiation Exposure of the UK Population: 2010 Review. at <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/518487/PHE-CRCE-026_-_V1-1.pdf>. Public Health England. Chilton, Didcot, Oxfordshire. (2016).

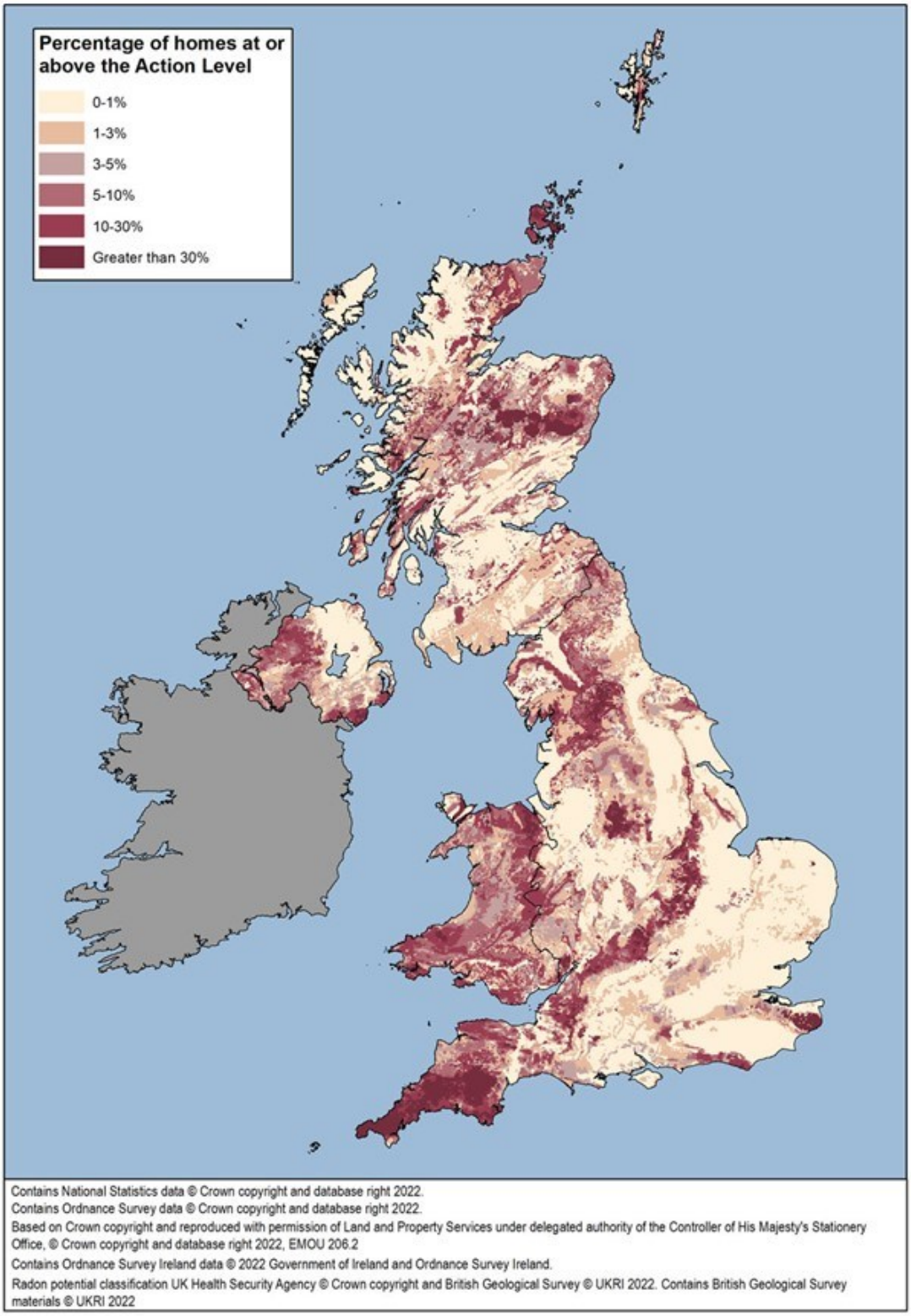

Figure 15.10: *Percentage of homes in the UK at or above the radon action level. ©UK Health Security Agency (UKHSA) and British Geological Survey (BGS) (https://www.bgs.ac.uk/news/updated-radon-map-for-great-britain-published/). Used with the permission of UKHSA and BGS. Contains National Statistics data © Crown copyright and database right 2022. Contains Ordnance Survey data © Crown copyright and database right 2022. Based on Crown copyright and reproduced with permission of Land Property Services under delegated authority of the Controller of His Majesty's Stationery Office © Crown copyright and database right 2022, EMOU 206.2. Contains Ordnance Survey Ireland data © 2022 Government of Ireland and Ordnance Survey Ireland. Radon potential classification UK Health Security Agency © Crown copyright 2022. British Geological Survey © UKRI 2022. All rights reserved (BGS permit no. CP24/044).*

Non-native sources of ionising radiation

Nuclear weapons

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

Simon, S.L., Bouville, A., Land, C.E. Fallout from nuclear weapons tests and cancer risks: exposures 50 years ago still have health implications today that will continue into the future. *American Scientist*. **94** (1), 48–57 (2006).

A spotlight on nuclear weapons testing – the Castle Bravo incident, the nuclear disaster that history forgot

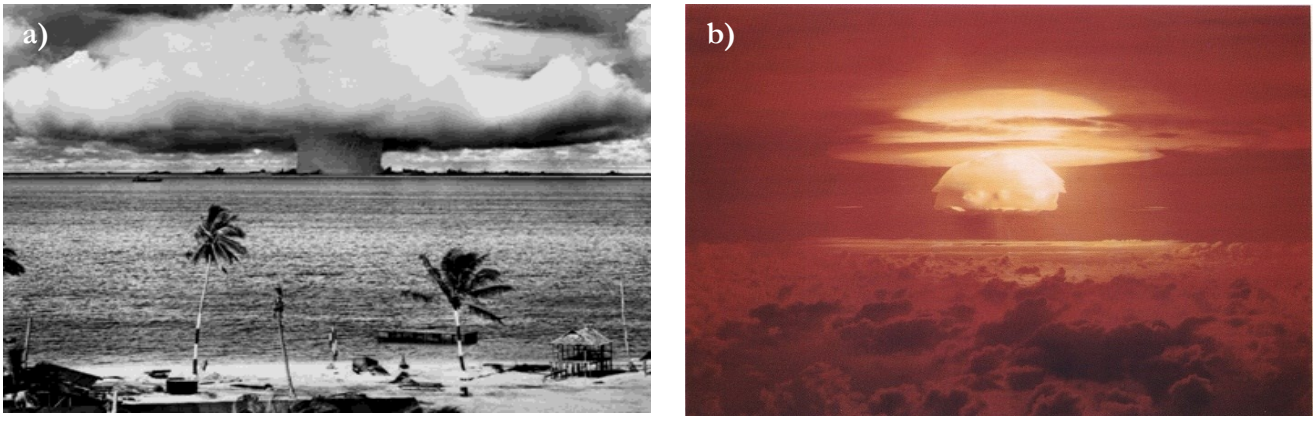

Figure 15.12: *a) Castle Bravo mushroom cloud from Bikini Atoll, b) Mushroom cloud rising in the atmosphere seconds later. ©Public Domain. a) Unknown author. b) United States Department of Energy (https://en.wikipedia.org/wiki/File:Castle_Bravo_Blast.jpg).*

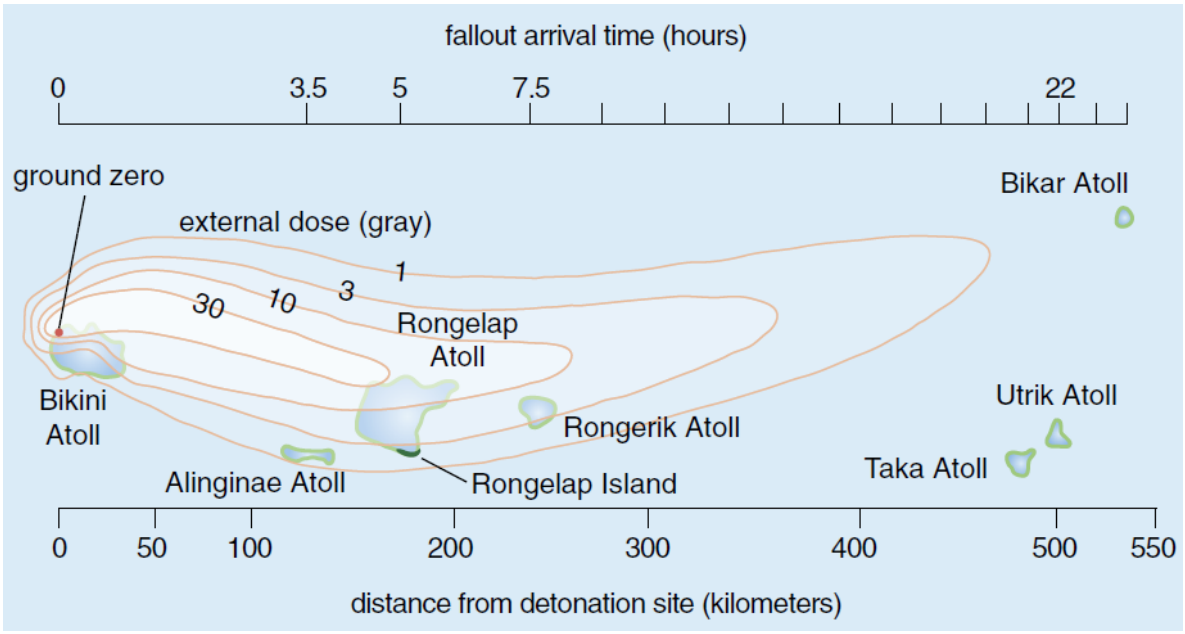

Figure 15.13: *The fallout plume from the Castle Bravo nuclear test. It appears that the above chart under-represents the extent of the fallout, which went further and wider. SourceSimon et al. 2006 (doi: 10.1511/2006.57.982). Used with the permission of Sigma Xi.*

Simon, S.L., Bouville, A., Land, C.E. Fallout from nuclear weapons tests and cancer risks: exposures 50 years ago still have health implications today that will continue into the future. *American Scientist*. **94** (1), 48–57 (2006).

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

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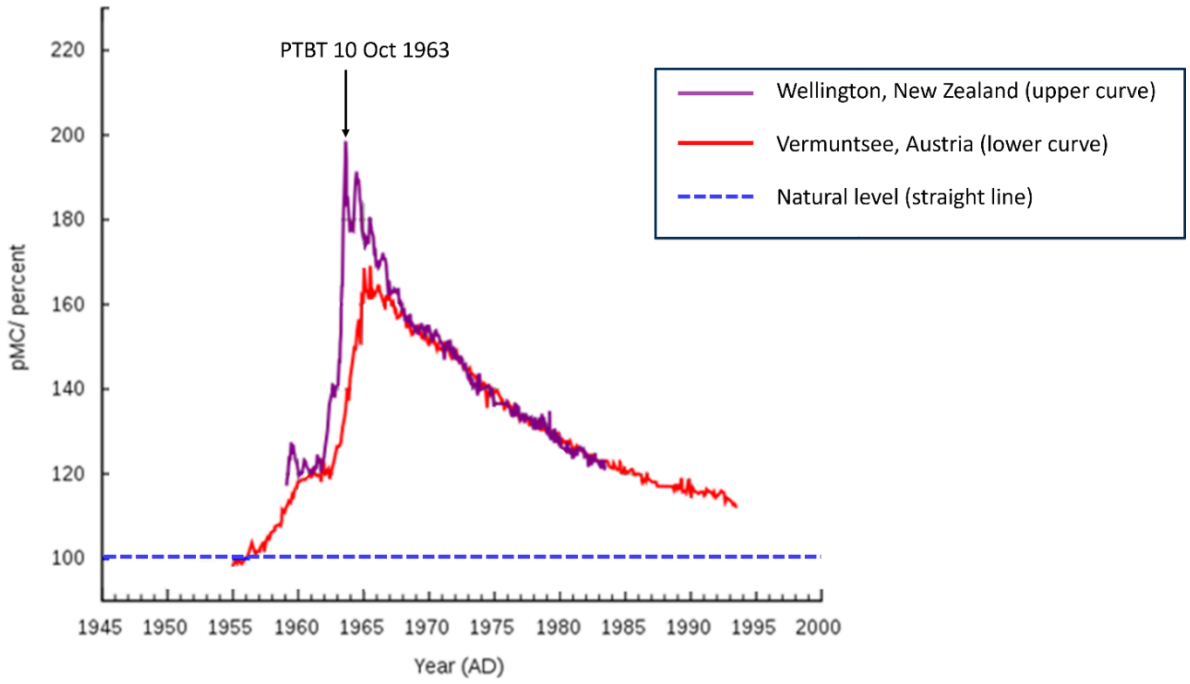

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Figure 15.15: *Atmospheric concentration of radioactive carbon-14 (^{14}C) almost doubled as a result of atmospheric testing of nuclear weapons. ^{14}C concentrations have been falling since the signing of the Partial Test Ban Treaty (PTBT). Adapted from Hokanomono ©Public Domain (https://commons.wikimedia.org/w/index.php?curid=634564).*

Nuclear power generation

Workplace exposure

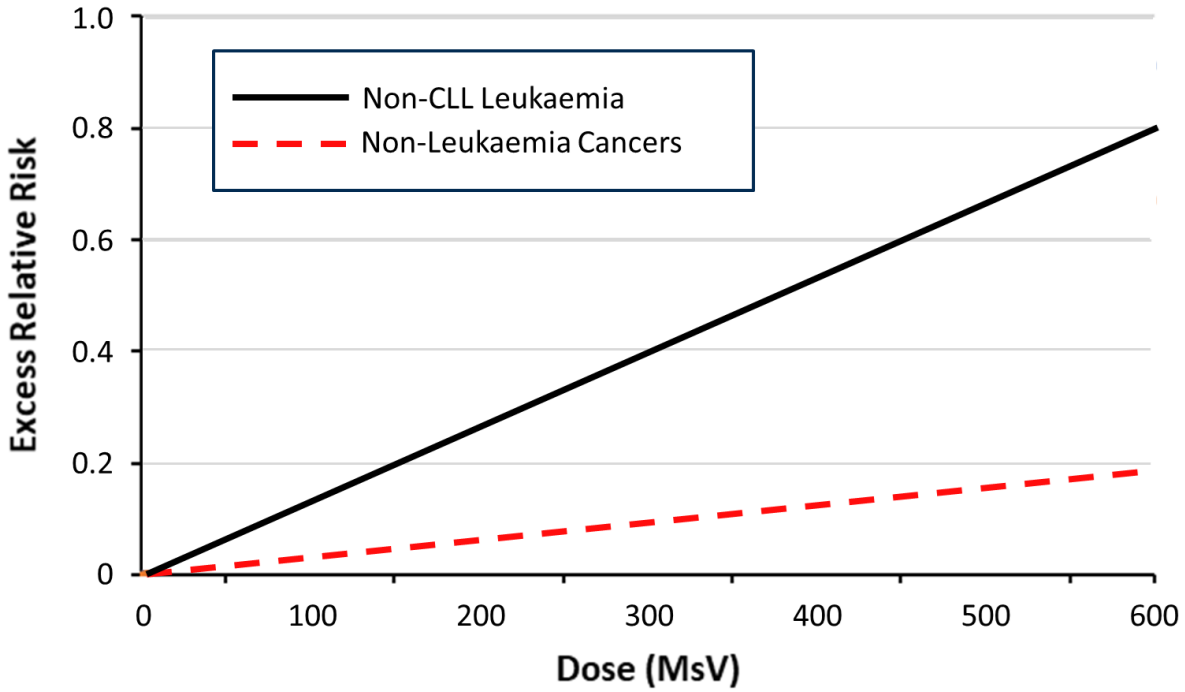


Figure 15.16: *Trend in relative risks for UK nuclear industry workers for non-CLL leukaemia and non-leukaemia cancers. Data from Gillies et al. 2019 (doi:10.1667/RR15358.1) and Haylock et al. 2018 (doi:10.1038/s41416-018-0184-9). Nature CC BY 4.0 creativecommons.org/licenses/by-sa/4.0. By John Mauremootoo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

Gillies, M., Haylock, R., Hunter, N., Zhang, W. Risk of leukemia associated with protracted low-dose radiation exposure: updated results from the National Registry for Radiation Workers study. *Radiation Research*. **192** (5), 527–537, doi: 10.1667/RR15358.1 (2019).

Haylock, R.G.E., Gillies, M., Hunter, N., Zhang, W., Phillipson, M. Cancer mortality and incidence following external occupational radiation exposure: an update of the 3rd analysis of the UK national registry for radiation workers. *British Journal of Cancer*. **119** (5), 631–637, doi: 10.1038/s41416-018-0184-9 (2018).

Nuclear power plant accidents

Fukushima

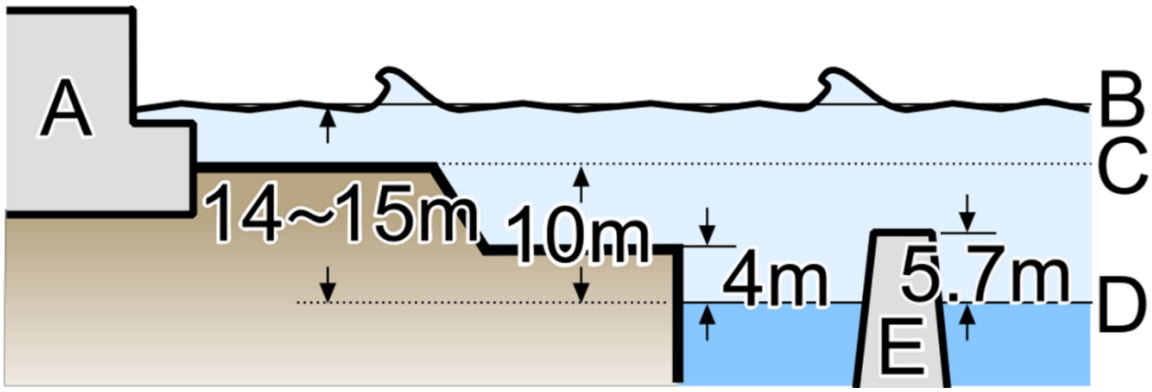


Figure 15.17: *The height of the tsunami that struck the Fukushima Daiichi nuclear power plant. A: Power station buildings B: Peak height of tsunami C: Ground level of site D: Average sea level E: Seawall to block waves. Source: Shigeru23 (https://commons.wikimedia.org/wiki/File:Fukushima_I_Powerplant_(Tsunami_height).png) - CC BY-SA 3.0 creativecommons.org/licenses/by-sa/3.0.*

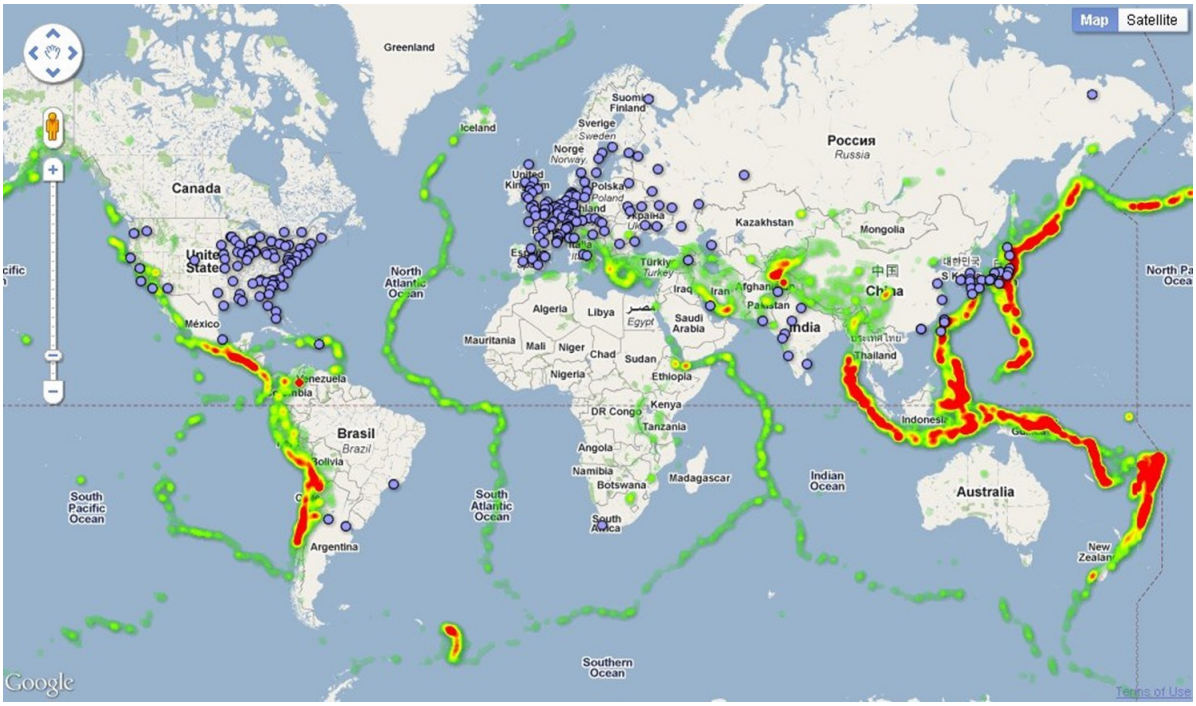


Figure 15.18: *Nuclear power plants (circles) and heatmap of earthquake-prone areas worldwide (2011). Source:* J.L.Saavedra (2011). CC BY 4.0. https://creativecommons.org/licenses/by/4.0.

Nuclear power and sea level rise

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

Medical diagnostics

Table 15.3: Comparison of radiation doses from medical imaging tests and typical background radiation. Adapted from Lin (2010).[119]

Examination	Radiation dose (mSv)	Approx. time to accumulate a comparable natural dose from background sources
Computed tomography		
Sinuses	0.6	2 months
Head	2.0	8 months
Chest	7.0	2 years
Chest (pulmonary embolism)	10	3 years
Abdomen and pelvis	10	3 years
Multiphase abdomen and pelvis	31	10 years
X-rays		
Extremity	0.001	Less than 1 day
Chest	0.1	10 days
Lumbar spine	0.7	3 months
Abdomen	1.2	5 months
Nuclear medicine		
Lung ventilation/perfusion	2.0	8 months
Bone scan	4.2	16 months
Cardiac perfusion (sestamibi)	12.5	4 years
Fluoroscopy		
Barium swallow	1.5	6 months
Coronary angiography	5-15	20 months – 5 years
Other		
Bone densitometry (DEXA – dual-energy X-ray absorptiometry)	0.001	Less than 1 day
Mammography	0.7	3 months

Lin, E.C. Radiation risk from medical imaging. *Mayo Clinic Proceedings*. **85** (12), 1142–1146, doi: 10.4065/mcp.2010.0260 (2010).

Medical therapies

Table 15.4: Range of typical cancer treatment radiotherapy ionising radiation doses. Source: Lumen Physics.[152]

Type of Cancer	Typical dose (sievert)
Lung	10–20
Hodgkin's disease	40–45
Skin	40–50
Ovarian	50–75
Breast	50–80+
Brain	80+
Neck	80+
Bone	80+
Soft tissue	80+
Thyroid	80+

Lumen Physics Therapeutic Uses of Ionizing Radiation. at <https://courses.lumenlearning.com/physics/chapter/32-3-therapeutic-uses-of-ionizing-radiation/>.

Air travel

Table 15.5: Cosmic radiation doses on several flight routes and the number of flights necessary per route for cumulative exposure to 1 mSv. Adapted from Barish (2004)[164] and Di Trolio et al. (2015).[165]

Route estimates	Dose/flight (µSv)	Flights for 1 mSv
Darwin to Singapore	9	107
Darwin to Perth	16	62
London to Singapore	42	23
London to New York	45	23
Melbourne to London	65	15
Melbourne to Johannesburg	71	14
New York to Tokyo	150	6
Note: 1 mSv = 1000 µSv		

Barish, R.J. In-flight radiation exposure during pregnancy. *Obstetrics & Gynecology*. **103** (6), 1326–1330, doi: 10.1097/01.AOG.0000126947.90065.90 (2004).

Di Trolio, R., Di Lorenzo, G., Fumo, B., Ascierto, P.A. Cosmic radiation and cancer: is there a link? *Future Oncology*. **11** (7), 1123–1135, doi: 10.2217/fon.15.29 (2015).

Measuring radiation

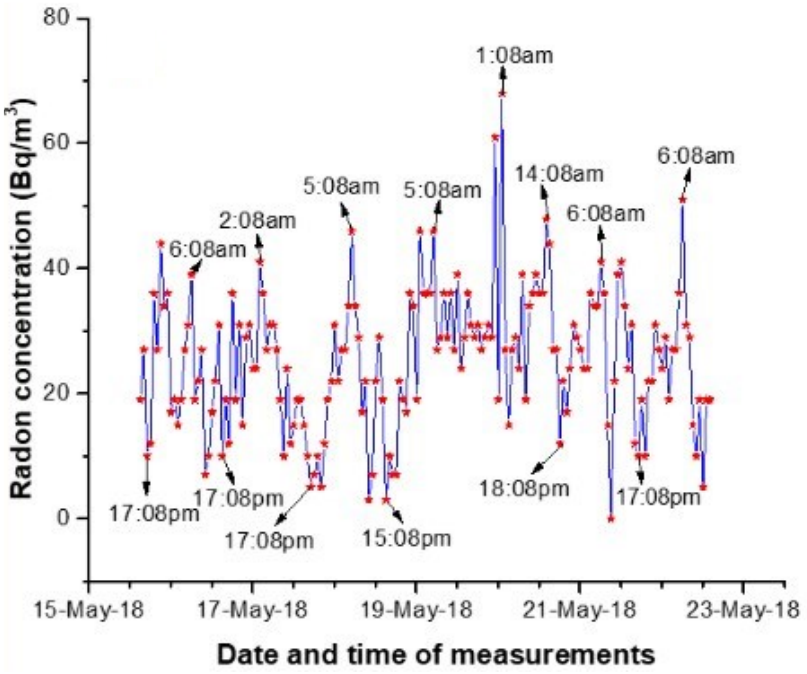


Figure 15.20: *Variation in radon levels in a building in Vietnam over several days. Source: Viet et al. 2018 (doi: https://doi.org/10.32508/stdj.v21i2.432) Science & Technology Development Journal. CC BY 4.0. creativecommons.org/licenses/by/4.0.*

Viet, L.H., Dong, S.S., Son, N.A., Duy, T.H. Measurement of indoor radon concentration in Dalat, Vietnam. *Science and Technology Development Journal.* **21** (2), 71–76, doi: 10.32508/stdj.v21i2.432 (2018).

Chapter 16. Ionising Radiation Solutions

No Figures and tables

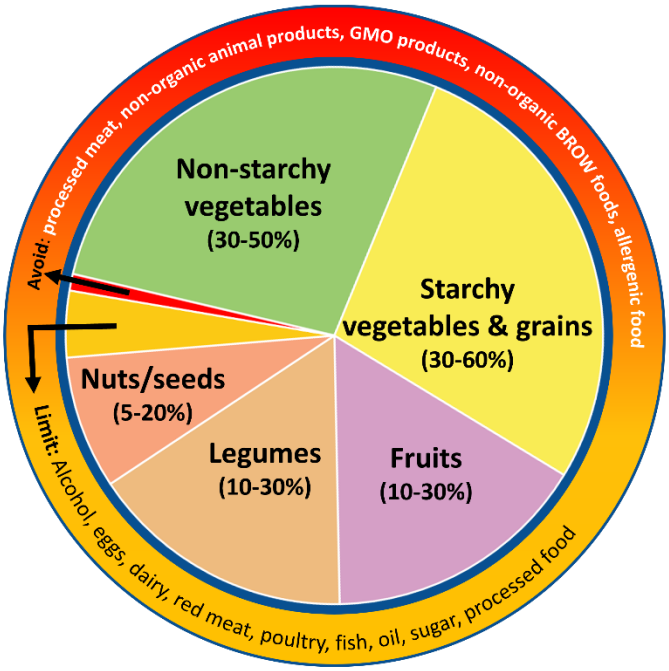
Part 6. Resilience – The Silver Lining in the Cloud of Electro-smog

“Wherever you may be on your life’s journey, every day you can make choices and decisions that will help make your body more capable of regeneration and radical resilience.”

***~ Sayer Ji**: American researcher, author, presenter, and the founder of Greenmedinfo.com. The most widely referenced, evidence-based natural health resource of its kind*

Chapter 17. Resilience – The Six Pillars of a Healthy Lifestyle (BESDME)

4. Diet – Eat Real Food and Hydrate Properly



Enough water intake to ensure clear to slightly straw-coloured urine

Don't beat yourself up about an occasional indiscretion

Figure 17.1: *The wholefood plant-rich diet plate. Derived from sources.*[39–41] *BROW refers to barley, rye, oats, and wheat products. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

1. Fuhrman, J. *Eat To Live: The Amazing Nutrient-Rich Program for Fast and Sustained Weight Loss*. Little, Brown and Co. New York. (2011).
2. Popper, P., Merzer, G. *Food Over Medicine: The Conversation that Could Save Your Life*. BenBella Books. Dallas, Texas. (2013).
3. Davis, B., Melina, V. *Becoming Vegan: The Complete Reference to Plant-Based Nutrition*. Book Publishing Company. Summertown, Tennessee. (2014).

Chapter 18. EMF Mitigation Treatments – Drugs, Supplements, Harmonisers and Beyond

The Biofield as a unified explanation for energy medicine

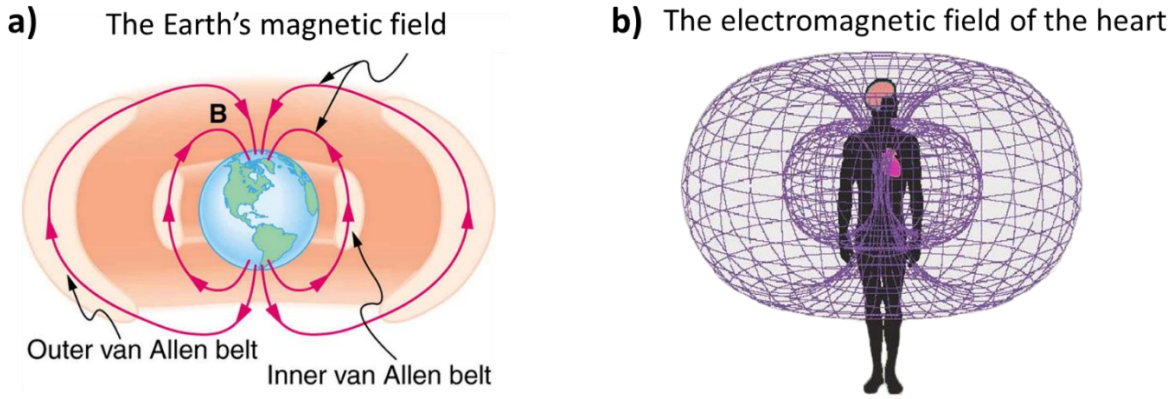


Figure 18.1: *Representations of a) The Earth's magnetic field, and b) The heart's electromagnetic field. The Earth's Magnetic Field by College Physics (https://pressbooks.online.ucf.edu/phy2054lt/) CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0. The magnetic field of the human heart – Public domain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

EMF harmonisers – Gamechangers, Band-Aid Solutions or Snake Oil?

SRT devices

SRT devices – mode of operation

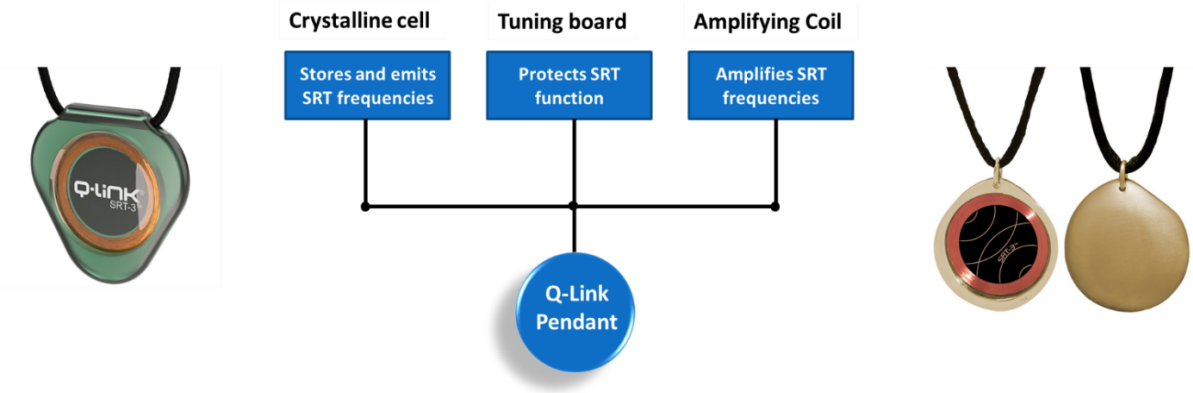


Figure 18.2: *Passive Sympathetic Resonance Technology™ (SRT) device components. By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

Studies on the protective biological effects of SRT devices

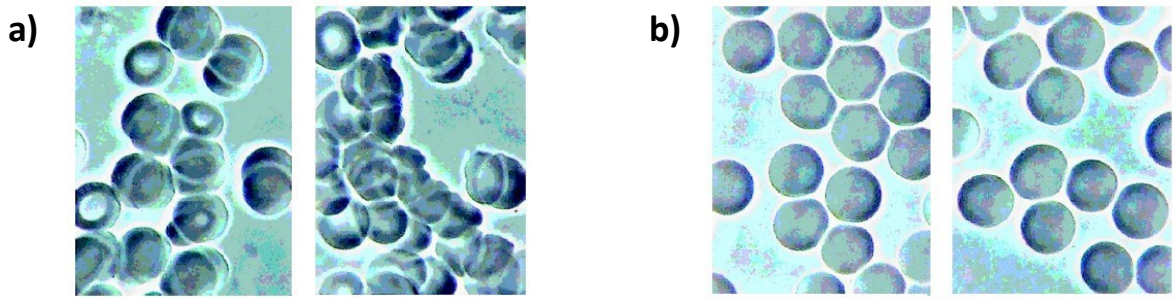


Figure 18.3: *a) Photos of live red blood cells in subjects without Q-Link; b) Photos of live red blood cells in the same subject with Q-Link. Source: Rubik 2002 (10.1089/10755530260511711). The publisher for this copyrighted material is Mary Ann Liebert, Inc. publishers. Used with the permission of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

Rubik, B. Sympathetic Resonance Technology: scientific foundation and summary of biologic and clinical studies. *Journal of Alternative and Complementary Medicine (New York, N.Y.)*. **8** (6), 823–856, doi: 10.1089/10755530260511838 (2002).

Insights from customer reviews

Figure 18.4: *Summary of 136 Amazon customer ratings of the Q-Link Triangle Acrylic SRT-3 Pendant (Aug 2007–Dec 2021). a) All global ratings, b) Ratings from 55 English language reviews (see text for details).By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

Biogeometry

The 'miracle' of Hemberg

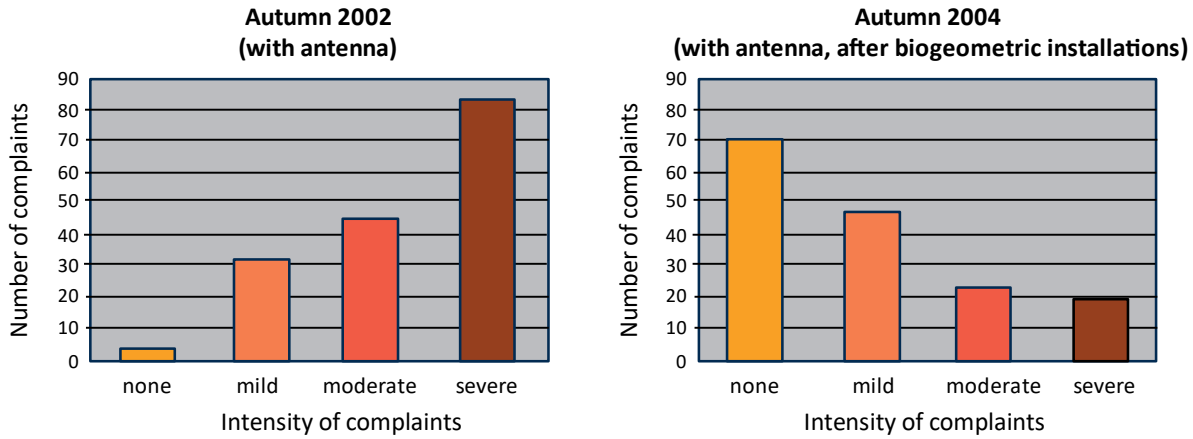
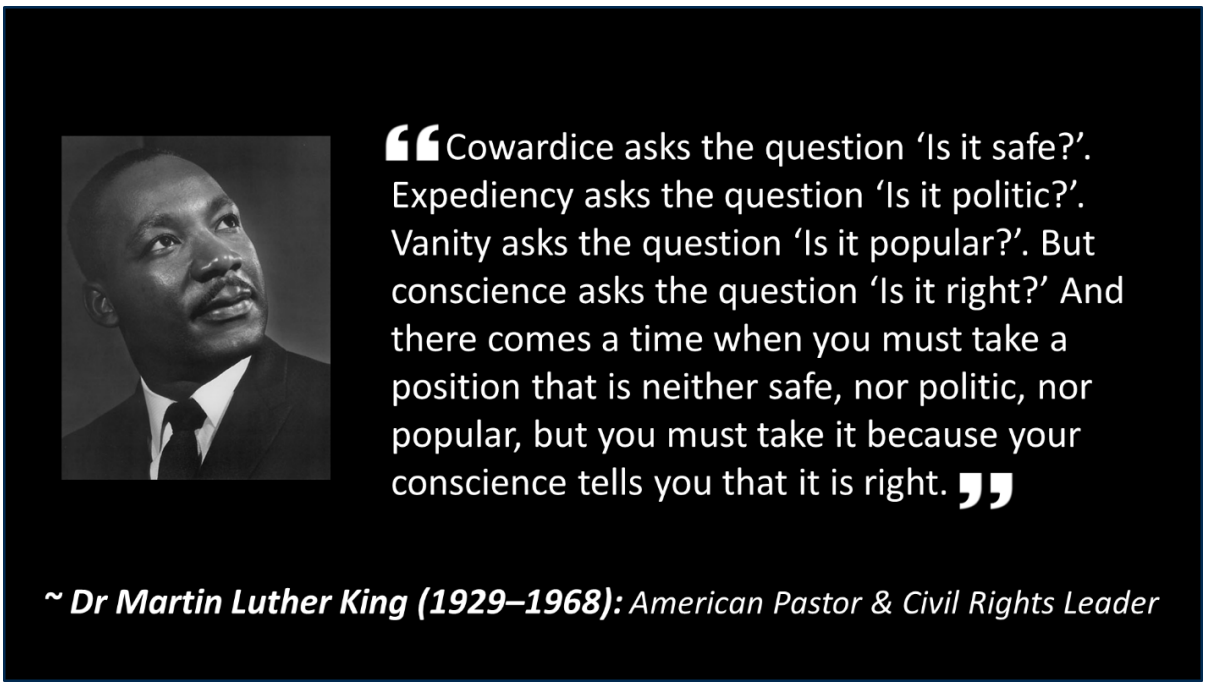


Figure 18.5: *Summary of results of a survey of Hemberg residents' health complaints before and after biogeometric installations. Source: Karim 2004 (https://ecf2f96e-2fee-4f3c-814b-5caa5a63b36e.filesusr.com/ugd/35c39f_ff18a77e979b465c9513d3a21e5b2d41.pdf). Used with the permission of GIBB Information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

Karim, I., Genossenschaft Information Baubiologie *Mobile Radiation in Hemberg: Harmonization with BioGeometry*. at <https://ecf2f96e-2fee-4f3c-814b-5caa5a63b36e.filesusr.com/ugd/35c39f_ff18a77e979b465c9513d3a21e5b2d41.pdf>. GIBB Information Organization for Building Biology. St. Gallerstrasse 28, CH-9230 Flawil. (2004).

Part 7. Serenity, Courage, and Wisdom – Towards Personal and Societal Change



Chapter 19. How Julie and I Live with EMFs – An n = 2 Experiment

Our works in progress

What stimulated you to embark on your health journeys?

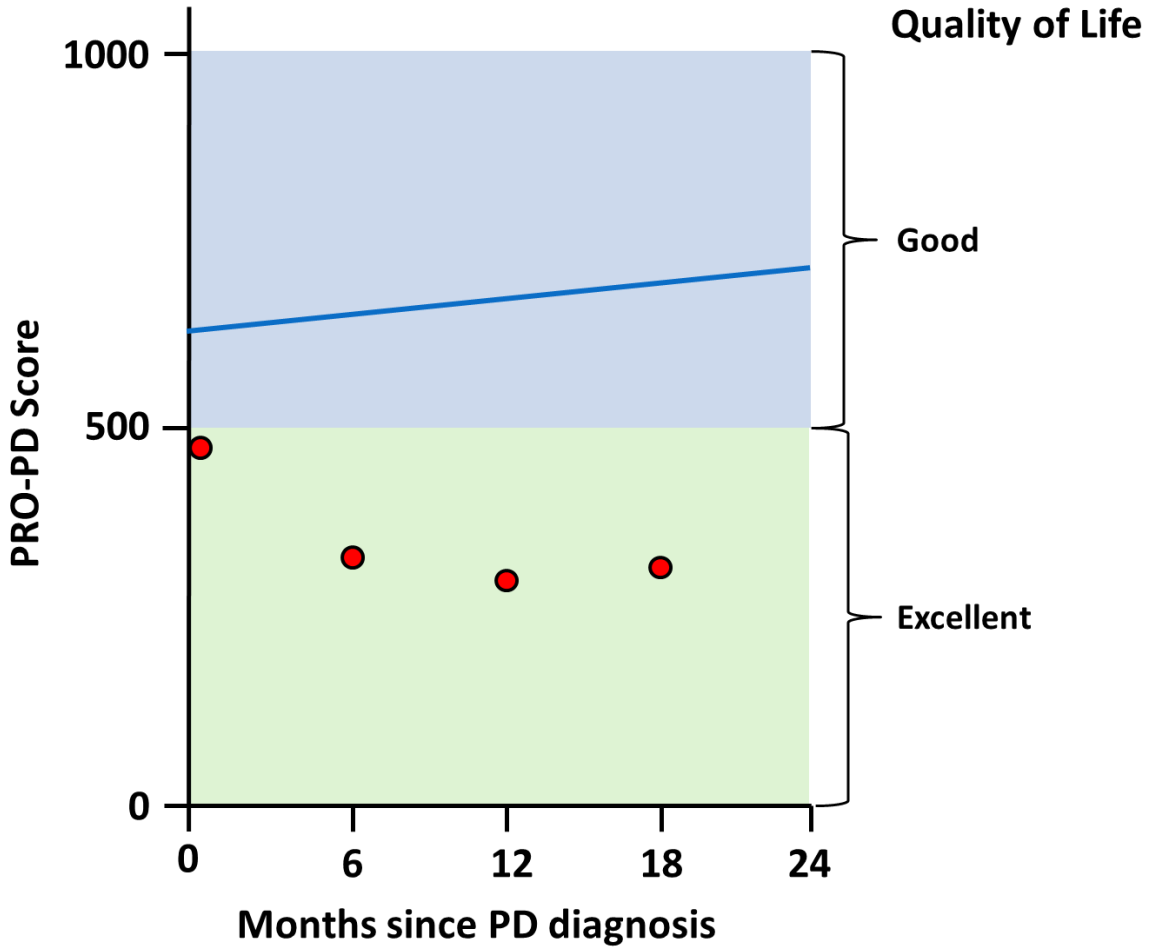
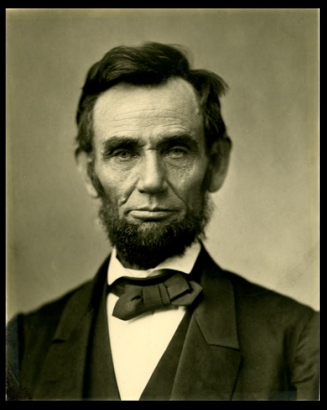


***Figure 19.1**: John Mauremootoo's Parkinson's disease symptom severity (PRO-PD scores) since diagnosis (circles), with average patient values for comparison (line). By John Mauremootoo CC BY-SA 4.0 creativecommons.org/licenses/by-sa/4.0.*

Chapter 20. A World Waiting to be Born – Technology as if People and the Planet Matter

"The dogmas of the quiet past, are inadequate to the stormy present. The occasion is piled high with difficulty, and we must rise with the occasion. As our case is new, so we must think anew and act anew. We must disenthrall ourselves, and then we shall save our country."



~ *From Abraham Lincoln's Annual Message to Congress — Concluding Remarks Washington, D.C. December 1, 1862.*

Individual and collective actions that can bubble up to a larger scale

Research and product development

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

Héroux, P. et al. Cell phone radiation exposure limits and engineering solutions. International Journal of Environmental Research and Public Health. **20** (7), 5398, doi: 10.3390/ijerph20075398 (2023).