



What are EMFs?

Electromagnetic fields (EMFs) are invisible energized waves (radiation) consisting of electric and magnetic fields traveling at the speed of light. Sources include cell towers, cell phones, Wi-Fi and power lines. The wireless revolution is increasing levels of non-ionizing EMF in the environment.

Non-ionizing EMFs Can Impact Health

Wireless and powerline lower frequency EMFs are non-ionizing, meaning they lack the energy to *directly* damage DNA. However, research finds these frequencies can cause biological effects *through indirect mechanisms*, even at exposure levels far below government limits.

The human body relies on internal bioelectricity for nerve signaling, cell communication, and processes like tissue repair. External EMFs can interfere with these delicate activities. All forms of life, from bacteria and plants to animals and humans have been shown to respond to magnetic fields.

EMF Exposure Can Trigger a Biological Cascade

Non-ionizing EMFs have been found to increase oxidative stress. When prolonged, this can trigger inflammation in the brain and body, disrupting healthy function and increasing risk of chronic disease. Accumulated studies have reported a myriad of cellular impacts, as well as associations with cancer, genetic effects, decreased testosterone, sperm damage, memory problems, altered thyroid hormone levels, and harm to animals and plants.

Research is ongoing and hundreds of scientists and medical experts recommend minimizing EMF exposure to reduce health risks.

“Children are disproportionately affected by environmental exposures, including cell phone radiation”

— American Academy of Pediatrics

Artificial EMFs Are Not Natural

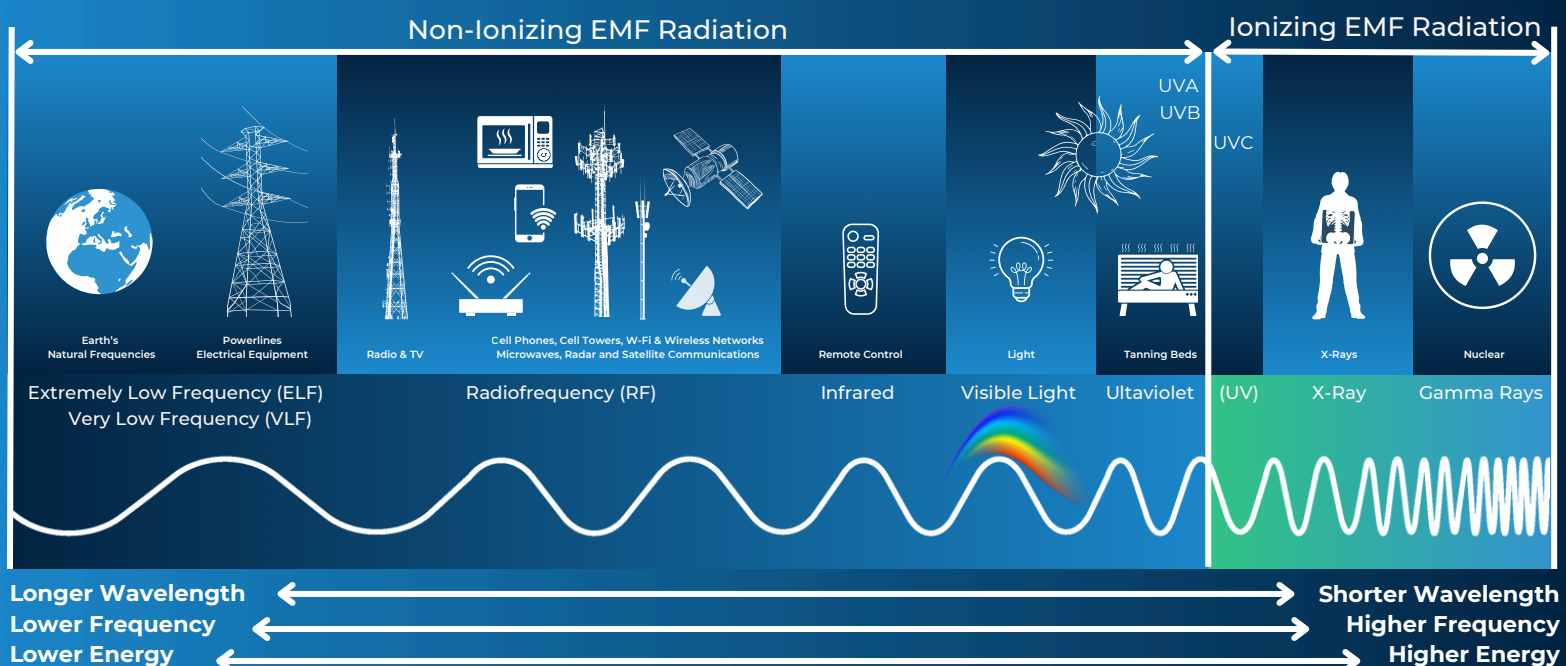
All living things have evolved surrounded by natural EMFs, such as the Earth's magnetic field, sunlight, and cosmic radiation.

Human-made EMFs, emitted from machines, are unlike natural EMFs. They are polarized and usually have repetitive, complex waveforms.

Wireless signals are pulsed and employ sophisticated modulation techniques involving multiple frequencies to transmit data, including ELF components. The waveform is highly variable, and its complex features are among the key parameters that enhance artificial EMFs' biological impacts.

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THE ELECTROMAGNETIC SPECTRUM





THE IONIZING VERSUS NON-IONIZING PARADIGM IS OUTDATED.

Non-ionizing EMFs can impact biology.

Non-ionizing frequencies can impact health. For example, UV radiation from the sun is divided into three frequency bands: UVA, UVB and UVC. Although UVC is ionizing, it does not reach the Earth's surface. By contrast, the sun's non-ionizing UVA and UVB rays penetrate the atmosphere and can damage the skin. The WHO/IARC classifies UVA and UVB as a human carcinogen.

Non-ionizing frequencies are used in medicine and agriculture because they can induce various biological effects.

Although they are non-ionizing, both RF and magnetic field ELF are classified as "possibly carcinogenic to humans" by the World Health Organization (WHO) International Agency for Research on Cancer (IARC) due to studies linking exposure to brain cancer (RF) and childhood leukemia (magnetic field ELF).

WHAT IS A FREQUENCY?



A "frequency" is the number of EMF wave cycles that pass a specific point per second, measured in Hertz.

- **One Hertz** (Hz) one wave per second.
- **One Kilohertz** (kHz) one thousand waves a second.
- **One Megahertz** (MHz) is one million waves per second.
- **One Gigahertz** (GHz) is a billion waves per second.

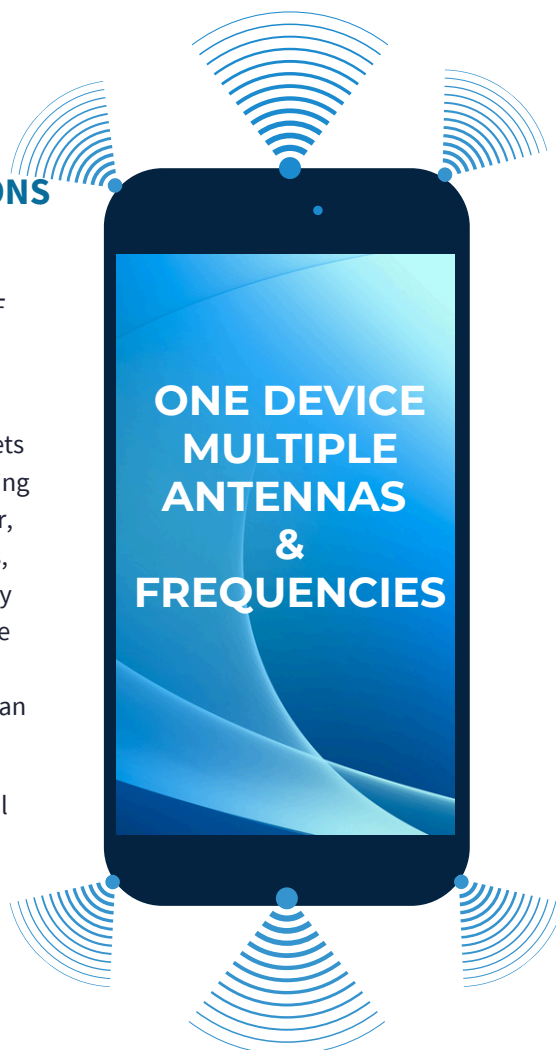
A RANGE OF EMF EMISSIONS FROM ONE DEVICE

People are exposed to numerous EMF frequencies all at once from just one device.

Smartphones and Wi-Fi laptops/tablets can have *at least 5* different RF-emitting antennas to transmit data via Cellular, Wi-Fi, Bluetooth, 4G and 5G networks, each with a different carrier frequency along with lower frequencies from the modulation. Carrier frequencies generally *start* around 450 MHz and can extend past 52 GHz.

In addition, screens emit LED artificial light linked to impacts to sleep and hormones.

The electrical components and charging cords emit magnetic fields and extremely low frequency EMF.



A RANGE OF FREQUENCIES

- LTE** **LTE:** 700 MHz to 2,300 MHz
- Wi-Fi** **Wi-Fi:** 2.45 GHz, 5 GHz and 6 GHz
- 5G** **5G: A wide range of frequencies**
 - Low band (FR1) 450 MHz - 1 GHz
 - Midband (FR1) 1 - 7.1 GHz
 - High Band (FR2) 24 - 71 GHz
- Bluetooth** **Bluetooth:** 2.4 GHz
- Low-Frequency EMF** (from pulsing/modulation)
1 to over 100 kHz
- LED Display** 320 - 790 THz
LEDs flicker in VLF and EMF bands
- Electrical** (battery & charging cord)
50/60 Hz and magnetic fields



Human-made EMFs versus Natural EMFs

Human-made electromagnetic fields: Ion forced-oscillation and voltage-gated ion channel dysfunction, oxidative stress and DNA damage (Review) by Panagopoulos et al. *International Journal of Oncology* (2021).

A mechanistic understanding of human magnetoreception validates the phenomenon of electromagnetic hypersensitivity (EHS) by Henshaw DL, Philips A. *Int J Radiat Biol*.

Oxidative Stress and NADPH Oxidase: Connecting Electromagnetic Fields, Cation Channels and Biological Effects by Georgiou & Margaritis. *International Journal of Molecular Sciences* (2021).

Polarization: A Key Difference between Man-made and Natural Electromagnetic Fields, in regard to Biological Activity by Panagopoulos et al. *Scientific Reports* (2015).

Real versus Simulated Mobile Phone Exposures in Experimental Studies by Panagopoulos et al. *BioMed Research International* (2015).

Biological and Health Effects

Cancer epidemiology update, following the 2011 IARC evaluation of radiofrequency electromagnetic fields (Monograph 102) by Miller et al. *Environmental Research* (2018).

Cellular and molecular effects of non-ionizing electromagnetic fields by Lai & Levitt. *Reviews on Environmental Health* (2023).

Effects of Radiofrequency Electromagnetic Radiation on Neurotransmitters in the Brain by Hu et al. *Frontiers in Public Health* (2021).

Exposure to magnetic fields and childhood leukemia: A systematic review and meta-analysis of case-control and cohort studies by Brabant et al. *Reviews on Environmental Health* (2022).

Health impact of 5G: Current state of knowledge of 5G related carcinogenic and reproductive/developmental hazards as they emerge from epidemiological studies and in vivo experimental studies by Belpoggi on behalf of the European Parliament Directorate-General for Parliamentary Research Services. Publications Office of the European Union (2021).

Immune Responses to Multi-Frequencies of 1.5 GHz and 4.3 GHz Microwave Exposure in Rats: Transcriptomic and Proteomic Analysis by Zhao et al. *International Journal of Molecular Sciences* (2022).

Wireless technologies, non-ionizing electromagnetic fields and children: Identifying and reducing health risks by Davis et al. *Current Problems in Pediatric & Adolescent Health Care* (2023).

Wireless technology is an environmental stressor requiring new understanding and approaches in health care by McCredden et al. *Frontiers in Public Health* (2022).

Planetary electromagnetic pollution: It is time to assess its impact by Bandara & Carpenter. *The Lancet Planetary Health* (2018).

Relationship between radiofrequency-electromagnetic radiation from cellular phones and brain tumor: meta-analyses using various proxies for RF-EMR exposure-outcome assessment by Moon et al. *Environmental Health* (2024).

Thermal and non-thermal health effects of low intensity non-ionizing radiation: An international perspective by Belpomme et al. *Environmental Pollution* (2018).

Effects of non-ionizing electromagnetic fields on flora and fauna, Part 2 impacts: How species interact with natural and man-made EMF by Levitt et al. *Reviews on Environmental Health* (2021).

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“A recent evaluation of 2266 studies (including in-vitro and in-vivo studies in human, animal, and plant experimental systems and population studies) found that most studies (n=1546, 68.2%) have demonstrated significant biological or health effects ...”

-Bandara & Carpenter

The Lancet Planetary Health (2018)

Scientific Call For Stronger Safety Limits

Scientific evidence invalidates health assumptions underlying the FCC and ICNIRP exposure limit determinations for radiofrequency radiation: implications for 5G by the International Commission on the Biological Effects of Electromagnetic Fields. *Environmental Health* (2022).

Some thoughts on the possible health effects of electric and magnetic fields and exposure guidelines by Barnes & Freeman. *Frontiers in Public Health* (2022).

The roles of intensity, exposure duration, and modulation on the biological effects of radiofrequency radiation and exposure guidelines by Lai & Levitt. *Electromagnetic Biology and Medicine* (2022).

Incongruities in recently revised radiofrequency exposure guidelines and standards by Lin. *Environmental Research* (2023).

International Appeal: Scientists call for protection from non-ionizing electromagnetic field exposure by Kelley et al. *European Journal of Oncology* (2015).

Effects of non-ionizing electromagnetic fields on flora and fauna, Part 3. Exposure standards, public policy, laws, and future directions by Levitt et al. *Reviews on Environmental Health* (2021).

Addressing Wildlife Exposure to Radiofrequency Electromagnetic Fields: Time for Action by Froidevaux et al. *Environmental Science & Technology Letters* (2024).