

Health Physics Society  
 Specialists in Radiation Safety

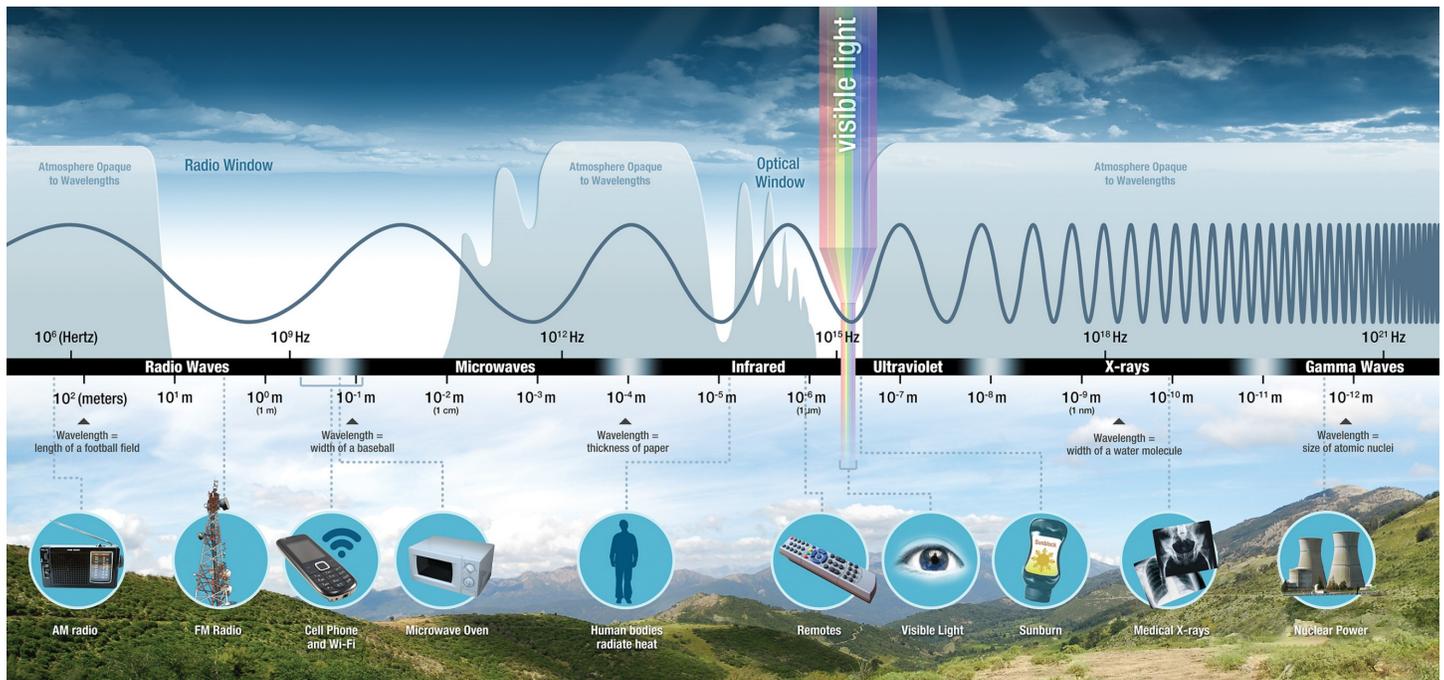
## Cell Phones and 5G Technology

### Introduction

The amazing device in your pocket called a cell phone or mobile phone, whether a flat-screen smart phone or a flip phone with a number pad, uses nonionizing radiation to transmit and receive voice and digital data. Technology tends to become “smarter” and more efficient as iterations of a certain process mature in industry. The 5th generation of mobile phone technology (that is, 5G) is no exception and operates at lower average energy levels than previous technology. To date, no adverse health effects have been established from cell phone use or being in proximity to cell towers.

### What Is Nonionizing Radiation?

Radiation may be classified into two types: nonionizing and ionizing. Put simply, nonionizing radiation differs from ionizing radiation in the way it acts on materials like air, water, and living tissue. Unlike x rays and other forms of ionizing radiation, nonionizing radiation does not have enough energy to remove electrons from atoms and molecules.



Courtesy of NASA

Nonionizing radiation exists all around us from many sources such as the sun, power lines, microwave ovens, radios, wireless fidelity (Wi-Fi) internet routers, cell phones, and cell towers, including 5G. Radiation in this context means energy that propagates through space, such as light from a flashlight. The dividing line between ionizing and nonionizing radiation occurs in the ultraviolet part of the electromagnetic spectrum. Radiation in the ultraviolet band and at lower energies (to the left of ultraviolet) is nonionizing radiation, while at the higher energies to the right of the ultraviolet band it is called ionizing radiation. As we move to the left of the visible light band, we move to lower frequencies and lower

energies and longer wavelengths. By “frequency” we mean how many cycles of the wave occur in a given time—usually expressed in cycles per second or hertz (Hz). The wavelength is the distance between wave peaks. In these lower frequencies on the left side of the electromagnetic spectrum, we find infrared, microwave, and radiofrequency (RF) radiation. Microwaves share their frequencies as part of the RF band, so in this fact sheet, the reference to RF includes frequencies within the microwave band. Familiar devices such as Wi-Fi routers, Bluetooth® systems, and cell phones operate in the RF range.

## ***Health Effects of Radiofrequency Radiation***

To date, no credible evidence of adverse health effects has been established for cell phone use or being in proximity to cell towers. It is well established that excessive exposure to RF energy at *high* power levels is potentially hazardous, principally due to excessive heating of tissue. Hazards include skin burns and other thermal damage to tissue, cataracts, and physiological effects resulting from excessive heat deposition in the body. Cell phones, however, operate at power levels that are *far too low* to result in such thermal hazards.

The question of adverse health effects from cell phones has been studied by scientists and health agencies since the early 1990s. In response to public concerns, industry and governments have supported numerous animal and human studies, and there is now a large amount of relevant scientific literature on the topic. These reports agree that available credible evidence does not show that the use of cell phones or exposure to emissions from their base stations (cell towers) causes brain cancer or any other health effect.

***To date, no adverse health effects have been established from cell phone use or being in proximity to cell towers.***

## ***Safety Standards for Radiofrequency Radiation***

Exposure guidelines have been developed to guard against hazards from excessive exposure to RF energy by a number of reputable organizations. The Institute of Electrical and Electronics Engineers’ most recently revised standard was published in March 2019 (IEEE 2019). The International Commission on Non-Ionizing Radiation Protection guidelines were updated in 2020 (ICNIRP 2020) with information from the World Health Organization, the Scientific Committee on Emerging and Newly Identified Health Risks, and the Swedish Radiation Safety Authority.

In the US, RF exposures are regulated by the Federal Communications Commission (FCC). Current FCC limits date to 1996 (FCC 1997), but in August of 2019, the FCC issued a press release stating that it intends to maintain its current RF exposure safety standards, citing a statement from the director of the US Food and Drug Administration Center for Devices and Radiological Health that the “available scientific evidence to date does not support adverse health effects in humans due to exposures at or under the current limits . . .” (FCC 2019).

## ***5G: What Is It? How Does It Differ From the Other Gs?***

Fifth Generation, or 5G, refers to a set of standards for cellular networks. Networks known as 5G can be significantly faster than those of the past, e.g., 3G or 4G. 5G is improved because it has faster transfer rates and shorter delays. It is essentially the next generation of wireless communications technology. The new 5G technology is not specific to any frequency—it will operate across a wide range of the RF spectrum.

Fifth Generation technology is a jump forward in communications technologies. The uses and implications of the technology are far reaching and will impact medicine, agriculture, transportation, energy, and many other areas. Example applications include medical device control (e.g., cardiac devices or insulin pumps), high-resolution entertainment streaming, video gaming, remote control over aircraft and other vehicles, smart home technology, and augmented reality systems, to name but a few.

## Health Effects of 5G



Courtesy of F. Muhammad from [Pixabay](#)

There are three issues that may concern the public related to exposure from 5G: exposures from base stations, environmental exposures, and exposure from your own phone. Let's look at all three.

First, exposures from base stations. Wireless carriers are legally required to ensure that their stations comply with regulatory limits, which are set with a substantial safety factor to help ensure protection of public health. A recent study determined that each 5G cell tower may result in overall lower radiation fields than those generated by current technologies (Chiaraviglio et al. 2019). The 5G antennas are “smart” in that they use focused beams, each capable of propagating in a different direction. Signals are focused toward specific users, and areas with no users have significantly lower signals. The net effect is that time-averaged exposure levels to the population will be lower than those from current technologies.

Second, environmental exposures. Numerous researchers have examined human exposures to RF radiation in urban areas. Measured exposures were a small fraction of accepted national and international limits. The biggest source of exposure is our own smart phone. Exposures from 5G networks are anticipated to not be very different from those we currently experience from 3G and 4G networks and are likely lower. Exposure levels are expected to remain well below internationally accepted exposure limits and, from a regulatory perspective, must *always* comply with the exposure limits.

Third, exposures from your cell phone and Bluetooth earpiece. Your cell phone is a smart device that attempts to optimize reception by increasing or decreasing power based on the signal it receives from a base station. It emits more RF energy when it is far from a base station. Very little energy is emitted when you have “full bars” of connectivity with the cell tower. The energy emitted by your cell phone is far below that which would create a thermal hazard. Your Bluetooth wireless earpieces emit significantly less RF than your cell phone does; so if you intend to further reduce your RF exposure, use a wireless earpiece or even a wired headset while your phone is in your hand or your pocket.

Another area of expressed concern has been the expanded use of higher frequencies to enable greater speed and data throughput in the deployment of 5G. Although not traditionally used in the past for cell phone use, the biological effects at these frequencies are well known and included in the international standards. As stated earlier, wireless carriers are required to ensure that these exposure safety standards are met regardless of frequency used.



Courtesy of Free-Photos from [Pixabay](#)

### ***Should I Be Worried About 5G or Other RF Exposures?***

The Australian Radiation Protection and Nuclear Safety Agency stated it the most clearly: “There is no established evidence that low level radio wave exposure from 5G and other wireless telecommunications can affect the immune system or cause any other long term or short term health effects” (ARPANSA 2020).

Further, the Committee on Man and Radiation, which is comprised of career professionals who deal with environmental and health issues associated with electromagnetic exposures from across the nonionizing spectrum, concluded that “while we acknowledge gaps in the scientific literature, particularly for exposures at millimeter wave frequencies, the likelihood of yet unknown health hazards at exposure levels within current exposure limits is considered to be very low, if they exist at all” (Bushberg et al. 2020).

## Commonly Asked Questions

Below are some commonly asked questions and answers from experts in the field of nonionizing radiation protection. Still have questions? Check out our [Ask the Experts](#) feature for more on cell phones, RF radiation, and powerline fields.

**Question:** I live and work near cell towers. Should I be concerned about my RF exposure?

**Answer:** The RF levels from cell towers are far below US and other regulatory safety limits. Health agencies have repeatedly studied the large body of scientific literature related to RF fields and health and they consistently conclude that no clear evidence exists that RF exposure levels below international limits produce any adverse health effects, although they all recommend that more research be done. Some individuals have reported nonspecific symptoms such as headaches when they consider themselves to be exposed to RF fields at levels far below safety limits, but controlled studies have failed to link the symptoms to actual RF exposure, as opposed to the belief of an individual that he/she has been exposed. Read the full answers to [Q13181](#) and [Q11223](#) for more information.

**Question:** I am pregnant. Is it safe to use my cell phone?

**Answer:** A cell phone emits electromagnetic radiation of various frequencies at very low intensity and would not affect the development of a fetus, even if the mother placed the cell phone on her abdomen during her pregnancy. The mother's reproductive and developmental risk for her growing embryo would not be altered by these exposures.

**Question:** I am concerned about the nonionizing radiation my four-year-old son gets. He is exposed to Wi-Fi, a giant TV, an iPad, cell phones, and cordless phones and his food is microwaved. I have read that both the pulsing of Wi-Fi and low-frequency nonionizing radiation can be harmful. Is this true?

**Answer:** The kinds of exposures you mentioned (use of tablet computers, cell phones, Wi-Fi, etc.) are entirely ordinary in modern society. While they may involve some exposure to electromagnetic fields including RF energy, the levels of exposure are invariably far below US and major international exposure limits. Additionally, some of the things you mentioned (eating microwaved food, being near a TV) do not entail any noticeable exposure to electromagnetic fields. The known hazards of RF energy are associated with excessive heating of tissue and do not occur with ordinary use of consumer devices. For many years, there has been some level of public concern about health risks from low-level RF exposure. In response, thousands of studies of various description have been conducted during the past half century on biological effects and possible health hazards of RF energy. These have been reviewed by many health agencies, who have consistently failed to find clear evidence of any health hazard from RF exposure below internationally accepted safety limits. Check out the [full answer to Q12067](#) for additional details.

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### ***Resources for More Information***

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The Health Physics Society is a nonprofit scientific professional organization whose mission is excellence in the science and practice of radiation safety. Formed in 1956, the Society has approximately 3,500 scientists, physicians, engineers, lawyers, and other professionals. Activities include encouraging research in radiation science, developing standards, and disseminating radiation safety information. The Society may be contacted at 950 Herndon Parkway, Suite 450, Herndon, VA 20170; phone: 703-790-1745; fax: 703-790-2672; email: [HPS@BurkInc.com](mailto:HPS@BurkInc.com).