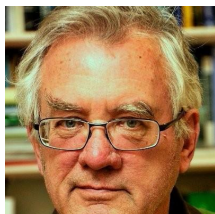


Skin and the 5G Communication System

Expect skin and general health problems



Hugo Schooneveld, PhD — Doctor of Biology (1970), Hugo Schooneveld was a principal investigator, neurobiologist, and comparative insect endocrinologist at Wageningen Agricultural University (1965–1999). He also conducted investigations to assess health problems after exposure to electromagnetic fields (EMFs), evaluated EMF intensity in homes and workplaces, developed analytical tools to study EMF structure and the mixtures of frequencies generated by electronic equipment and energy-saving lamps, and assessed the significance of “dirty electricity” (transient high-frequency interference). Now retired, he serves as an adviser to the Dutch Foundation for Electrohypersensitivity.

Translator's note. This document is an English translation of the French version supplied as “Notre version française de son texte *The 5G communication system – Expect skin and general health problems*.” Numbered citations are retained exactly as they appear in the source. The supplied document contains no bibliography or reference list.

Abstract

In the Netherlands, the first fifth-generation mobile-telephony transmitters were put into service by three telecommunications companies. Their transmitters operate mainly at 700 MHz. In a sense, these are “entry-level 5G” transmitters, without the features of the 3.5 GHz transmitters expected in 2022 and the 26 GHz transmitters that will arrive in 2027 or later. Some people could therefore experience additional problems of electrical stress—in short, electrohypersensitivity (EHS). This would be due not only to chronic 50 Hz synchronization pulses in the signal, but also to the very large number of 3.5 GHz microantennas that must be installed, thereby increasing exposure. The proposed 26 GHz transmitters would increase the risk of skin lesions and disruption of physiological functions due to non-thermal effects. Skin is a large, delicate, thin, and fragile organ. The recently updated exposure limits of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) do not take into account the position and special functions of skin. 5G radiation will produce effects in biological matter, but no one is currently studying the links between these physiological effects and possible health problems. It is time to establish a working group specifically to elucidate the effects of 5G radiation on skin and well-being—and to adjust exposure limits accordingly.

Transmitters and biological effects in order of appearance

In the Netherlands, three Internet providers—KPN, VodafoneZiggo, and T-Mobile—launched their 5G channels after acquiring broadcasting licenses in the auction held on 21 July 2020. These licenses concern frequencies in the 700 MHz band (as well as 1400 and 2100 MHz). Electromagnetic fields (EMFs) at this frequency travel a long distance and penetrate house walls better than those from existing transmitters. The transmitters will initially be installed on existing transmission towers, whether or not they are integrated into 4G systems.

Within a few years, we will have 3.5 GHz systems with limited MIMO (Multiple-Input Multiple-Output), which will be installed mainly in streets and public spaces. These systems will be able to handle many more conversations and data.

Only after several years will the 26 GHz band become operational. These advanced transmitters are equipped with all 5G options¹, such as ultrafast connections for many users simultaneously, with massive MIMO and pulsed microwave beamforming. This will give everyone who registers with a 5G smartphone their own connection, grouped with the transmitter wherever they are. Because of the high frequency and therefore short wavelength, the fields of these transmitters will consist of millimeter waves (mm waves). All 5G systems radiate pulsed fields day and night, at a pulse frequency of 50 (or 60) Hz. Internet providers have never studied the potential health effects and do not intend to do so². Hundreds of scientists have expressed their concerns in the 5G Appeal, addressed to the United Nations, the World Health Organization, and the United Nations Environment Programme³. The reasons for these concerns are listed below.

Health effects—Pulsed fields are generally harmful

People may develop hypersensitivity (allergy) to low-frequency radiation from household appliances or to radiofrequency (RF) radiation from transmitters at home or outdoors, or to both. In many cases, digital electronics are responsible, particularly the switched-mode power supplies in electronic equipment, which produce a pulsed “dirty” waveform on electrical cables. Approximately 3% of citizens have developed hypersensitivity to this, called “electrical hypersensitivity” or electrosensitivity (EHS)^{4,5}.

In addition, several household devices pollute the airwaves with pulsed RF/microwave transmission signals, including digital cordless phones (DECT), Wi-Fi, mobile phones, Bluetooth and Zigbee protocols, and other communication modes. All of these sources of high-frequency EMFs are pathogenic. The remedy is to switch off or remove the equipment, or otherwise move as far away from it as possible⁶.

Transmitters in second- (2G), third- (3G), and fourth-generation (4G) mobile-telephone systems also generate comparable EHS problems among people living near these antennas: chronic fatigue, sleep problems, ringing in the ears, headaches, and many related problems⁷.

These transmission signals are also pulsed. A physical feature of electronic pulses is that the rising and falling edges of the signal, such as those visible on an oscilloscope, are very steep and the pulse duration is very short: from a few to several hundred microseconds.

Some physiological processes in the body are disrupted by these pulses, and the mechanisms involved are not yet agreed upon by experts. One or more functions of the nervous system are presumably affected, although these precise effects have not been further analyzed.

The fields of 5G transmitters are also pulsed at a frequency of 50 (or 60) per second⁸. The arrival of more 5G transmitters will increase electromagnetic pressure on humans. With the planned installation of an unprecedented number of 3.5 GHz transmitters in the form of small cells in streets and picocells in offices, as well as Internet of Things (IoT) applications in homes, the total number of transmitters will rise enormously⁸. We are concerned about the health of many people.

ICNIRP: “The skin must protect the body against millimeter waves.”

Nonsense! Skin is an integral part of the body. Skin receives all mm waves and may be damaged—and, consequently, the inside of the body may also be affected. Mm waves are absorbed by water molecules, which raises the temperature in tissues, just as in a microwave oven. Mm waves penetrate the body to only 1 mm or less and are consequently trapped in water-containing structures in skin, which thus becomes the principal receiver.

The International Commission on Non-Ionizing Radiation Protection (ICNIRP)¹⁰ simply sees skin as a kind of shell that absorbs mm waves and thereby protects the body against their effects. It does not consider skin separately in terms of exposure limits, but as a limb¹¹. The advantage of this reasoning for telecommunications is that radiation intensity can be increased by a factor of 2.5. Whereas ICNIRP tolerates an average increase in body temperature of 2 °C, for a limb the increase may be as much as 5 °C. This undermines the skin by concentrating in it all the radiant energy actually intended for the

body as a whole. Skin is approximately 1 mm thick¹², has an area of up to 2 m², and a mass of 7 kg, representing approximately 10% of body mass¹³. By capturing all incident energy, skin theoretically accumulates ten times more electromagnetic energy than intended. In fact, this would be the case if it had a homogeneous structure. Skin, however, contains layers with hydrophilic or lipophilic properties. Only water-containing structures can absorb mm-wave energy, and these are precisely the layers that are now heavily overloaded. The impacts remain to be defined.

Skin, a large and delicate organ

Skin is a metabolically active organ with a highly complex structure and performs numerous organic¹⁴, endocrine, and immunological functions. It contains a range of receptors, including many unmyelinated (not protected by insulating myelin) free nerve endings, with neuroactive substances, cytokines, and other regulatory compounds. The exact functions of all these components have been only partially clarified. Given the vulnerability of all these components to EMFs, and to mm waves in particular, effects on the health of skin and the body are a concern¹⁶.

Skin morphology

Figure 1 below shows the layered structure of skin, with the outermost stratum corneum consisting of dead cells. Mm waves may be partially reflected by this layer, depending on its moisture content. Beneath it is the layer of epithelial cells forming the body of the epidermis, the keratinocytes. Underneath, the dermis is the largest part of skin and contains many structures, such as blood vessels; sweat glands with ducts; muscle fibers; branches of the nervous system, often containing many types of sensors for neuroactive signaling substances; sensory cells; and hair. It also contains various freely moving cell types, such as leukocytes, macrophages, and cells of the immune system. At the base is the hypodermis, associated with a basement membrane and muscle layers.

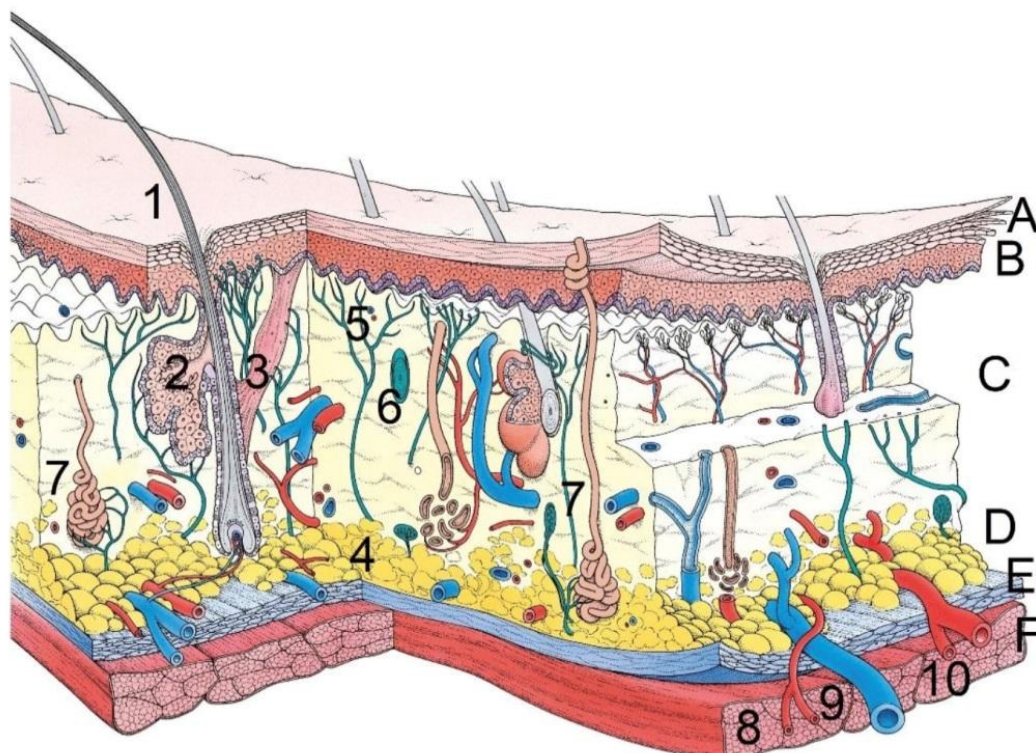


Figure 1. Schematic representation of a cross-section of skin. Layers: A—stratum corneum; B—epidermis; C—dermis; D—hypodermis; E—basement membrane; F—muscle layer. Complete components with innervation and blood supply: 1—hair; 2—hair follicle; 3—muscle; 4—adipose tissue; 5—branched free nerve endings; 6—macrophage; 7—sweat gland with a drainage duct spiraling toward the exterior; 8—muscle layer; 9—vein; 10—artery. Source: Alamy Stock Photo.

Functions of skin

Skin is not merely the target organ of the nervous and neurohormonal systems; above all, it is a rich source of several types of hormones and immunoactive substances¹⁷. Skin can be regarded as a semi-autonomous peripheral organ that protects the rest of the body against damage caused by mechanical forces, dehydration, heat, and cold. In addition, it is equipped with several types of senses and sensors for monitoring relevant environmental factors.

Skin has a dense peripheral nerve network for communication with the central nervous system, both upstream and downstream. Communication also occurs through the bloodstream and signaling substances of the immune system. Every “experience” is “noticed” and will lead to compensatory responses that maintain homeostasis.

Thermal effects of 26 GHz 5G waves

Elongated structures in skin act as receiving antennas for millimeter-wave radiation¹⁸. These may be blood vessels, fluid-filled intercellular spaces, and, in particular, the drainage ducts of sweat glands. The helical end of these ducts, filled with conductive sweat, is ideally suited¹⁹ as a microwave antenna. These ducts may therefore be expected to overheat, damaging the cell itself and the surrounding tissue.

This would be even worse in some locations because biological structures are not homogeneous conducting masses. In a model approach using dead bovine brains, the first millimeter of brain tissue was heated to 35 °C after 30 minutes of irradiation with a 39 GHz field²⁰. This heating was approximately 175 times greater than with a 1.9 GHz field and was explained by the microarchitecture of brain tissue. Obviously, the meninges are not skin, and there is greater uncertainty in the assumptions used. Nevertheless, this illustrates the excessive simplification of ICNIRP principles. Heating is treated as a simple process of heat diffusion; in reality, heat diffusion differs in complex composite tissue layers.

Non-thermal tissue effects of millimeter waves

The non-thermal effects of waves are biologically important. They include, among other things, physical effects on the structure of biomolecules and changes in the function of biological processes in which temperature plays no role²¹. These non-thermal effects occur at field densities well below ICNIRP exposure limits²².

Neurological effects

There are several examples of the non-thermal stimulatory influence of mm waves on the activity of nerve and brain tissue. It is not the cell bodies of spinal-cord neurons that are sensitive to wave disturbances. Rather, it is the “bare” portions of nerve processes—dendrites and neurites/axons—that are not partly surrounded by insulating glial sheaths. “Bare” nerves in the mouse paw respond to mm-wave stimulation with a decrease in spontaneous spike activity. This is due to a further decrease in the negative potential of the cell membrane, making it less sensitive to stimulus transmission²³.

In an in-vitro culture of neurons taken from a thin slice of rat cerebral cortex, neuronal activity could likewise be suppressed by mm-wave irradiation. This result required a precisely adjusted dose: a stimulation strength that was too low or too high had a suboptimal effect. This is due to the complexity of the neuronal network in this tissue sample. The most effective stimulation-field intensity was orders of magnitude below the thermal limit for this frequency range²⁴.

The stimulation frequency is also important because it can induce frequency-dependent resonances in the bare axonal membrane. Elastic membrane displacements occur there, and consequently the membrane ion gates can no longer propagate optimally across the lipid membrane and function as an ion channel²⁵.

Molecular effects

Many molecular and cellular effects have been found following exposure to mm waves in the upper-GHz range. In the former Soviet Union, extensive research on this subject was already conducted during the last century. Several health problems were reportedly treated successfully in this way^{30,31}. Mm waves have also been shown to be effective for cancer treatment³², but in the Western world the publications—mostly Russian—have never attracted much attention.

In searching for the effects of mm waves on humans, Dariusz Leszczynski³³ found only 99 articles in biological databases, of which only 11 concerned humans. There is still no clear picture of the principal physicochemical or molecular effects of mm waves on any biological material. Effects on mucosal cells, fibroblasts, keratinocytes, lymphocytes, and melanocytes have been found in human cells in vitro. There was considerable variability in the effects on different skin types and between individuals. Health status also affects the strength of the effects.

Effects of mm waves have been found on gene expression, chromosome breaks, oxidative stress, immunological processes, genotoxicity, and inflammation, among other endpoints. It is often said that mm-wave energy would be too weak to influence biochemical interactions. However, resonances with cellular structures or charged biomolecular groups could explain mm-wave effects, including disruption of hydrogen bonds or influences on van der Waals forces³⁴.

Structural change in biomolecules

The prevailing view is that EMFs can generate resonances in charged chemical groups at the surface of macromolecules, such as proteins. Because of configurational changes, connections between the protein and the substrate may or may not occur. This applies to all types of receptors and voltage-gated calcium ion channels³⁵. Charged groups on the proteins of ion gates may undergo a conformational change because of alternating electric fields, changing the permeability of calcium channels. The same applies to ion gates for other types of ions³⁶. An uncontrolled influx of ions can disrupt cell or organ function—and therefore the organism as a whole.

Effects on the genome

Most experiments with mm waves have been conducted in recent years and are summarized by reference 26. Research has concerned effects on biomolecules, cellular membrane potentials, ion gates, and cell division²⁷ in animals. Effects have also been observed on gene expression, transcription, protein shape, oxidative stress, immune reactions, and other functions²⁹. Long-term exposure to 35 GHz fields produces both thermal stress and inflammation of the skin³². Irradiation of rats with radiofrequency fields from a digital enhanced cordless telephone (DECT) or a smartphone produces major changes in protein configuration in the mouse brain³⁹. In addition, irradiating human skin for one hour with 900 MHz fields from a GSM telephone at a specific absorption rate of 1.3 W/kg produced a change in the synthesis of eight proteins⁴⁰. These observations indicate that radiofrequency fields modify DNA and RNA expression²⁸.

More research is needed—but what kind?

Previous experiments have been conducted with mm waves at very different frequencies and intensities, but none contained the precise frequency and data modulation of the 5G waves currently in use. In addition, tests were often conducted with field intensities far above ICNIRP limits, which we consider too high. We must repeat the experiments using the current field parameters encountered in daily life, while 5G systems are being implemented rapidly³⁷.

What type of research is needed?

We are looking for “targets” of EMF impact on the body^{1,28}. There is clearly damage to cells and DNA, but its importance for the development of health problems remains unknown. Some claim that the increased incidence of melanoma in Sweden is the result of increased tissue damage caused by radiofrequency radiation⁴¹. In the Netherlands, there has been a spectacular increase in the number of skin cancers of the basal-cell carcinoma type in recent years, particularly in the head and neck region⁴². This is entirely speculative, but could there be a connection with excessive exposure of patients to 4G mobile-phone fields? What should then be expected from the high densities of 5G waves?

Fundamental biological studies on disruption of physiological processes are indispensable, but well-designed epidemiological studies are also necessary. A report by the European Parliament supports this need¹⁵. Despite the European Union’s acceptance of the precautionary principle³⁸, there is no indication that initiatives for new research have been announced.