

# Is the Legacy of 5G Side Lining the Effects of its Electromagnetic Radiation on Living Kind and Planet Earth?

Mamatha Shankarappa  
 Department of Information Technology  
 Ambo University

**ABSTRACT:** Communication has become a basic human need so are the modern communication technologies. Definitely they will play a vital role in sustaining our future. 5G is the next step in the evolution of a cellular communication with a far better features comparing to its descendent generations. 5G promises to support at least 100 billion devices to get connected around the world & is expected to be even ten to hundred times faster than 4G with download speed of 10 Gb per second. As the Scientists and public health experts are bothering about the lightning speed of 5G without fully understanding its health effects, through this article an effort is been made to explore the radio frequency & EMF effects on human body & the kais it creates in our living environment. As end users, we are supposed to know that all cell phones & cellular towers emit non ionizing radio frequency energy & 5G is not excluded from this rather it will emit much more to fulfil its extended features.

**KEY WORDS:** 5G, EMF, RF & EMR, millimetre microwave & Health hazards.

## I. INTRODUCTION

BioInitiative reports that human beings are bio-electrical systems & any exposure to artificial EMFs in the environment can interact with biological processes in human body. In 2011, International Agency for Research on Cancer (IARC) part of the World Health Organisation (WHO) has classified [13-19] the cell phone radiations as a possible class 2B human carcinogen (cancer-causing agent) based on the increased risk for glioma, a malignant type of brain cancer associated with wireless phone use[2]. More recently the \$25 million National Toxicology Program concluded that radio frequency radiation of the type currently used by cell phones can cause cancer [21]. Another research by Martin Blank Ph.D says via cellular stress responses, Electro Magnetic Force (EMF) can damage to the biological cells & DNA[15]. It is also observed as it disrupt the blood-brain barrier(BBB). This could pose high health risk to the living kind & more harm to the environment letting the world to live inside an electromagnetic cage [19].

5G promises to support connectivity to a wide range of new applications & use cases starting from homes to smart homes, schools, workplaces, cities, open spaces & also traffic safety, critical infrastructure, Industry processes & very high media delivery by utilising the features of IOT[18] leading to challenge of spectra scarcity.

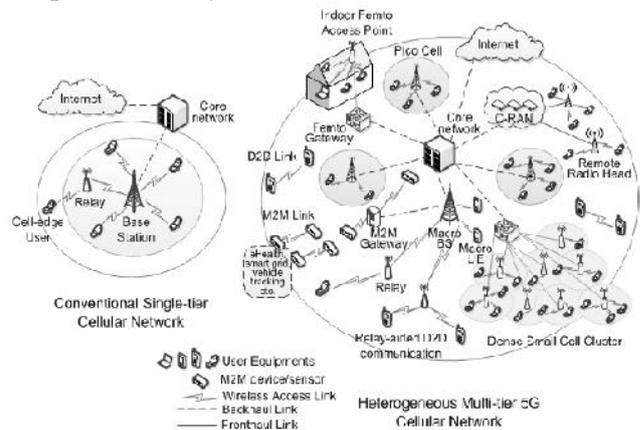


Figure.1 An illustration of conventional and 5G cellular wireless network [22].

5G implements these features by deploying many more radios very densely in cities, towns & extending it to rural areas as well unlike the previous generations as shown in Fig.1 [22]. To achieve this 5G will use higher frequency bands than previously thought possible which are untested frequencies of 24 to 100 GHz or more[6][10]. Federal communication commission (FCC) has set to be approved these frequencies.

Cell phone as of now uses non-ionic radio waves that falls between FM radio & microwaves for communication. Radio frequency [RF] or radio wave is a form of electromagnetic radiation (EMR) which is emitted & absorbed by charged particles including cell phones [13]. EMR is of two types, ionic & non-ionic. The non-ionic radiations [17] don't have enough energy to damage the DNA structure directly & cause cancer unlike ionic radiations such as X-

rays, gamma rays and ultraviolet (UV) rays which have an ability to break the DNA's chemical Bond.

A well-known biological effect of RF is heating which is in line with the food cooked in microwave ovens. The RF is used even to heat or cook food. When the cell phone is held near to the ear, head or hands of our body, the biological cells & tissues nearby exposes to RF causing the surrounding area to be heated up but this heat is not sufficient to increase the whole body's temperature.

The amount of RF energy absorbed by the user's body from the cell phone is known as Specific Absorption Rate(SAR). It varies from phone to phone, models to manufacturers & country to country. The upper limit of SAR in USA is 1.6 W/kg of the body weight [17]. However FCC says, comparing SAR is misleading since the value is based on the cell phone operating at its highest power, not on the user's normal usage. 5G is also planning to use new frequency band of spectrum below 6Hz, as well as higher spectrum of 100 GHz[18]. They have not been tested properly for their effects on human health & this brings more concerns.

The densification of heterogeneous networks is the core feature of 5G. It is implemented using more sophisticated new technologies like Device to Device(D2D), Machine to Machine(M2M), Cloud Radio Access Network(C-RAN), Massive MIMO, millimeterWave to serve trillions of devices. It will definitely dump us into an electrosmog [21] as the biological & environmental hazards of these legacy technologies are not thoroughly observed. EMF pioneer and Nobel prize nominee Dr. Robert Becker says

*"The greatest polluting element in the earth's environment is the proliferation of electromagnetic fields."*

The current researches up to now have concluded that the cell phones & cellular towers are carcinogenic. The intake of carcinogen is causing endless side effects on the human body causing cardiovascular, dermal, developmental & immunological disorders, a few to be mentioned [13].



Figure.2 : cell phones radiation linking to the brain

Another group of studies as in Fig.2 demonstrated the brain tumors linking to radio frequency especially in case of children. A particular study at Orebro Hospital, Swedan identified 290% increased risk of brain tumor in case of children who have used cell phone for ten years & more [13].

## II. ELECTROMAGNETIC RADIATION AND ITS SIDE EFFECTS

### A. ELECTROMAGNETIC RADIATIONS:

Electromagnetic radiation is a range of radio frequency from 30KHz to 300 GHz. These radio frequency (RF) electromagnetic fields(EMF) are used in telecommunication applications like radio, television & cell phone transmissions. It is this frequency which determines the energy of electromagnetic radiation. Electromagnetic spectrum used for various purposes are shown in Fig-3

### THE ELECTROMAGNETIC SPECTRUM

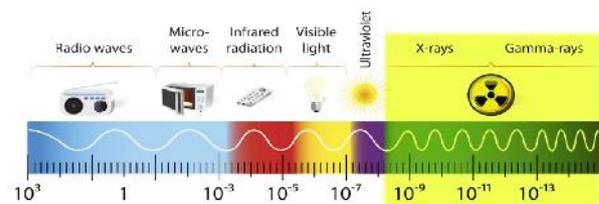


Figure.3: An illustration of electromagnetic spectrum

As discussed earlier, the high frequency has high energy, it is grouped under ionising radiations where as low frequency has low energy & grouped as non-ionising radiations [16]. Mainly human body being bioelectric, it absorbs energy from devices which emits radio frequency electromagnetic radiations. The amount of energy the human body absorbs is estimated by SAR Watts/kg of body weight [16]. However 3% to 5% of the population has electrical sensitivity[9]. They will have clear reaction to EMF. William Rea, MD Director of the Environmental Health Center, Dallas, Past President of American Academy of Environmental Medicine says, *"Sensitivity to electromagnetic radiation is the emerging health problem of the 21st century."*

### B. RF & OUR BRAIN:

As per FCC exposure guidelines RF is a non-ionising type of radiation unable to break chemical bonds of DNA & also not able to produce enough heat to damage tissue irrespective of some studies

showing, in hotspots the temperature goes as high as 6 degrees & the absorption of RF is not uniform [15]. However RF can cause other damages as per many researches. Jerry Phillips, Ph.D., a biochemist and Director of the Excel Science Center at the University of Colorado explained in his recent interview with Scientific American, how living cells react to RF radiation [15]:

*"The signal couples with those cells, although nobody really knows what the nature of that coupling is. Some effects of that reaction can be things like movement of calcium across membranes, the production of free radicals or a change in the expression of genes in the cell.*

*Suddenly important proteins are being expressed at times and places and in amounts that they shouldn't be, and that has a dramatic effect on the function of the cells. And some of these changes are consistent with what's seen when cells undergo conversion from normal to malignant."*

It is clear from the fact that the body being bioelectric, chances of biological damage are expected. To start with, our body uses electrons to communicate. It is also made up of biological cells. Inside every biological cell, a power plant called mitochondria is present. This mitochondria is severely impacted by electromagnetic fields causing cellular dysfunction [15].

According to Dr. Keith Black, Chairman of Neurology at Cedars-Sinai Medical Center in Los Angeles [14]:

*What microwave radiation does in most simplistic terms is similar to what happens to food in microwaves, essentially cooking the brain. So in addition to leading to a development of cancer and tumors, there could be a whole host of other effects like cognitive memory function, since the memory temporal lobes are where we hold our cell phones.*

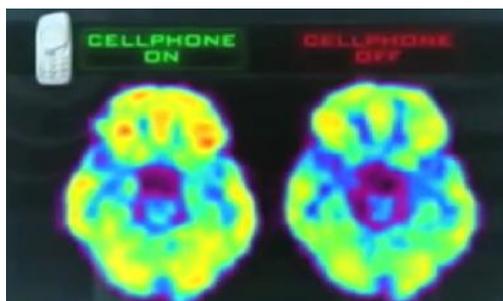


Figure.4: PET Scan showing changes in the upper part of brain when it is closer to cell phone antenna.

A study published in the Journal of the American Medical Association funded by U.S government says using positron emission tomography or PET scan, it is possible to determine the change in glucose levels. It says cell phone radiations can trigger brain cells to metabolize glucose at an increased rate but the effect of increase in glucose metabolism is unknown [15]. It indicates that the cell phone radiation has remarkable influence on brain. Each time when the cell phone is placed to the ear, the brain is artificially activated as seen in Figure-4.

According to Indian Thermal Analysis Society study by Dr. Girish, it is not safe to keep the human body for more than 19 minutes in a microwave oven of 700-1000W. He relates this observation to emphasise people not to use cell phones for more than 19 minutes at a time & also People using cell phones to a particular brain side have more risk of damaging that side of the brain, leading to complex disorders that may or may not be reversible. The brain in the right side of the figure.5 is damaged.



Figure.5 Cross-section of brain from controlled group & exposed group related to albumin [14].

Another important concern from 1975 is on the Blood-Brain Barrier(BBB). It is a membrane which prevents the toxic materials entering the brain. Two minutes of exposure to EMR causes the BBB to leak. It increases the BBB permeability [9].

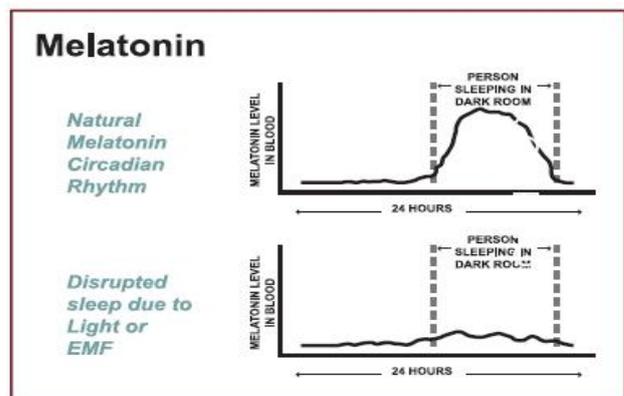


Figure.6: variation of Melatonin when exposed to EMF

An extensive research has been conducted on the effects of EMFs on melatonin hormone. Melatonin is secreted by the pineal gland which is located in the centre of the brain. It controls the sleeping & waking up cycles, it enhances immune system, lowers cholesterol & blood pressure. It also plays a major role in producing antioxidant to prevent cancer, Alzheimer, Parkinson's & other diseases. EMF exposure can shut down melatonin secretion in the body as seen in Figure-6 according to the recent study.

Another important concern is effect of new frequencies (5G) on our skin, as the human body has millions of sweat ducts. Dr. Ben-Ishai of Hebrew University, Israel expressed as, our sweat ducts will act like an array of helical antennae when exposed to these new (5G) wavelengths. We become more conductive. This is supported by another study in New York experimented with 60 GHz stating [21]

*the analyses of penetration depth show that more than 90% of the transmitted power is absorbed in epidermis & dermis layer*

A well-known study on rats also has shown a prolonged exposure to electromagnetic radiations leading to severe brain damage.

### C. EXISTING CELLULAR TOWERS (BTS) & THEIR EFFECTS

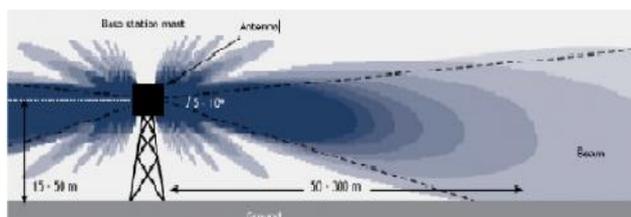


Figure.7 Sensitive distance from the cellular tower (BTS).

People living nearby cellular towers are exposed to high electromagnetic radiations constantly & affected by alterations in the functioning of biological cells & tissues. They are also at higher risk in acquiring radiation diseases. In one of the case study conducted by Indian Thermal Analysis Society (ITAS), three cancer cases were found in the same building that lies opposite to a cell phone tower [14]. The damage to the brain & risk increases with more number of cell phone companies sharing single tower as per ITAS.

However based on different case studies, ITAS concluded that the health risk due to electromagnetic radiations is higher for those people who live within

the radius of 50 to 300 meters as shown in Fig-7. This conclusion is made based on the fact that the acceptable standard of radiation is 9.2Watt per square meter in India. The danger zone differs from country to country based on their acceptable standard of radiation. 580-1000 Micro-Watts per square centimetre for USA which translates, people who live around 2 to 2.5 miles are at a higher health risk [14].

According to Building Biology Institute of Germany, anything above 10 Micro Watt per square meters should be a matter of concern because it will affect biological cells of all living kind including plants, animals & humans. It is considered to be even severe when the tower emits 10 Micro Watts per square centimetre.

When it comes to 5G, to provide the highest speed possible it is planning to use untapped frequencies like millimetre wave (mmW) of 30 GHz to 300 GHz including some lower & mid-range frequencies. mmW tend to be absorbed by rain & plants, doesn't pass through buildings properly. As it is high frequency with shorter wavelengths, it cannot travel for long. This will be dealt by adding more cell stations at shorter distances meaning wireless antenna might be existing almost everywhere on lamp post, Utility pole, home, shop, office & entire neighbourhood in all towns & cities. The whole place will be polluted with electromagnetic radiations, creating an 'electrosmog'.

### III. MAJOR HEALTH HAZARDS

There exists a deficiency of expert consensus on biological effects of cellular radiations with respect to its significance & credibility [1]. As of now it remained as a debate in various electronic media.

It has been observed with substantial evidences about the major health problems among the people who are living near to the cellular towers viz., cancers, Tumors a particular Gliomas, Dry eye, fatigue, stress disorders, muscle problems & damage to the brain depending upon the number of cell companies using a single tower[2][3] [14].

However people may suffer from the following health problems due to variations in the electrical activities of brain due to constant cell phone use [14]:

- Seizures
- Paralysis

-Stroke

-Psychosis

-Cardiovascular problems

Thousands of studies link low-level wireless radio frequency radiation exposures to a long list of adverse biological effects, including [21]:

- DNA single and double strand breaks
- oxidative damage
- disruption of cell metabolism
- increased blood brain barrier permeability
- melatonin reduction
- disruption to brain glucose metabolism
- generation of stress proteins

Among other major problems that have been linked to excessive cell phone usage are Damaged blood vessels that translate to loss of protection to brain, Sleep disorders, Irreversible fertility, Hearing loss due to overheating of ear drums, Damage to red blood cells – slowing down blood circulation and thereby exposure to other diseases.

Horrible health effects were observed by millimetre microwave (mmW). It is not only worsening the human health but also eliminating the pollinators as per the studies related to Bee & Microwave Radiation, the bees are going to extent very soon.

#### A. EFFECTS ON THE SKIN:

Skin problems as shown in Fig.8 are mainly caused by overheating of cells. It includes rashes, sores, and even skin tumours rarely.



Figure.8: Skin rashes & sores due to overheating of cells

In a recent study by Dr. Yael Stein of Hebrew University, Isreil, a newly planned to use mmW technology can even cause physical pain to our skin as our nociceptors flare up on exposure to the mmW & recognises it as a damaging stimuli. This can even lead to the extent of many skin diseases including skin cancer after prolonged exposure[21].

#### B. EFFECT ON THE EYES

Lens opacity linked to cataracts was found on rats exposed to mmW in 1994 study. The Medical Research Institute of Kanazawa Medical University found through an experiment that 60GHz mmW antennas can cause various types of thermal injuries. The thermal effect of mmW can gradually penetrate below the surface of the eyes [21].

After eight hours of exposure to microwave radiation the epithelial cells of rabbits were damaged in a study conducted by chinese in 2003& the EMF of cell phone has caused the de-arrangement of retinal differentiation in chicken embryo as per the study conducted by physicians & surgeons in 2009 at Pakistan college [21].



Figure.9: Our bodies and eyes aren't designed for modern digital lifestyles and workplaces[23].

The most recent study by world Economic Forum shown in Fig.9 reports about the digital eye strain caused due to the blue light emitted by the screens of smart phones, tablets and even desktops. The symptoms of digital eye strains are blurred vision, dry eyes, headache, neck & back pain[23].

#### C. CELL PHONE & CANCER

In 2011 the World Health Organization (WHO) classified radio frequency radiation as a possible group B carcinogen meaning something which causes cancer or helps cancer growth. The Recent \$25 million National Toxicology Program concluded that radio frequency radiation of the type currently used by cell phones can cause cancer.

The risk is more among the children as they have smaller brains, lower skull bone density, less effective blood brain barrier & more connective tissue making them capable of absorbing up to 3 times more than an adult.

In animal studies the cause of cancer & chemical carcinogenic effects are significantly found. Currently the National Institute of Environmental Health Sciences (NIEHS), which is part of the National Institutes of Health (NIH) is carrying a

voluminous study on rodents in highly specialized labs that can specify and control sources of radiation and measure their effects.

However many epidemiologic studies already exists to support the association of cell phone with cancer. Interphone, a case-control study, the Danish Study, a cohort study, the Million Women Study & another cohort study are popular among them.

#### D. OTHER EFFECTS ON HUMAN BODY

The environmentalists along with health experts are now trying to create awareness about the harmful effects of low frequency EMR. This has initiated a lot of research institutions to choose these effects as an issue in their research areas. It includes the study related to the effects of radiation on different parts & aspects of the human body including the heart, the immune systems, the cell growth rates & the bacteria resistance.

A recent Armenian study suggested mmW has serious effect on water, cell plasma & genome. They have found that bacteria on interaction with MMW have altered their sensitivity especially with respect to antibiotic. The combination of antibiotic & mmW showed antibiotic resistance in bacteria. Hence the concern here is human health. We will develop low resistance to bacteria as our cells become more vulnerable.

In reality these experiments are done on other animals mainly on mice. Later the results are correlated with the human body as live experiment on human body is not possible.

### IV AWARENESS

#### A. FACTS :

We shouldn't forget about things which are seen in Fig-9 were once told as safe by the health agencies are no more considered to be in the safe list anymore.



Figure.9 : cigarettes, asbestos & gasoline.

The fact is it took the health agencies & governments nearly 200 years to put label on

cigarettes stating they are harmful & during this time, they released many studies which said there is no link between cigarettes & cancer.

When we consider a recent study by the National Toxicology Program which has concluded that wireless radiation causes cancer, 70% of non-industry studies support the research & assess RF as harmful but when it comes to industry sponsored researches only 32% accept it [10]. Irrespective of percentage of acceptance, it is clear from the study that RF is harmful & it is ignored due to corporate interests. Corporate giants rather care about the revenue by ignoring the threat & putting the public at risk.

Companies do acknowledge the litigation related to the health effects due to cell phones & RF transmitters. They do accept the adverse health effects of RF & threat to cancer. In Washington D.C., Nokia is facing 19 separate cases related to brain tumour caused by EMR. The lawsuit is asking to manipulate the emission guidelines for testing [10].

#### B. VOICES AGAINST 5G & EMR:

The educated environment concerned community & health experts who already have enough knowledge on the bane of EMR are trying to bring an awareness among the public & research groups since the new technologies which are going to be implemented by 5G have not been properly tested for living kind & the atmosphere. Prof. Girish Kumar, Professor at Electrical Engineering Department at IIT Bombay says

*“Along with the 5G there is another thing coming – Internet of Things. If you look at it combined the radiation level is going to increase tremendously and yet the industry is very excited about it... they project 5G/IoT business to be a \$7 trillion business.”*

When such a valuable new technology is made available to people, the same amount of health concerns are expected from the corporates without any bias. Prof. Trevor Marshall, Director Autoimmunity Research Foundation, California says

*“The new 5G wireless technology involves millimeter waves (extremely high frequencies) producing photons of much greater energy than even 4G and WiFi. Allowing this technology to be used without proving its safety is reckless in the extreme, as the millimeter waves are known to have a profound effect on all parts of the human body.”*

It shouldn't become a corporate lobby to entertain only big revenues and profits compromising our own safety & dis-respecting the creatures of our planet earth. According to, Dr. Martin Pall, professor emeritus of biochemistry and basic medical sciences at Washington State University,

*"We're clearly at a point where we can confidently debunk the industry's argument of more than 20 years that there cannot be a biological mechanism of action from these low-intensity EMFs. According to industry, the forces electromagnetic fields place on electrically charged groups in the cell are too weak to produce biological effects."*

Many research & academia personalities have expressed their opinions based on their existing scientific & technical knowledge, exposure as well as the research they have under taken.



Figure.10 : CNN talk show on cell phone risk

Finally common people are becoming alert now due to electronic media as in the Fig-10. A good awareness is been created among the public through this kind educative programs. There are some social groups on online as well including the subject experts & interest groups who come up with good discussions.

## V PRECAUTIONS & SUGGESTIONS

Dr. Girish of ITAS says a human body can be safely kept in a microwave oven of 700-1000W for only 19 minutes[14]. This means that,

*"People can carry on a cell phone conversation only for 19 minutes at a time without harming themselves."*

### A. VOLTAGE-GATED CALCIUM CHANNEL (VGCC):

Recently, Dr. Martin Pall, has proved low intensity EMF's emitted by cell phones & wireless devices including wireless infrastructure are a primary mechanism for biological dysfunction by building a

case of Voltage-Gated Calcium Channel (VGCC) [15]. He explains by activating VGCC in cells, long reported association between electromagnetic fields & a wide range of biological effects including health effects like neuropsychiatric, hormonal & cardiac effects, chromosomal breaks, lowered fertility, oxidative stress, changes in calcium signalling, cellular DNA damage, break down of blood brain barrier, melatonin depletion & cancer can be studied

### B. CALLS FOR REVISED STANDARDS & REGULATIONS IN CELL PHONES & 5G

In September 2016, a letter with supporting documents, regarding the 5G harm was submitted to FCC by the Global Union Against Radiation Deployment from Space (GUARD). It warned FCC that 5G violates Article 3 of The UN Declaration of Human Rights which states that [21]

*"everyone has the right to life, liberty and security of person."*

A well-known proponent Devra Davis, Ph.D an epidemiologist & author of the book, 'Disconnect' is one among to ask for revised cell phone standards & regulations. Davis emphasises that the current standards set by FCC does not apply to the large scale of population in an article to STAT.

On 27 May 2016, she insists FCC to revise the standard for an average person. It is designed for SAM or Standard Anthropomorphic Man who is larger than an average person, ranked as 10 percent more than all military recruits in 1989 weighing 200 pounds with 11 pound head & 6.2 feet height. He assumed to be less talkative & not used the cell phone for more than 6 minutes.

Camilla Rees from ElectromagneticHealth.org says FCC is enforcing its own thermal guidelines. She says FCC SAR limits are focusing more on potential heating effects by side lining the low intensity biological effects which are equally important.

However some of the precautionary measures to the current situation may include[19]

1. It is necessary to acquire sufficient knowledge about the different types of EMFs & their effects even as a common person
2. Obtain the readings of EMF using EMF meter in your surrounding & identify the hotspot.
3. Mitigate your exposure either by eliminating the source or being away from radiation. Shield your body properly when the exposure is inevitable.

However all the above said points still holds good for 5G except for the fact that the current EMF meters are not designed to measure frequencies of mmW as Alasdair Philips, a researcher from Powerwatch stated by the next three years, RF meters may cover the frequency ranges of proposed 5G.

### C. SUGGESTIONS

The demands of speed, sophistication, coverage & comforts of communication are going to be fulfilled in 5G by dumping all of us in to a global electromagnetic cage. There will be no place left in the future without EMR irrespective of our need to communication. 5G is going to put us in a state of inevitability. Unless a proper safety measures are invented either through natural or technical means, living kind is at risk.

A lot of new integrative programs & courses need to be embedded into the Universities in partnership with corporates & research institutions who are in the same field, with proper infrastructure emphasising on necessary core researches considering safety measures as a priority under the guidance of International Telecommunication Union (ITU). Even though developed countries like Germany do have some courses like Electromagnetic Radiation Experts, Building Biologists, they might be too basic when we compare them the future sophisticated technologies used in 5G. These programs should be launched worldwide since 5G will be operating globally. Another important threat in 5G is a security issue when the whole globe is networked. However new inventions is always an option.

The scope of this article is limited to only human health issues but further it can be extended to other living beings including plants as well.

### VI CONCLUSION

A big contemporary & future threat to create healthy society is man- made ‘electrosmog’ for sure. The atmosphere is already polluted by this technically originated, nonionizing electromagnetic radiations & the nature of pollution is such that there is no safe place to hide on this planet earth. We have no evolutionary immunity against the direct & indirect adverse effects or to the natural interference of our body’s bioelectrical system caused due to EMR & the new technologies of 5G. Hence this article is an appeal to the industry, national & international

regulatory bodies to studiously look into the solution without ignorance.

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