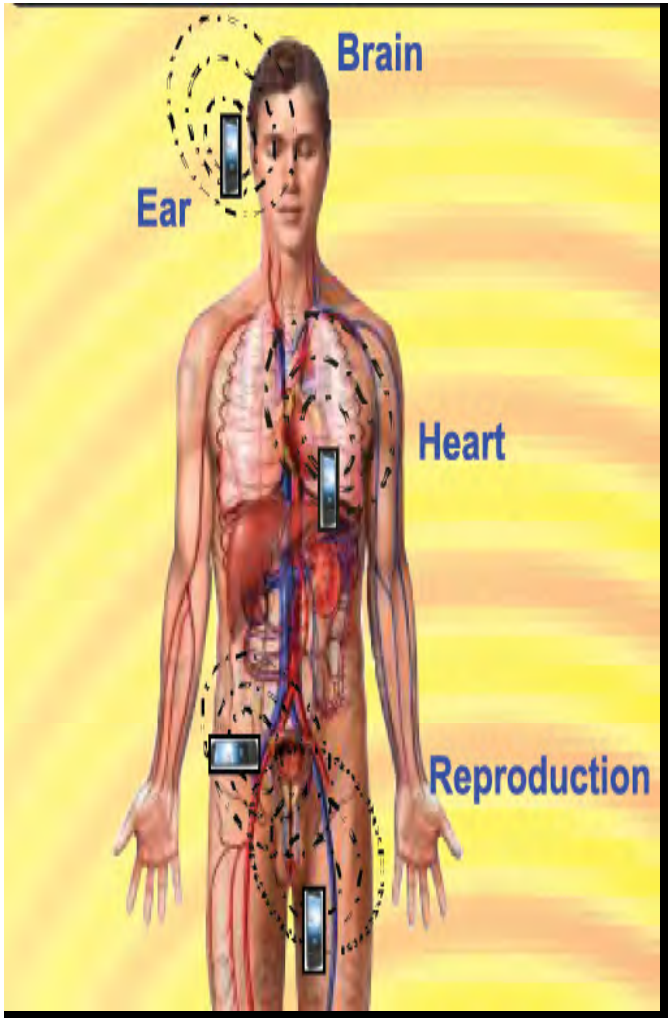
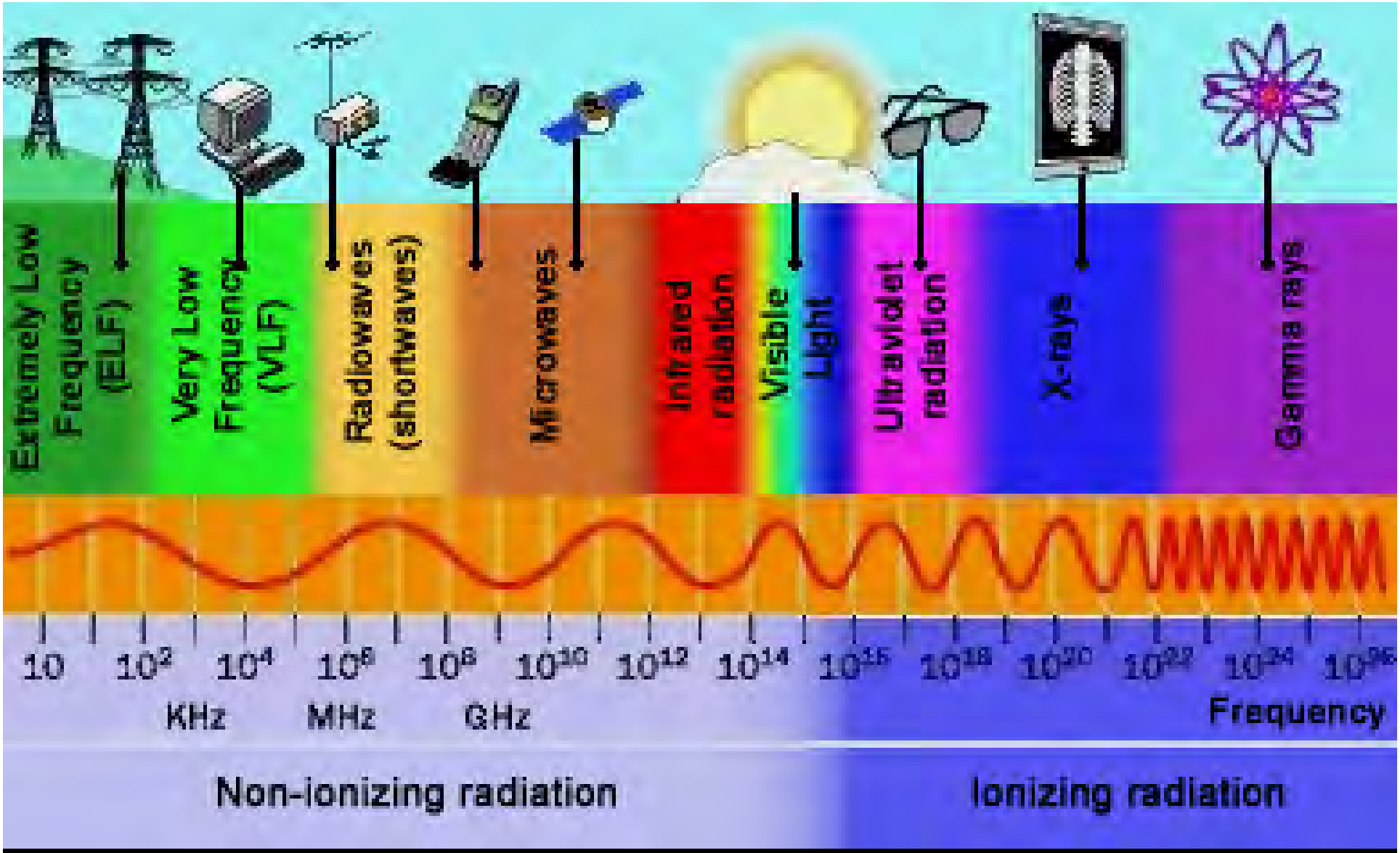




Radio Frequency Radiations and Human Health: An Indian Scenario

Dr. R. S. Sharma
Sr. Deputy Director General & Scientist-G
Division of RCH
Indian Council of Medical Research
New Delhi –110 029



Type of Mobile Radiation:

- **Between 900 to 1800 MHz**
- **Falls in the range of microwave radiation**

http://www.astrosurf.com/luxorion/Radio/spectrum-radiation.png

1. **Biological effects** – Effects are measurable responses to a stimulus or to a change in the environment and are not necessarily harmful to our health

2. **Health Hazard** - Changes that are irreversible and stress the systems for long period of time.

Factors influence the EMF effect on human health

Environmental factors

- Ambient temperature
- Air velocity
- Humidity
- Electrical property of the environment
- Altitude
- Geo-pathic radiation

Biological factors

- Mass, Shape and the size of the body
- The orientation of the body with the field vectors
- Electric property of the body
- Age, gender, activity level
- Muscles contents and fat contents
- Bone Mineral Density
- Debilitation and/ or other diseases would also contribute

Effects of Radio Frequency Radiation (RFR)

Every living and non-living things consists of a variety of atoms.



Atom contains electrons, protons, neutrons etc.



Every living and non-living thing is in a state of vibrational harmonic resonance.

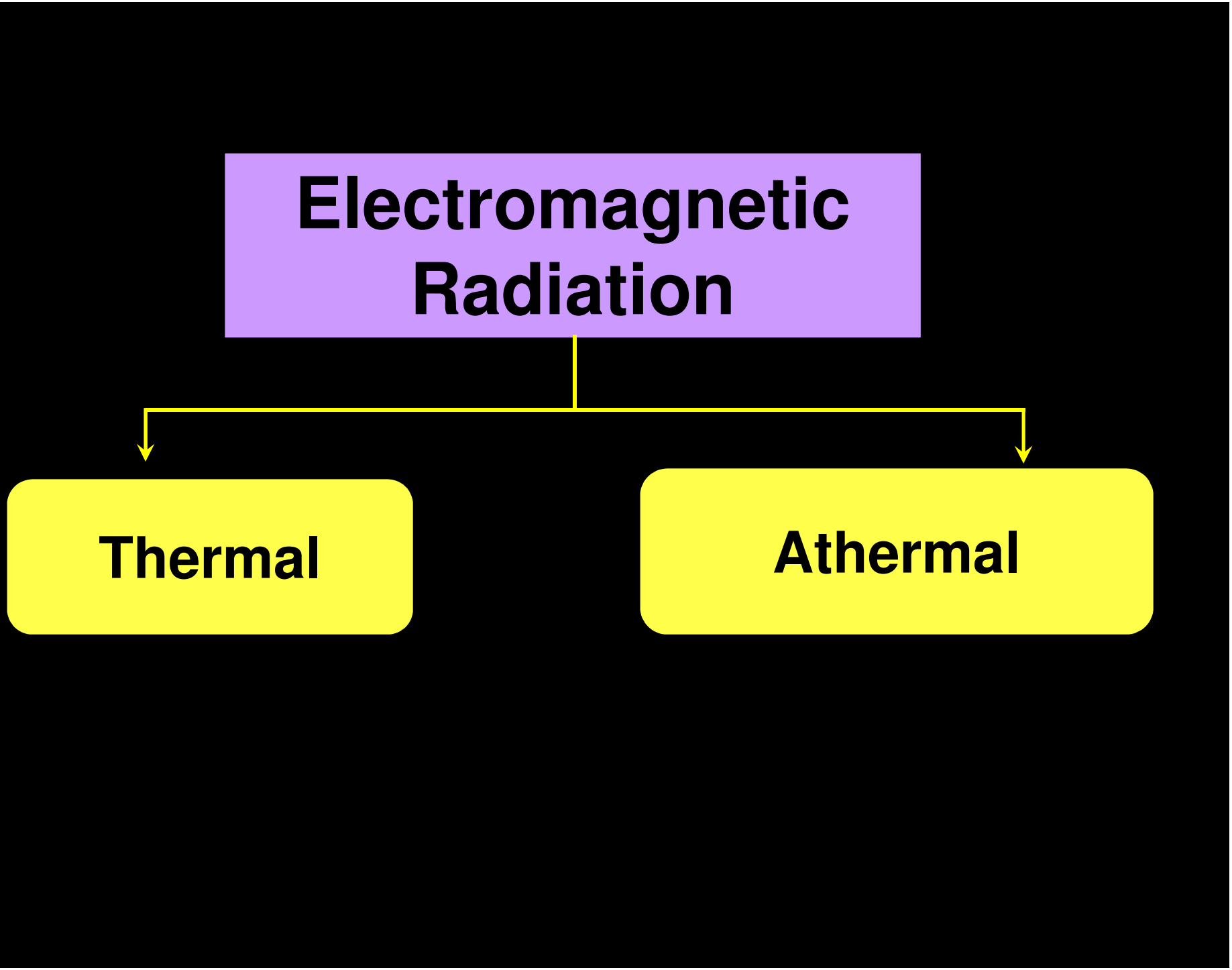


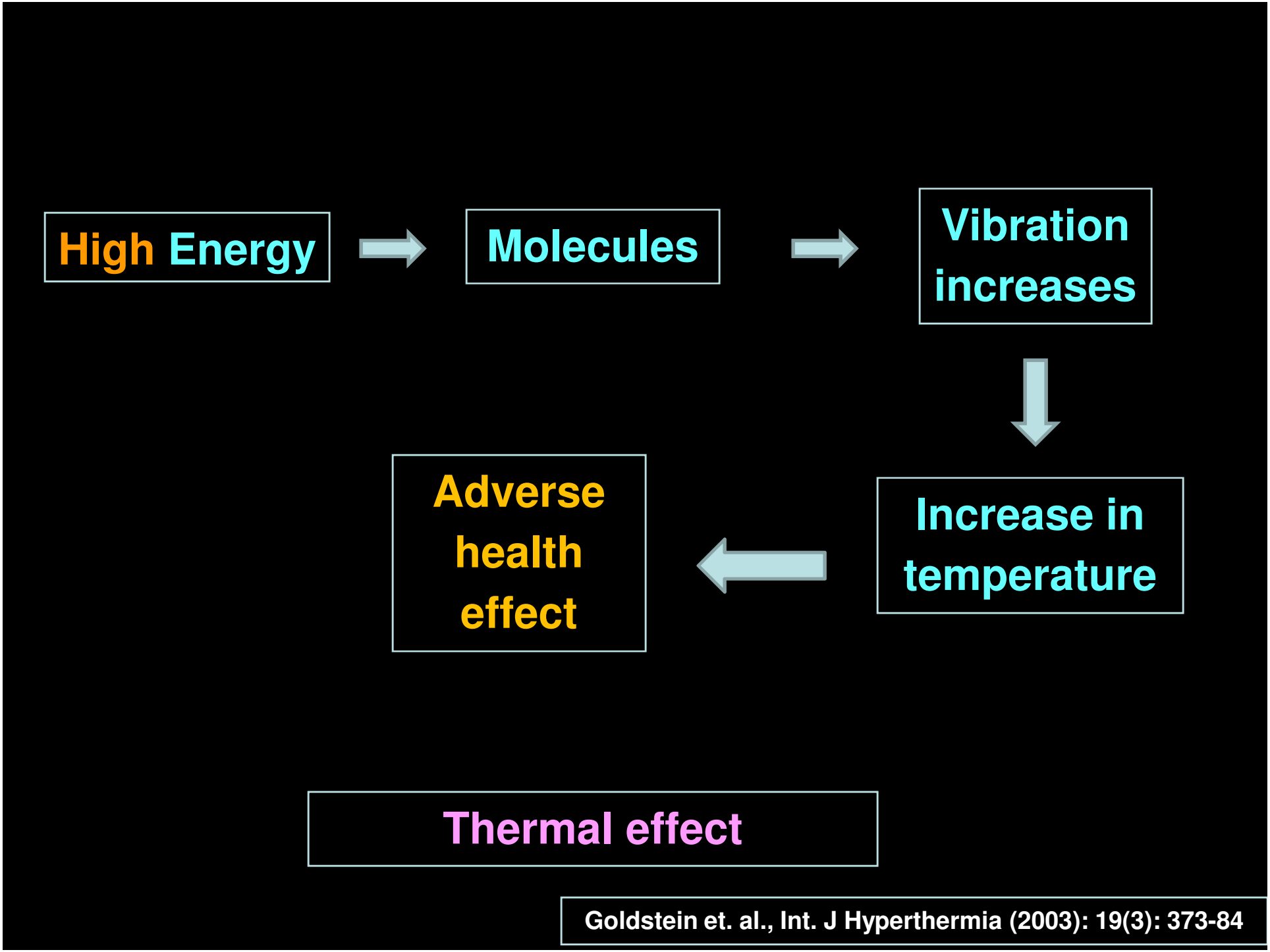
Every system, organ, tissue, cell and molecule of the human body vibrates within a certain range of frequency.



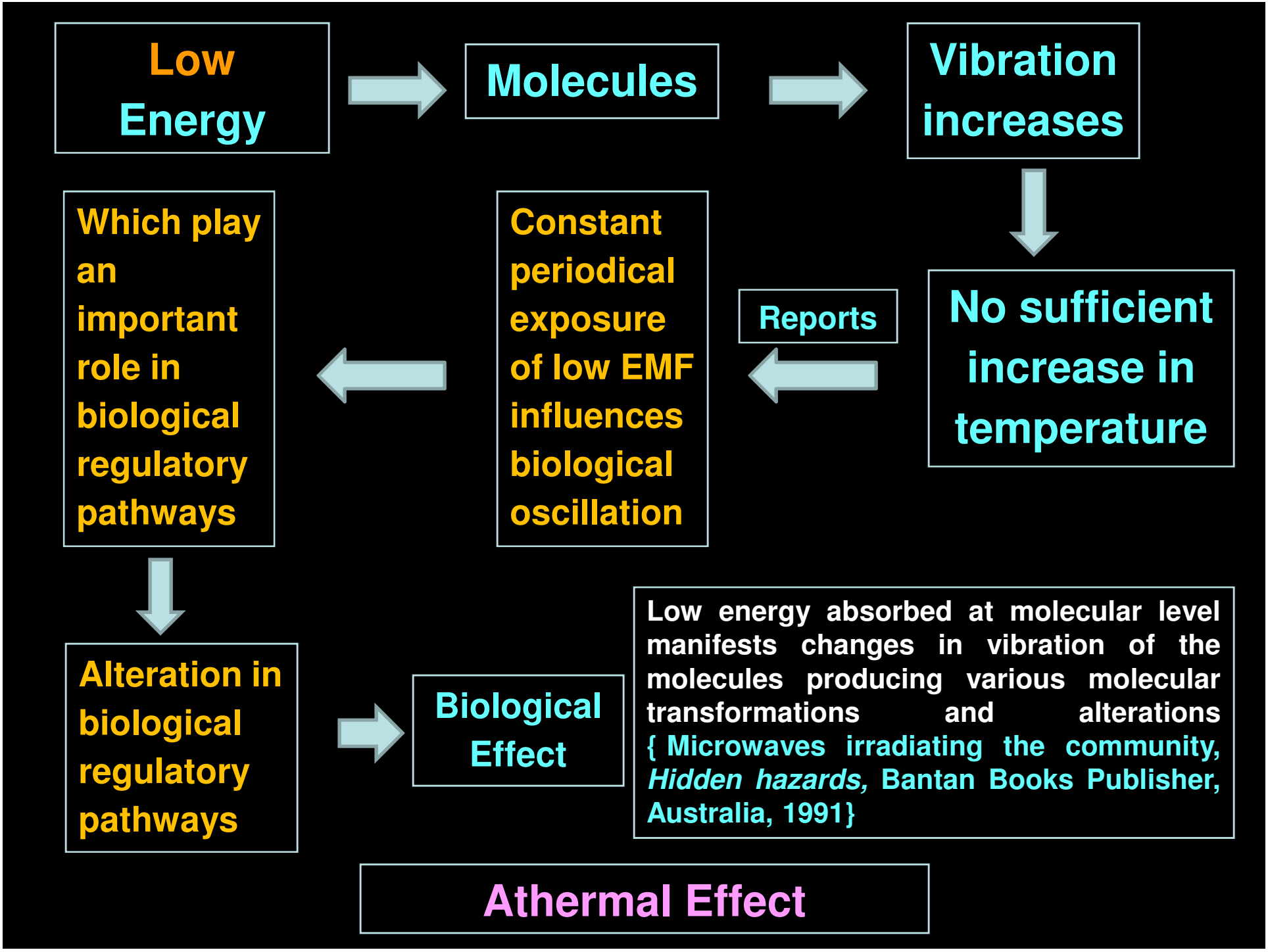
A healthy body broadcasts a frequency between 62 and 72 Hz

Bruce Taino, 1992


Electromagnetic Radiation
Thermal
Athermal



Goldstein et. al., Int. J Hyperthermia (2003): 19(3): 373-84


Low Energy
Molecules
Vibration increases
No sufficient increase in temperature
Reports
Constant periodical exposure of low EMF influences biological oscillation
Which play an important role in biological regulatory pathways
Alteration in biological regulatory pathways
Biological Effect
Low energy absorbed at molecular level manifests changes in vibration of the molecules producing various molecular transformations and alterations { Microwaves irradiating the community, *Hidden hazards,* Bantan Books Publisher, Australia, 1991}
Athermal Effect

Biological effect of RFR
Indian Studies

Honey Bees

Exposure to cell phone radiations produces biochemical changes in workers Honey Bees

Nedima et. al. Toxicol. Int. (2011)

Ten bees workers → 10 Min. | 20 Min. | 40 Min.

Control

Ten bees workers → 10 Min. | 20 Min. | 40 Min.

Cell Phone radiation

Extracted the Hemolymph

Behavioral observation

- Reduced motor activity
- En masse migration

Biochemical observation

- Carbohydrates
- Glycogen
- Glucose
- Total lipid cholesterol protein

↑ At 10 & 20 Min. exposure

↓ At 40 Min. exposure

Electromagnetic radiation (EMR) clashes with Honey Bees

S. Pattazhy, 2013

Control hives - No cell phone exposure

→ 5 to 10 day

All workers return to hives

Cell Phone

10 Meter away from the Hives

→ 5 to 10 day

After few days the workers never return to hives

Thriving hives left with

Only queen, eggs hive bounds immature worker bees

Colony Collapse/ Disrupting Syndrome

Indian Studies

Genetic alteration

1. **Gandhi & Singh, Int J Hum Genet (2005) 5:259-265.**
   - **Increased number of micro nucleated buccal cells and cytological abnormalities in cultured lymphocytes**
   - **Indicating the genotoxic response from mobile phone use.**

2. **Gandhi & Anita, Int J Hum Genet (2007) 11: 99-104.**
   - **A correlation between mobile phone use and DNA and chromosomal damage in lymphocytes of individuals was observed which may have long-term consequences in terms of neoplasia and/or age-related changes.**

3. **Rekhadevi et. al., Toxicol Int (2009) 16:09-19.**
   - **Genetic damage of peripheral lymphocytes and buccal epithelial cells in the mobile telephone user increased significantly, as compared with control.**

4. **Chaturvedi et. al., Electromagnetics Research B (2011) 29: 23-42.**
   - Increase in erythrocyte and leukocyte counts in mice exposed to RFR.
   - A significant DNA strand break in brain cells and the loss of spatial memory in mice.
   - This report for the first time provides experimental evidence that continuous exposure to low intensity microwave radiation may have an adverse effect on the brain function by altering circadian system and rate of DNA damage.

5. **Kesari et. al., Cell Biochem Biophys. 2014; 68(2):347-58.**
   - The data indicated that radiation emitted from 3G mobile phone significantly induced DNA strand breaks in brain.
   - Significant increase in micronuclei, caspase 3 and apoptosis
   - Increase in phosphorylation of hsp27, hsp70, and p38 mitogen-activated protein kinase (p38MAPK), which leads to mitochondrial dysfunction-mediated cytochrome c release and subsequent activation of caspases, involved in the process of radiation-induced apoptotic cell death.
   - Study shows that the oxidative stress is the main factor which activates a variety of cellular signal transduction pathways.
   - Results conclude that 3G mobile phone radiations affect the brain function and cause several neurological disorders.

Reproductive Alteration

1. **Kesari et. al., Indian Journal of Experimental Biology (2010) 47:987-992.**
   - **Chronic exposure to Radio Frequency Radiation (RFR) imitated from cell phone causes a significant decrease in protein kinase C and total sperm count along with increase apoptosis in male rat (2 h/day x 35 days at 0.9 W/kg SAR).**
   - **Significant reduction in testicular size, weight and in sperm counts.**

2. **Kumar et. al., Clinics (2011) 66:1237-1245.**
   - **Significant increase in caspase and creatine kinase.**
   - **Significant decrease in testosterone and melatonin level in exposed rat.**
   - **Data indicates that reactive oxygen species (a potential inducer of cancer) are the primary cause of DNA damage.**
   - **RFR exposure causes apoptosis during spermiogenesis or sperm maturation.**

3. **Veerachari SB, Vasan SS., Int J Infertility Fetal Med 2012;3(1):15-21.**
   - **Human semen samples exposed to EMR showed a significant decrease in sperm motility and viability**
   - **Increase in reactive oxygen species (ROS) and DNA fragmentation index (DFI)**
   - **Study concluded that mobile phones emit electromagnetic waves which lead to oxidative stress in human semen and also cause changes in DNA fragmentation.**

4. **Meena et. al., Electromagn BioL Med. 2014; 33(2):81-91.**
   - **The melatonin prevent oxidative damage biochemically by significant increase in the levels of testicular LDH-X, decreased levels of melondialdehyde (MDA) and ROS in testis.**
   - **Melatonin reversed the effects of Micro Waves (MWs) on Xanthine Oxidase (XO), protein carbonyl content, sperm count, testosterone level and DNA fragmentation in testicular cells.**
   - **These results concluded that the melatonin has strong antioxidative potential against MW induced oxidative stress mediated DNA damage in testicular cells.**

5. **Shahin et. al., Free Radic Res. 2014; 48(5):511-25.**
   - **Micro Wave irradiation induced a significant decrease in sperm count and sperm viability along with the decrease in seminiferous tubule diameter and degeneration of seminiferous tubules in mice.**
   - **The reduction in testicular 3β HSD activity and plasma testosterone levels was also noted in the exposed group of mice.**
   - **Increased expression of testicular induced Nitric Oxide Synthase (i-NOS) was observed in the MW-irradiated group of mice.**
   - **These adverse reproductive effects suggest that chronic exposure to nonionizing MW radiation may lead to infertility via free radical species-mediated pathway.**

Biomarkers alteration

1. **Kesari et. al., Appl Biochem Biotechnology (2012) 166:379-388.**
   - **A significant decrease in the level of pineal melatonin of exposed group (2h/day x 45 days at 2.45 GHz) as compared with sham exposed.**
   - **A significant increase in creatine kinase, caspase 3 and calcium ion concentration was observed in whole brain of exposed group of animals as compared to sham exposed.**
   - **The alteration in expression of these biomarkers clearly indicate possible health implication of such exposures**

2. **Paulraj and Behari, Cell Biochem Biophys (2012) 63:97-102.**
   - **This study reveal that chronic exposure of rat to microwave radiation (2h/day x 35 days at 9.9 GHz, 1.0 W/kg SAR) alter the activity of certain enzymes.**
   - **Significant increase in calcium ion efflux and the activity of Ornithine Decarboxylase (ODC).**
   - **Significant decrease in Protein Kinase C (PKC) activity.**
   - **Since these enzymes are related to growth, therefore any alteration in them may lead to affect functioning of the brain and its development.**

3. **Balakrishnan et. al., J Environ Pathol Toxicol Oncol. 2014;33(4):339-47.**

Hsp70 is an independent stress marker among frequent users of mobile phones

- **The aim of this study was to measure the serum concentrations of heat shock protein (HSP) 70 and C-reactive protein (CRP) and the expression levels of the *hsp70* gene among frequent users of mobile phones (FUMPs).**
- **120 employees of information technology (IT)/IT enabled service companies and 102 infrequent users of mobile phones (IFUMPs) as controls.**
- **The serum concentrations of HSP70 and CRP were measured**
- **Highly significant higher concentrations of serum HSP70 and CRP were observed among FUMPs than IFUMPs.**
- **A higher level of *hsp70* gene expression was observed among FUMPs than IFUMPs.**
- **Thus, the study convincingly demonstrated the role of serum HSP and CRP as systemic inflammatory biomarkers for mobile phone-induced radiation**

Audiometry alteration

1. **Panda et. al., J Otolaryngol Head neck Surg (2010) 39:5-11.**
   - **A retrospective, cross sectional, randomized, case control study.**
   - **112 subjects who were long term mobile phone users (>1 year) and 50 controls who had never used a mobile phone underwent a battery of audiologic investigations.**
   - **Changes in the various parameters were studied in the mobile phone and non-mobile phone using-ears of subjects and corresponding-ears of the controls to ascertain the effects of electromagnetic exposure.**
   - **No significant difference between users and controls for any of the audilogic parameters.**
   - **However, trends for audiologic abnormalities were seen within the users.**
   - **High frequency loss and absent distortion product otoacoustic emissions were observed with an increase in the duration of mobile phone use, excessive use of mobile phones, and age more than 30 years.**
   - **Additionally, users with some complaints during mobile phone use demonstrated absent distortion product otoacoustic emissions and abnormalities in auditory brain stem response.**
   - **This study reported long term and intensive mobile phone use may cause inner ear damage.**

2. **Panda et. al., Otolaryngol Head Neck Surg. (2011); 144(4):581-5.**

- **This study was undertaken to assess and compare potential changes in hearing function at the level of the inner ear and central auditory pathway due to chronic exposure to electromagnetic waves from both global system for mobile communications (GSM) and code division multiple access (CDMA) mobile phone usage.**
- **125 subjects who were long-term mobile phone users (>1 year; 63 GSM and 62 CDMA) and 58 controls who had never used mobile phones underwent audiological investigations.**
- **The changes in various parameters were studied in mobile-using and non-mobile-using ears of both GSM and CDMA subjects and corresponding ears of the controls.**
- **GSM and CDMA users were found to be at a significantly higher risk of having Distortion-Product Otoacoustic Emissions (DPOAE) absent as compared with controls.**
- **They were found to have higher speech frequency thresholds and lower MLR wave and Na and Pa amplitudes.**
- **More than 3 years of mobile phone usage emerged as a risk factor.**
- **The damage done was bilateral, with the quantum of damage being the same for both GSM and CDMA. Long-term and intensive GSM and CDMA mobile phone use may cause damage to cochlea as well as the auditory cortex.**

3. Sahoo and Sebastian. Indian Journal of Otology (2011): 17 (3): 97-100.

- Explored a possible relationship between prolonged mobile phone usage and sensorineural deafness.
- The study was conducted in a medical college situated in rural India.
- A total of 100 persons between the age group of 20-45 years using mobile phone for at least 5 years were selected and screened for sensorineural deafness.
- Use of cellular phones was assessed by a questionnaire.
- Mean number of daily calls and minutes were asked for to calculate the cumulative use in hours for all years.
- The most frequently used ear during cellular phone calls was noted, or whether both ears were used equally.

- Otoscopic examinations were performed by an otolaryngologist before testing in order to rule out any external or middle ear pathology that could affect audiometric measurements.
- The hearing levels of subjects were tested using pure tone audiometry.
- It is found that the prevalence of sensorineural deafness was 3% and there is a linear relationship between the duration of mobile phone use and the degree of the severity of deafness.
- It is not clearly known whether mobile phone use is the direct cause of deafness in these subjects but the absence of other causes might point towards its etiological role.

Cell Phone Tower

1. **Gandhi and Komal. Current Trends in Technology and Science, 3: 337-342; 2014.**
   - **Increase in various kinds of health symptoms (i.e. headaches, blurred vision, skin and cardiovascular problems, dizziness, depression, nausea, memory loss, tinnitus, loss of appetite, feeling of discomfort and bowel disturbance) in people residing within 200 meters of cell phone towers in comparison to control group.**
   - **A significant increase in case of headache was observed in female in comparison to male residing near the cell phone tower.**

2. **Mahajan et. al., Molecular cytogenetics 2014 7 (suppl 1): P49.**
   - **Genetic damage in some individual residing within 150 meters of cell phone towers.**
   - **The genetic damage in term of micronuclei and nuclear buds was significantly higher in people residing within 150 meters of cell phone towers in comparison to control.**
   - **Simultaneously the condensed chromatin and karyolitic cells also showed significant increase in the people residing near the cell phone towers.**

3. **Gandhi et. al., Electromagnetic Biology and Medicine. 2014, Jul 9:1-11.**

- **A cross-sectional case control study also reported significant increase in DNA damage with reference to DNA migration length, Damage Frequency (DF) and Damage Index (DI) in people residing within 300 meters of cell phone towers in comparison to people residing more than 300 meters away from the cell phone towers.**

- **The study also reported that the females had significantly elevated DNA damage frequency than the male residents.**

ICMR Study

- ICMR has initiated a multi-disciplinary, comprehensive, prospective, long term cohort study to find out adverse effects of RFR, if any, emitted from cell phone on adult Indian population.
- Under this study efforts are going on to examine whether use of cell phone is associated with:
  - Reproductive dysfunctions and infertility,
  - Neurological disorders (cognitive behavior, sleep related disorders, depression etc.),
  - Cardiovascular disorders,
  - Otorhinolaryngology (ENT) disorders
  - Carcinogenic effect
  - Hematological changes
  - Biochemical changes
  - Hormonal changes

- The provision has also been made under this study to measure specific absorption rate, power density, wave length and frequency of RFR emitted from various types of cell phones used by the enrolled subjects.

- Under this study efforts are also going on to survey the health status of the people residing near the cell phone tower in Delhi.

Department of Science and Technology (DST)

- Invited projects to address this issue.

- Around 17 proposals have been approved and funded.

Government of India
Ministry of Communications & Information Technology
Department of Telecommunications

REPORT OF THE
INTER-MINISTERIAL COMMITTEE
ON
EMF RADIATION

Members of the Inter-Ministerial Committee

Dr. R S Sharma Scientist ICMR	Arvind Duggal Advisor, Deptt. Of Bio-Technology	R N Jindal Scientist 'E' MOEF
U K Srivastava DDG (R), TEC	T K Vardakrishnan Jt. WA, WPC, DoT	G P Srivastava DDG(CS), DoT
P.K. Panigrahi Sr. DDG (BW), DoT Member Secretary		Ram Kumar Advisor (Technology), DoT Chairman

The summary of the recommendation made by the Inter-Ministerial Committee on this subject

Mobile Handsets: -

1. **Adoption of SAR level for mobile handsets limited to 1.6 Watt/Kg, averaged over a 6 minutes period and taken over a volume containing a mass of 1 gram of human tissue as per the FCC norms of United States.**
2. **SAR value information is to be embossed and displayed in the handset.**
3. **Information on SAR values for mobile handsets should be readily available to the consumer at the point of sale so that one can make sure of the SAR value of the handset while buying a cell phone.**
4. **Government may consider amendments in the Indian Telegraph Act 1885 & rules notified there under and necessary legislations if any so that only mobile handset satisfying radiation standards should be permitted for import / manufacture or sold in the country.**
5. **Mobile hand set manufactured and sold in India or Imported from other countries should be checked for compliance of SAR limit and no hand sets of SAR value above the prescribed standard adopted in India should be manufactured or sold in the country.**

6. **SAR data information of the mobile handsets should be available on the manufacturer's web site and in the manufacturer's handset's manual.**
7. **To bring awareness, the manufacturer's mobile handset booklet should contain the following for safe use :**
    a. **Use a wireless hands-free system (headphone, headset) with a low power Bluetooth emitter to reduce radiation to the head.**
    b. **When buying a cell phone, make sure it has a low SAR.**
    c. **Either keep your calls short or send a text message (SMS) instead. This advice applies especially to children, adolescents and pregnant women.**
    d. **Whenever possible, use cell phone when the signal quality is good.**
    e. **People having active medical implants should keep their cell phone at least 30 cm away from the implant.**
8. **The Information is made available on Government website with list of SAR values of different mobile phones.**

Mobile Base Stations: -

9. The RF exposure limits in India may be lowered to 1/10th of the existing level keeping in view the data submitted by COAI/ AUSPI during presentation made to the committee and trend adopted by other developed countries.

10. To provide static continuous testing / measuring centers for online monitoring of radiation level at prominent places in metro/cities and the data to be sent to the central server for information.

11. Apart from self certification for compliance of radiation norms on EMF exposure as is presently being done, the mobile service providers should also measure the radiation level of certain prominent places and display it for information of the general public. They should also have mobile unit for its measurement wherever necessary.

12. DOT should create a national data base with the information of all the base station, their emission levels and display on public domain for public information.

13. Impose restrictions on installation of mobile towers near high density residential areas, schools, playgrounds and hospitals.

14. For the future expansion of telecom network in the country use low power micro cell transmitters with in-building solutions in place of the present trend of using high power transmission over mobile towers / high rise buildings.
15. To conduct the long term scientific research related to health aspect of EMF radiation exposure and associated technologies in India in the following areas:
    - o Health effect of RF exposure in children.
    - o Health effect of RF exposure in Foetus, mothers and elderly persons.
    - o Combined electromagnetic field radiation effect exposure from multiple antennas of a shared infrastructure sites
16. It is recommended for use of hands free and ear phone technologies such as blue tooth handsets and ear phone so as to minimize the contact of head with cell phone.
17. Department of Telecom may create a document "Radio waves and safety in our daily life" indicating various Dos and Don'ts related to mobile users clarifying various myths regarding deployment and use of radio waves and mandate each operator to print and issue the same to their customer at the point of sale for enhanced customer awareness. This will help in facilitating the right inputs and creating an environment where everyone can use the radio waves safely.

Public concern

Pulprilhad Pur, New Delhi



Rahugupta T-10B Pulprahilad Pur New Delhi




SPEECH & DRA
CERTIFICATE COU
PREMPURI


RELIANCE
RELIANCE
HAJIALI
HAJIALI
JUICE

CASE STUDY Usha Kiran Building, Worli, Mumbai



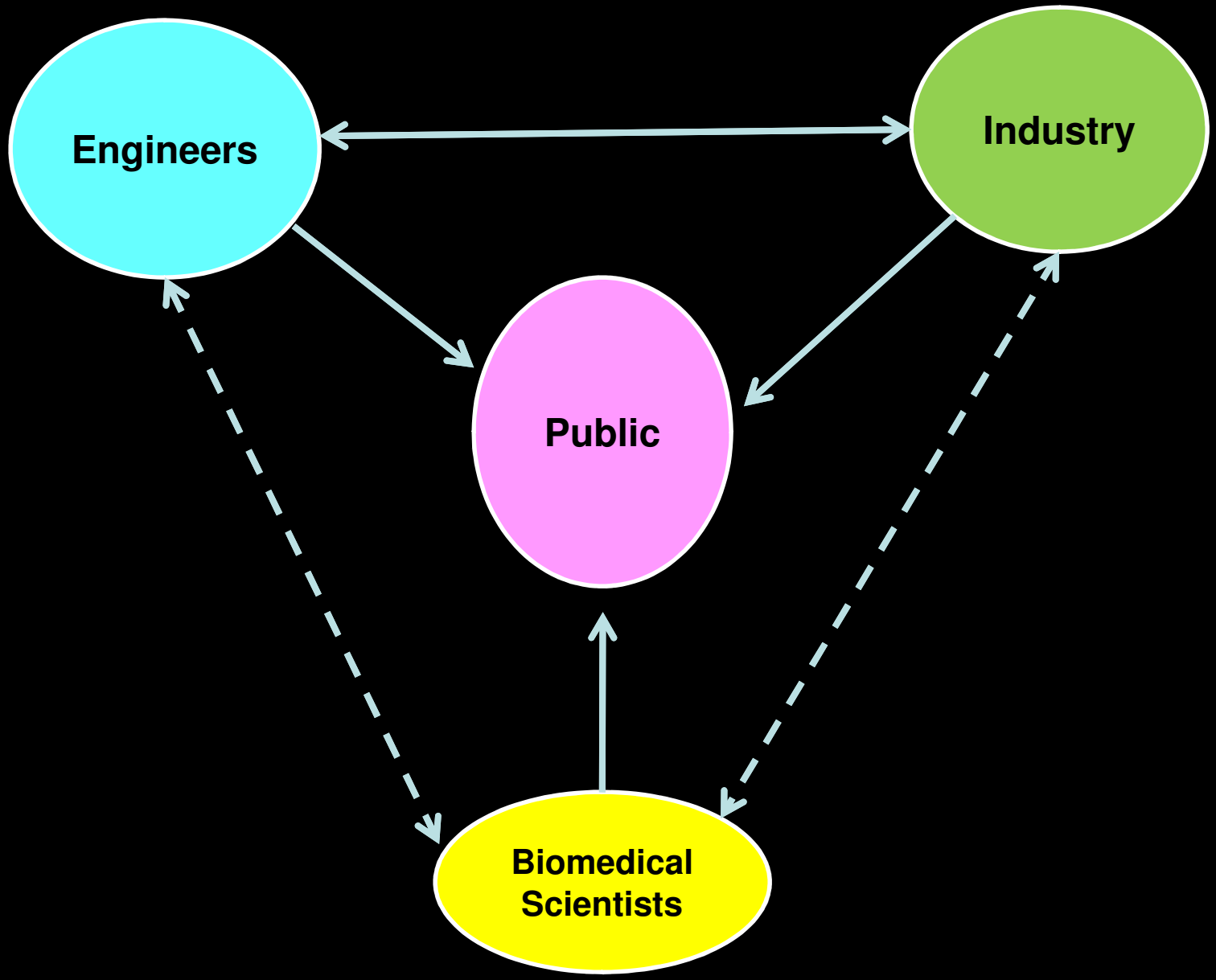
The cell phone towers installed on the Vijay Apartments terrace at Carmichael Road **pic/Bipin Kokate**



Usha Kiran Building

Six cancer cases in consecutive floors (5^{th}, 6^{th}, 7^{th}, 8^{th} and 10^{th}) directly facing and at similar height as the mobile phone towers of four telecom companies placed on the roof of opposite building.

Disconnect



Cell Phone Biological Studies

	Effect	No Effect	Total
Industry Funded	27 (29%)	66 (71%)	93 (30%)
Non-Industry Funded	147 (69%)	67 (31%)	214 (70%)
Total	174 (57%)	133 (43%)	307

Chris Busby and Roger Coghill (2006)

Conclusion

1. WHO/ICNRP should accept the fact that RFR emitted from cell phone and cell phone tower has got biological effect.

2. Needs to conduct comprehensive multi disciplinary prospective long term cohort studies in different populations and different countries (But without private funding)

3. And based on these results, each country should develop health based precautionary guidelines to protect their population.


भारतीय आयुर्विज्ञान अनुसंधान परिषद
INDIAN COUNCIL OF MEDICAL RESEARCH

Thank you