Radio Frequency Radiation and Human Health: Technical Studies from India

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

(i) Scientific Hypothesis

(ii) Studies published from India

(iii) Policies & Guidelines in this area

(iv) Public concern

1. **Health** – Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.

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

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

Questions arise

- What are these biological effects.
- Can we ignore these effects, if they exist.
- If not, then what measures we should take

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

(i) Scientific Hypothesis

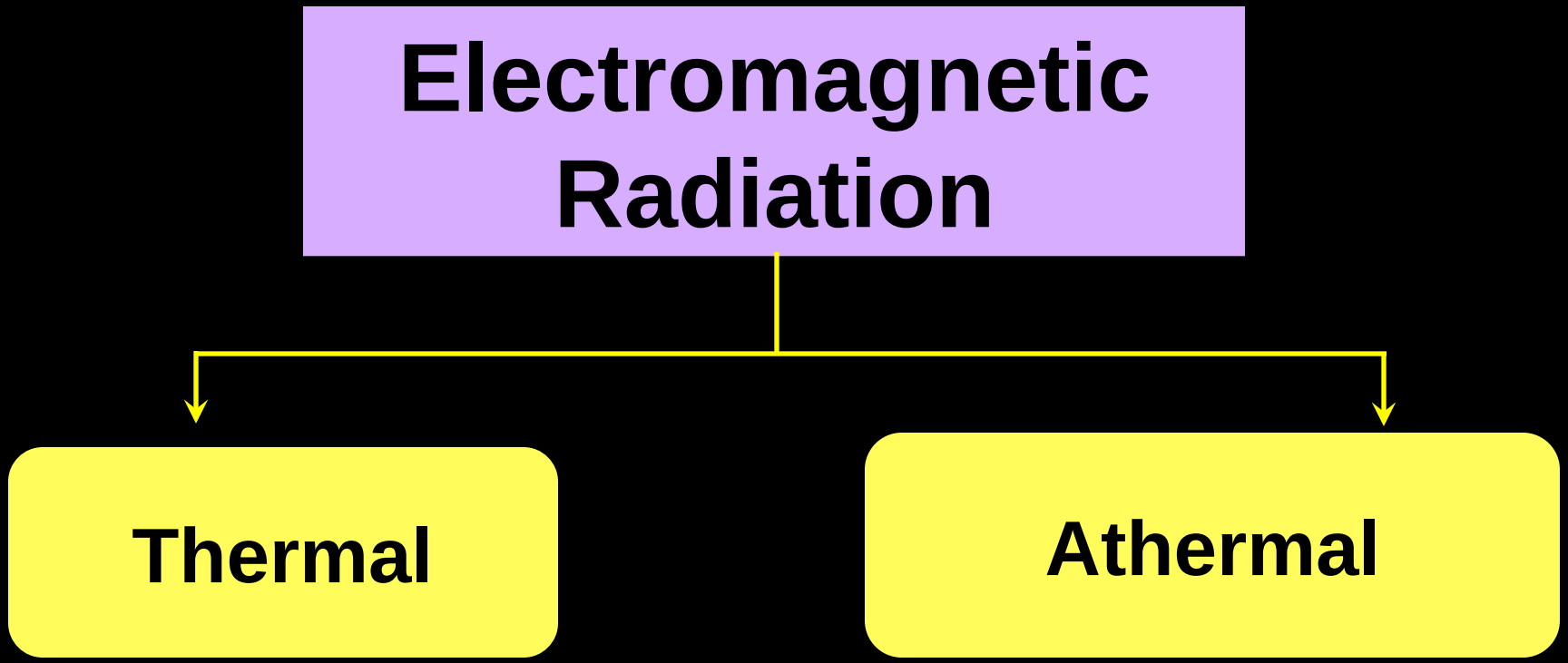
Effects of Radio Frequency Radiation (RFR)

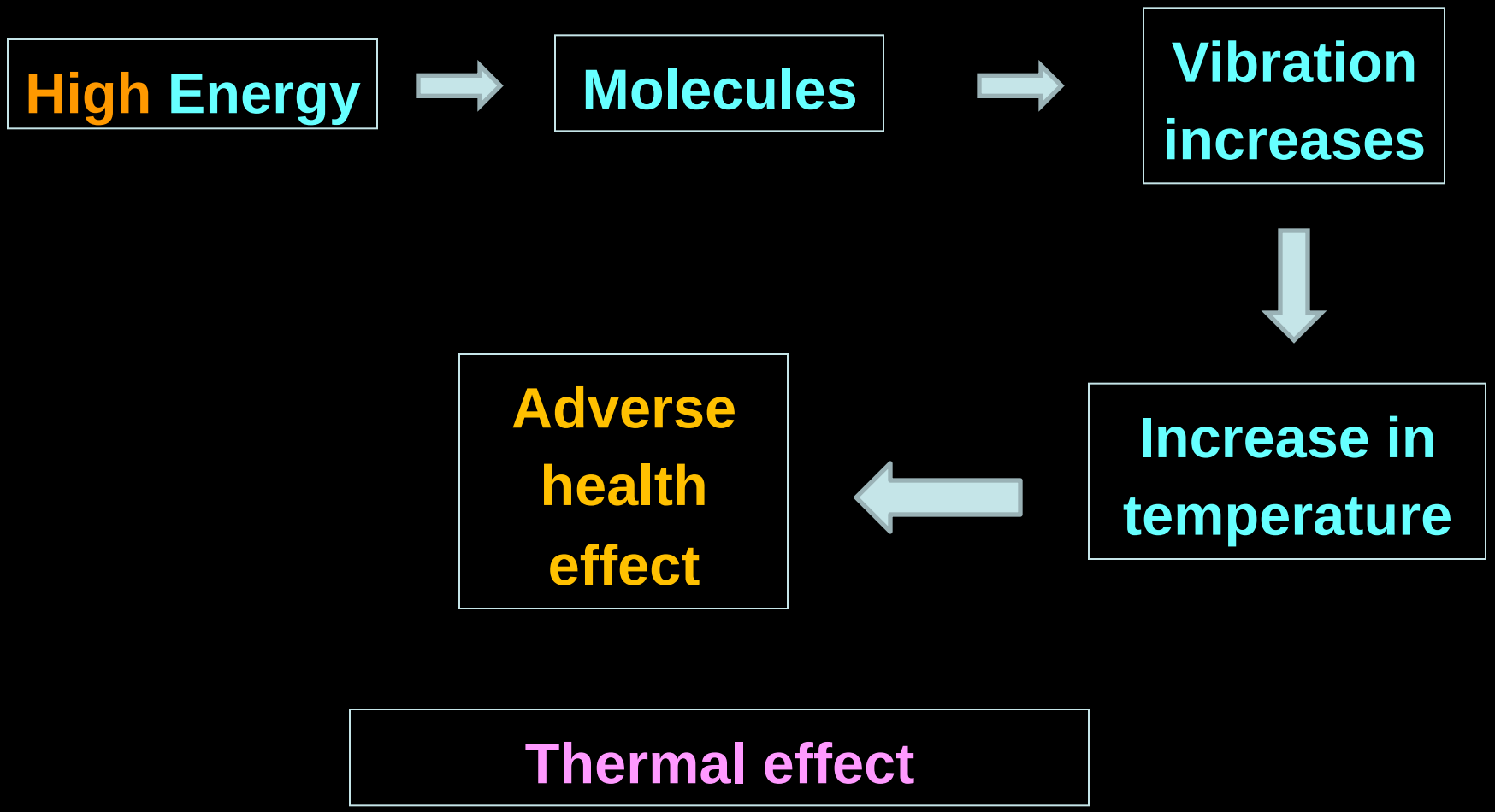
Every living and non-living things consists of a variety of atoms.

Atom contains electrons, protons, neutrons etc.

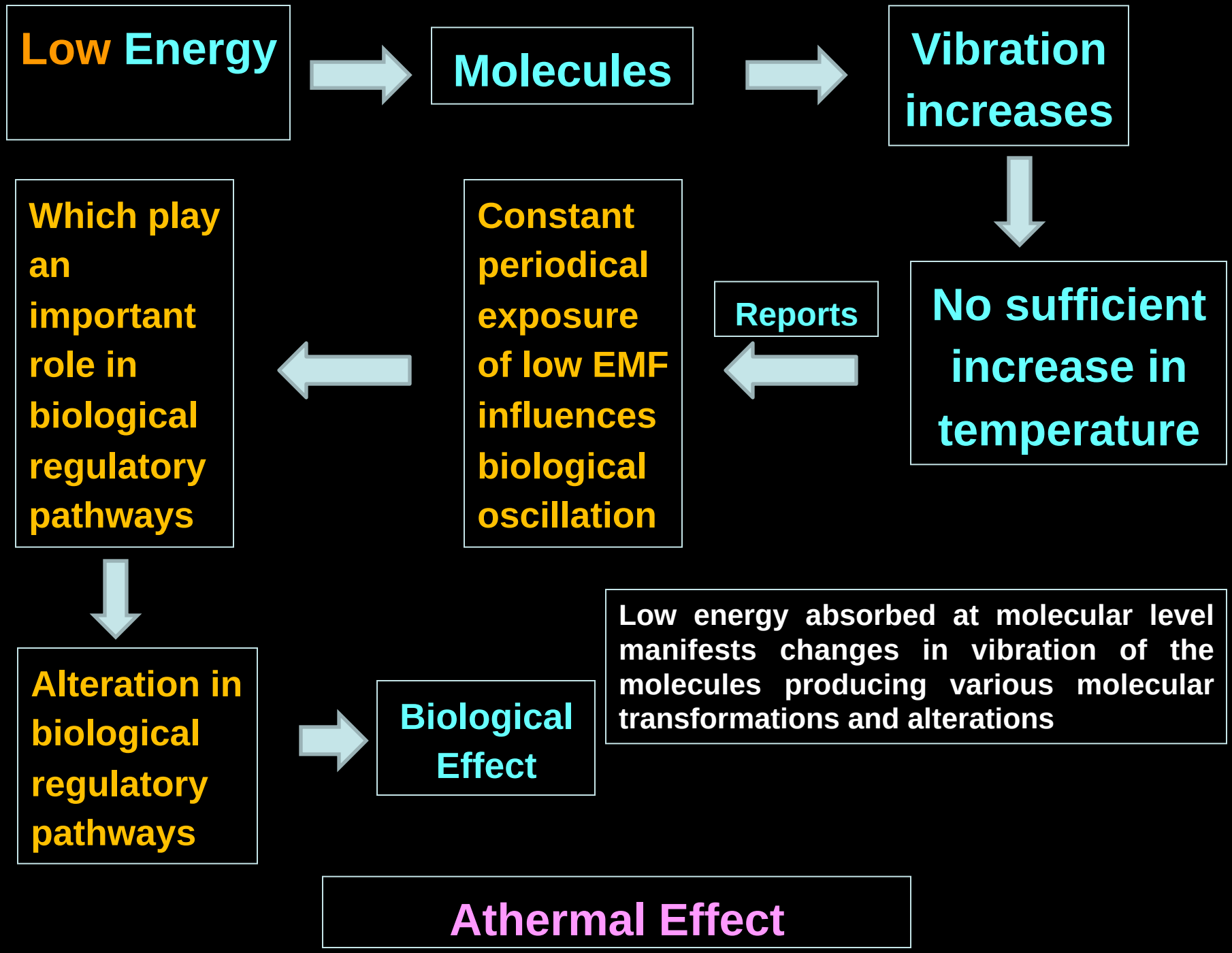
Every living and non-living thing is in a state of vibrational harmonic resonance.

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


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
Athermal Effect

Impacts of RF on Honey Bees

Albert Einstein

Honey Bee

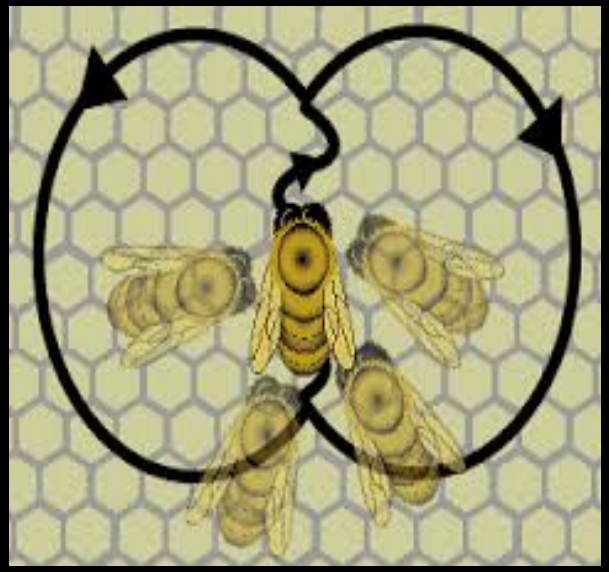
Earth

If the bee disappeared off the surface of the globe then man would only have four years of life left. No more bees, no more pollination, no more plants, nor more animals, no more man.

Canadian Bee Journal in 1941

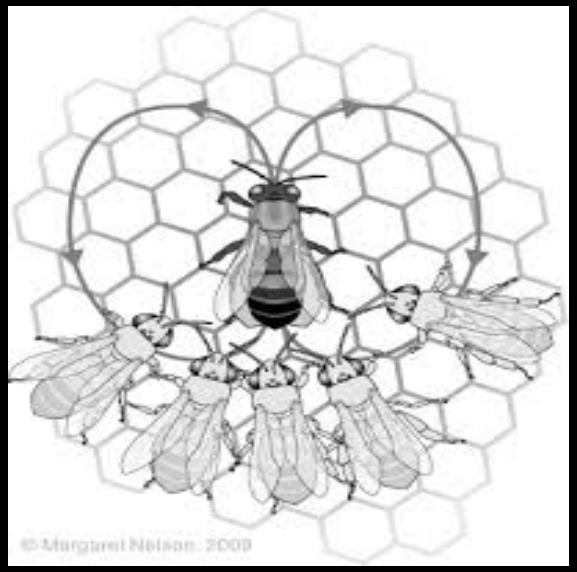
Decoding the language of the Honey Bees

Nobel Lecture, December 12, 1973
Karl Von Frisch
University of Munich, Federal Republic of Germany



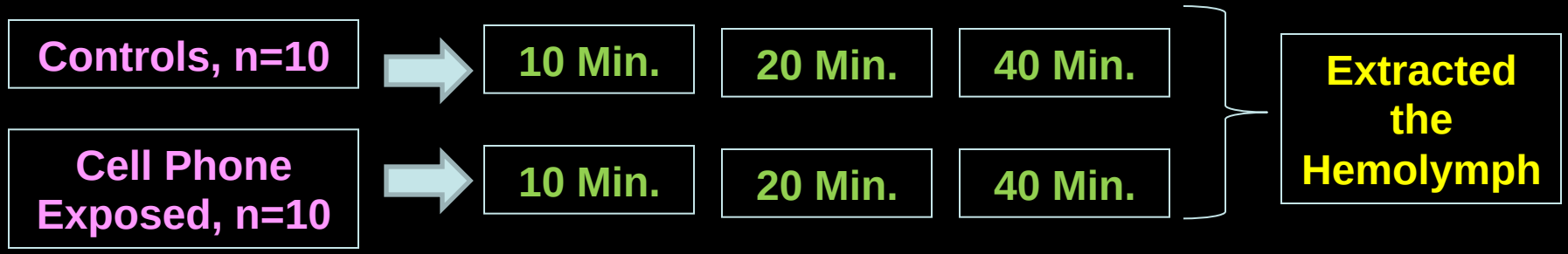
Waggle Dance

Shacking Dance



Tremble Dance

Exposure to cell phone radiation produces biochemical changes in worker Honey Bees, Neelima et al., 2011



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

- During initial quiet period rise in concentration of biomolecules due to stimulation of body mechanism to fight stressful condition.
- At later stages there was decline in the concentration of biomolecules because the body had adapted to the stimulus.

Neelima et. al. Toxicol. Int. 2011; 18:70-72

Electromagnetic radiation (EMR) damages Honey Bees (Sainudeen, 2011)

Control hives, n=3
No cell phone exposure

→ 10 day → All workers return to hives

Test hives, n=3
Cell Phone exposure for 10 min./day

→ 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

S Sainudeen Sahib. Mun. Ent. Zool. 2011, 6:396-399

(ii). Genotoxicity Studies published from India

Cytogenetic Studies

1. Cytogenetic Damage in Mobile Phone Users: Preliminary Data

Gandhi & Singh, Int J Hum Genet (2005) 5:259-265 (25 users/25 controls)

Table1: Cytogenetic damage in mobile phone users

Subject Code	*Brand & Model No.*	*SAR (W/kg)*	*Duration of use (yr.)*	*Daily freq. of calls (No.)*	*Duration of calls (min.)*		*Daily Exposure (hr.)*		*Kept on "On" mode (hr)*	*Phone attendance (ear)[a]*	*Micro-nucleated cells (%)*	*Aberrant metaphases (%)*
					IN	*OUT*	*IN*	*OUT*				
MM 1	Ericssion S-828	0.77	4.5	20	23	22	14	12.70	13	B	1.10	35.83
MM 2	Panasonic 9210	1.75	4.5	19	15	23	13	10.53	18	L	1.05	30.83
MM 3	Siemens C-35	1.33	5.0	13	17	12	23	9.11	18	R	0.91	31.67
MM 4	Nokia 3310	1.24	5.0	11	6	13	2	2.58	15	R	0.91	43.33
MM 5	Samsung 620	1.38	5.0	14	15	15	13	6.75	17	R	0.77	52.50
MM 6	Nokia 3310	1.24	5.0	28	20	25	13	16.00	12	R	0.91	40.00
MM 7	Nokia 5110	1.45	5.0	14	16	16	31	12.00	14	R	0.80	28.33
MM 8	Nokia 3310	1.24	5.0	11	3	12	16	2.16	13	R	0.74	29.17
MM 9	Nokia 3315	1.47	3.5	35	25	14	9	11.92	13	B	0.81	26.67
MM 10	Nokia 3315	1.47	3.0	15	13	13	4	4.12	18	R	0.72	26.67
MM 11	Nokia 3310	1.24	3.0	11	3	13	11	2.93	12	L	0.60	28.33
MM 12	Nokia 3310	1.24	3.0	13	14	13	11	5.38	14	B	0.85	20.00
MM 13	Samsung N-500	1.21	4.0	13	13	8	23	6.72	13	R	0.90	27.50
MM 14	Panasonic 9215	1.92	3.5	13	8	12	12	4.20	13	L	0.85	21.67
MM 15	Nokia 3315	1.47	3.5	25	13	15	13	9.15	17	R	0.84	26.67
MM 16	Samsung AR-220	1.56	3.5	35	25	10	12	10.83	16	R	0.77	
MM 17	Samsung AR-220	1.56	3.0	16	18	8	9	4.83	15	R	0.66	
MM 18	Nokia 3315	1.47	4.0	15	22	8	20	9.33	14	R	0.59	
MM 19	SonyCMB-1200	1.39	3.0	14	15	11	13	5.82	13	R	0.73	
MM 20	Siemens C-35	1.33	4.0	17	13	5	9	3.37	13	L	0.90	
MM 21	Nokia 3315	1.47	4.5	25	20	24	14	14.67	18	R	0.85	
MM 22	Nokia 3315	1.47	3.0	18	30	26	16	15.80	15	R	0.77	
MM 23	Motorola Startac-130	0.1	3.0	14	13	7	18	5.53	12	R	0.68	
MM 24	Samsung AR-220	1.56	3.5	13	4	13	9	3.41	18	R	0.88	
MM 25	Samsung AR-220	1.56	3.0	23	18	4	9	4.23	18	R	0.83	
TOTAL (n=25 for MNT; n=15 for PBL)										0.82**±0.094	31.28**±10.29	
Control (n=25 for MNT; n=15 for PBL)										0.06±.0003	10.66±4.59	

[a] L-left ear, R-right ear, B-both ears

** - Highly significant when compared to total control group ($P<0.05$ and $P<0.01$; Student's 't' test)

Gandi & Singh, Cytogenetic Data on Controls, 2005

Table 2: General information of and cytogenetic damage in normal healthy individuals -control group

Subject Code	*Age (yr.)*	*Socio-economic status*	*Alcohol Intake ml/wk*	*Smoking (Cig/day)*	*Non-Veg gm/day*	*Micro-nucleated cells (%)*	*Aberrant meta-phases (%)*
MC 1	20	Middle	500	-	250	0.06	14.00
MC 2	27	Middle	500	-	250	0.06	10.00
MC 3	48	High	-	-	-	0.06	9.47
MC 4	21	Middle	750	-	250	0.06	8.42
MC 5	24	Middle	400	-	-	0.12	11.00
MC 6	26	Middle	400	-	250	0.06	6.00
MC 7	28	Middle	-	-	-	0.06	15.00
MC 8	45	Middle	-	-	400	0.11	9.00
MC 9	18	Middle	400	-	400	0.06	11.58
MC 10	32	Middle	-	-	400	0.06	8.00
MC 11	25	Middle	-	-	-	0.05	15.00
MC 12	23	Middle	400	-	250	0.06	9.00
MC 13	29	High	400	-	-	0.11	8.42
MC 14	45	Middle	-	-	-	0.06	12.00
MC 15	35	High	750	-	250	0.05	13.00
MC 16	45	Middle	-	-	250	0.00	
MC 17	45	High	750	2-3	250	0.11	
MC 18	21	Middle	500	-	250	0.00	
MC 19	45	Middle	-	4-7	-	0.06	
MC 20	32	Middle	750	-	500	0.06	
MC 21	30	Middle	750	-	-	0.05	
MC 22	28	Middle	-	-	250	0.00	
MC 23	50	Middle	750	-	250	0.10	
MC 24	25	Middle	-	-	250	0.05	
MC 25	40	Middle	750	-	250	0.06	
TOTAL (n=25 for MNT; n=15 for PBL)						0.06±.0003	10.66± 4.59

- **Increased number of micro nucleated buccal cells and cytological abnormalities in cultured lymphocytes**
- **Indicating the genotoxic response from mobile phone use.**

Ranges of Cytogenetic Damage in non-users compared to heavy users of mobile phones (Gandhi & Singh 2005)

	%Micro-nucleated cells	*%Aberrant Metaphases*
Control	***0.00-0.12%***	***6.00-15.00%***
Exposed	***0.59-1.10%***	***20.00-52.50%***

range of values obtained highly significant

2. Genetic damage in mobile phone users: some preliminary findings

Gandhi Gursatej, Ind J Hum Genet (2005) 11: 99-104 24 users/ 11 controls

Subject code	Brand & Model No.	Saw W/kg.	Duration of use year	Daily frequency of calls (No.) In	Daily frequency of calls (No.) Out	Duration of calls (min) In	Duration of calls (min) Out	Kept on On mode hour	Phone attend-ence (ear)	Placement of phone: on move	Placement of phone: at Home	Placement of phone: In Hand	Placement of phone: Shirt Pocket	Placement of phone: In Office	Occupation	Health effect	MN test: Mnd cells/ 2000 cells scored (%)	SCGE assay: Damaged cells average DNA (%)	SCGE assay: Migration Length (μm)
A 1f	Nokia 3310	1.27	3	20	5	20	10	24	R	Bag	Bedside	L	–	–	Student	–	–	27	26.14
A 2f	Ericssion LX-588	1.51	5	6–8	5–6	20–25	20–25	24	R	Bag	Table	L	–	–	Student	–	7 (0.35)	46	29.09
A 3f	Samsung 210	1.56	2.5	6–7	5–6	15	5	24	R	Bag	Table	R	–	Table	Research fellow	–	–	24	30.33
A 4	Panasonic GD 70	0.99	3	4	10–12	2–3	2–3	24	R	Pocket	Table	R	Yes	Drawer	Sales executive	Heart pain	5 (0.25)	56	20.14
A 5	Nokia C 131	0.87	2.5	6	10–15	2–3	1	24	L	W. pouch	Table	R	–	Belt	Mechanic	Heart pain	3 (0.15)	32	31.12
A 6	Panasonic	0.99	3	30–35	20–25	7–8	4–5	24	R	T. pocket	Belt	R	Yes	B. pocket	Business	–	7 (0.35)	48	16.91
A 7	Nokia 6210	1.45	4	70–75	60–65	1–2	1–2	24	R	B. pocket	Table	R	Yes	B. pocket	Sales executive	–	9 (0.45)	58	19.83
A 8	Samsung 220	0.59	2	5–6	5–6	3	2	18	R	W. pouch	Belt	L	No	Belt	Business	–	2 (0.10)	63	27.74
A 9	Nokia 3310	1.24	2	15–17	10–12	30	15	24	L	T. pocket	Table	R	Yes	Trousers	Customer care service	–	10 (0.50)	49	28.89
A 10	Nokia 3315	1.47	3	10–15	5–6	1–2	1–2	24	L	Pocket	Table	R	Yes	Table	Business	Sleeplessness, memory loss	6 (0.30)	33	25.09
A 11	Nokia 3310	1.24	2.5	16–20	4	20–30	10	24	R	Pocket	Table	R	Yes	–	Unemployed	–	–	28	28.50
A 12	Nokia 3310	1.24	4	6–7	3–4	20	10	24	R	Pocket	Bedside	R	Yes	Table	Business	–	4 (0.20)	43	31.86
A 13	Nokia 3315	1.47	2	5–6	2–3	25–30	2–3	18	L	T. pocket	Table	R	No	Pocket	Field work	–	3 (0.15)	57	26.87
A 14	Nokia 3315	1.47	2.5	4–5	2–3	5–10	5–7	16	R	Pocket	TV	R	Yes	Drawer	Software analyst	–	2 (0.10)	26	26.61
A 15	Nokia 3310	1.24	2.5	20–22	13–15	1–2	1–2	24	L	Pocket	Pocket	R	No	Pocket	Marketing	–	3 (0.15)	47	26.08
A 16	Motorola C 350	1.36	3.5	15–20	4–5	10–15	2	24	R	Pocket	Pocket	L	No	Table	Business	–	5 (0.25)	53	24.30
A 17	Nokia 3610	1.42	2.5	10–11	4–5	2–3	1–2	24	L	Pocket	Pocket	R	Yes	Pocket	Surveyor	–	7 (0.35)	26	28.46
A 18	Ericsson T 100	1.66	2.5	5–6	3–4	10	10–15	24	L	B. pocket	Table	R	No	–	Student	–	6 (0.30)	23	30.60
A 19	Samsung R 20	0.59	2	10–12	6–7	3	2	18	R	Pocket	Hand/pocket	R	Yes	Pocket	Medical representative	–	7 (0.35)	39	26.82
A 20	Nokia 3315	1.47	1	10–15	10–15	5–10	3–4	24	R	T. pocket	Hand	R	No	Table	Unemployed	–	3 (0.15)	42	24.47
A 21	Nokia 3310	1.24	2	10–15	4–5	2.25	0.5–1	24	R	T. pocket	Hand	L	No	Trousers	Hardware and networking engineer	–	–	58	28.06
A 22	Panasonic EB-GD 70	0.99	3	10–12	5–10	11.5	1.5	24	L	Pocket	Table	R	No	Pocket	Supervisor	–	4 (0.20)	18	29.77
A 23	Nokia 3310	1.24	3	10–20	10–12	10–15	5–10	24	R	Pocket	Shelf	R	No	Table	Business	–	–	21	28.33
A 24	Nokia 3110	1.27	3	15–20	10–12	10	5–7	24	R	Pocket	Table	R	No	Table	Business	–	–	39	26.17
A 25f	Samsung 220	0.59	1.5	10–20	4–5	45	10	24	L	Pocket	Table	R	No	–	Student	–	4 (0.20)	–	–
A 26f	LG 2030	1.55	2.5	8–10	3–4	2–3	1–2	24	R	W. pouch	Bedside	R	No	–	Student Less attentivity	Memory loss/	3 (0.15)	–	–
Total (n=20 for MNT; n=24 for SCGE)																	100/40,000 (0.25*** ±0.0006)	954/2400 (39.75***)	26.76*** ±0.054
Control (n=8 for MNT; n=10 for SCGE)																	8/16,000 (0.0005)	104/1,000 (10.40)	8.1 ±0.028

* L-left ear, R-right ear, B-both ears; f-female; B./T.pocket- breast/trousers pocket;W-waist

* - Significant when compared to total control group (P<0.05 and P<0.01; Student's 't' test)

- **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.**

Genetic Damage in Non-users vs. Mobile Phone Users (Gandhi, 2005)

	MN Test Mnd cells/ 2000 cells scored (%)	*SGCE assay Damaged Cells average DNA (%)*	*SGCE assay Migration length (µm)*
Control	***0.0005***	***10.40***	***8.1± 0.028***
Exposed	***0.25± 0.0006***	***39.75***	***26.76± 0.054***

non-overlapping range of values highly significant

3. Comparison of genetic damage in cell phone users and non-users

Rekhadevi et. al., Toxicol Int (2009) 16:09-19 (55 exposed/ 55 controls)

Table 2. Inter-group comparison of mean DNA damage (comet tail length in mm), micronucleus frequency (buccal cells and lymphocytes) and chromosomal aberrations in controls and exposed subjects.

Group	n	DNAdamage (μm) (mean±S.D)	MN/1000 BN (mean±S.D)		CA(%) (mean±S.D)
			Buccal cells	Lymphocytes	
Control	55	7.45±0.98	1.63±0.55	3.36±1.09	1.32±0.47
Exposed	55	13.68±2.13*	3.03±0.94*	5.29±1.04*	2.41±0.87*

MN/1000 BN: Micronuclei /1000 Binucleated cells. *P<0.05

2 to 3 fold increased genetic damage of peripheral lymphocytes and buccal epithelial cells in mobile telephone users increased significantly, as compared with controls.

4. **2.45ghz (cw) microwave irradiation alters circadian organization, spatial memory, DNA structure in the brain cells and blood cell counts of male mice, Mus musculus**

Chaturvedi et. al., Electromagnetics Research B (2011) 29: 23-42.

Male Mice exposed (2 h/day x 30 days, 2.45 GHz)

- **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. Effect of 3G Cell Phone on heat shock proteins/p38MAPK in Rat Brain

Kesari et. al., Cell Biochem Biophys. 2014; 68(2):347-58.

Male Wistar Rats (2 h/day x 60 days, 3G mobile)

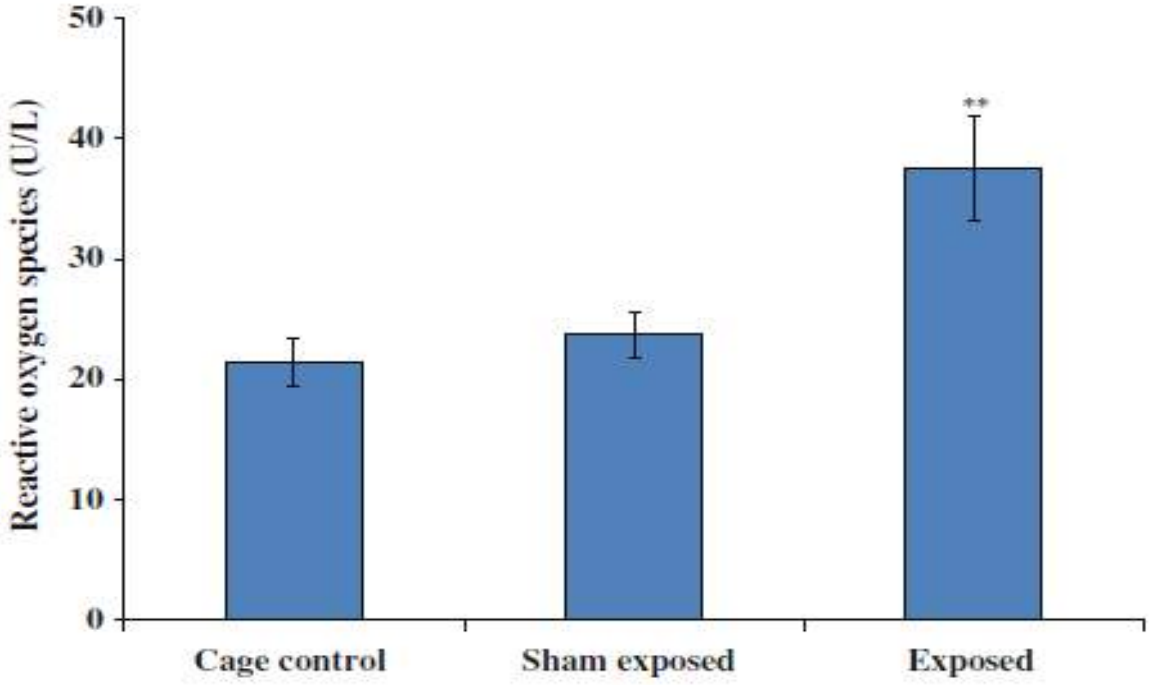
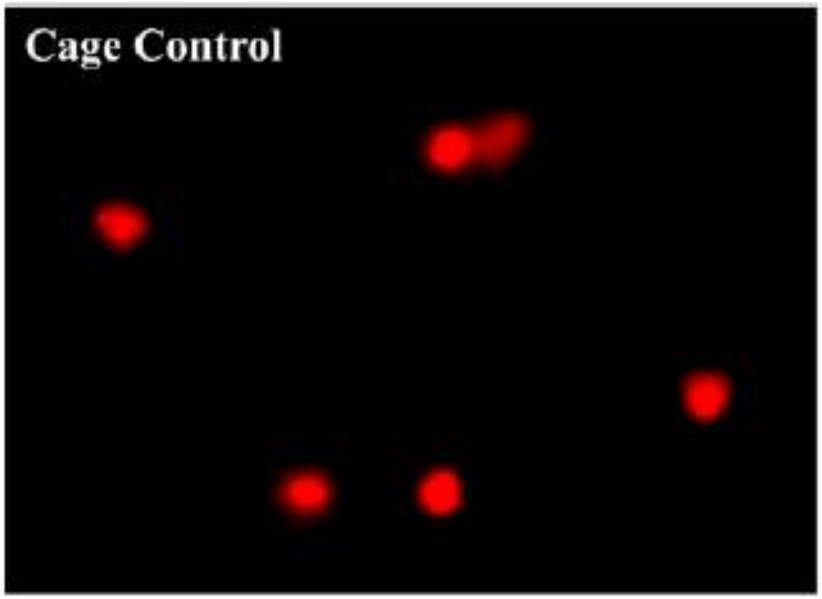
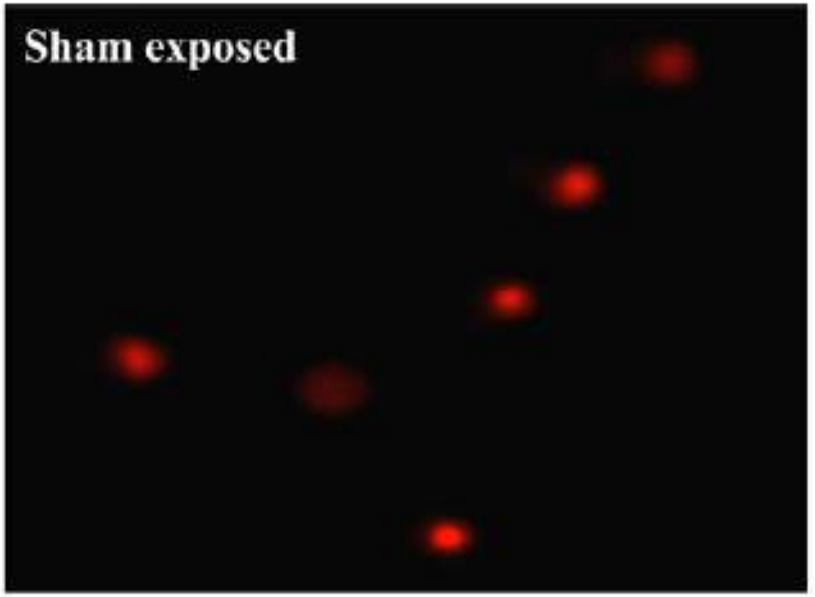
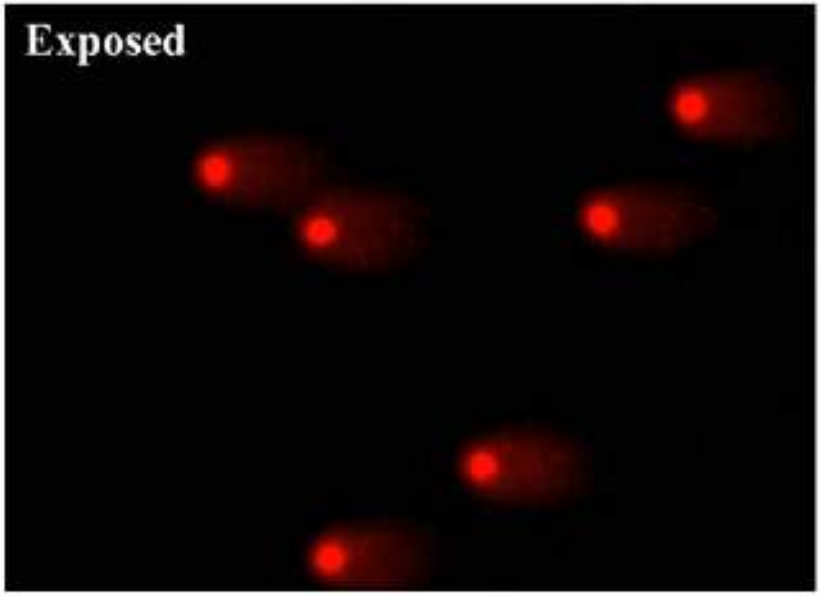


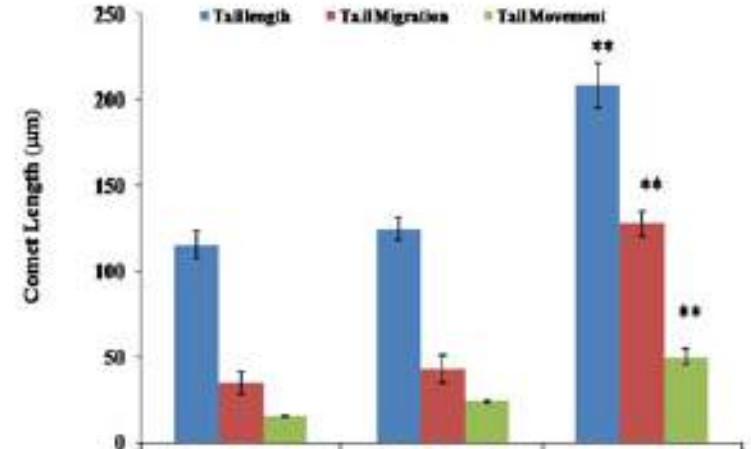
Fig. 2 Comparative reactive oxygen species level in brain of sham exposed, cage control, and 3G mobile-exposed Wistar rat measured by DEPPD assay. ROS is expressed in units. One unit is equal to 1 mg/l H_2O_2. ROS value is calculated from standard curve. *Asterisks* indicates statistically significant results with statistical variation of mean ± SD

Kesari et al, 2014, rat brain comet assay



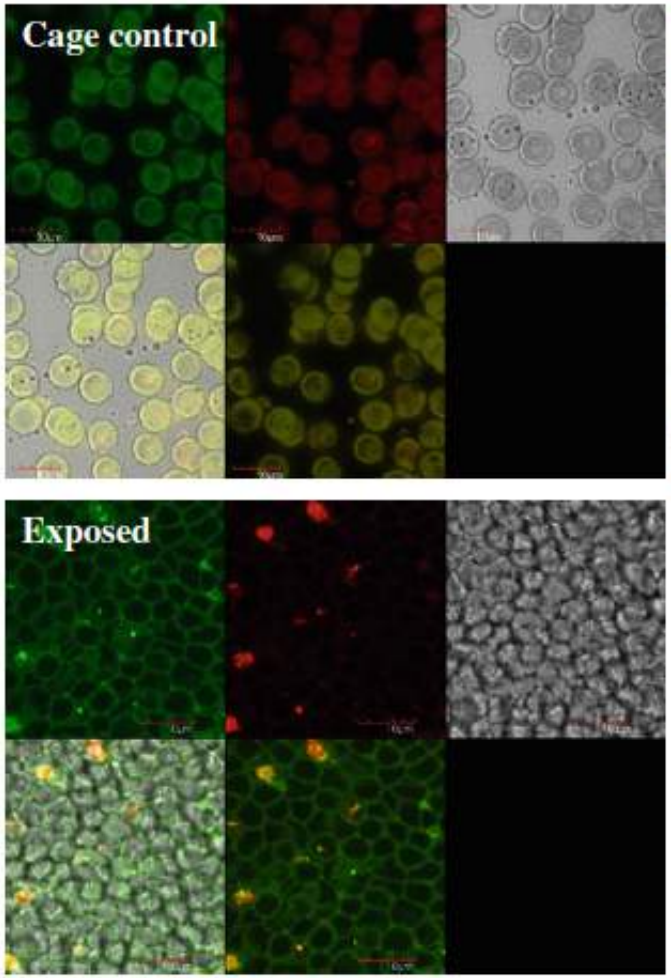






	Cage Control	Sham Exposed	Exposed
Tail length	115.12	124.7	208.35
Tail Migration	34.57	42.79	127.44
Tail Movement	15.13	23.58	49.91

Kesari et al; 2014 – Micronucleated polychromatic erythrocytes rat



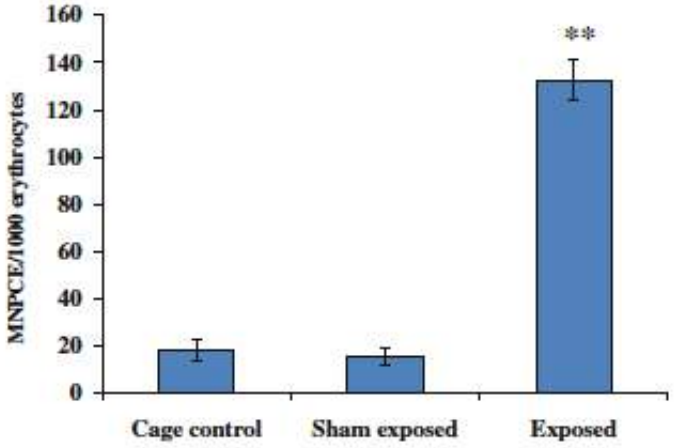


Fig. 4 Micronucleated polychromatic erythrocytes (MNPCE) cells of 3G mobile phone exposed, sham exposed, and cage control stained with Acridine orange. The *graph* indicates number of MNPCE among all three groups. *Asterisks* indicates statistically significant result with statistical variation of mean ± SD

Kesari et al 2014 reduced caspase after cellphone exposure

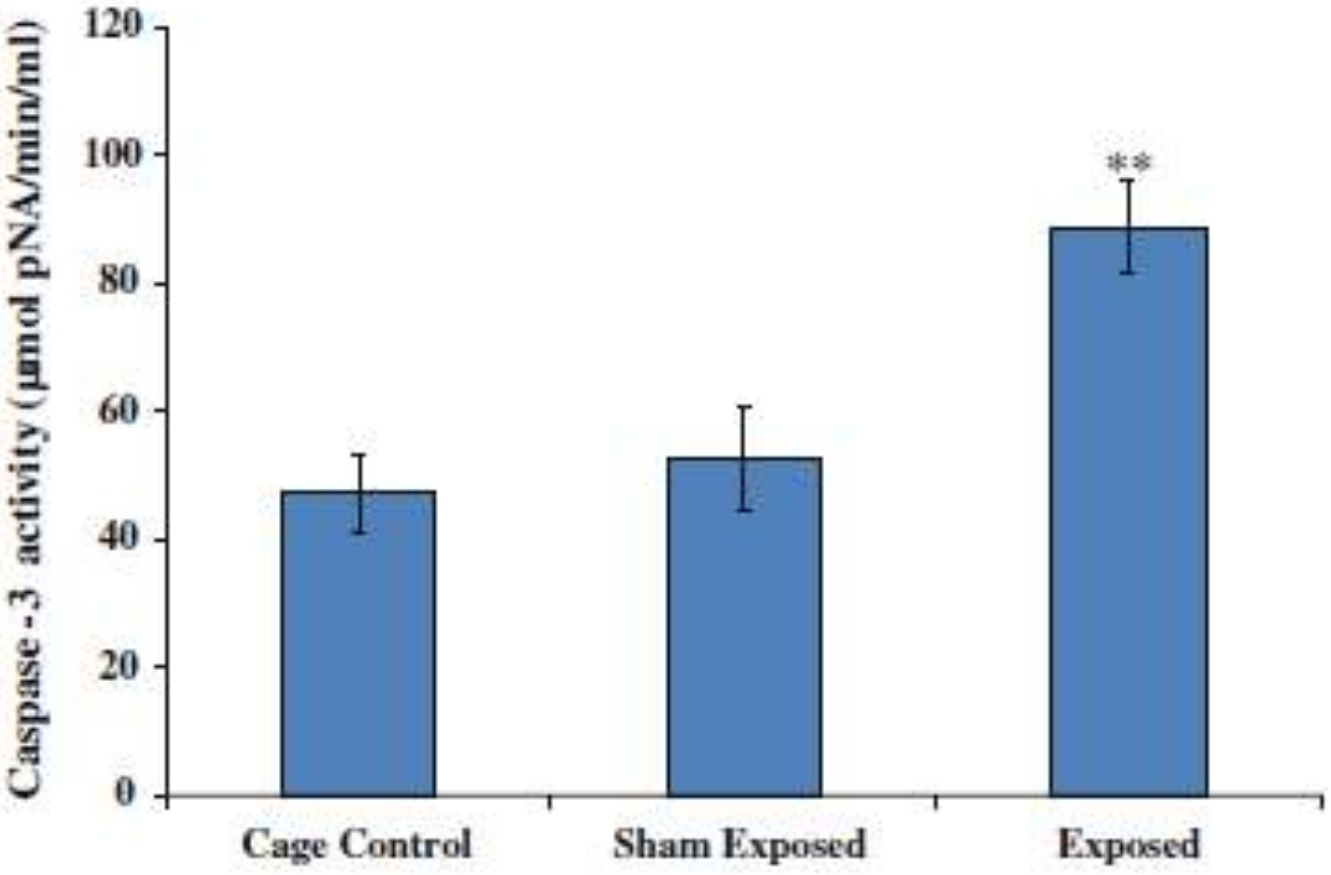


Fig. 6 The comparison of caspase 3 activity among the cage control, sham exposed, and exposed groups. Caspase 3 activity is expressed as µmol pNA/min/ml. *Asterisks* indicates statistically significance result with statistical variation of mean ± SD

Oxidative stress activates a variety of cellular signal transduction pathways.

- Radiation emitted from 3G mobile phone significantly induced DNA strand breaks in neurons.
- Significant increase in micronuclei, caspase 3 and apoptosis
- Increase phosphorylation of hsp27, hsp70, and p38 mitogen-activated protein kinase (p38MAPK) leads to mitochondrial dysfunction-mediated cytochrome c release and subsequent activation of caspases and apoptosis.

Reproductive Alteration

6. Mobile phone usage and male infertility in Wistar Rats

Kesari et. al., Indian Journal of Experimental Biology (2010) 47:987-992.

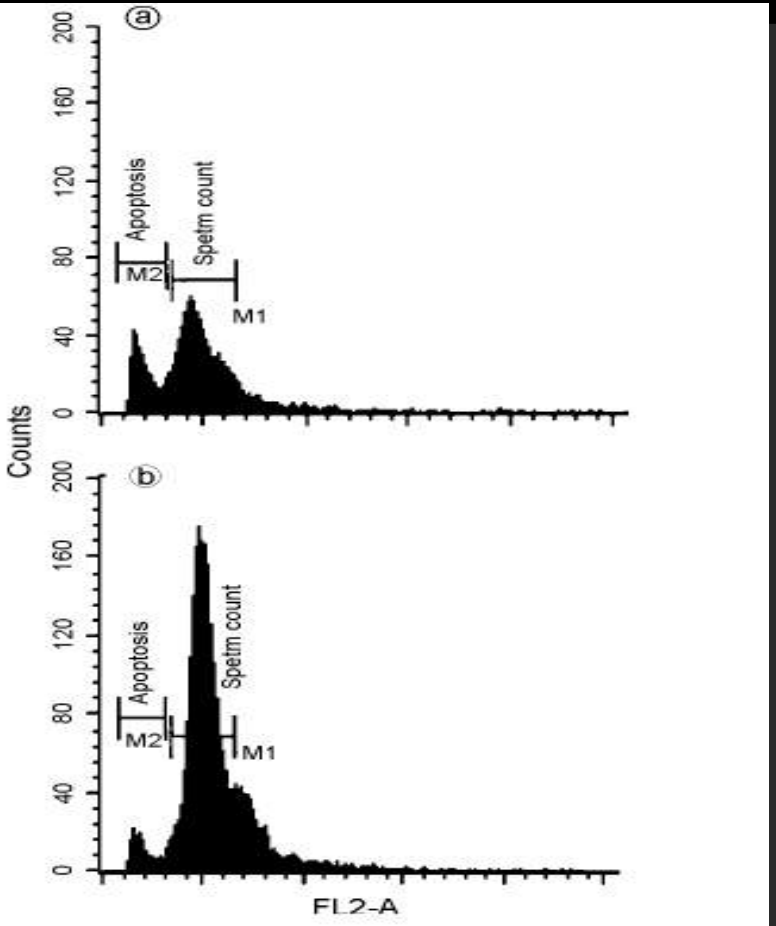


Fig. 2— Flow cytometry analysis of mobile phone exposed (a) and sham exposed (b) sperm. Sample shows comparative analysis of apoptotic and total sperm cell count. Histogram of fluorosphere blue-fluorescence (FL2-A) used to count the total apoptotic cells (M2) and total sperm cell count (M1).

- **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 wistar rats (2 h/day x 35 days at 0.9 W/kg SAR).**
- **Significant reduction in testicular size, weight and sperm counts.**

8. Mobile Phone Electromagnetic Waves and Its Effect on Human Ejaculated Semen: An *in vitro* Study

Veerachari SB, Vasan SS., Int J Infertility Fetal Med 2012;3(1):15-21.

n=20 Healthy Volunteers, semen sample exposed to 60 mins., cell phone kept at 2.5 cm

Table 2: Comparison of sperm parameters, ROS and DFI between exposed and unexposed samples of the study and control samples

Variables	*Intervention*	*Study sample*	*Control sample*
Sperm count (millions/ml)	Preexposure	50.65 ± 16.96	51.10 ± 17.55
	Postexposure	50.55 ± 17.16	51.00 ± 17.39
	p-value	0.428	0.163
Viability (%)	Preexposure	51.30 ± 5.77	51.30 ± 5.77
	Postexposure	47.70 ± 5.24	50.78 ± 5.98
	p-value	<0.001**	0.042*
Motility (%)			
• Progressive	Preexposure	33.15 ± 6.12	32.05 ± 6.21
	Postexposure	25.70 ± 4.86	31.80 ± 6.10
	p-value	<0.001**	0.276
• Nonprogressive	Preexposure	19.90 ± 7.12	20.35 ± 7.73
	Postexposure	20.05 ± 6.17	20.50 ± 6.58
	p-value	0.404	1.000
• Immotile	Preexposure	46.95 ± 9.28	47.60 ± 9.46
	Postexposure	53.80 ± 7.95	47.85 ± 8.91
	p-value	<0.001**	0.285
• Total motility (progressive and nonprogressive)	Preexposure	53.05 ± 9.29	52.4 ± 9.46
	Postexposure	45.75 ± 7.49	52.3 ± 8.97
	p-value	0.035*	1.000
ROS ($\times 10^6$ cpm)	Preexposure	31.75 ± 26.03	31.70 ± 25.76
	Postexposure	38.10 ± 27.51	33.05 ± 26.73
	p-value	<0.001**	<0.001**
DFI (%)	Preexposure	42.35 ± 16.01	42.86 ± 15.94
	Postexposure	49.80 ± 18.22	43.55 ± 16.76
	p-value	<0.001**	0.059***

*Moderately significant (p-value: $0.01 < p \leq 0.05$)
**Strongly significant (p-value: $p \leq 0.01$)
***Suggestive significance (p-value: $0.05 < p < 0.10$)

- **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.

9. Melatonin reduces oxidative stress in male Wistar rats

Meena et. al., Electromagn BioL Med. 2014; 33(2):81-91.

n=6 in each four groups, 2 hrs./day for 45 days with 2.45 GHz

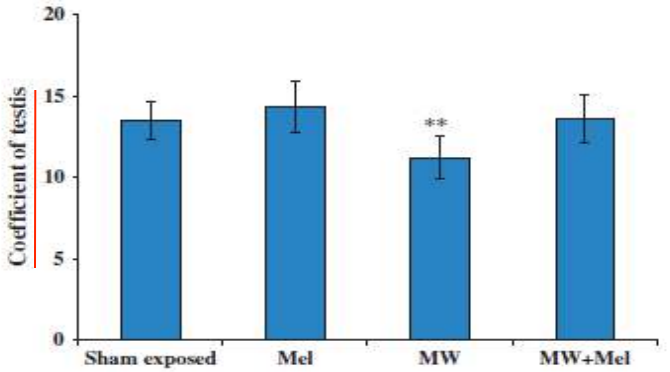


Figure 1. Coefficient of testis is the ratio of weight of the testis (mg) to animal weight (g). Legends indicate the organs types. **Statistically significant at $p = 0.01$, (versus sham exposed and Mel).

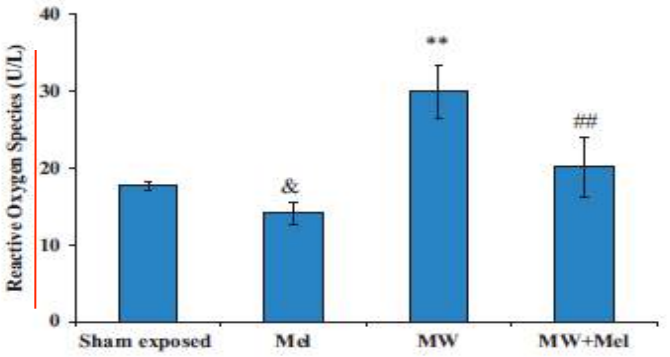


Figure 2. The preventive effects of melatonin (Mel) on reactive oxygen species (U/L) in the rat testis exposed to microwave radiation. $**p<0.001$ (versus sham exposed and Mel), $\#\#p<0.001$ (versus MW), $\&p<0.05$ (versus sham exposed).

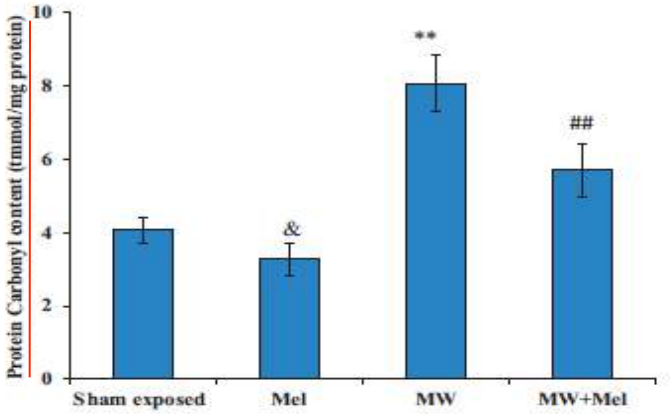


Figure 3. Concentration of carbonyl groups (μmol/g protein) in the rat testis exposed to microwave radiation (MW). $**p<0.001$ (versus sham exposed and Mel), $\#\#p<0.001$ (versus MW), $\&p<0.01$ (versus sham exposed).

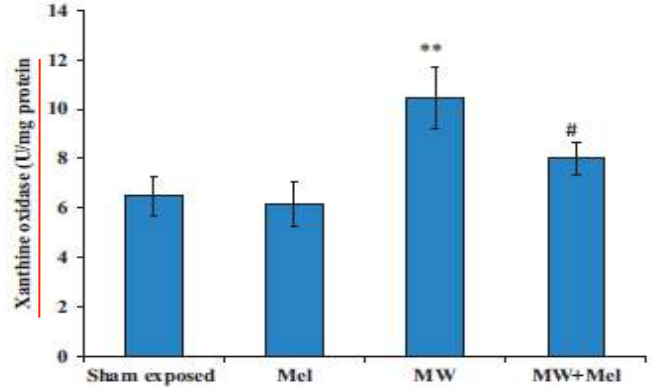
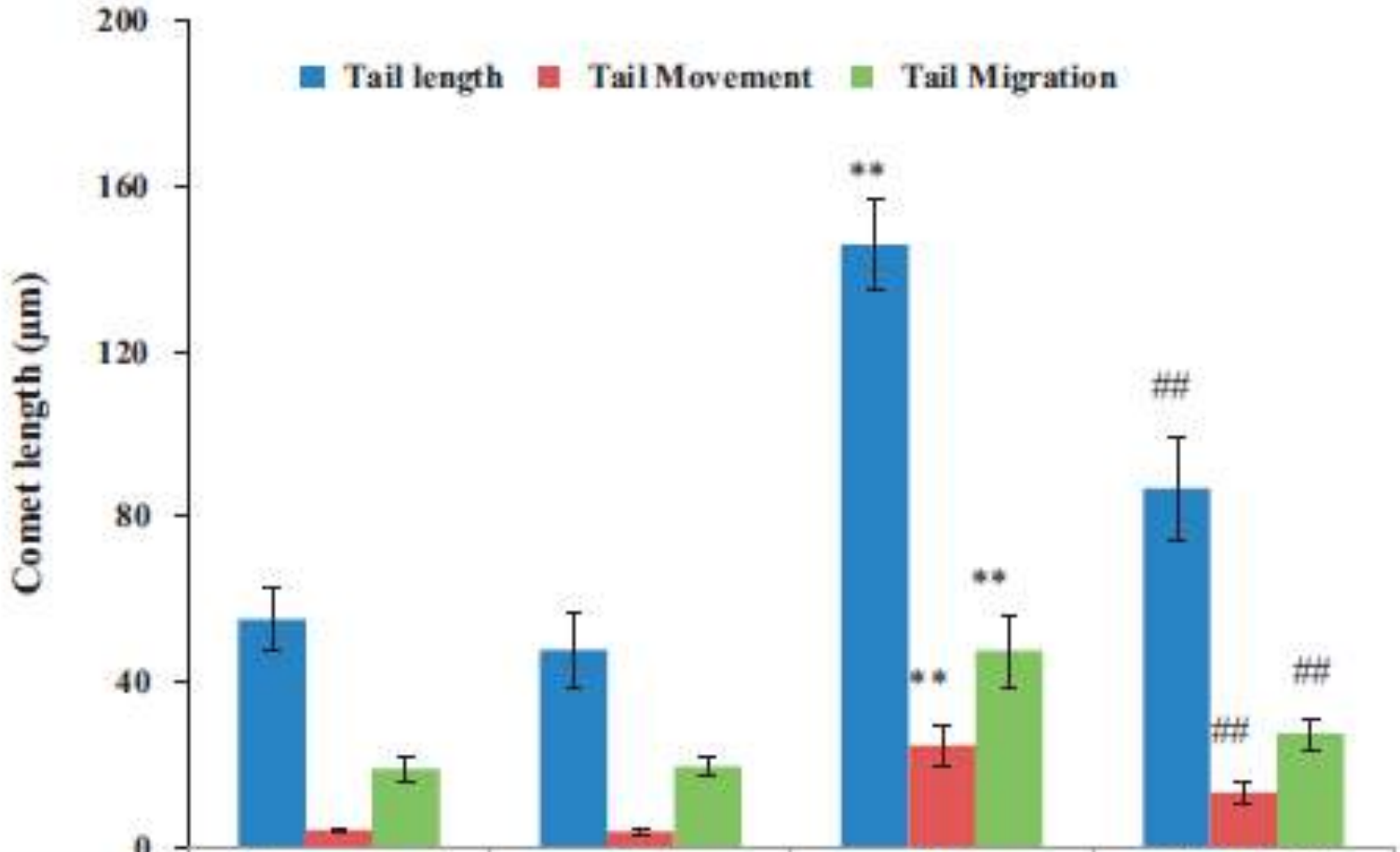


Figure 4. Xanthine oxidase (XO) activities (U/g protein) in testis tissues of rats exposed to microwave. $**p<0.001$ (versus sham exposed and Mel), $\#p<0.01$ (versus MW).



	Sham exposed	Mel	MW	MW+Mel
Tail length	55.1	47.58	145.68	86.66
Tail Movement	4.033	3.59	24.43	13.04
Tail Migration	18.73	19.48	47.39	27.26

Figure 7. Quantitative analysis of DNA strand breaks in sperm cells of microwave exposed wistar rats. $^{**}p < 0.001$ (versus sham exposed and Mel), $\#\#p < 0.01$ (versus MW).

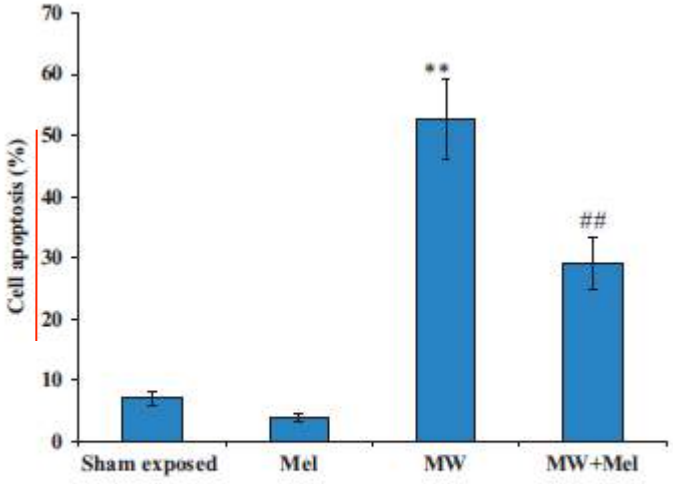


Figure 9. The effects of melatonin (Mel) on sperm cell apoptosis in wistar rat exposed to microwave radiation. $^{**}p < 0.001$ (versus sham exposed and Mel), $^{\#\#}p < 0.001$ (versus MW).

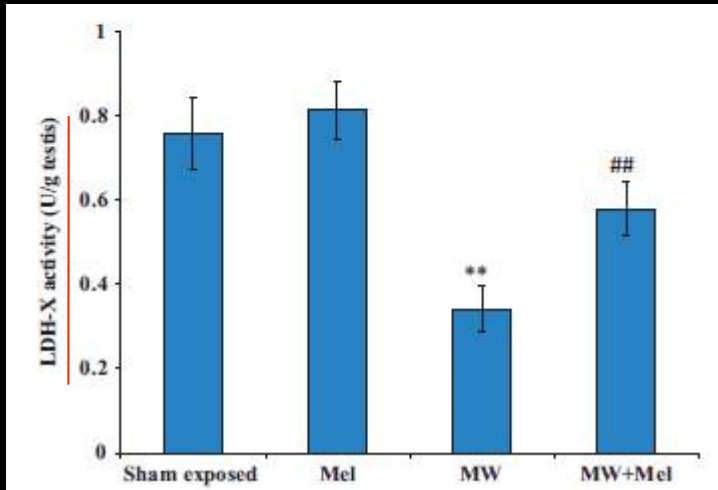


Figure 10. Effect of microwave exposure on testicular LDH-X activity (U g^{-1} testis) in Wistar rats. $^{**}p < 0.001$ (versus sham exposed and Mel), $^{\#\#}p < 0.001$ (versus MW).

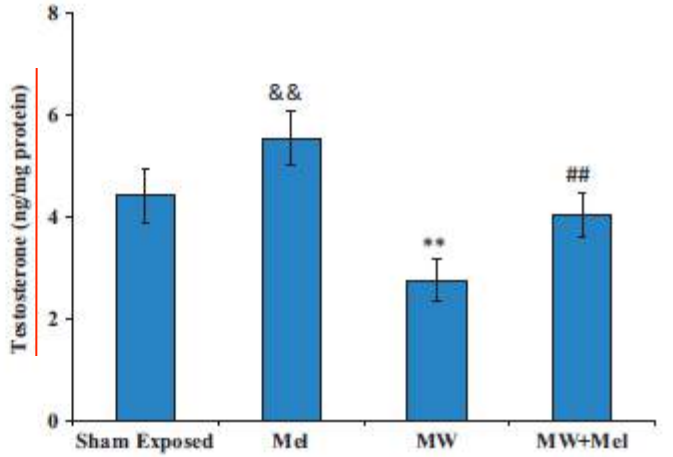


Figure 11. Level of testosterone (ng/mg protein) in the rat testis exposed to microwave radiation (MW). $^{**}p < 0.001$ (versus sham exposed and Mel), $^{\#\#}p < 0.001$ (versus MW), $^{\&\&}p < 0.001$ (versus sham exposed).

- **Melatonin prevents oxidative damage biochemically by significant increasing 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.**
- **Melatonin has strong antioxidative potential against MW induced oxidative stress mediated DNA damage in testicular cells.**

10. **2.45-GHz microwave irradiation adversely affects reproductive function in male mouse, *Mus musculus by inducing oxidative and nitrosative stress***
Shahin et. al., Free Radic Res. 2014; 48(5):511-25.

n=20 in each two groups, 2 hrs./day for 30 days with 2.45 GHz

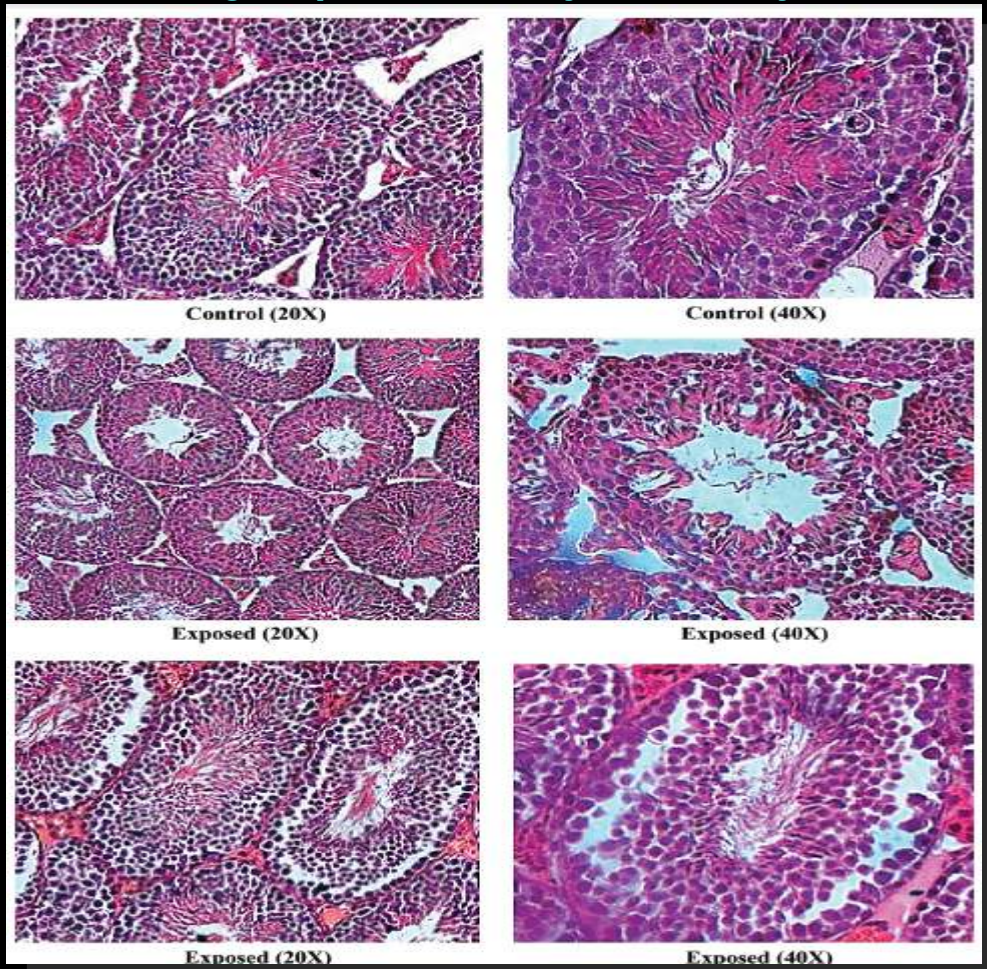


Figure 2. Transverse Section of testis of microwave-irradiated mice (H&E staining). Note significant decrease in the seminiferous tubule diameter and damaged seminiferous epithelium as well as degenerated Leydig cells in the testis of exposed mice (middle and lower panel) compared to that of control (upper panel) Germ cell of exposed mice have a degenerated appearance in the epithelium. Formation of gaps were also seen between the peripheral layers of spermatogonial cells in the seminiferous tubules of nonthermal low-level 2.45-GHz microwave-irradiated mice.

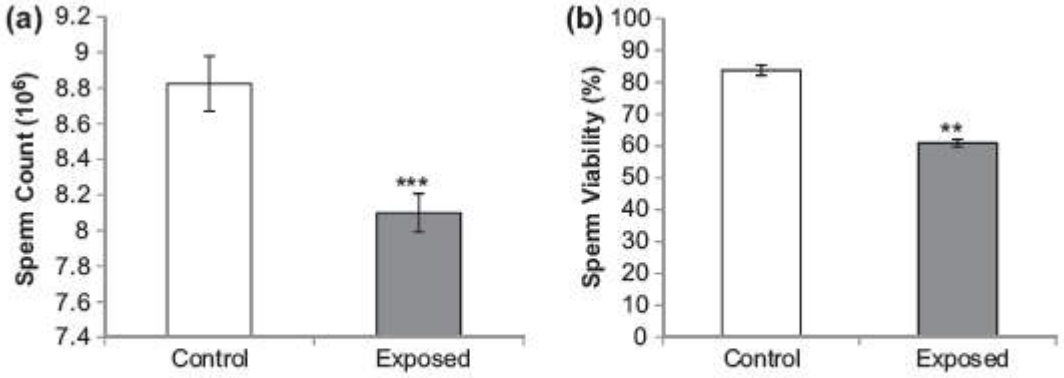


Figure 3. Effect of 2.45-GHz microwave (MW) irradiation on the (a) sperm count and (b) sperm viability of mice. MW irradiation significantly decrease the number of sperm along with increased number of dead sperm compared to that of control. Data are presented as mean ± standard deviations ($n = 15$). Significance of difference from control, $^{**}p < 0.01$, $^{***}p < 0.001$.

- **Microwave irradiation induced a significant decrease in sperm count and sperm viability along with a decrease in seminiferous tubule diameter and degeneration of seminiferous tubules in mice.**
- **Reduced testicular 3β HSD activity and plasma testosterone levels**
- **Increased expression of testicular induced Nitric Oxide Synthase (i-NOS)**

These adverse reproductive effects suggest that chronic exposure to nonionizing MW radiation may lead to infertility via free radical species-mediated pathway.

Biomarkers alteration

11. Pathophysiology of Microwave Radiation: Effect on Rat Brain

Kesari et. al., Appl Biochem Biotechnology (2012) 166:379-388.

n=6 in each two groups, 2 hrs./day for 45 days with 2.45 GHz

Table 1 Data for biochemical studies between exposed and sham-exposed rats

Parameters	Sham exposed	Exposed	*P* value
Melatonin (pg/mg of protein)	81.03±8.01	53.56±9.20	<0.001
Creatine kinase activity (IU/mg of protein)	1.12±0.17	1.80±0.11	<0.012
Caspase 3 activity (µmol pNA/min/ml)	44.05±1.43	46.83±1.83	0.015
Calcium ion concentration (PPM)	0.17±.004	0.33±0.01	0.001

- 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

12. Biochemical Changes in Rat Brain Exposed to Low Intensity 9.9 GHz Microwave Radiation

Paulraj and Behari, Cell Biochem Biophys (2012) 63:97-102.

n=8 in each two groups, 2 hrs./day for 35 days with 9.9 GHz PD=0.125 mW/cm^2

- **This study revealed that chronic exposure of rat to microwave radiation alter the activity of certain enzymes.**
- **Significant increases in calcium ion efflux and the activity of Ornithine Decarboxylase (ODC).**
- **Significant decreases in Protein Kinase C (PKC) activity.**

Since these enzymes are related to growth, therefore any alteration in them may affect brain functioning and development.

13. Hsp70 Is an Independent Stress Marker Among Frequent Users of Mobile Phones

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

TABLE 1: Demographics and Basic Health Parameters of Study Subjects

Variables	IFUMPs (n = 102)	FUMPs (n = 120)	P Value
Age, years (range)	39.5 (18–70)*	29.1 (19–57)*	—
Male	38.1 (1867)*	29.6 (1957)*	—
Female	44 (22–70)*	24 (22–30)*	—
Duration of mobile phone use, years			
1–5	—	50	—
6–10	—	65	—
>10	—	5	—
Duration of minor ailments, years			
Headaches			
1–5	—	17	—
6–10	—	32	—
>10	—	3	—
Sleeping disturbances			
1–5	—	17	—
6–10	—	15	—
>10	—	2	—
Ear problems			
1–5	—	16	—
6–10	—	18	—
>10	—	0	—
Serum CRP concentration (mg/dL)	0.13 ± 0.12	0.17 ± 0.16	<0.04
Serum HSP70 concentration (ng/mL)	985.34 ± 227.18	1116.001 ± 269.86	<0.00012
Fold induction (*hsp70* gene expression)	1.06 ± 0.22	2.01 ± 1.30	$<7.06 \times 10^{-13}$

*- CRP, C-reactive protein; HSP, heat shock protein; IFUMP, infrequent user of mobile phones; FUMP, frequent user of mobile phones.

n=120 IT Employees FU

n=102 IFU non-IT Employees

- **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).**
- **Highly significant higher concentrations of serum HSP70 and CRP were observed among more highly exposed compared to controls.**
- **A higher level of *hsp70* gene expression was also observed**

- **Thus, the study convincingly demonstrated the role of serum HSP and CRP as systemic inflammatory biomarkers for mobile phone-induced radiation**

16. Prevalence of sensorineural deafness in habitual mobile phone users

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

- **Explored a possible relationship between prolonged mobile phone usage and sensorineural deafness in healthy volunteers in rural India.**
- **A total of 100 (62 M and 38 F) persons between the age group of 20-45 years using mobile phone for at least 5 years were selected and screened for sensorineural deafness.**

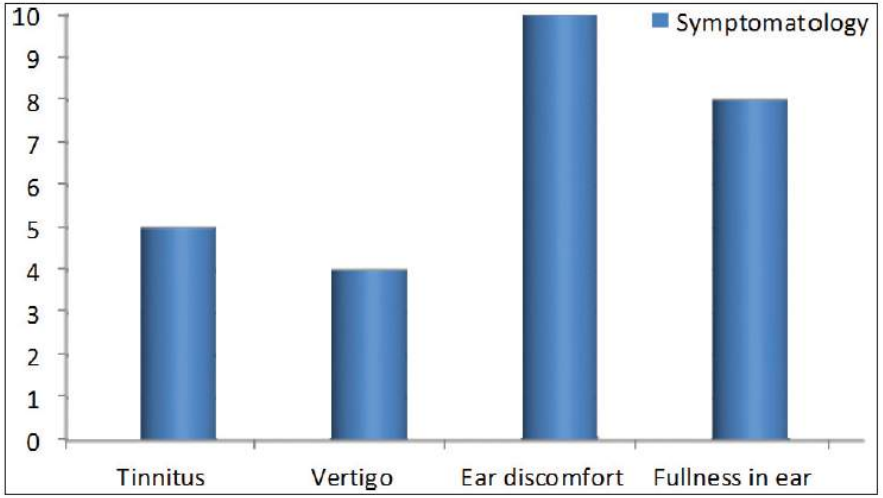


Figure 1: Symptomatology of subjects

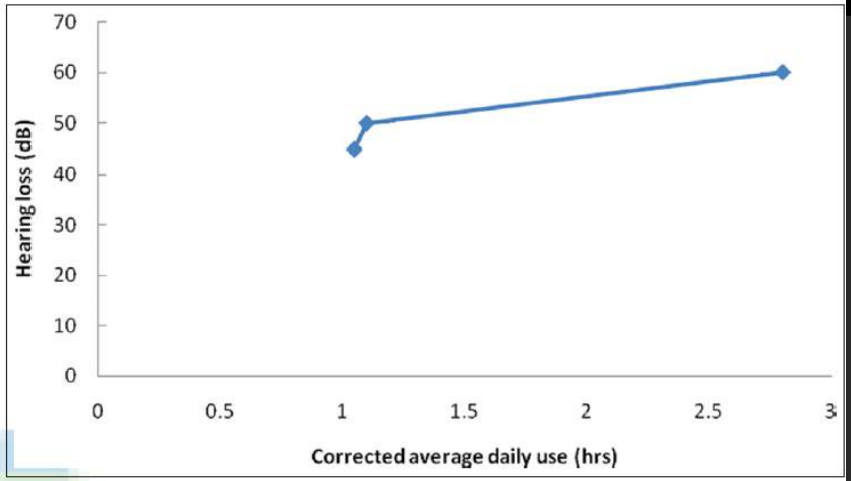


Figure 2: Relationship between average daily use and severity of deafness

- 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.

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

(iii). Policies & Guidelines in this area

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

Recommendations of the Inter-Ministerial Committee 9/1/2012

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.**

Recommendations of the Inter-Ministerial Committee 9/1/2012

Mobile Handsets: -

Mobile hand set manufactured and sold in India or Imported from other countries should be checked for compliance of SAR limit

No hand sets of SAR value above the prescribed standard adopted in India should be manufactured or sold in the country.

Additional Recommendations 2012

To bring awareness, the manufacturer's mobile handset booklet should contain the following for safe use:

6. 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.

Mobile Base Stations Indian Government Advice: -

The RF exposure limits in India have been lowered to 1/10th of the some international standards (ICNIRP)

Apart from self certification for compliance of radiation norms on EMF, mobile service providers should also measure the radiation level of certain prominent places and display it for information of the general public.

Department of Telecommunications (DOT) should create a national data base with the information of all the base stations, their emission levels, and display on public domain for public information.

No mobile towers installed 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

To conduct the long term scientific research related to health aspect of EMF radiation exposure and associated technologies in India in the following areas:

- Health effect of RF exposure in children.
- Health effect of RF exposure in Foetus, mothers and elderly persons.
- 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.

.

(iv). Public concern

Pulprilhad Pur, New Delhi

Rahugupta T-10B Pulprahilad Pur New Delhi


SPEECH & DRA
CERTIFICATE COU
PREMPURI


RELIANCE
RELIANCE
HAJIALI
HAJIALI
JUICE

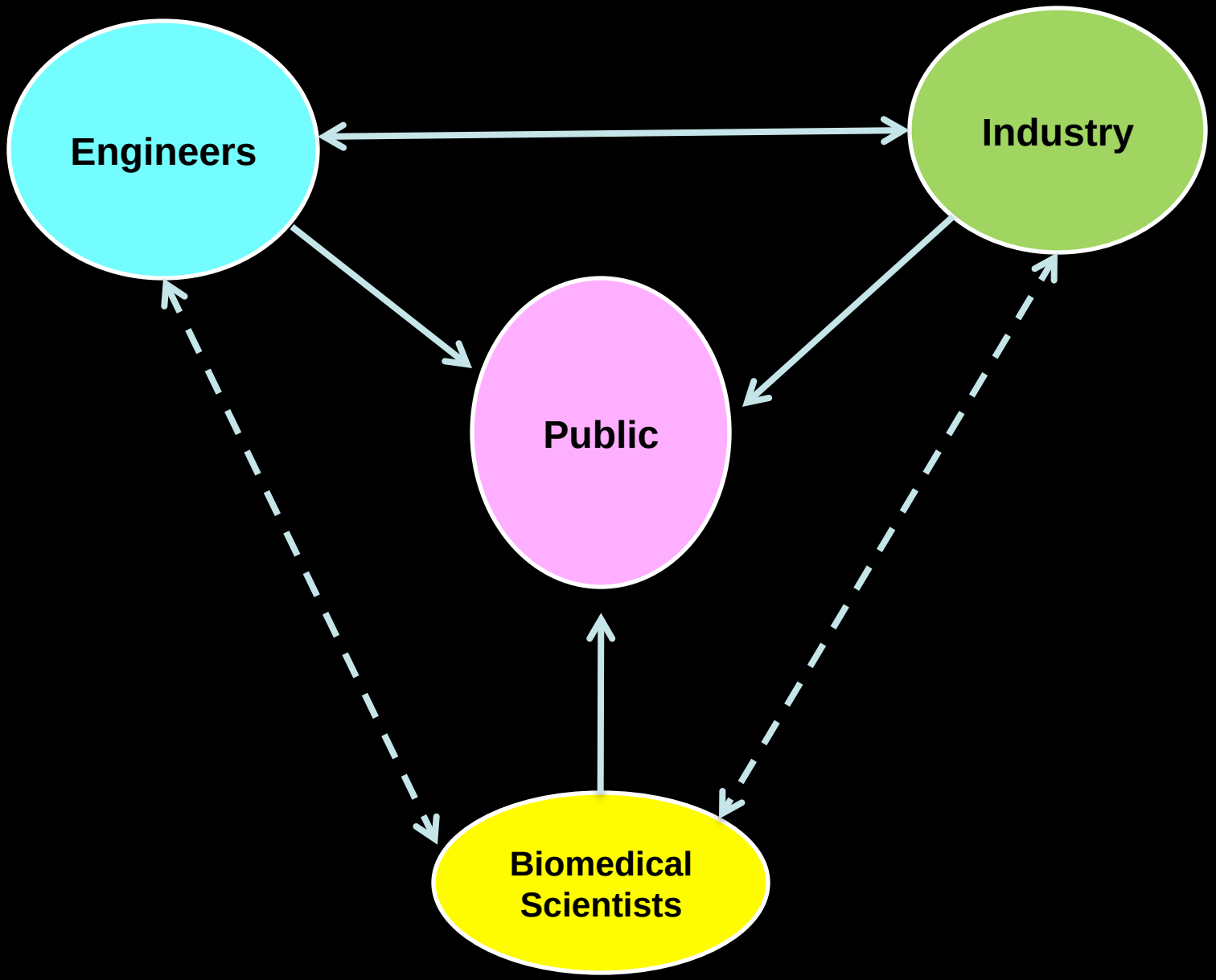
CASE STUDY Usha Kiran Building, Worli, Mumbai

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 —publication sponsorship bias?

	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. Authorities should acknowledge that cell phone and tower radiation has biological effects on humans and wildlife.

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

3. After these results are obtained, each country should develop health based precautionary guidelines to protect their population.

4. But till these results are available authorities should issue appropriate advisories to reduce or avoid adverse effects of radiation, if any.

Thanking you

radheyss@gmail.com