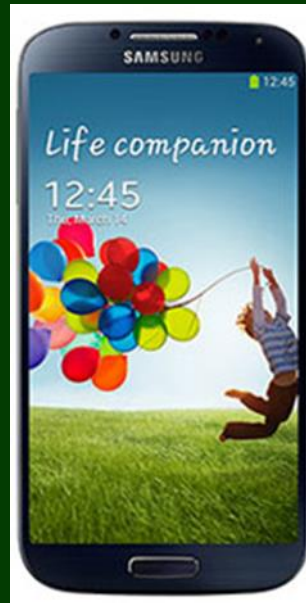


# Biological Effects of Low-intensity Radiofrequency Electromagnetic Radiation

## Time for a Paradigm Shift in Regulation of Public Exposure



**Priyanka Bandara PhD (UNSW), Steve Weller BSc (Monash)**  
Oceania Radiofrequency Scientific Advisory Association (ORSAA)

# RF-EMR Exposure has Skyrocketed!

Natural background RF-EMR:

$$<10^{-15} \text{ W/m}^2$$

100 – 200 m from Mobile Phone  
Base Station:

$$7.5 \times 10^{-2} \text{ W/m}^2$$

At 0.3m from a WiFi laptop :

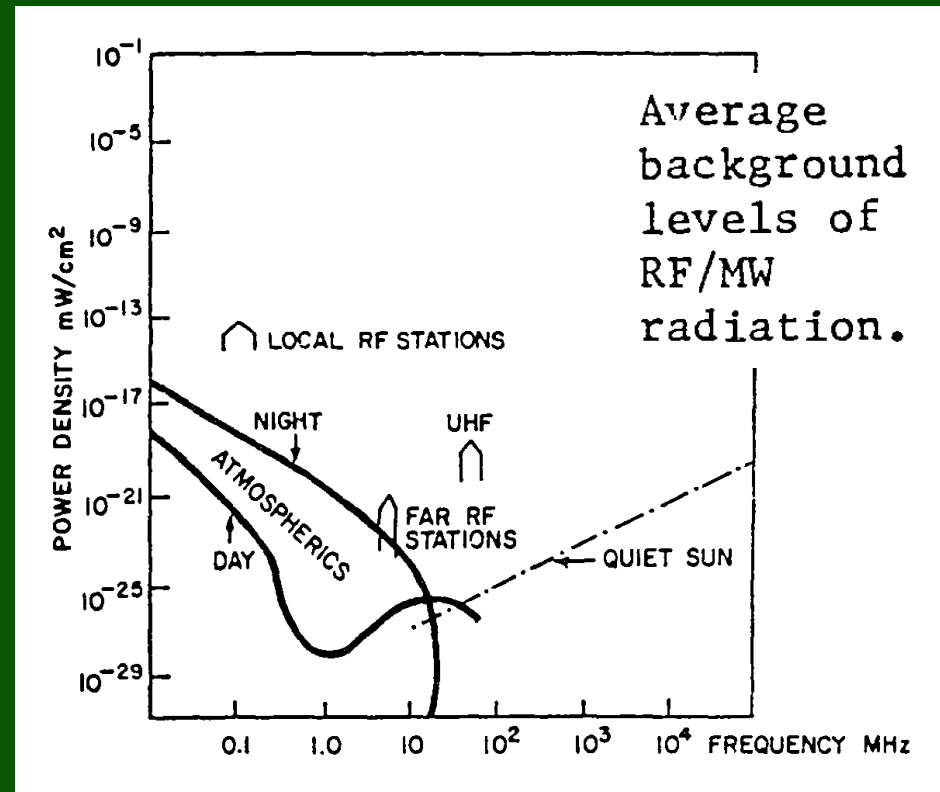
$$4.7 \times 10^{-2} \text{ W/m}^2$$

ARPANSA standard :

$$2 - 10 \text{ W/m}^2$$

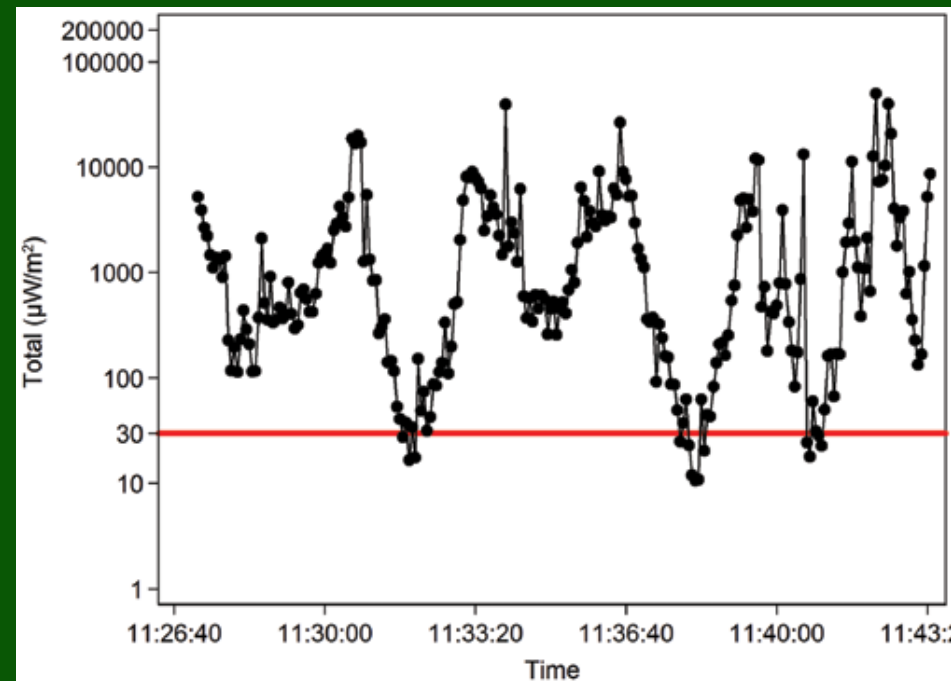
Bioinitiative recommendation:

$$3 \times 10^{-5} \text{ W/m}^2$$



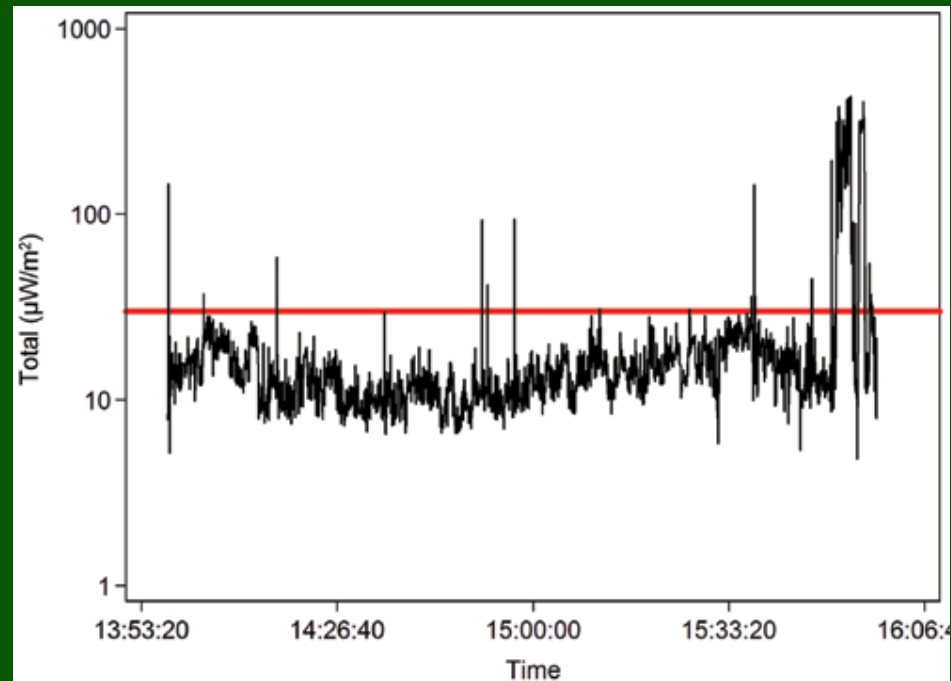
Raines, J. K. Electromagnetic field interactions with the human body: observed effects and theories. National Aeronautics and Space Administration (NASA), Goddard Space Flight Center, Greenbelt, Maryland 20771 (1981), Fig. 3, pp 9.

# RF-EMR Exposure Varies by Orders of Magnitude



RF exposure ( $\mu\text{W}/\text{m}^2$ ) at Stockholm Central Station, Sweden. Mean exposure 2,817  $\mu\text{W}/\text{m}^2$  ( $2.8 \times 10^{-3} \text{ W}/\text{m}^2$ ).

Red line: exposure limit of 30  $\mu\text{W}/\text{m}^2$  suggested by the Bioinitiative Report. 9 November 2015.



At the World Health Organization, Geneva, Switzerland. Mean 21.5  $\mu\text{W}/\text{m}^2$  ( $2.1 \times 10^{-5} \text{ W}/\text{m}^2$ ).

3 March 2017.

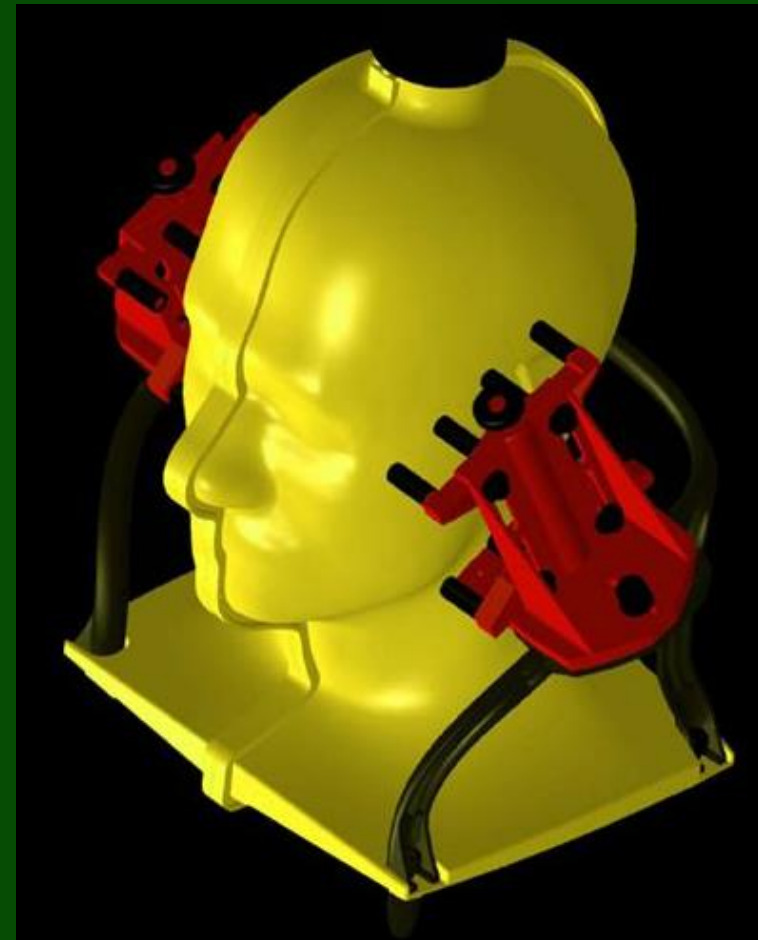
EME Spy 200 exposimeter (88-5,850 MHz) used.

Hardell, L. Internat J Oncol. 51, 405-413, doi:10.3892/ijo.2017.4046 (2017)

# Current Thermal Regulation of Public Exposure

Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) has set exposure standards (RPS3 - 2002)

- Based on 1998 guidelines of the International Commission on Non-Ionizing Radiation Protection (ICNIRP)
- Based on short-term thermal (heating) effects
- 6 minutes



**SAM**  
Head phantom

Standard Anthropometric Man



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
WASHINGTON, D.C. 20460

JUL 16 2002

OFFICE OF  
AIR AND RADIATION

The FCC's current exposure guidelines, as well as those of the Institute of Electrical and Electronics Engineers (IEEE) and the International Commission on Non-ionizing Radiation Protection, are thermally based, and do not apply to chronic, nonthermal exposure situations.

that results from an increase in body temperature. The FCC's exposure guideline is considered protective of effects arising from a thermal mechanism but not from all possible mechanisms. Therefore, the generalization by many that the guidelines protect human beings from harm by any or all mechanisms is not justified.

Sincerely,

A handwritten signature in black ink, which appears to read "Norbert N. Hankin". The signature is fluid and cursive, written over the printed name.

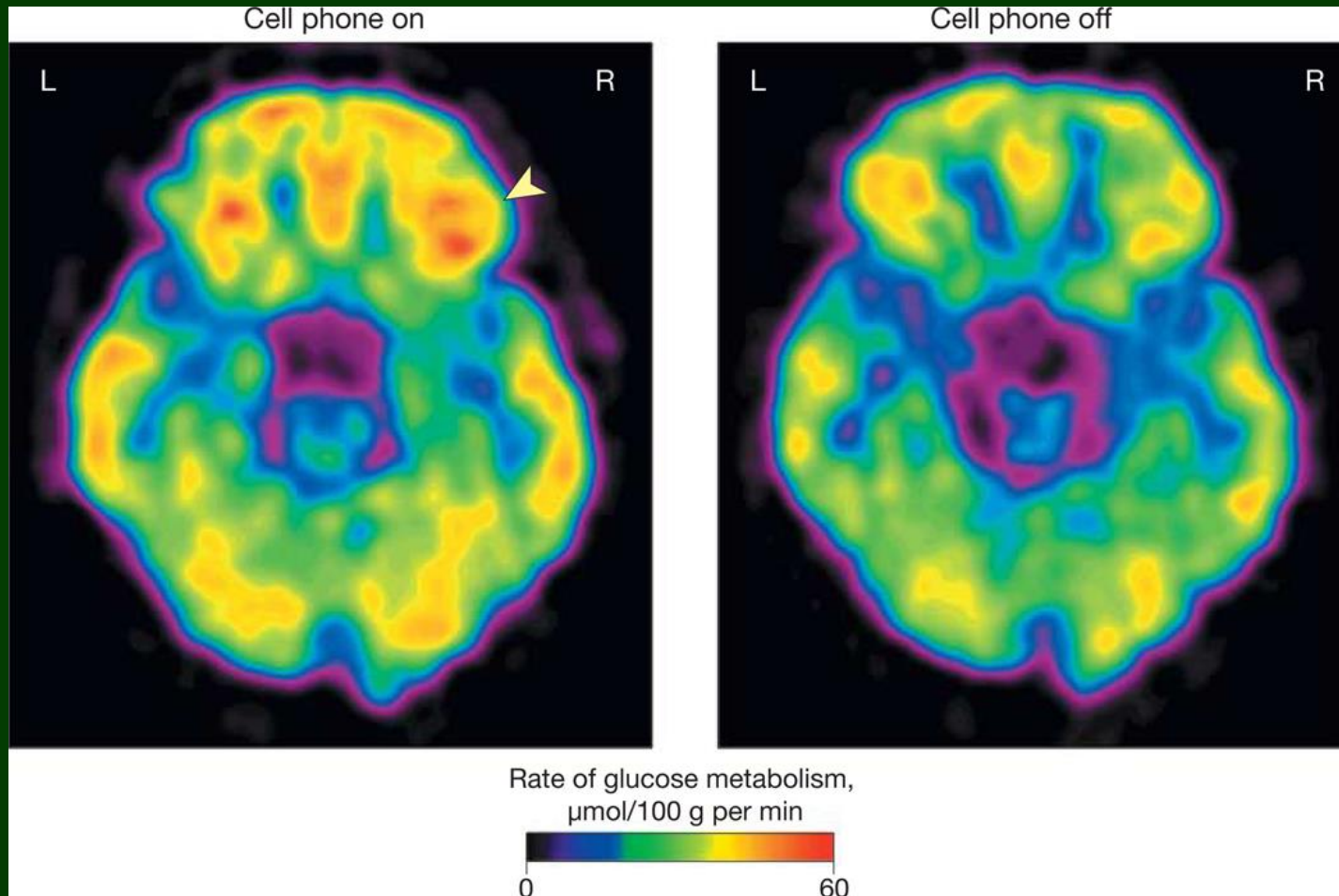
Norbert Hankin  
Center for Science and Risk Assessment  
Radiation Protection Division

# No Scientific Consensus on “Safe Limits” of RF-EMR

- Exposure standards/guidelines vary between countries by up to 1000 times
- 225 EMF scientists from 41 countries have appealed to the WHO and the UN for biologically-based exposure guidelines – **International EMF Scientist Appeal**



# Mobile phone radiation alters brain glucose metabolism



NIH USA  
study  
47 healthy  
participants.  
“on”: 50 min  
mobile  
phone  
exposure on  
right side

Brain Glucose Metabolic Images Showing Axial Planes at the Level of the Orbitofrontal Cortex. Glucose metabolism in right orbitofrontal cortex was higher for the “on” than for the “off” condition (Volkow N et al., JAMA. 2011; 305(8): 808–813).

# Investigating RF-EMR Effects at Cellular and Subcellular Level

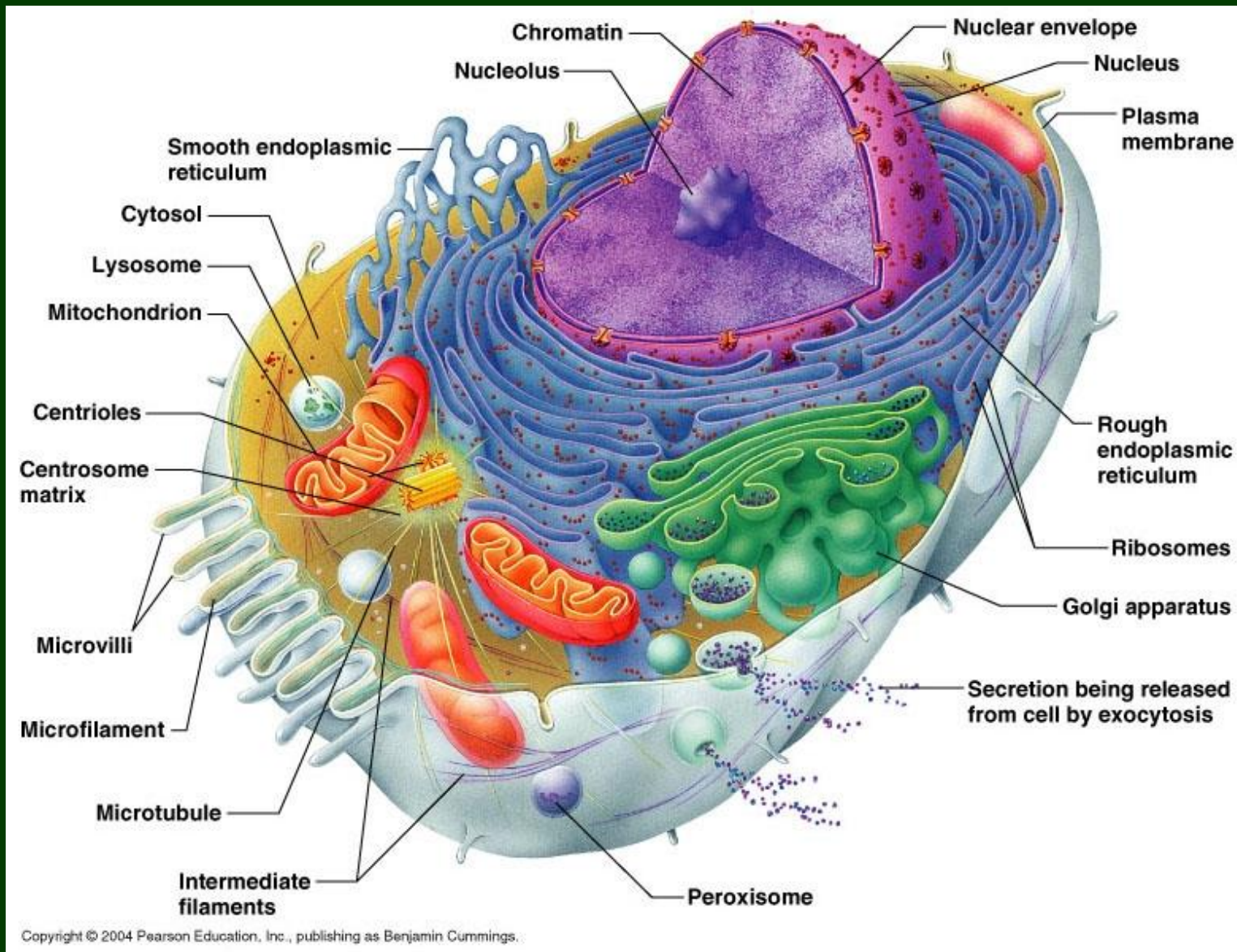


Image credit: Pearson Education Inc, Benjamin Cummings.



# Biological Effects Occur at “low intensity” Exposures

- Increase cellular Oxidative Stress
- Change membrane voltage-gated ion channels
- Alter gene expression - mRNA, protein
- Genotoxic effects (DNA damage)
- Cell membrane damage - blood brain barrier
- Metabolic ,immune, hormonal disruption
- Sperm damage
- Neuro-behavioural problems
- Cancer initiation/promotion

# Low-intensity RF-EMR Causes Oxidative Stress in Cells

## Some Effects of Weak Magnetic Fields on Biological Systems

*RF fields can change radical concentrations and cancer cell growth rates*



by Frank Barnes and Ben Greenebaum

*Damages, such as aging, cancer, and Alzheimer's, are associated with radical concentrations that are elevated for extended periods of time.*

**Emeritus Prof. Frank Barnes**, Uni of Colorado, former Chair of Electronic Devices Society of IEEE, Vice President of IEEE publication activities.

**Emeritus Prof. Ben Greenebaum**, Uni of Wisconsin-Parkside, former long-serving Editor-in-Chief of *Bioelectromagnetics*

Barnes F and Breenebaum B. IEEE Power Electronics Magazine, March 2016: 60-68.

# Our Review of Oxidative Stress Studies

- Our database contains over 2400 studies at present (<http://www.orsaa.org/resources.html>)
- Analysed studies with endpoints related to oxidative stress – 25 July 2017

ORSAA Database - OCEA x Research\_Review\_V4 (N4 x

Secure | [https://n432.fmphost.com/fmi/webd#Research\\_Review\\_V4](https://n432.fmphost.com/fmi/webd#Research_Review_V4)

Found 2 / 2500

de Iuliis

**Article** | Exposure | Study Categories | Effects Categories | Study Statistics

Title: Mobile Phone Radiation Induces Reactive Oxygen Species Production and DNA Damage in Human Spermatozoa In Vitro

1st Author: De Iuliis | Initials: GN | Select | Check for other publications by Author

Authors: De Iuliis GN, Newey RJ, King BV, Aitken RJ | Country: AUS

Web URL: <http://www.emf-portal.de/viewer.php?aid=17394&l=e> | URL

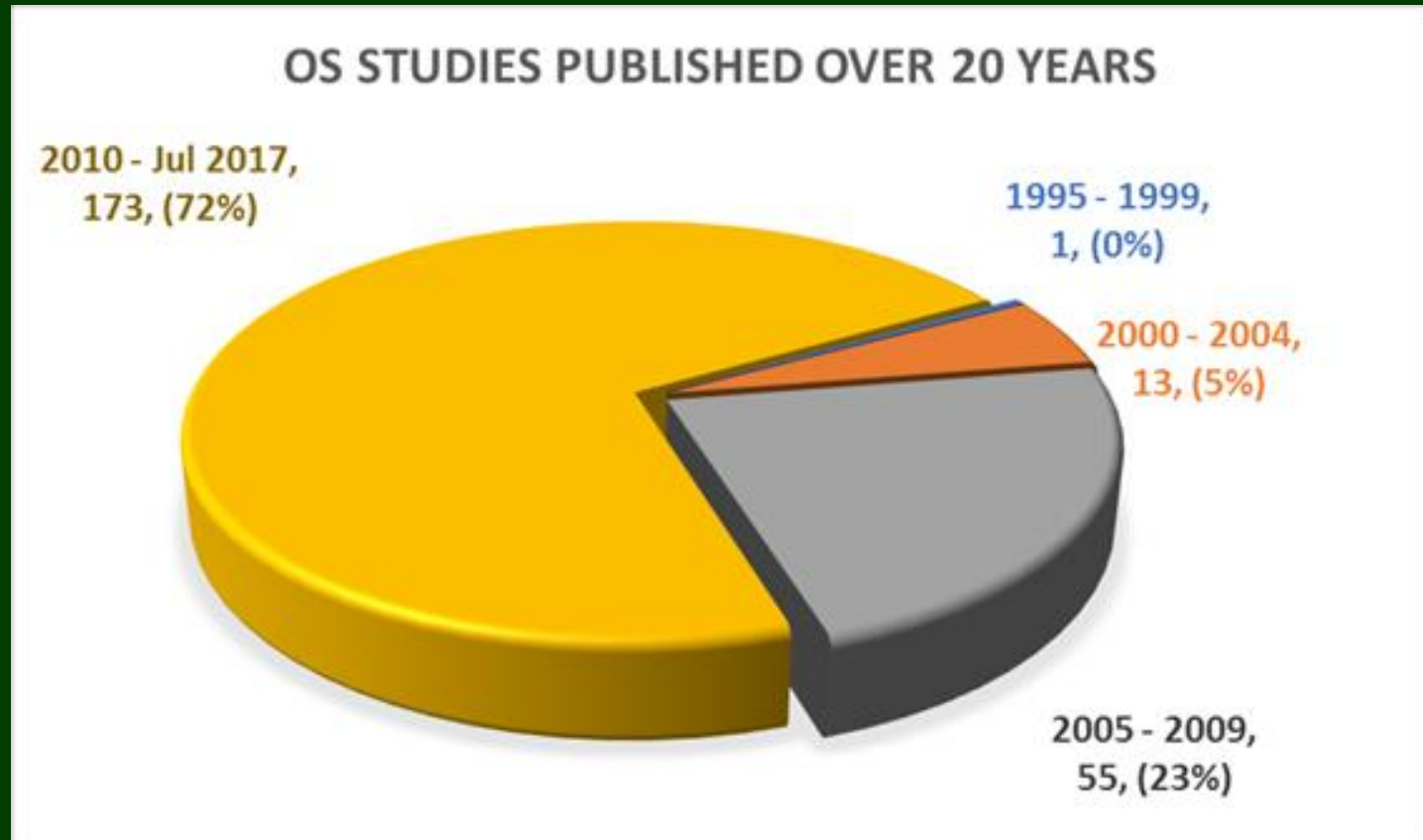
Article URL: <http://journals.plos.org/plosone/article/asset?id=10.1371/journal.pone.0006446.PDF> | URL

**Synopsis Below** | Date Published: 01/07/2009 | Spreadsheet View & CSV Download

Aim: To study the influence of radiofrequency electromagnetic fields on the cell biology (e.g. oxidative stress, DNA damage) of human spermatozoa in vitro (of 22 healthy donors).

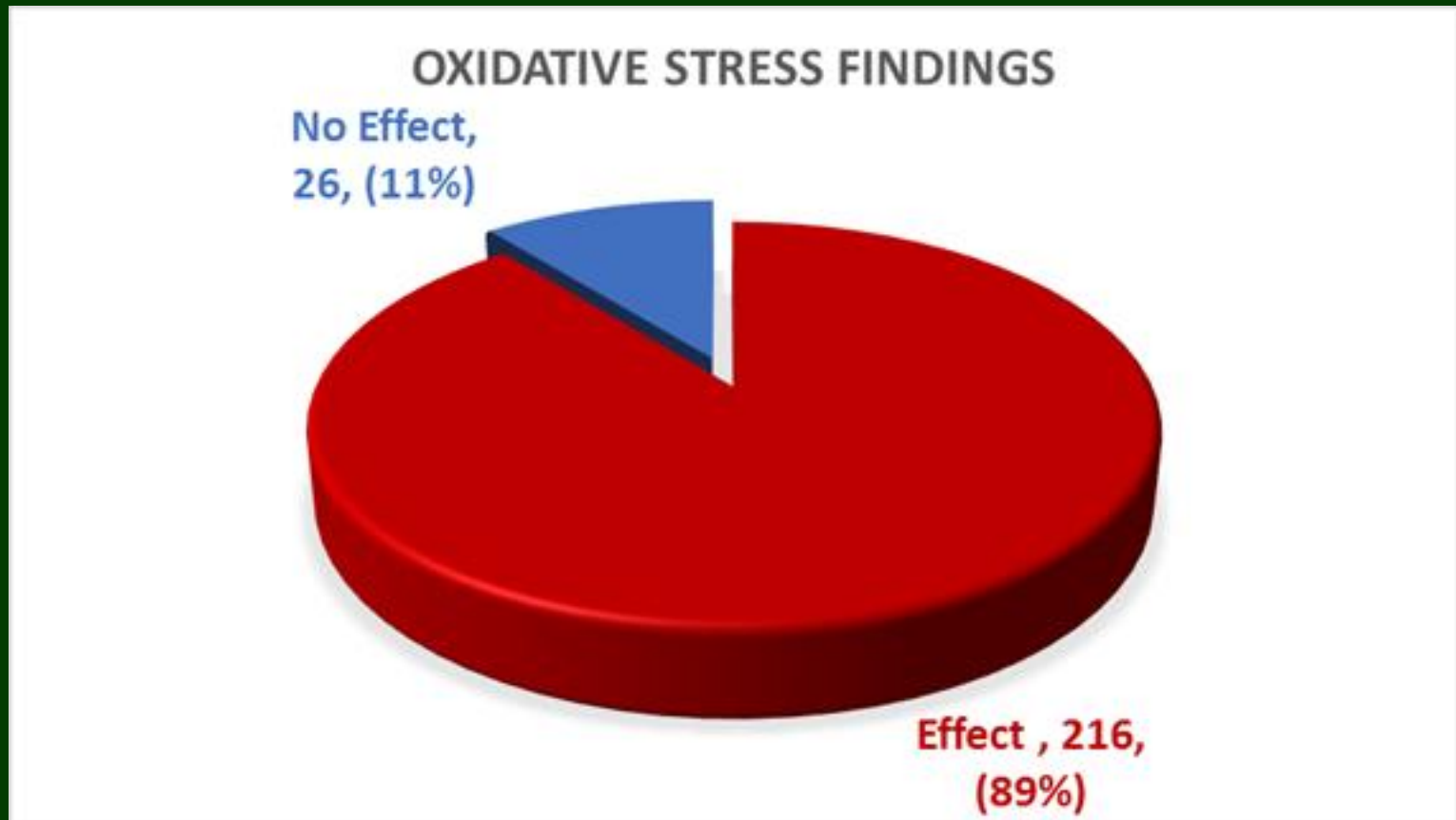
# Oxidative Stress Studies

- 242 studies investigating OS
- Only one before the year 2000
- 55 (23%) between 2005-2009
- 173 (72%) since 2010



# Low Intensity RF-EMR Causes Oxidative Stress in Cells

- Review reported 93 out of 100 studies to find RF-EMR to cause Oxidative Stress (OS) Yakymenko, I. et al. Electromag Biol Med. 35, 186-202 (2015)
- **We found 216 positive studies and 26 negative studies**





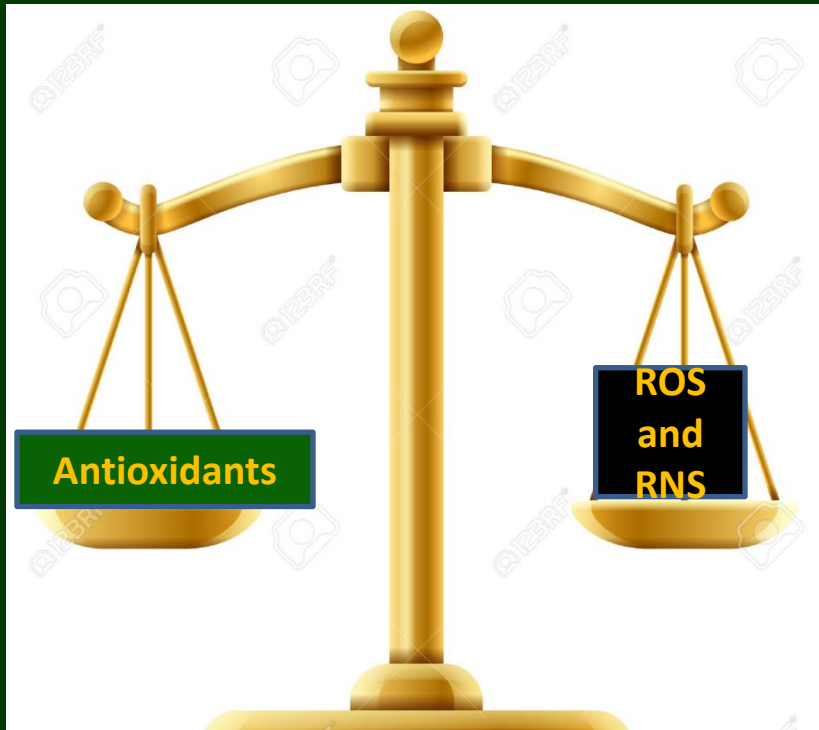
# Oxidative Stress Studies – Origin

- 242 studies done in 29 countries
- **Australia only 1 study – Effect**
- USA – 7 out of 8 Effect
- China all 26 Effect
- India all 35 Effect
- Turkey – 76 out of 80 Effect

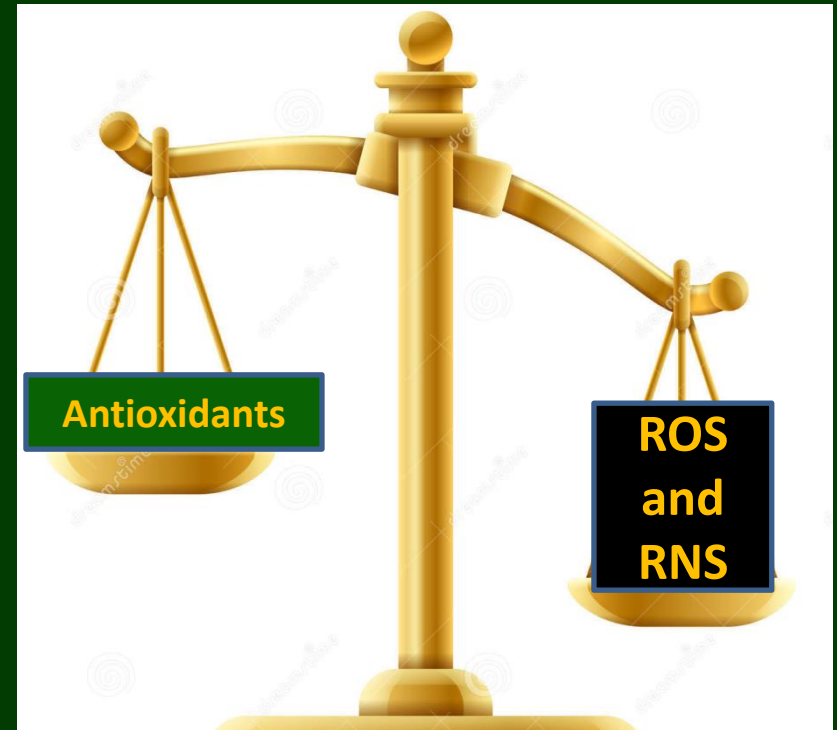
Country	Total # Papers	Effect Papers	No Effect Papers
Australia	1	1	0
Bulgaria	1	1	0
Brazil	6	1	5
Switzerland	2	2	0
China	26	26	0
Germany	2	0	2
Egypt	9	9	0
Finland	3	2	1
France	2	1	1
Greece	2	2	0
Croatia	5	5	0
India	35	35	0
Iran	11	11	0
Israel	4	3	1
Italy	4	2	2
Jordan	1	1	0
Japan	1	0	1
Korea	8	4	4
Nigeria	5	5	0
Oman	1	1	0
Poland	4	4	0
Russia	4	3	1
Saudi Arabia	4	2	2
Serbia	5	5	0
Tunisia	4	4	0
Turkey	80	76	4
Ukraine	3	3	0
United States	8	7	1
South Africa	1	0	1
Total	242	216	26

# Oxidative Stress and its Implications in Health

Normal cell physiology – Redox equilibrium



Oxidative Stress – cell physiology disrupted



Maintaining the Redox Homeostasis is critically important for cellular health

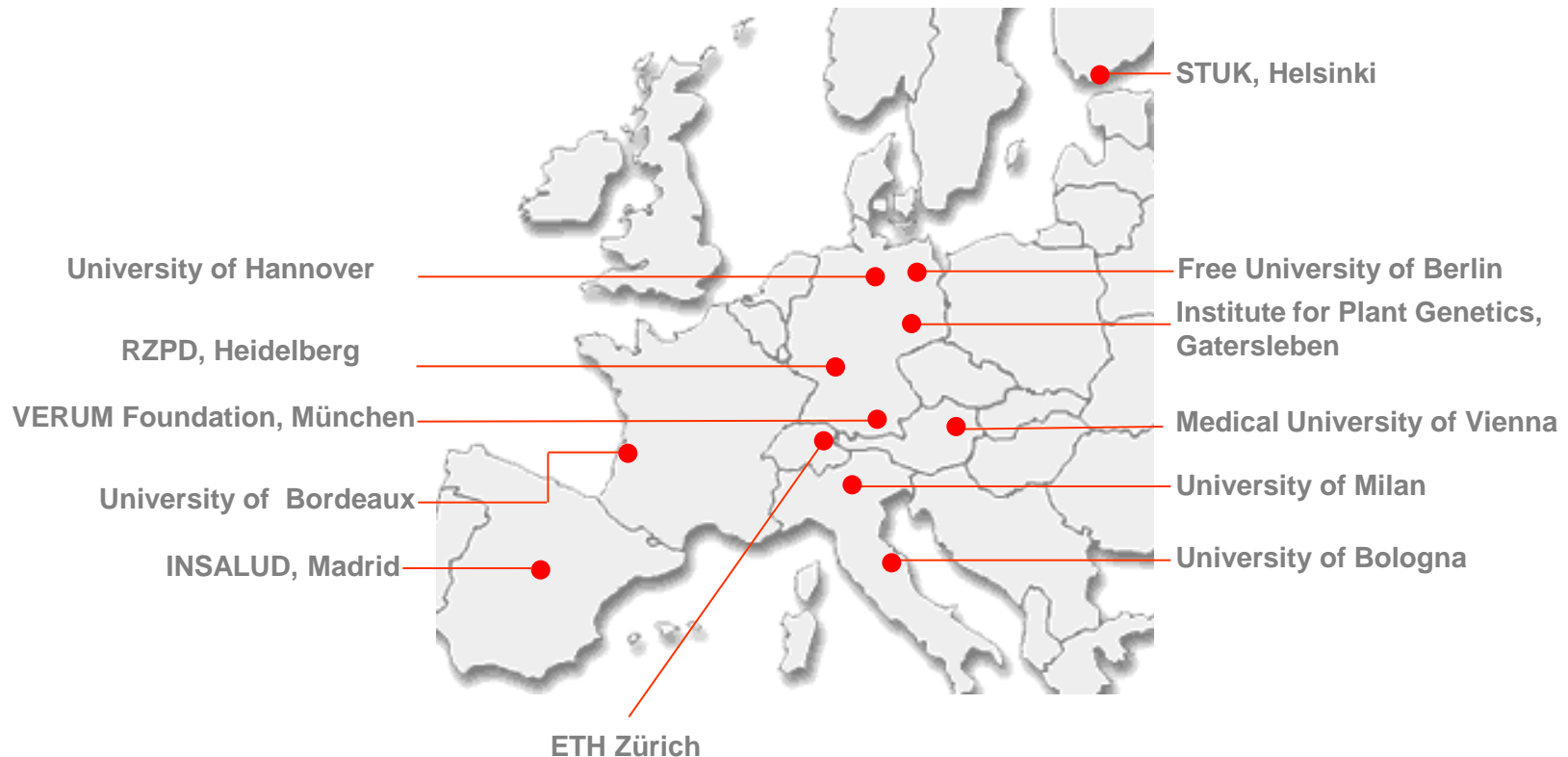
>> disruption in favour of pro-oxidants causes oxidative stress

>> direct damage to biomolecules and disrupt biological functions

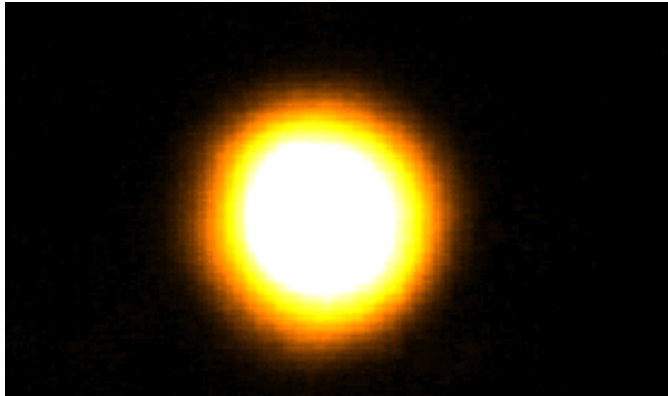
# Risk Evaluation of Potential Environmental Hazards From Low Energy Electromagnetic Field Exposure Using Sensitive *in vitro* Methods



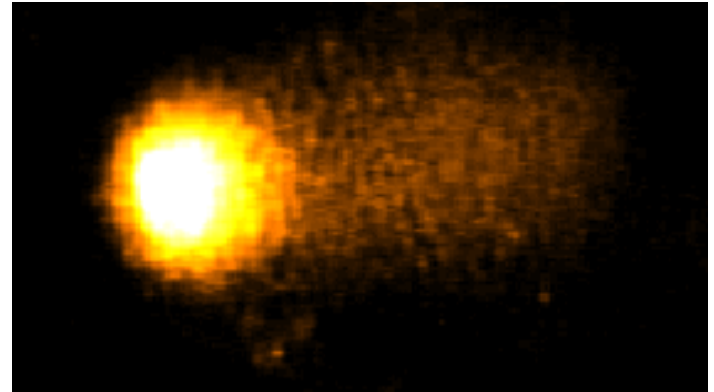
A project funded by the European Union under the programme "Quality of Life and Management of Living Resources",  
Key Action 4 "Environment and Health": QLK4-CT-1999-01574



# DNA Damage Shown by Comet Assay

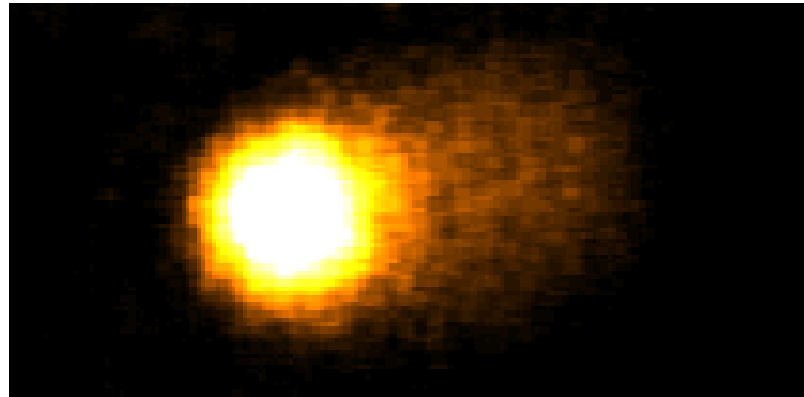


sham exposure



gamma-radiation 0.5 Gy

1600 chest X-rays



RF-EMF: 1800 MHz; SAR 1.3 W/kg; 24h

Mobile phone 24 hr  
ICNIRP 2 W/kg

Diem E et al., Non-thermal DNA breakage by mobile-phone radiation (1800 MHz) in human fibroblasts and in transformed GFSH-R17 rat granulosa cells in vitro. *Mutat Res.*

2005;583(2):178-83.

© Clinical Chemistry, Free University of Berlin

# RF-EMR Can Damage DNA in Brain Cells *in vivo*

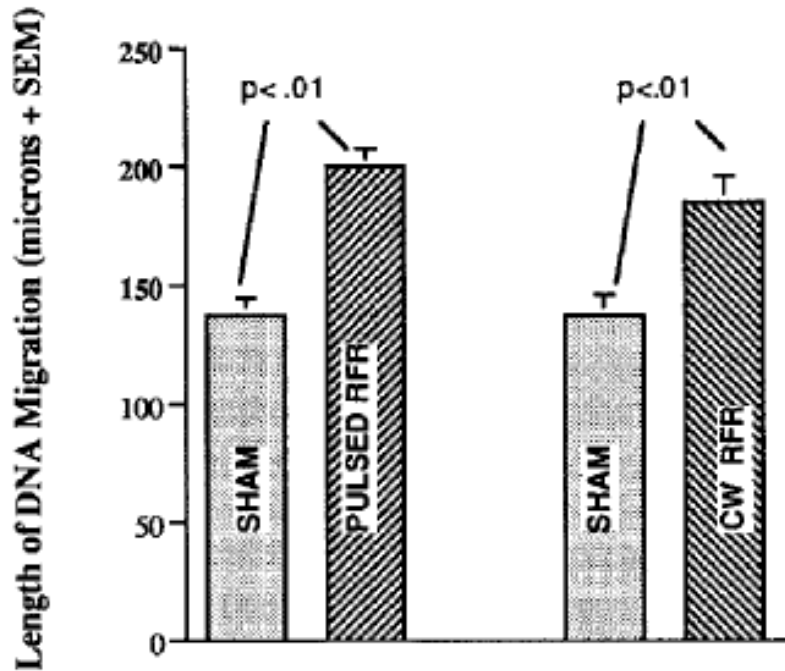


Figure 1. Single-strand DNA breaks in brain cells of rat after exposure to either pulsed- or continuous-wave RFR. Each bar represents data from eight animals (plotted mean + SEM).

DNA breaks in brain cells of rats exposed to 2 hours of 2.45 GHz non-thermal RF-EMR at 1.2W/kg whole body exposure (pulsed or continuous waves) vs. sham exposure

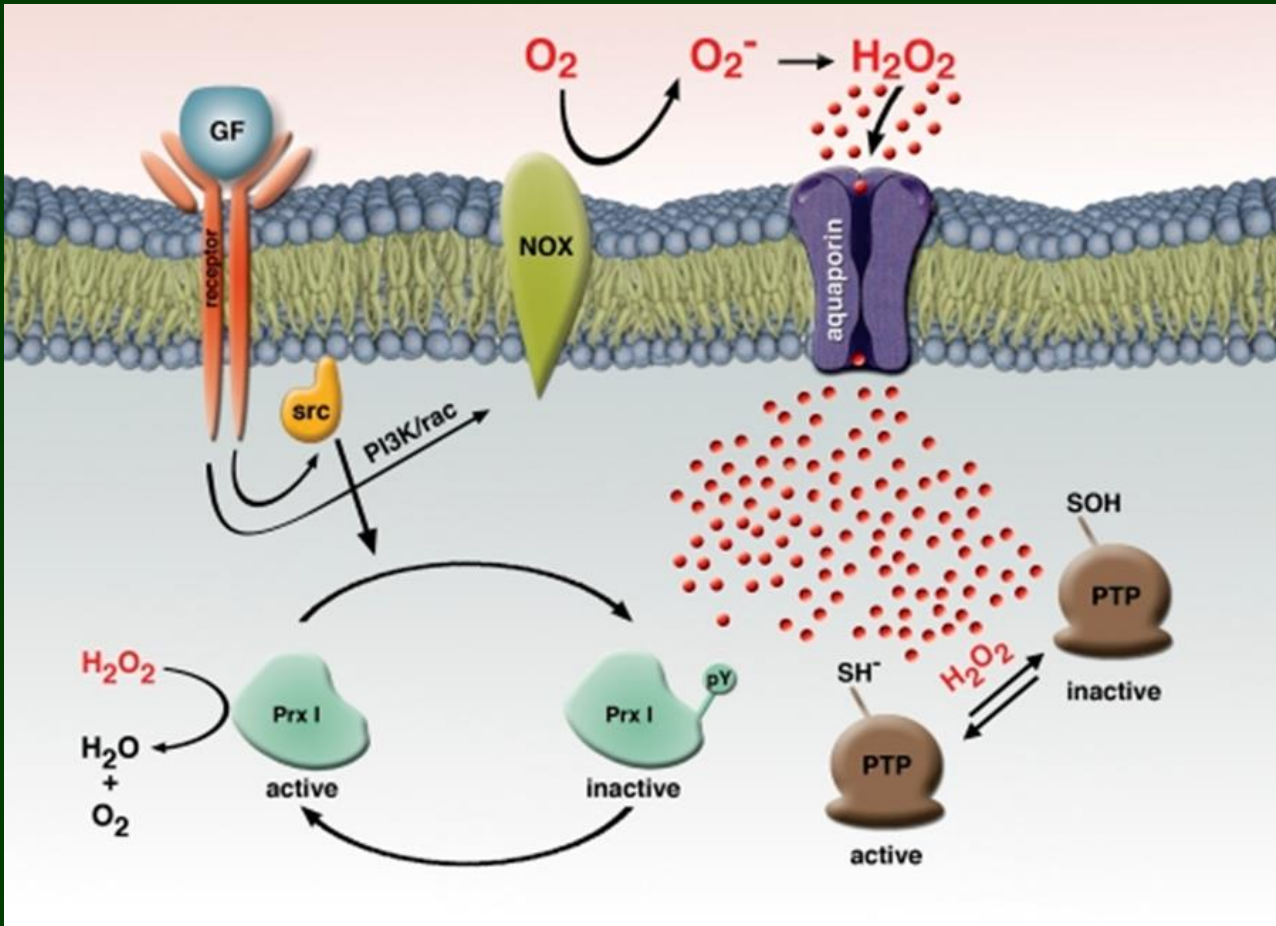
Brains removed 4 hr after the exposure and DNA examined

Lai H. and Singh P., INT. J. RADIAT. BIOL 1996; 69(4): 513- 521

**US National Toxicology Program confirmed DNA damage by RF in 2016**



# ROS and RNS Mediate Cellular Signal Transduction AND Control Key Biological Functions



Critically important:

- concentrations
- location

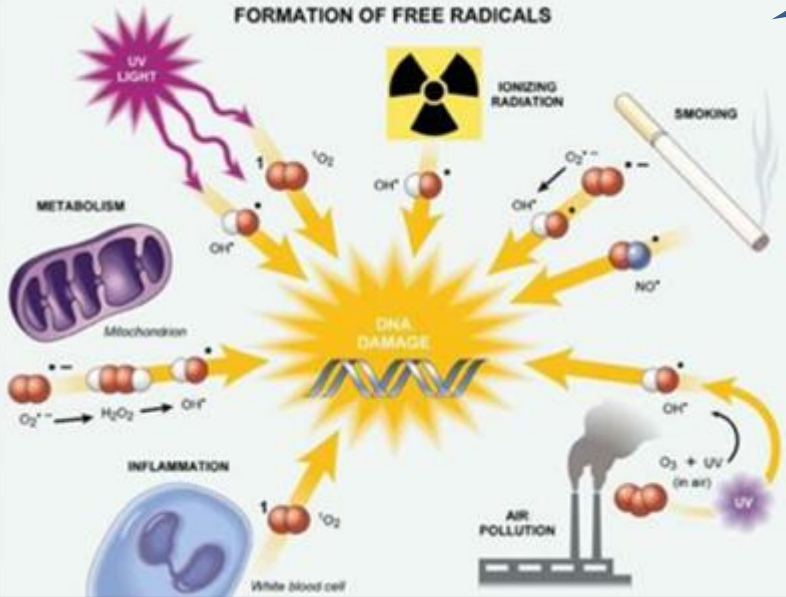
Control:

- Metabolism
- Growth
- Immune functions
- Hormonal functions

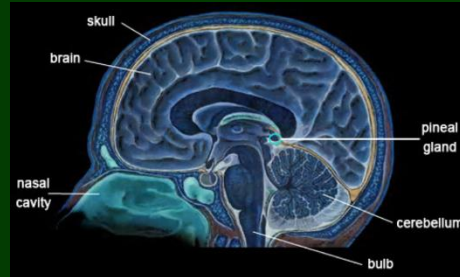
Image: Finkel T. Signal transduction by reactive oxygen species.  
J Cell Biol. 2011 Jul 11; 194(1): 7–15.

# RF-EMR

## FORMATION OF FREE RADICALS



increased oxidative stress and  
resultant cellular damage



reduced Melatonin

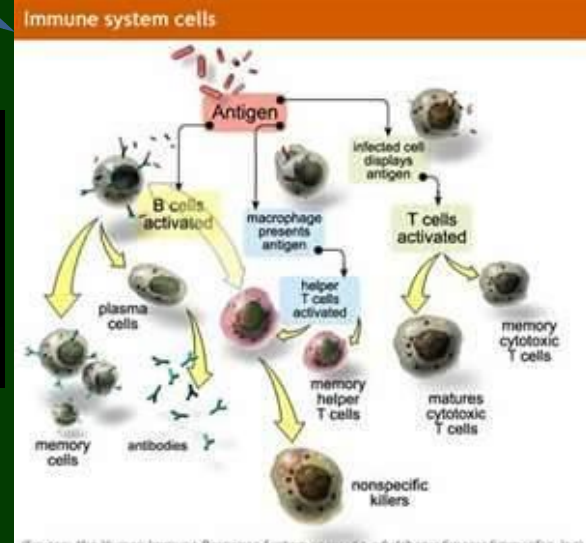
reduced antioxidant  
protection



## Multi System Dysfunction



## Chronic Disease



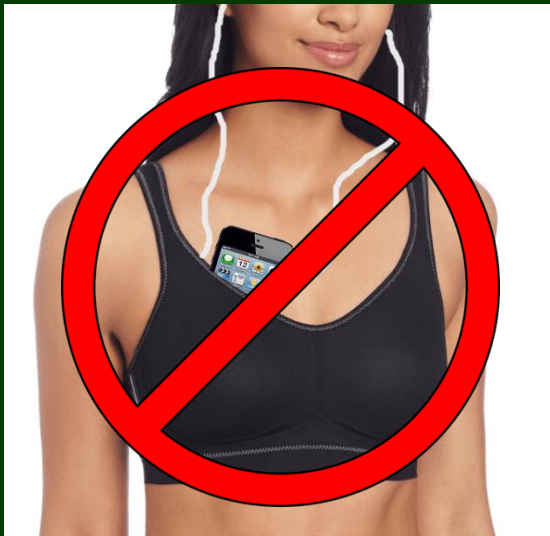
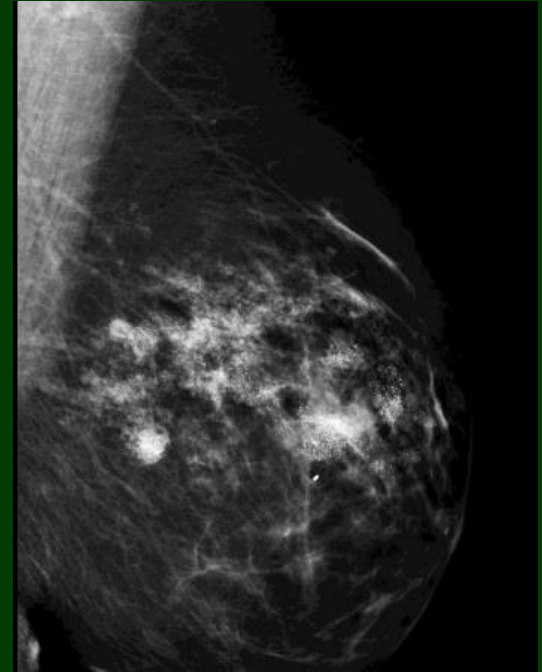
Immune dysfunction

# RF- EMR Can Damage the Male Reproductive Cells



Houston et al., Reproduction. 2016 Dec;152(6):R263-R276. Epub 2016 Sep 6.

# Mobile Phones May Cause Breast Cancer



West JG et al.  
Multifocal Breast Cancer in Young Women with Prolonged  
Contact between Their Breasts and Their Cellular Phones.  
Case Rep Med. 2013;2013:354682. doi:  
10.1155/2013/354682.



# Low Intensity RF-EMR Causes Oxidative Stress

- ARPANSA claim “the putative link between RF energy and altered ROS production remains tenuous”\* is incorrect and risks public health
- ARPANSA should have assigned a team of cell biologists and clinicians experienced in oxidative stress research to conduct their review on *in vitro* and *in vivo* studies instead of relying on a single biophysicist with limited expertise.

\* ARPANSA TRS-164, pp7 (2014)



# Conclusion

- There are biological/health effects at currently permitted RF exposures
- ARPANSA statement “The ARPANSA Standard is based on scientific research that shows the levels at which harmful effects occur and it sets limits, based on international guidelines, well below these harmful levels.”\* is not supported by the scientific evidence.
- ARPANSA should take immediate measures to:
  - Reassess the scientific evidence on biological effects of RF-EMR
  - Set a new Standard based on biological effects, discarding thermally-based ICNIRP guidelines
  - Inform the Australian public of the potential risks
  - Educate the public on exposure reduction – particularly of children
  - Advise the government to give preference to wired communication systems over wireless

\* ARPANSA Fact Sheet “Mobile Phones and Health”

<https://www.arpansa.gov.au/sites/g/files/net3086/f/legacy/pubs/factsheets/MobilePhonesandHealth.pdf> ( accessed 6 Aug 2017)

Additional Slides if needed for Q & A

# RF-EMR Can Affect Foetal and Early Childhood Development



The age of iPads, iPotties and iTeddies

# Neuro-behavioural problems are the leading cause of health burden on in young Australians

		Age group							
		Under 5	5-14	15-24	25-44	45-64	65-74	75-84	85+
Males	1	Pre-term/lbw complications	Asthma	Suicide/self-inflicted injuries	Suicide/self-inflicted injuries	Coronary heart disease	Coronary heart disease	Coronary heart disease	Coronary heart disease
	2	Birth trauma/asphyxia	Anxiety disorders	Alcohol use disorders	Back pain and problems	Lung cancer	Lung cancer	COPD	Dementia
	3	Other disorders of infancy	Autism spectrum disorders	RTI/motor vehicle occupant	Alcohol use disorders	Other musculoskeletal	COPD	Dementia	Stroke
	4	SIDS	Conduct disorder	Depressive disorders	Poisoning	Back pain and problems	Diabetes	Stroke	COPD
	5	Other congenital conditions	Depressive disorders	Asthma	Depressive disorders	Suicide/self-inflicted injuries	Bowel cancer	Lung cancer	Prostate cancer
Females	1	Birth trauma/asphyxia	Anxiety disorders	Anxiety disorders	Anxiety disorders	Other musculoskeletal	Coronary heart disease	Coronary heart disease	Dementia
	2	Pre-term/lbw complications	Asthma	Depressive disorders	Depressive disorders	Breast cancer	Lung cancer	Dementia	Coronary heart disease
	3	Other disorders of infancy	Depressive disorders	Asthma	Back pain and problems	Back pain and problems	COPD	COPD	Stroke
	4	SIDS	Dental caries	Suicide/self-inflicted injuries	Other musculoskeletal	Anxiety disorders	Other musculoskeletal	Stroke	COPD
	5	Cardiovascular defects	Upper respiratory conditions	Bipolar affective disorder	Asthma	Lung cancer	Breast cancer	Lung cancer	Diabetes

Latest data from Australian Institute for Health & Welfare (2016 release)

# There is a Pandemic of Developmental Neurotoxicity

“To control the pandemic of developmental neurotoxicity, we propose a global prevention strategy”

Dr. Philippe Grandjean, MD and Dr. Philip J Landrigan, MD

**Neurobehavioural effects of developmental toxicity.** Lancet Neurology: 14  
February 2014

DOI: [http://dx.doi.org/10.1016/S1474-4422\(13\)70278-3](http://dx.doi.org/10.1016/S1474-4422(13)70278-3)

# EMR Can Alter Brain Development & Behaviour

**In assessing the biological effects, it was found that behavior was the most sensitive biological component to RF/MW irradiation. It was observed that behavioral effects were**

(Radiofrequency Microwave Radiation Biological Effects and Safety Standards: A Review. US Air Force Materiel Command, New York, 1994, p20).

- Pre/post-natal exposure to cell phones associated with behavioural problems and hyperactivity in children – Danish study on 13,000 mothers and children. (Divan HA et al., Epidemiology 2008;19:523-529)
- Prenatal exposure to cellphone radiation caused structural and functional deficits in the brains of mice - ADHD like behaviour (Aldad TS et al., Fetal Radiofrequency Radiation Exposure From 800-1900 MHz-Rated Cellular Telephones Affects Neurodevelopment and Behavior in Mice. Scientific Reports. 2012;2:312)
- Dr. Martha Herbert (Harvard Uni/Massachusetts General Hospital) shows how EMR can contribute to autism (Herbert M and Sage C. Pathophysiology. 2013 Jun;20(3):191-209)
- EMR from cell phones alters brain waves (Loughran SP, Bioelectromagnetics. 2012 ;33(1):86-93; Leung S et al., Clin Neurophysiol. 2011;122(11):2203-16; Thomas S et al., Occup Environ Med. 2010;67(12):861-6; Croft RJ et al., Bioelectromagnetics. 2010;31(6):434-44;



# Neuro-behavioural Symptoms Near RF-EMR Transmitters

## Mobile Base Stations

- Spain - Navarro et al., Electromag Biol Med 2003; 22:161-169.
- France - Santini et al., Electromag Biol Med. 2003; 22:41-49.
- Poland - Gadzicka E et al, Biuletyn PTZE Warszawa 2006; 14:23-26 .
- Austria - Hutter et al., Occup Environ Med 2006; 63:307-313.
- Egypt - Abdel-Rassoul et al., Neurotoxicology 2007; 28:434-440.
- Germany - Blettner et al., Occup Environ Med 2009; 66:118-123.
- Germany - Berg-Beckhoff et al., Occup Environ Med 2009; 66:124-130 .
- India - Augner C, Hacker GW. Indian J Occup Environ Med. 2009; 13(3):141-145.
- Poland - Bortkiewicz et al., Int J Occup Med Environ Health 2012; 25(1):31-40 .
- Germany - Eger H & Manfred J. Umwelt·Medizin·Gesellschaft, Feb 2010: 130-139.
- Spain - Gómez-Perretta C et al., BMJ 2013; 3(12):1-7.
- Iran - Shahbazi-Gahruei et al., Electromagn Biol Med 2014;33(3):206-10
- India - Gandhi G et al., Electromag Biol Med. 2015;34(4):344-54.

## Military Radar

- Cyprus - Preece et al., Occup Environ Med 2007;64:402–408.

## Broadcast Tower

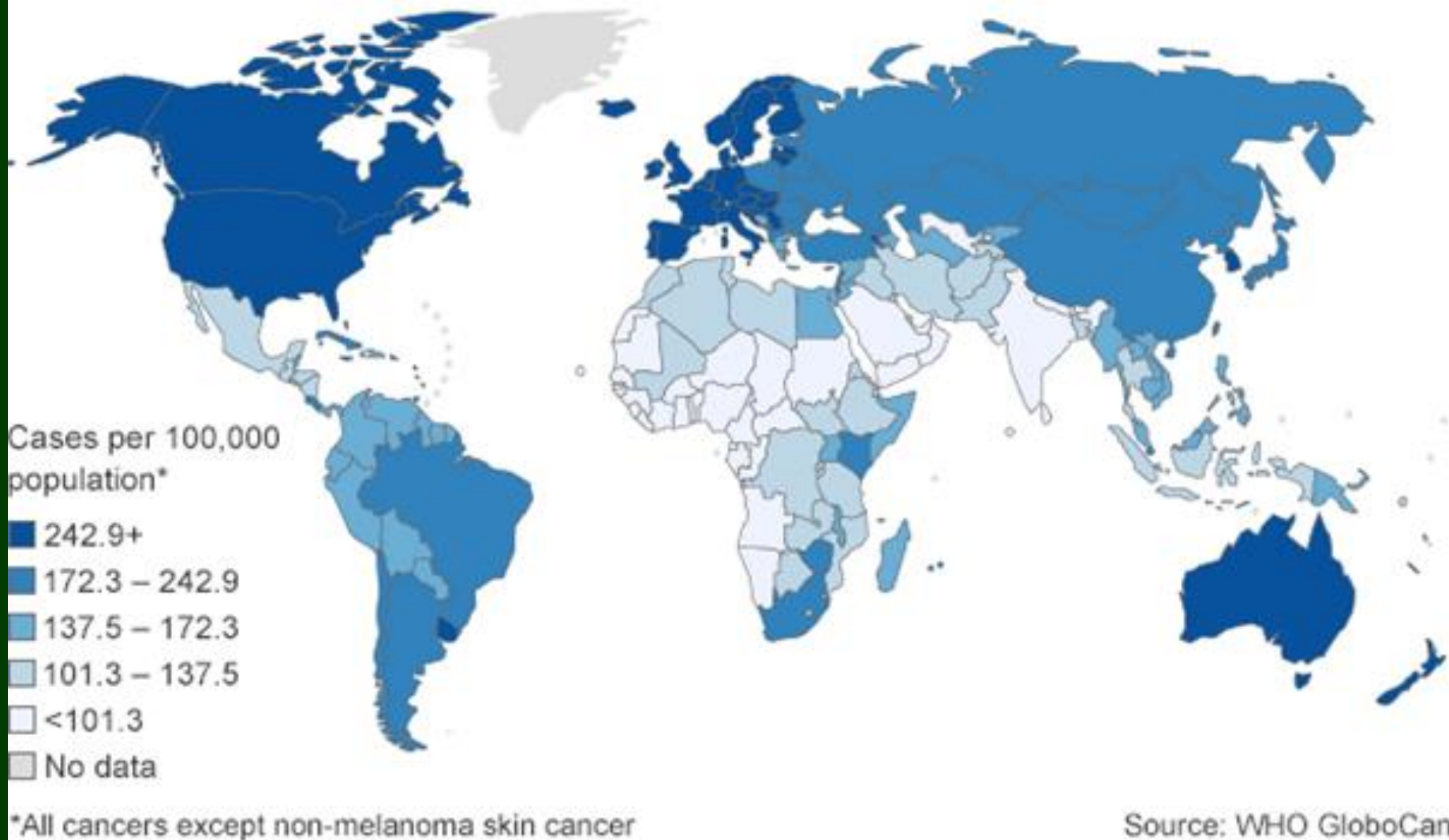
- Italy - Boscolo, P., et al., Int J Immunopathol Pharmacol, 2006. 19(4 Suppl): p. 43-8

**All above 15 studies found increased symptoms**

# EMR and Neurological Symptoms/ Cognitive Effects

- Headache, lethargy, dizziness, cognitive deficits, decreased concentration, dysaesthesia and other neurological symptoms (Hocking B and Gobbo F. J Health Saf Environ 2011, 27(3): 185-195; Reeves G. "Review of Extensive workups of 34 USAF Patients Overexposed to RF." Aviat Aero Envt Med 2000; 71(3); 206–215) and Hocking B. 2001; 72(6); 590-1. )
- Memory loss, difficulty concentrating, irritability and depression in US embassy workers in Moscow exposed to RF-EMR (outside max. 5  $\mu\text{W}/\text{cm}^2$ , inside  $<0.1 \mu\text{W}/\text{cm}^2$ ) Lilienfeld AM et al., Foreign service health status study - evaluation of health status of foreign service and other employees from selected eastern European posts. Final Report (Contract number 6025-619073) to the U.S. Department of State, July 31, 1978.
- Increased headaches/migraine associated with mobile phone use in 52,680 Danish 7 year olds (Sudan M. et al., The Open Pediatric Medicine Journal, 2012, 6, 46-52).
- Neuro-behavioural effects associated with mobile/cordless phones in high school students in NZ (Redmayne M et al., Environmental Health 2013, 12:5).
- Mobile phone use associated with faster but less accurate responses to cognitive tasks in 13 year old Australian students (Abramson MJ et al., Bioelectromagnetics. 2009 Dec;30(8):678-86)
- Mobile phone use affects cognitive functions of adolescents, young adults and older adults (Leung S et al., Clin Neurophysiol. 2011 Nov;122(11):2203-16; Thomas S et al., Occup Environ Med. 2010 Dec;67(12):861-6;

## World cancer cases 2012

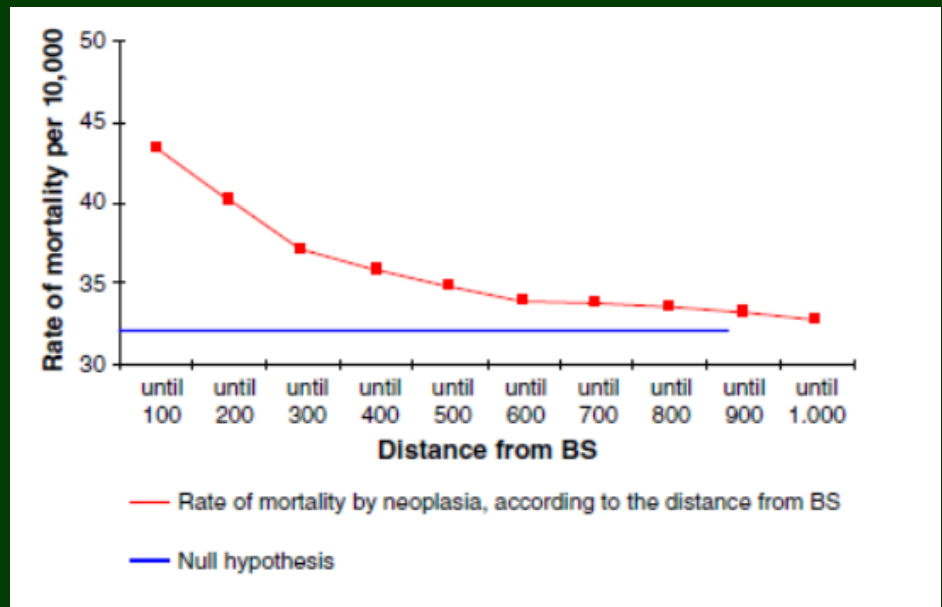


**World Cancer Report** by the World Health Organization (WHO)'s International Agency for Research on Cancer (IARC) . March 2014.

(<http://www.iarc.fr/en/publications/books/wcr/wcr-order.php>).

# Cancer Deaths Near Mobile Base Stations

Distance from MBS	Number of Cancer deaths
0-100 m	3569
100-200 m	1408
200-300 m	973
300-400 m	482
400 -500 m	292
<b>Total 0 – 500 m</b>	<b>6724</b>
Beyond 1000 m	147



**Cancer deaths within 500m from MBS:  $6724/7191 = 93.5\%$**

**Can't prove causality but needs to be considered with other evidence**

(Dode et al., Mortality by neoplasia and cellular telephone base stations in the Belo Horizonte municipality, Minas Gerais state, Brazil. Science of The Total Environment 2011;409:3649–65)

# Cancer Clusters Near Radio/TV/Mobile Transmitters

**Australia** – increased childhood leukaemia incidence and mortality near radio/TV transmitters in N. Syd (Hocking B et al., Med J Aust. 1996; 165(11-12):601-5)

**UK** – increased cancer near radio/TV towers (Dolk et al., Am J Epidemiol, 1997a; 145 (1):1-9, and 1997b;145(1):10-17), increased cancer incidence near MBS (Stewart A et al., Perspect Pub Health. 2012;132(6):299-304).

**Vatican city** – increased leukaemia (Micholozzi P. et al., Regional Health Authority, Rome, Italy. Epidemiology, July 1998, Vol 9, Number 4, Supplement 354P)

**USA** - increased childhood cancer near radio/TV tower (CCSFDPH, 1988: Report on Cancer Incidence in San Francisco. Department of Public Health, San Francisco, CA) and increased childhood leukaemia in Hawaii (Maskarinec, G., and Cooper, J. 1993;Am. J. Epidemiology:138:666)

**Sweden** – correlation between melanoma and FM radio transmitters (Hallberg O and Johansson O. Arch Environ Health, 2002;57(1):32-40 ).

**Germany** – increased cancer within 400 m of MBS (Eger et al., Umwelt Medizin Gesellschaft 2004;17(4) 1-7)

**Israel** – increased cancer (Wolf & Wolf, 2004 Int J Cancer Prevention 1(2):2-19)

**Korea** – increased cancer in women near a radio tower (Ha M et al., Arch Environ Health, 2003; 58(12) 756-62) and increased childhood leukaemia (Ha M et al., Am J Epidemiol. 2007;166(3):270-9)

**Brazil** – Increased cancer mortality near MBS (Dode et al., Science of The Total Environment 2011;409:3649–65)

## RF-EMR and Cancer – animal studies

- US govt study found non-thermal exposure for 2 years to 2.45 GHz (WiFi and radar frequency) caused 4 times more cancers in exposed rats.  
Affected immune, hormonal, metabolic functions Chou C.K et al., Bioelectromagnetics, 1992. **13**(6): p. 469-96).
- Australian study found more than doubling of cancer in irradiated transgenic mice. Repacholi M.H. et al., Radiat. Res. 1997 May;147(5):631-40
- German studies found low RF-EMR levels (typical exposures) could promote cancer Lerchl A et al., Tumor promotion by exposure to radiofrequency electromagnetic fields below exposure limits for humans, Biochem Biophys Res Comm (2015), doi: 10.1016/j.bbrc.2015.02.151 ; Tillmann T et al., Int. J. Radiat. Biol. 2010;86(7):529-41
- US National Toxicology Program – preliminary data release 2016  
Significant increase in cancer risk in irradiated rats



# RF-EMR is Associated with Cancer – Human Evidence

**Use of a mobile phone >10 years increases brain cancer risk > 100%**

- Interphone (13 countries): 5,117 cases
- Hardell study (Swedish): 3, 439 cases
- Cerenat study (French): 447 cases

Cardis E. et al., Int J Epidemiol 2010;39:675–694; Occup Environ Med. 2011 Sep;68(9):631-40; INTERPHONE Study Group. Cancer Epidemiol. 2011 Oct;35(5):453-64

Hardell et al., Int J Oncol. 2008;32(5):1097-103; Int J Oncol. 2009;35(1):5-17; Int J Oncol. 2011;38(5):1465-74; Int J Epidemiol. 2011;40(4):1126-8; Pathophysiol. 2013;20(2):85-110; Carlberg M, Hardell L. Oncol Rep. 2015;33(6):3093-8; Hardell L & Carlberg M. Pathophysiol. 2015;22(1):1-13.

Coureau G et al. Mobile phone use and brain tumours in the CERENAT case-control study. Occup Environ Med. 2014 Jul;71(7):514-22.

# RF-EMR Can Damage DNA

Published Review - 2009

**49 studies - genotoxic effects (DNA damage)**

**43 studies - no genotoxic effects (no DNA damage)**

Ruediger, HW , "Genotoxic effects of radiofrequency electromagnetic fields"  
Pathophysiology, 2009;16 (2–3): 67–69

2006 to October 2014

**84 studies – genotoxic effects**

**41 studies - no genotoxic effects**

Prof. Henry Lai (Washington University)

Over 100 peer-reviewed studies showing DNA damage

**2016 – data released by US National Toxicology Program  
confirms DNA damage**

# RF- EMR Can Damage the Male Reproductive System

Review of **10 studies** (semen from **1492 men**) showed damage to sperm Adams JA et al., Effect of mobile telephones on sperm quality: A systematic review and meta-analysis. Environ Int. 2014;70:106-12

**4 hour** exposure to WiFi-enabled laptop damaged sperm Avendano C et al., Use of laptop computers connected to internet through Wi-Fi decreases human sperm motility and increases sperm DNA fragmentation. Fertil Steril; 2012;97(1):39-45

Study of **2028 college students** (2013-15) found sperm damage associated with mobile phone use. Zhang G. et al., Effects of cell phone use on semen parameters: Results from the MARHCS cohort study in Chongqing, China. Environ Int. 2016; 91:116–121

**Review of 27 studies investigating the effects of RF-EMR on the male reproductive system – 21 reported negative consequences** Houston BJ et al, Reproduction. 2016 Dec;152(6):R263-R276. Epub 2016 Sep 6

- **Low Fertility**
- **Increased risk of genetic defects in future generations**
- **Erectile dysfunction (impotence)**
- **Increased risk of testicular and prostate cancer**



# Evidence of RF-EMR Non-thermal Bioeffects – Key Scientific Reports

## Commissioned by Governments:

- Status of Research on Biological Effects and Safety of Electromagnetic Radiation – Telecommunication Frequencies. Division of Biophysics CSIRO, 1994 (**Australia**).
- The Stewart Commission Report, 2000 (**UK**).
- Bibliography of Reported Biological Phenomena ('Effects') and Clinical Manifestations Attributed to Microwave and Radio-frequency Radiation, Naval Medical Research Institute, 1971 (**USA**).
- Biological Effects of Electromagnetic Radiation (Radiowaves and Microwaves)- Eurasian Communist Countries. Army Medical Intelligence and Information Agency - Office of the Surgeon General, 1976 (**USA**).
- Radiofrequency Microwave Radiation Biological Effects and Safety Standards: A Review. Air Force Materiel Command, New York, 1994 (**USA**).

## Commissioned by Telecommunications Industry:

- ECOLOG Institute Report for T-Mobil, DeTeMobil Deutsche Telekom MobilNet GmbH. 2000 (Germany)
- International Patent Application (#WO 2004/075598 A1) by Swisscom 2003 (Switzerland).

## Prepared by Independent Scientists:

- Bio-Initiative Report 2012 (an international panel of experts). [www.bioinitiative.org](http://www.bioinitiative.org)

## The WHO's International Agency for Research on Cancer:

- IARC Monographs. Non-ionizing Radiation, Part 2: Radiofrequency Electromagnetic Fields. Volume 102. 2013 (Lyon, France)

# Electro-hypersensitivity is Similar to Acute Radiation Syndrome

- Symptoms of ARS may include **nausea, vomiting, headache, and diarrhea**.
  - These symptoms start within minutes to days after the exposure, can last for minutes up to several days, and may come and go.
- After the initial symptoms, a person usually looks and feels healthy for a period of time, after which he or she will become sick again with variable symptoms and severity that vary depending on the radiation dose that he or she received.
  - These symptoms include **loss of appetite, fatigue, fever, nausea, vomiting, diarrhea, and possibly even seizures and coma**.
  - This seriously ill stage may last from a few hours up to several months.
- People who receive a high radiation dose also can have **skin damage**. This damage can start to show within a few hours after exposure or it may be delayed for several days. It can **include swelling, itching, and redness of the skin (like a bad sunburn)** or may be more severe and include blisters or ulcers.
  - The skin may heal for a short time, followed by the return of swelling, itching, and redness days or weeks later.
  - Complete healing of the skin may take from several weeks up to a few years.
  - The time for skin to heal depends on the radiation dose the person's skin received.
  - People who receive a high radiation dose to all or part of the body also may experience temporary hair loss. It may take several weeks for the hair to grow back.

**US Centers for Disease Control and Prevention** <http://emergency.cdc.gov/radiation/ars.asp>