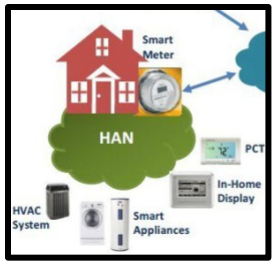


Smart Home

The Electromagnetic Age … A Sleeping Giant?

Malcolm Paterson, PhD

St. Saviour's Anglican Church
Penticton, BC
11 April 2015

Smart Grid

Malcolm Paterson BSc, MSc, PhD (Molecular Oncology)

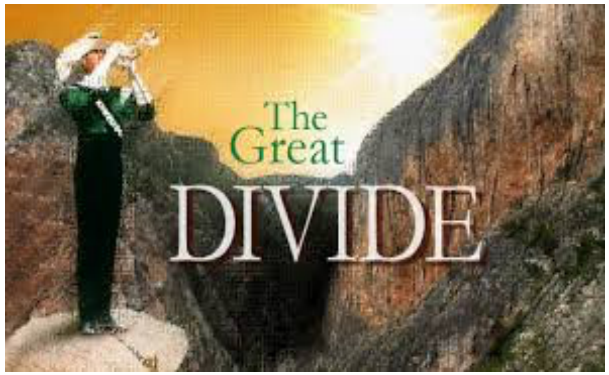
Disclaimer

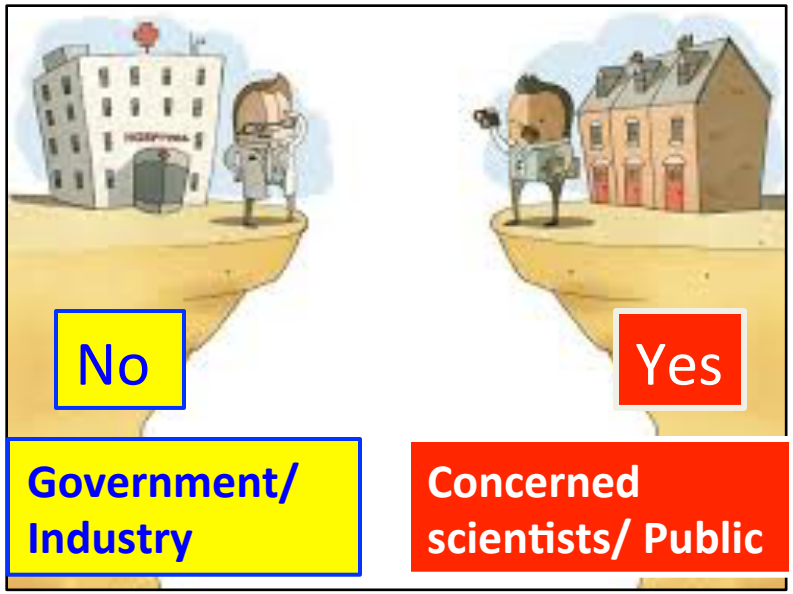
No professional associations ('own dime, own time')

(Apr-Sep 2014: Scientific Advisor, BCCA Sindi Ahluwalia Hawkins Centre for Southern Interior, Kelowna, BC)

Retainer: 3 grandchildren

Key Scientific Question
Potential Health Effects of Our Wireless Age?





"Do long term, low level emissions from cell phones, WiFi in schools, and smart meters cause health effects?"

Clearly, they cause many biological effects.

Lecture Goals

James Dewar

1. **Review validated science on potential threat to human health from electromagnetic radiation (EMR) – unwanted byproduct of our high tech world.**

2. **Create informed citizenry empowered with accurate science-based evidence – *knowledge is power*.**

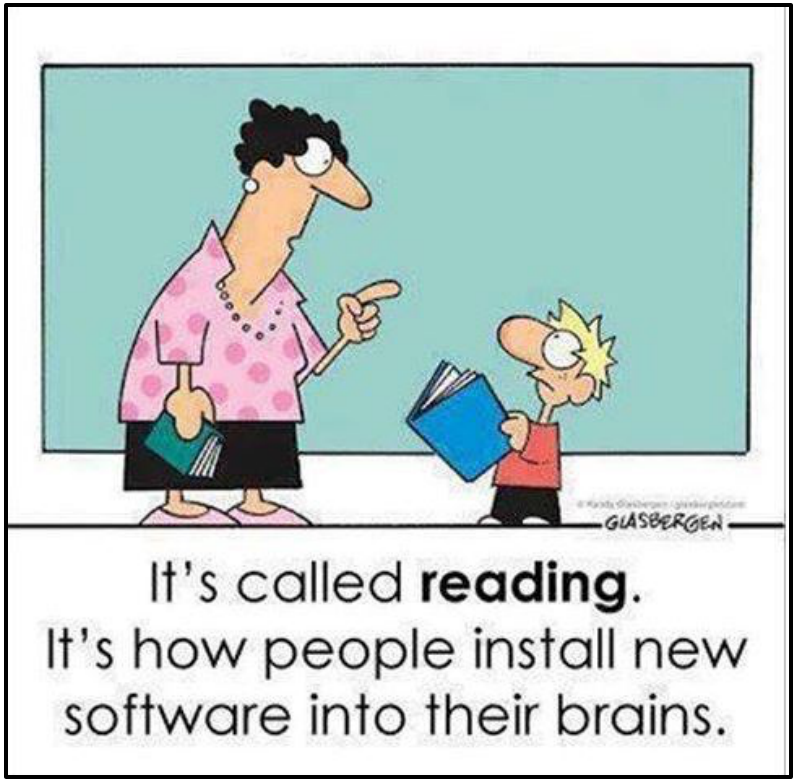
3. **Advocate urgent need for paradigm shift in decision-making (societal & personal) asking: "How can we prevent harm?" rather than "What level of harm is acceptable?"**

Outline

- Introduction: Radiofrequency (RF) devices & electromagnetic fields (EMF)
- Primer on scientific methods
- Current standards & guidelines
- Dissenting views: Bio-effects & adverse health effects
- Sensitive populations
- Coffee Break
- Smart meter/grid technology
- Public health impact: Great divide
- Late lessons from early warnings
- Game changer: Precautionary principle in risk management
- Concluding remarks

Lecture Format

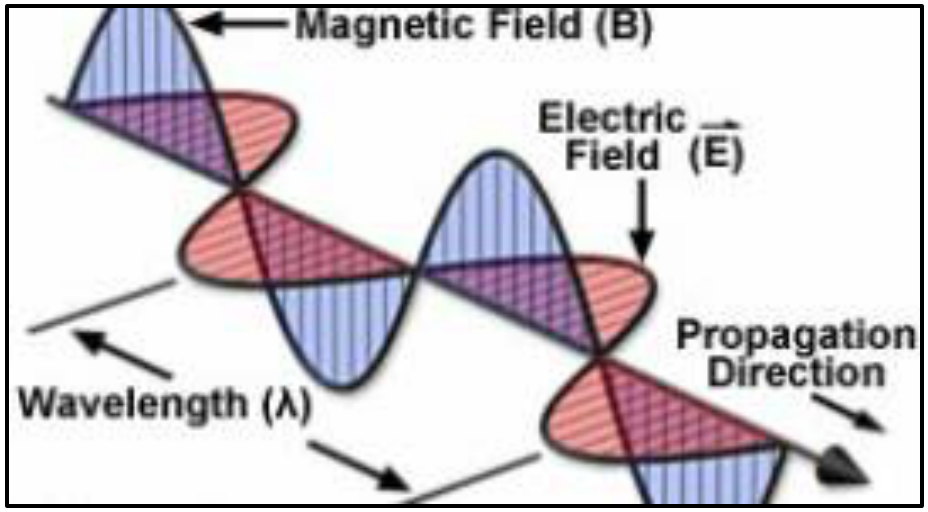
- **Two parts: limit no. of slides (~30) and duration of each formal talk (35 min)**
- **Leave 30 min for Q & A**

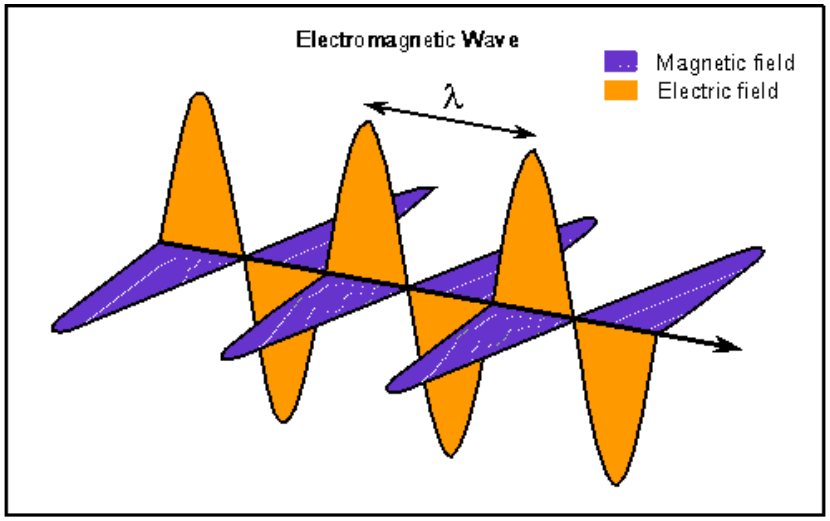


"They don't give us time to learn anything; we have to listen to the teacher all day."

Introduction: Radiofrequency (RF) devices & electromagnetic fields (EMF)

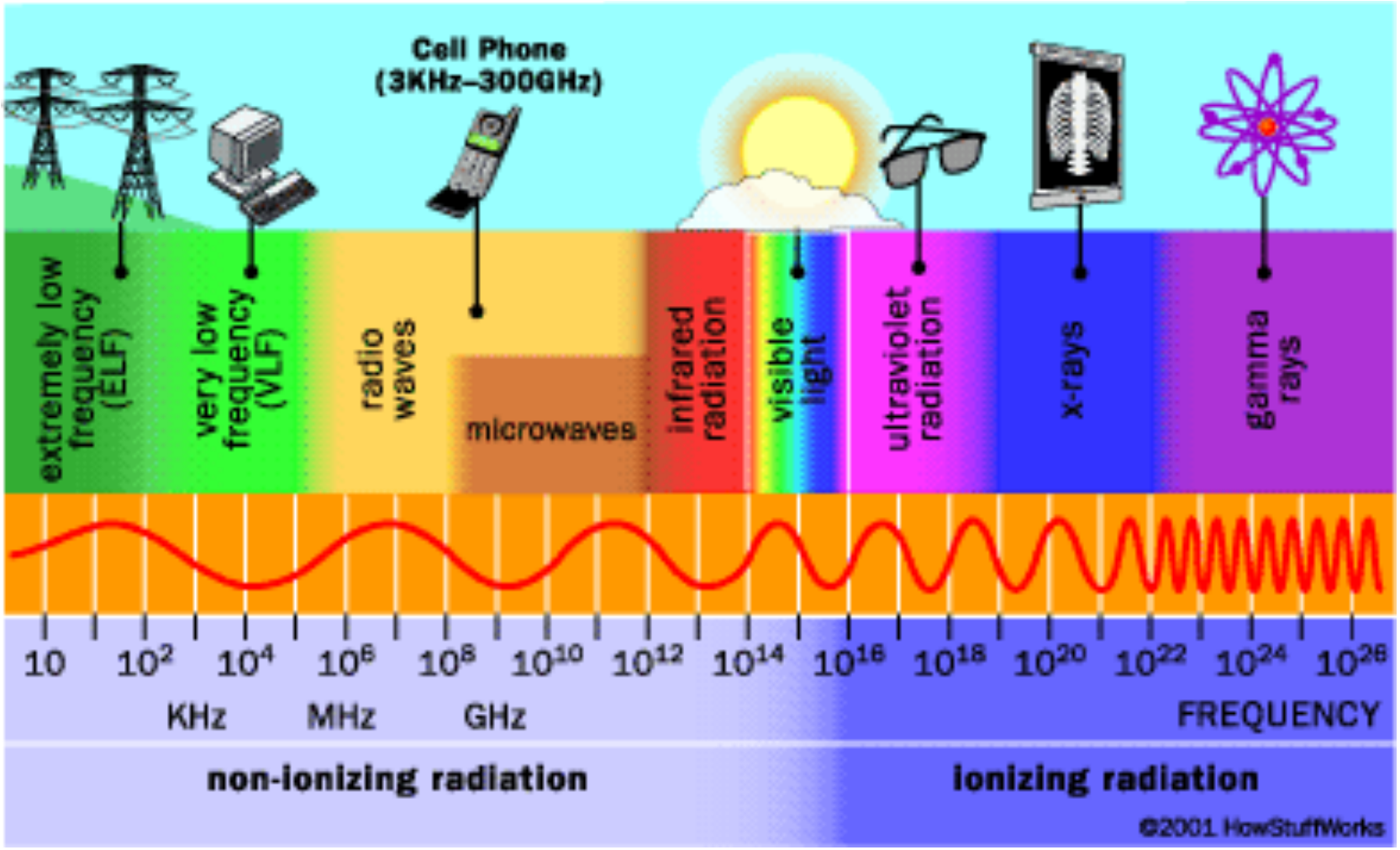
Properties of Electromagnetic Radiation



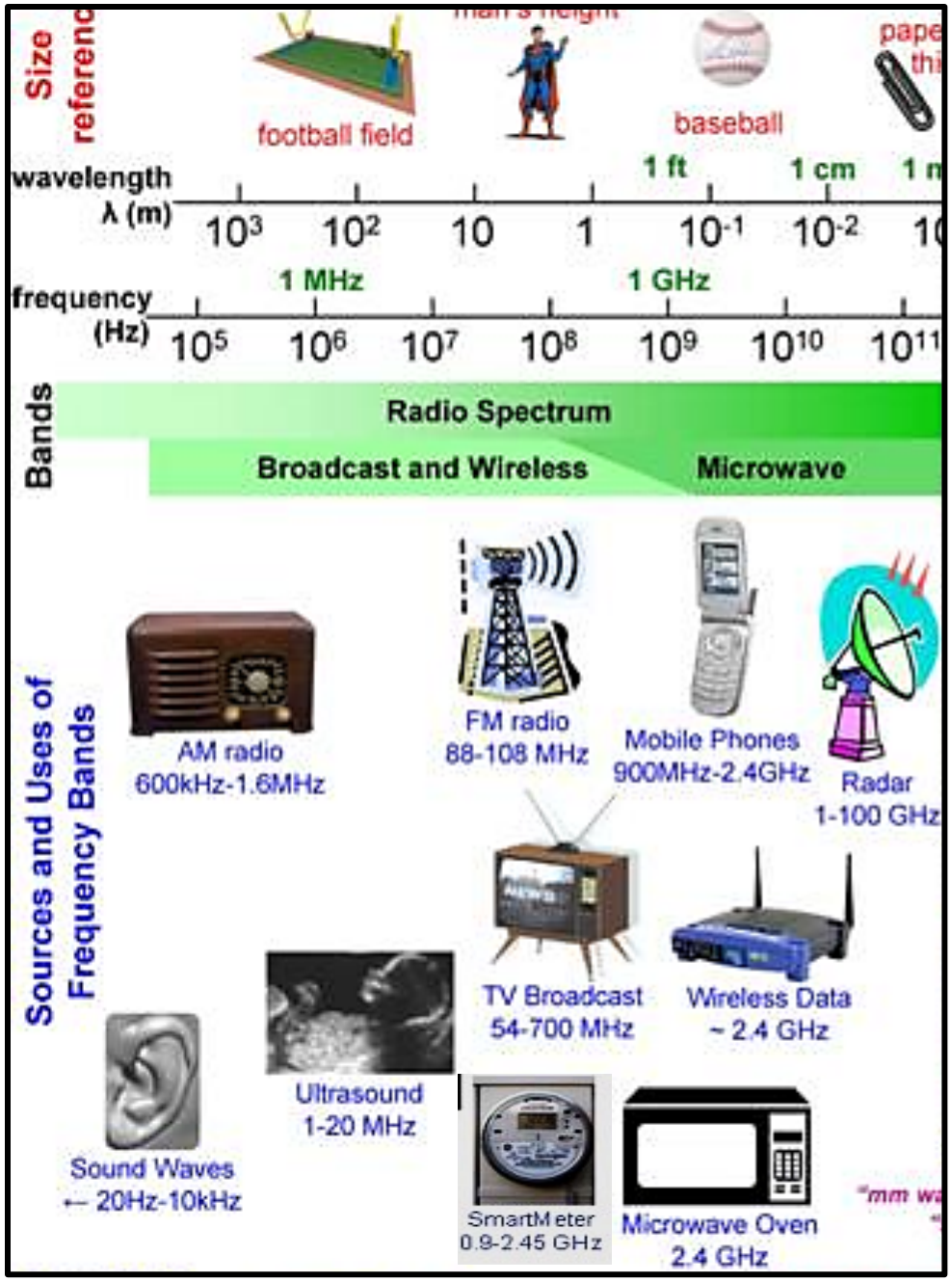


- Emits energy as self-sustaining & oscillating electric & magnetic fields
- Fields travel at right angles to each other and to direction of propagation
- Defined by frequency [# oscillations/sec, Hertz (Hz)] & wavelength (1/freq., m)
- Electric field (EF) arises from presence of electric charges; volts/m (V/m)
- Magnetic field (MF) due to motion of electric charges (alternating current); gauss (G) or tesla (T).

Electromagnetic Radiation (EMR) Spectrum



- **Higher frequency, shorter wavelength, higher energy**
- **Radiofrequency: 3kHz-300GHz (wireless devices/telecommunication systems)**



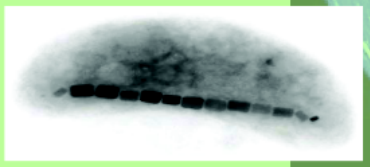
RF Spectrum

Wireless phones, WiFi routers, microwave ovens & smart meters have freq. range: 0.8 GHz to 2.4 GHz

Electrification: Recent Event

Magneto-reception in animal orientation & navigation: sensitive down to 0.1 mG

Geomagnetic field ~ 500 mG



Magnetotactic bacteria (2 bn)

Bird compass (90 m)

Early man (6 m)

Electrification (1878)

Earth forms (4.5 bn)

Big bang (13.2 bn)

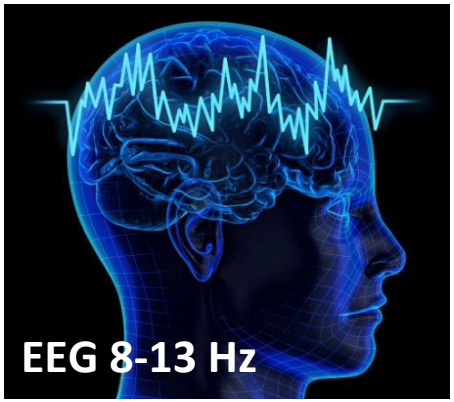
Present day

10^{11} 10^{10} 10^{9} 10^{8} 10^{7} 10^{6} 10^{5} 10^{4} 10^{3} 10^{2} 10^{1} 1

Time (years)

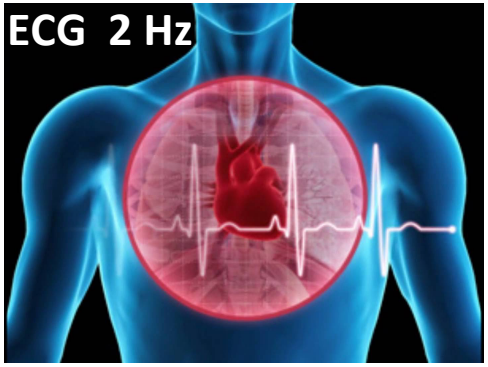
Modified from DL Henshaw 2012

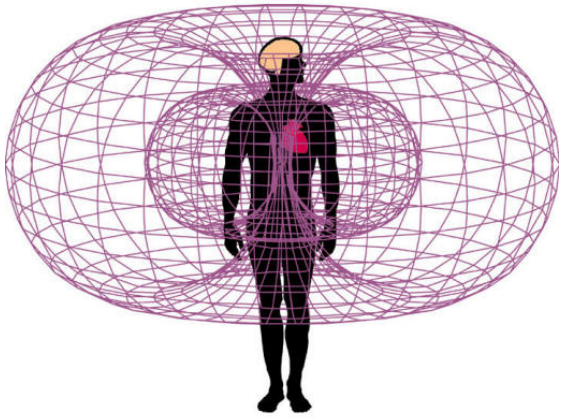
We're electromagnetic -- all wired up!



Brain activity

(Optimal 7.83 Hz)

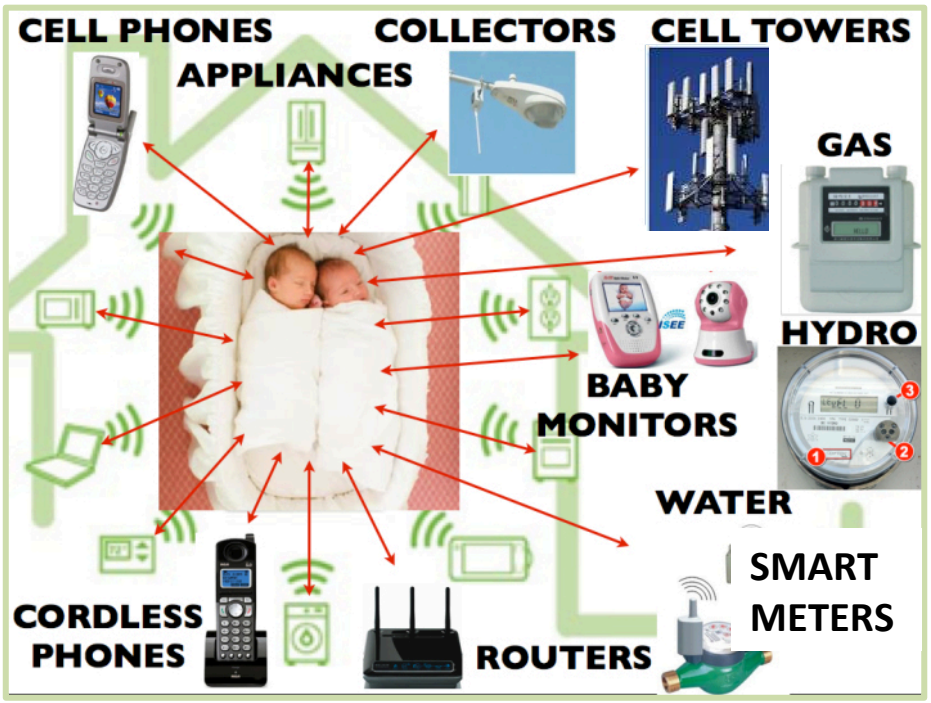




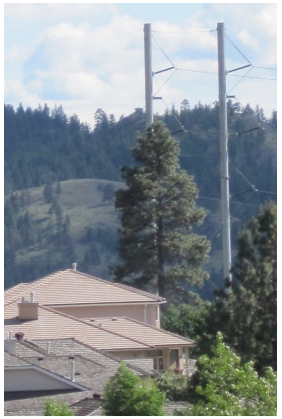
Electromagnetic field of heart

- **Our brain, heart, muscles and pancreas all work on electricity.**
- **Same power as used by computer**
- **When awake, human brain produces enough electricity to power small light bulb.**

…and We're Blanketed in 'Electro-Smog'



TV/RADIO TOWERS

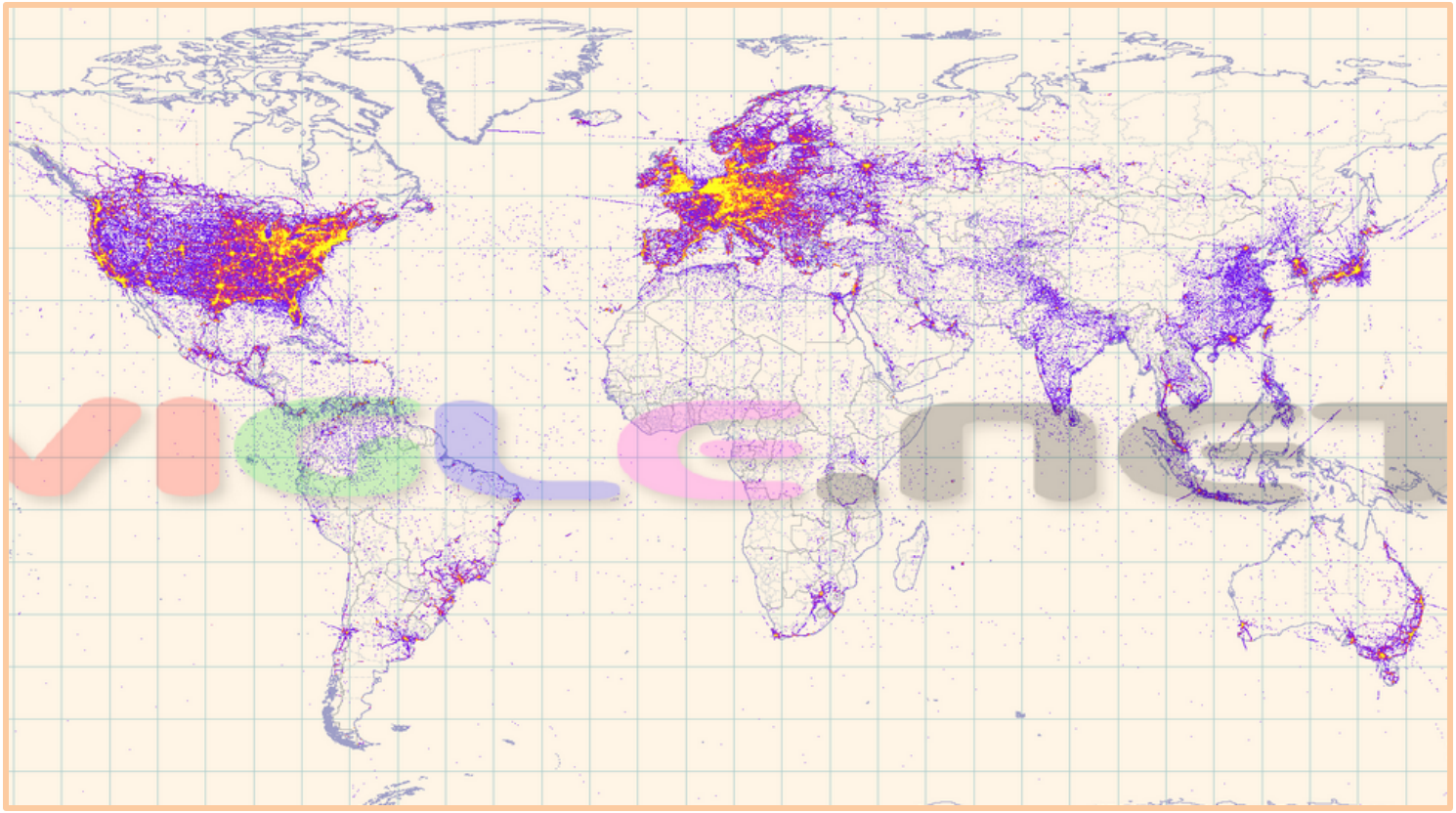


POWER LINES

SMART MATTRESS COVER

- Massive roll-out of wireless devices has led to record RF energy levels in our daily lives.
- Exposures are extensive, rising rapidly, and inescapable; vastly upping the stakes, both health and economic.

Global Wireless Map 2014

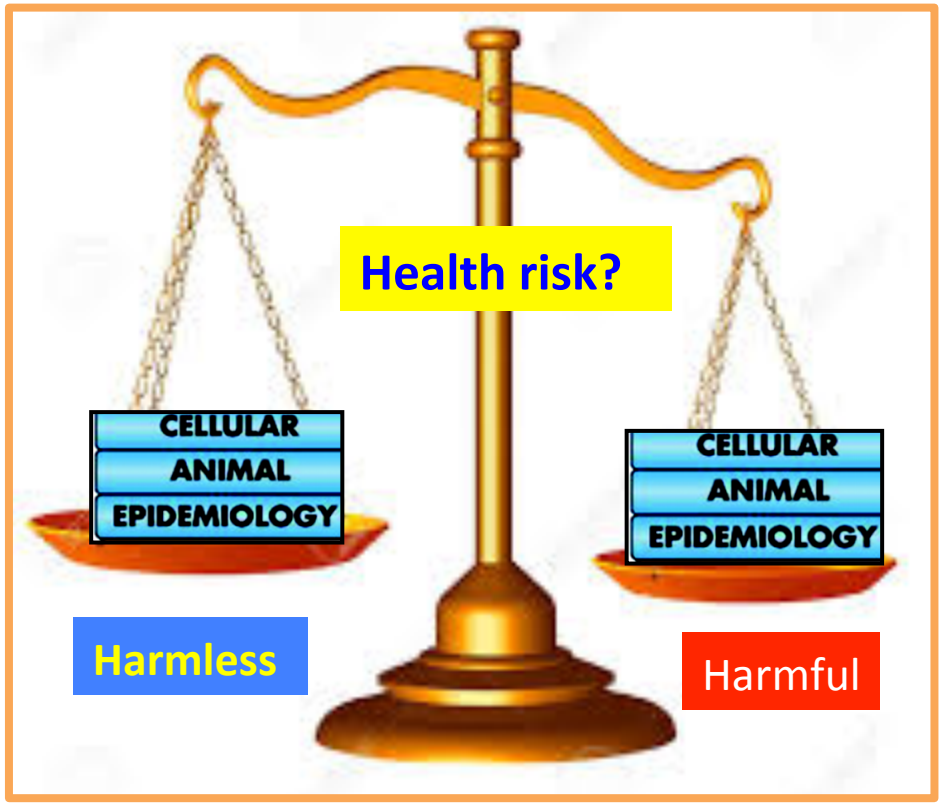


Source: www.wigle.net

- Current RF radiation levels in cities can be ~ 3 µW/cm^2 and increasing rapidly
- 3 of 4 persons today live in mega-cities (>10 million); many in developing countries where levels poorly controlled
- Increased 3000 times from 1980 background levels (.001 µW/cm^2).

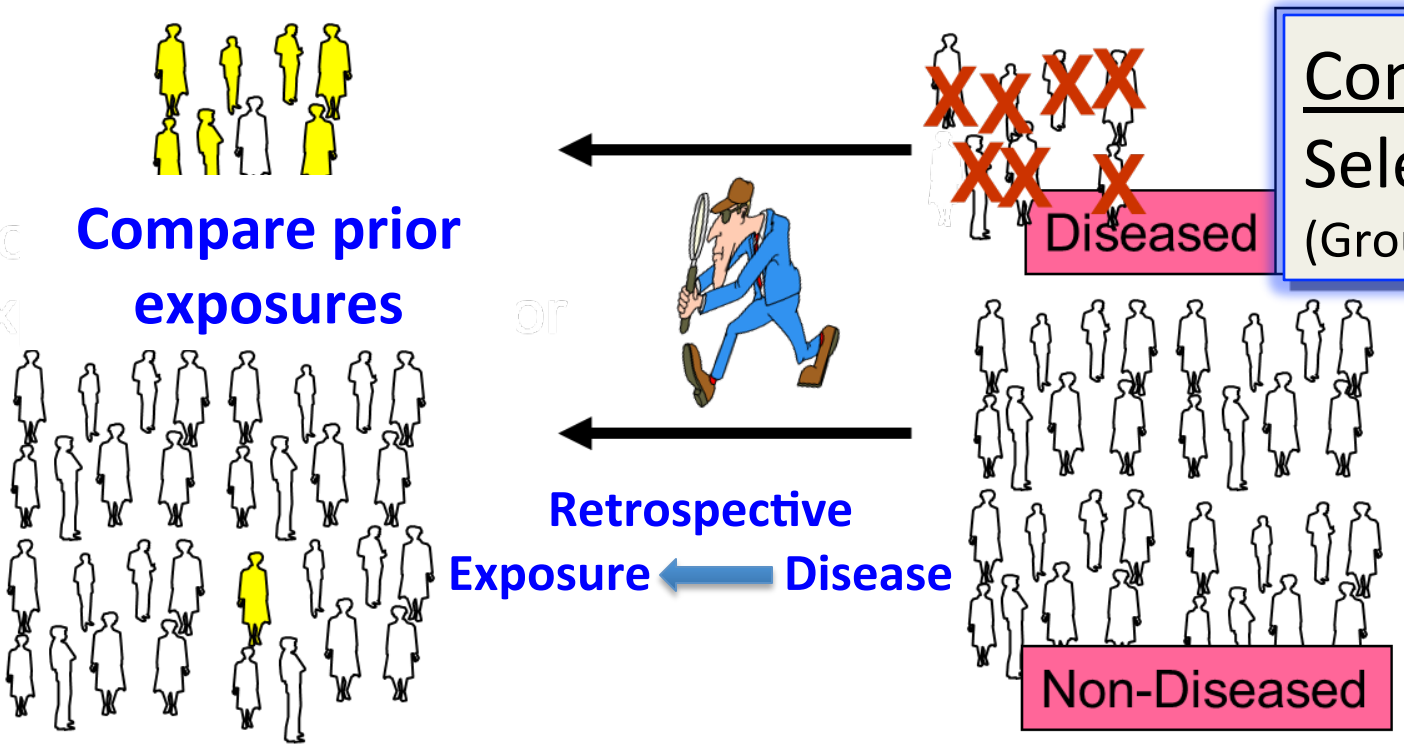
Primer on Scientific Methods

‘Weight-of-Evidence’ Review



- Evaluate all relevant studies in peer-reviewed scientific literature
- Three types of research considered:
  1. human epidemiology studies (disease distribution, causal factor linkage)
  2. experimental studies in animals (*in vivo* research)
  3. experimental studies in cells & tissues (*in vitro,* mechanistic studies)

Design of Case-Control Study



Confounders
Selection bias
(Groups matched?)

Critically dependent on: study design, observational astuteness of investigators

'You can observe a lot by watching.' **Yogi Berra**

Source: Boston University School of Public Health

Current standards & guidelines†

†Many national agencies, including Health Canada, rely heavily on international limits recommended by WHO review panels.

Exposure to RF Energy

Specific Absorption Rate (SAR):

- **rate at which body absorbs energy from RF radiation**
- **measured in watts per kilogram of tissue (W/kg)**
- **for whole body exposure, max. level is 0.08 W/kg averaged over 6 min[£]**

Power density:

- **amount of energy in EM field in free space**
- **measured in µW/cm²**
- **max. permissible exposure ranges from 200 µW/cm² for 30-300 MHz to ~500 to ~900 µW/cm² for 2.2-5.2 GHz[£]**
- **describes strength of radiation itself, not energy absorbed from radiation**

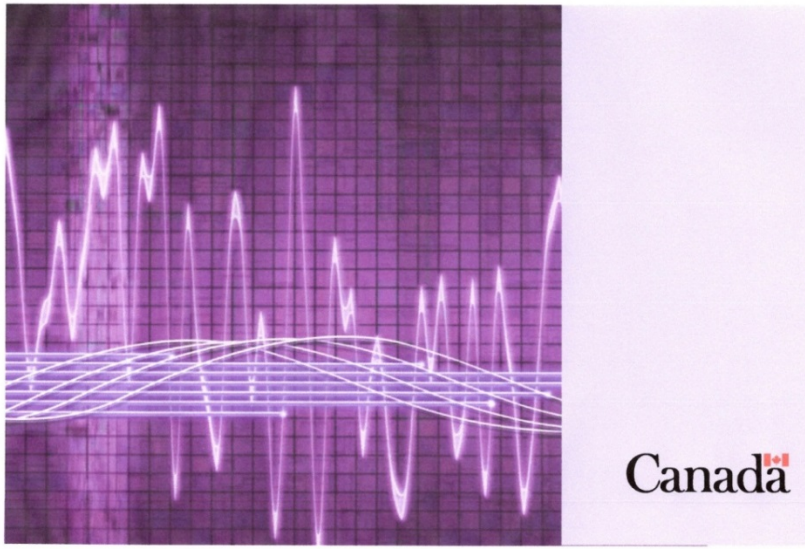
[£] Health Canada Safety Code 6

Health Canada Safety Code 6 (2015)€

Health Canada Santé Canada | Your health and safety... our priority. Votre santé et votre sécurité... notre priorité.

Environmental and Workplace Health Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz

Safety Code 6 (2015)

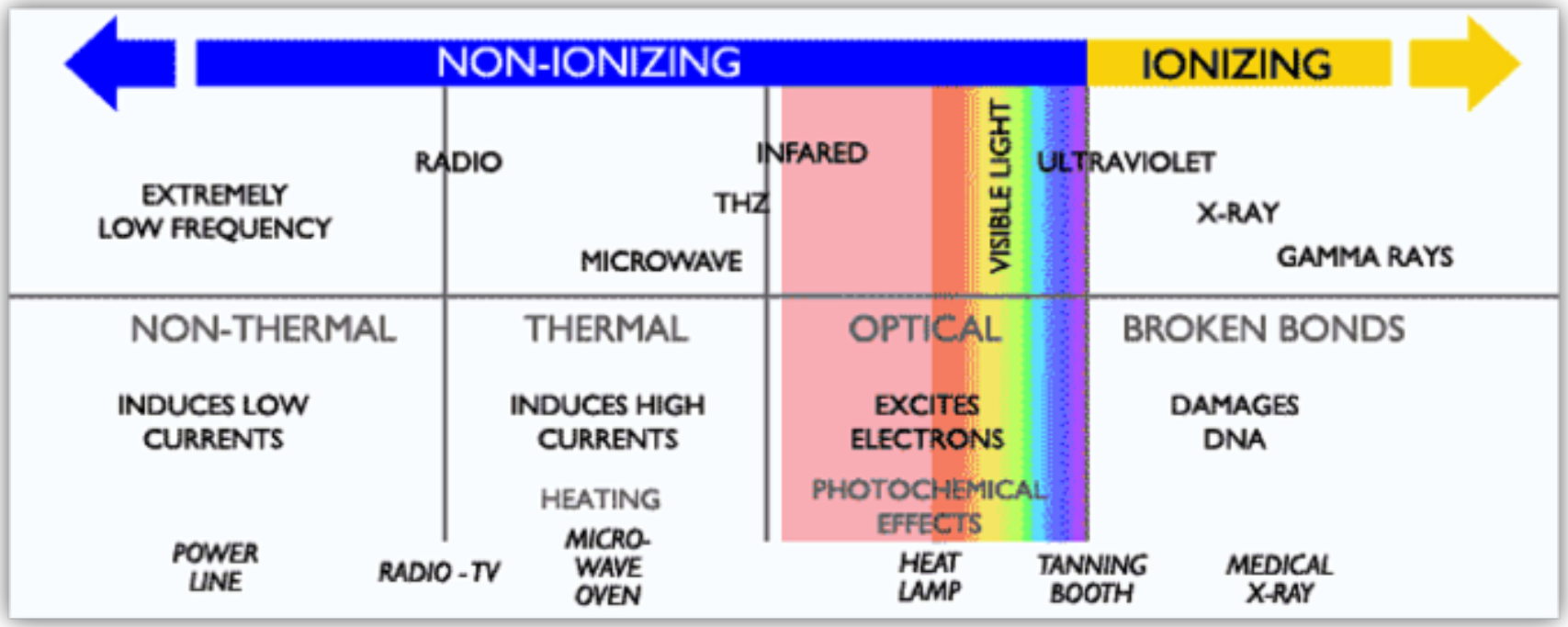


- **Purpose:** "establish **safety limits** for human exposure to **RF fields** in **the frequency range** from **3 kHz to 300 GHz."**
- "Despite **numerous research studies** on **RF fields** and health, **only established adverse effects** … relate to … **tissue heating** and **nerve stimulation (NS)…** from **short-term (acute) exposures**."
- **"… freq.** from **3 kHz to 10 MHz, NS** from **induced electric fields** within the body **must be avoided."**
- **"**For **freq.** from **100 kHz** to **300 GHz, tissue heating** can **occur** and **must be limited."**

€ **Code applies** to **…federally regulated sites…. may** also be **adopted** by the **provinces, industry ….**

Safety limits consider only tissue heating effects.

Health Canada's View: EMR and Health Effects



- " … **no scientific basis** for premise of **chronic** and/or **cumulative health risks** from **RF energy below limits** outlined in **Safety Code 6**."

- "These ***low-intensity, biological* effects** … are **not scientifically established**, **nor** are their **health implications sufficiently well-understood** … for making **science-based recommendations**.

Dissenting views:
Bio-effects† & adverse health effects

†Physiological, biochemical and molecular changes

Diverse Range of Bio-effects & Adverse Health Effects from RF EMF

- **Adult brain tumors (glioma, acoustic neuroma) Alzheimer's disease, sleep disturbances, cognitive disorders (decreased memory), impaired learning and behaviour in children, autism**
- **Leakage of protective blood-brain barrier**
- **Male infertility: impaired sperm quality, mobility & viability**
- **Immunity dysfunction (allergic & inflammatory responses)**
- **Electro-hypersensitivity (EHS): debilitating multi-system condition leading to lost productivity; recognized in Sweden, Germany, Denmark, Austria, USA**
- **Genotoxic effects: DNA strand breaks, reduced DNA repair, induction of stress-response proteins**
- **Neurotoxic effects: death of neurons, pulsed RF-EMF affects brain function**

- **Pulsed EMF has wide therapeutic application: bone and wound healing.**

Wireless (Cell &Cordless) Phones: Some Facts

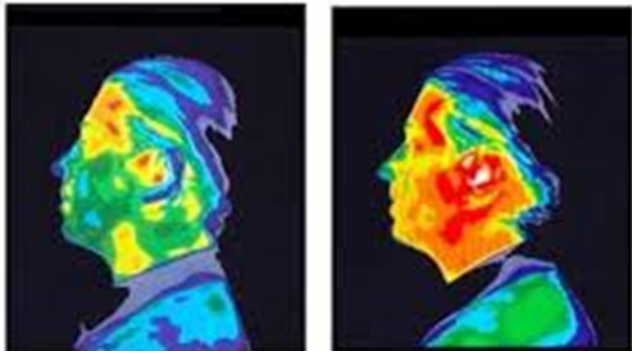
⌘

⌘

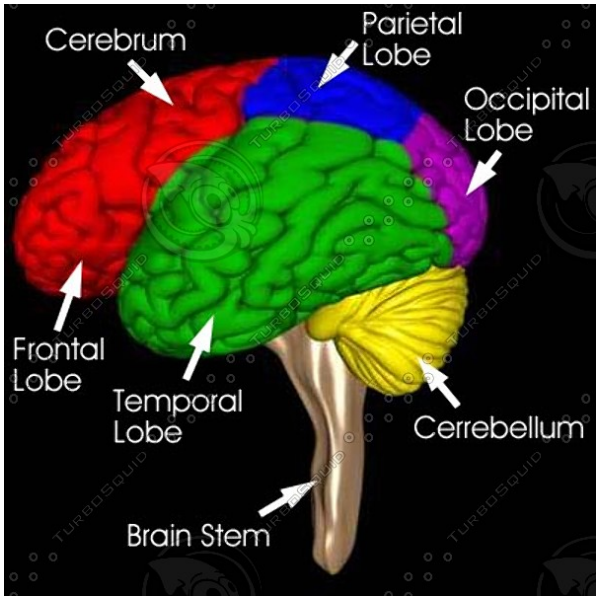
- Meteoric growth in usage in last 15 yrs
- Globally, ~ 7 billion subscriptions
- Analog, single band (450 or 900 MHz)
- Digital system (GSM), dual band (900/1800 MHz) , introduced in 1991
- 3G (1900/2100 MHz) dominant globally
- 4G (Terrestrial 3G) using 800/2600 MHz; established in Europe in 2009
- Cordless (1900 MHz) DECT; since 1990s

⌘Automatic Power Control

Wireless Phones & Brain Tumors



Thermographic image
no phone 15-min call



- Four case-control studies: Sweden (Hardell); Europe (Interphone; 25 centres in 13 countries); Korea; France (CERENAT)
- Increased risk for glioma (~2-4 times), acoustic neuroma, meningioma
- Higher risk with: higher cumulative hrs of use (>2000 hrs); longer time since first use (>10 yrs); most exposed area (same-side temporal, frontal lobes)
- Same-side phone use: 30 min/day for 10 yrs or more increases risk 3.7 times
- Alarming result, typical latency period: 15-25 yrs
- In 2011, these findings swiftly led IARC to classify RF-EMF as Group 2B 'possibly carcinogenic'.

International Agency for Research on Cancer

World Health Organization

PRESS RELEASE N° 208

31 May 2011

IARC CLASSIFIES RADIOFREQUENCY ELECTROMAGNETIC FIELDS AS POSSIBLY CARCINOGENIC TO HUMANS

Lyon, France, May 31, 2011 -- The WHO/International Agency for Research on Cancer (IARC) has classified radiofrequency electromagnetic fields as possibly carcinogenic to humans (Group 2B), based on an increased risk for glioma, a malignant type of brain cancer[1], associated with wireless phone use.

This classification applies to all RF-emitting devices, including WiFi.

- Robert A. Baan, PhD, IARC

This classification justifies the implementation of the Precautionary Principle.

- Dr. Darius Leszczynski, IARC

Mobile phone radiation causes brain tumors and should be classified as a probable human carcinogen (2A) (Review)

LL Morgan[1], AB Miller[2], A Sasco[3] and DL Davis[1]

Int. J. Oncol. 46: 1865, 2015

Glioblastoma
CT scan

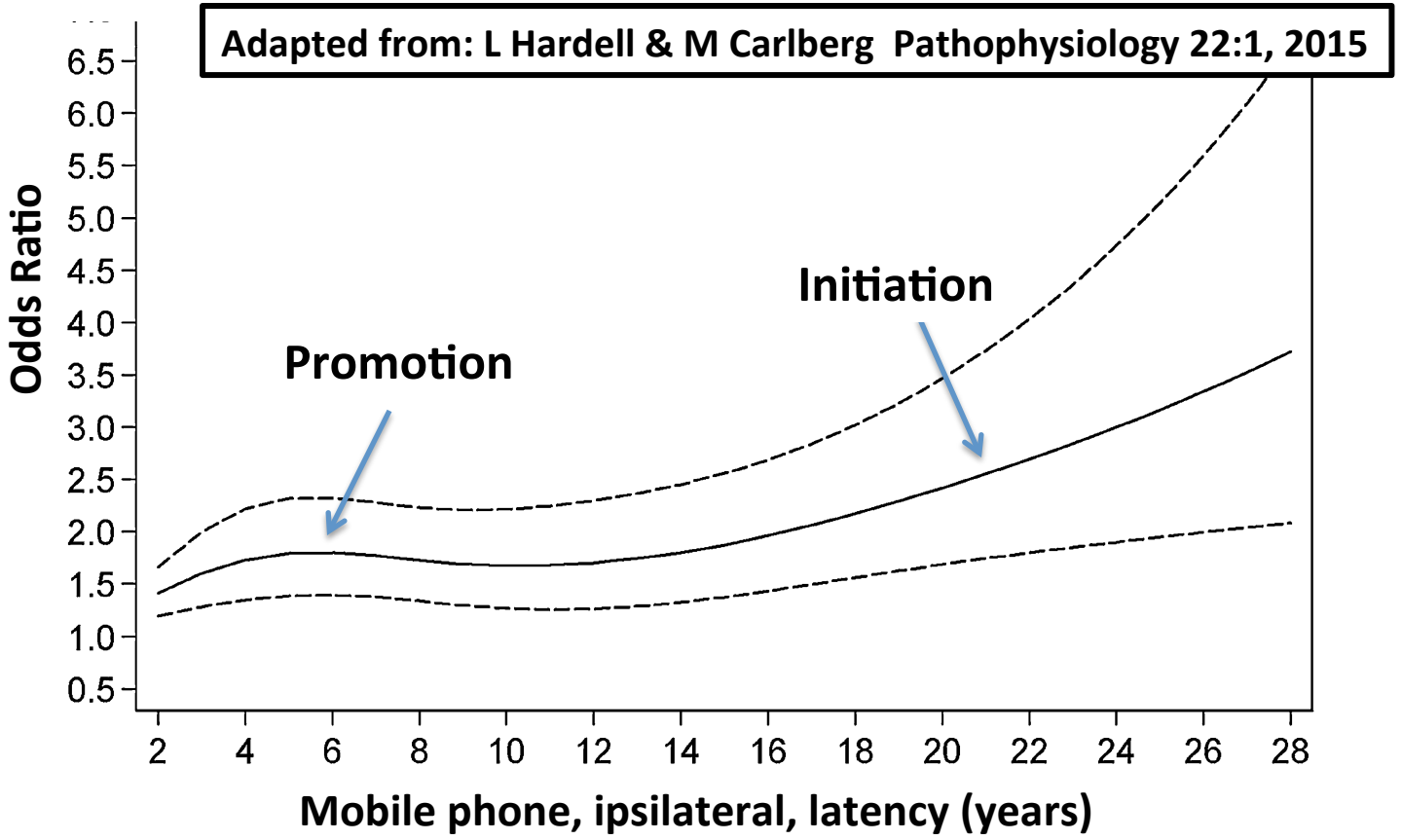


Figure: Plot of relationship between latency of same-side phone use and glioma

- **Mobile phone radiation acts as both initiator (long time for tumor development) and promoter (earlier development of already initiated tumor)**

RF-EMF and Tumor Promotion (Humans)

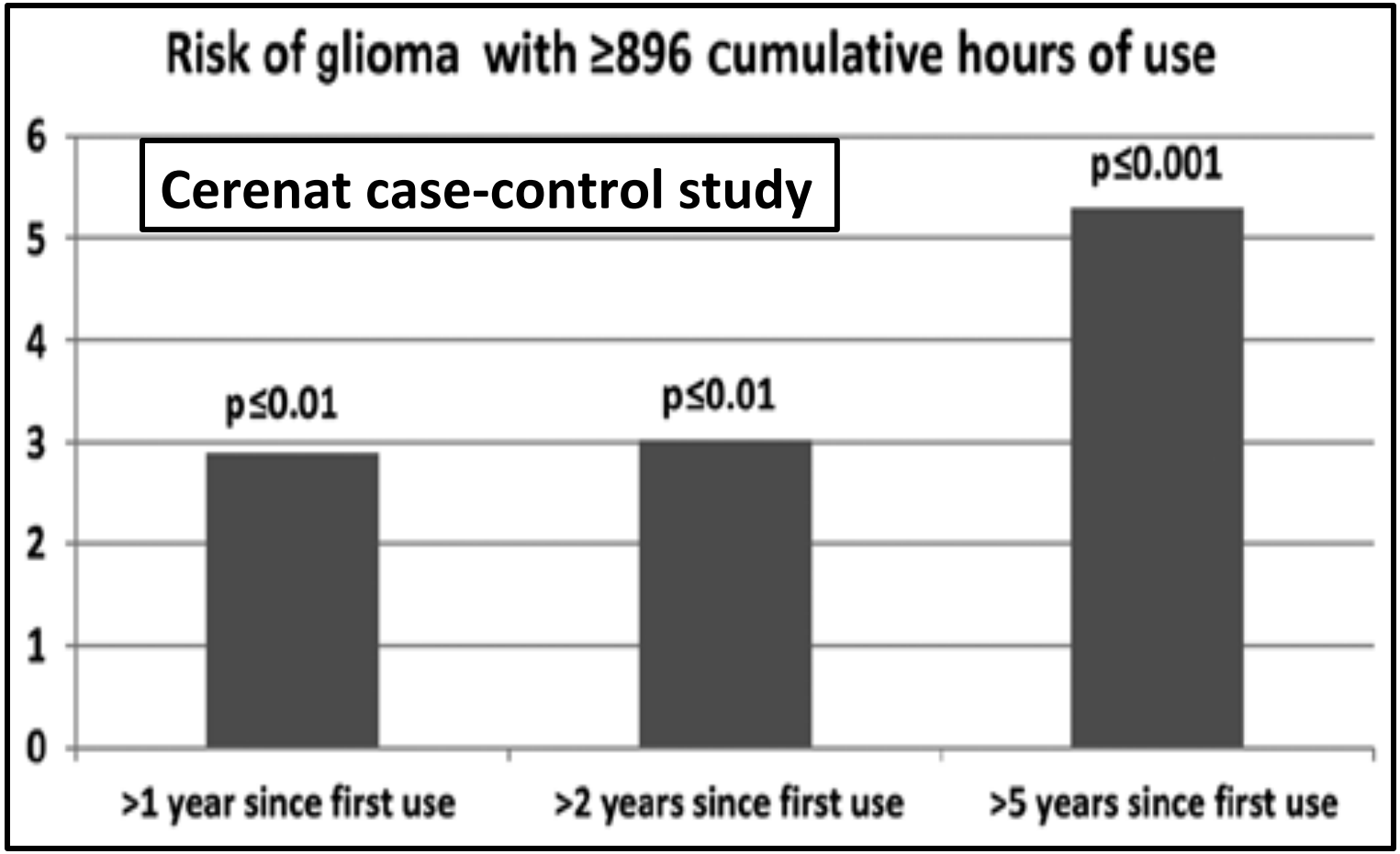


Fig. Risks among mobile phone users with increasing years of use

- **Risk increased 3 times after only 1-2 yrs of use.**
- **Also, reduced survival of glioblastoma patients linked to long-term use of wireless phones.**

LL Morgan *et al*. Int. J. Oncol. 46: 1865, 2015

RF-EMF and Tumor Promotion (Mice)

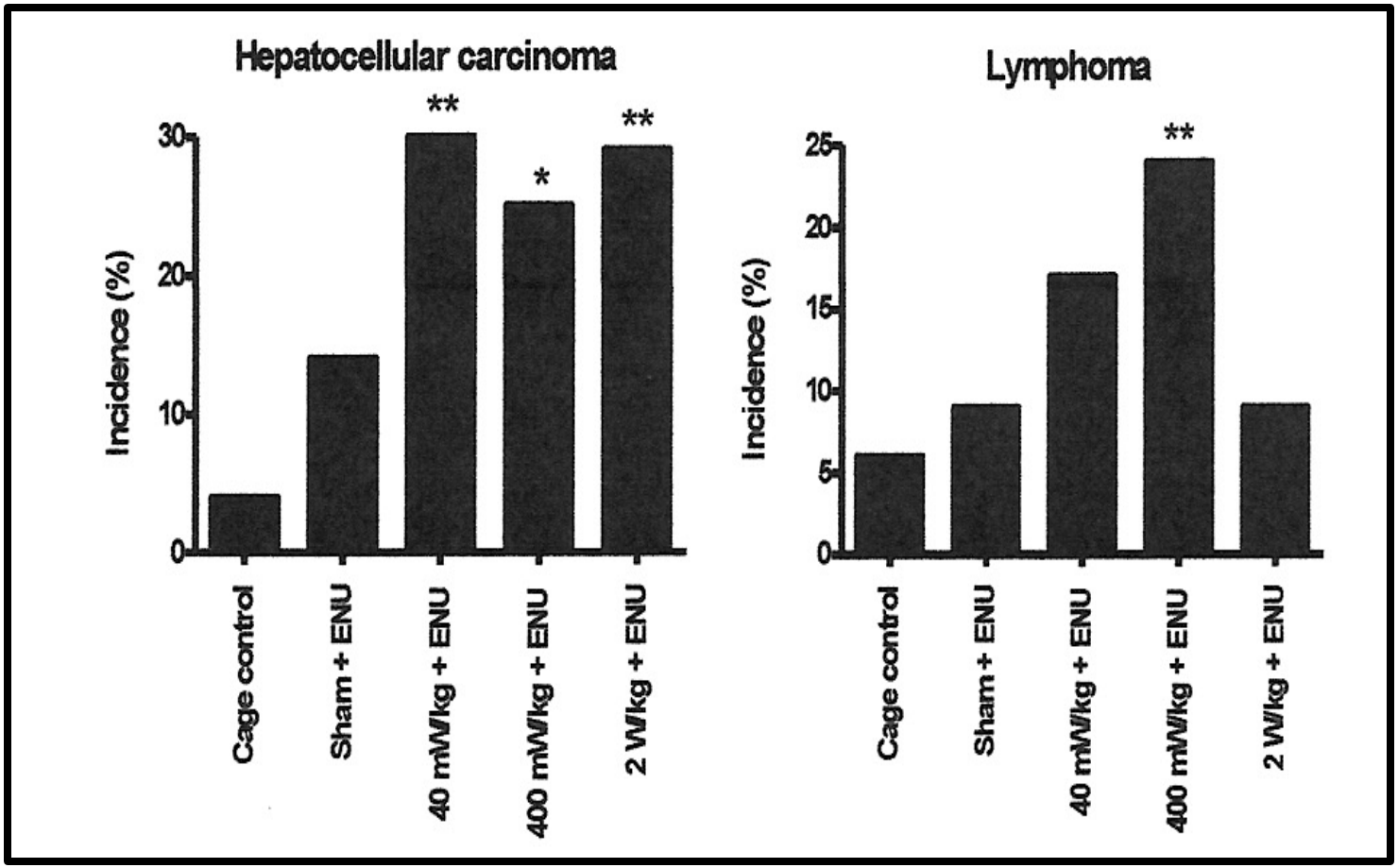
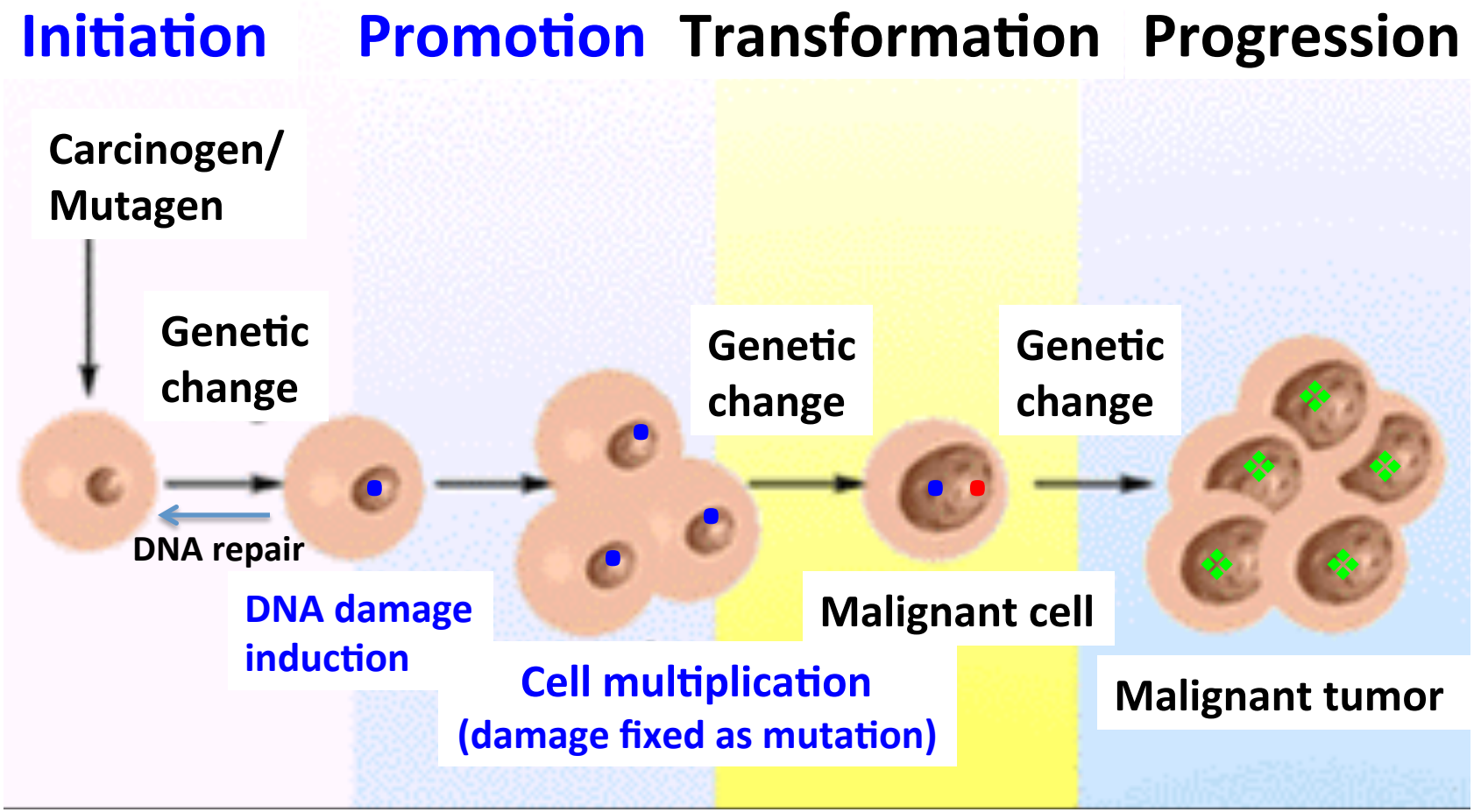


Fig. Effects of life-long (72-wks) exposure to RF-EMF in mice treated with ENU in utero. Tumor incidences given as percentage of animals (93-96 per group).

Promoting effects seen at low to moderate exposure levels (0.04 and 0.4 W/kg SAR); well below limits (2 W/kg local exposure) for phone users. No dose-response effect.

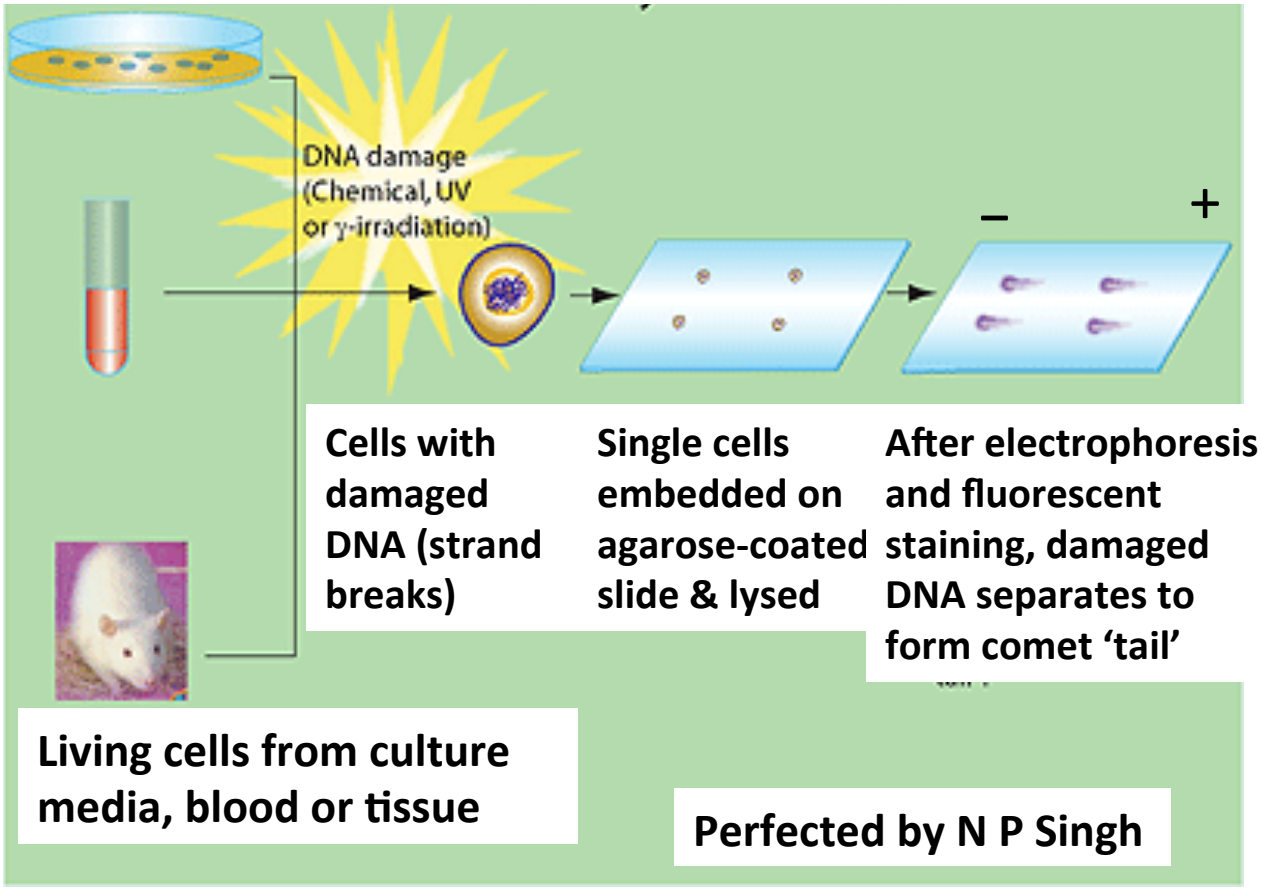
A. Lerchl *et al*. Biochem. Biophys. Res. Commun. 459:585, 2015

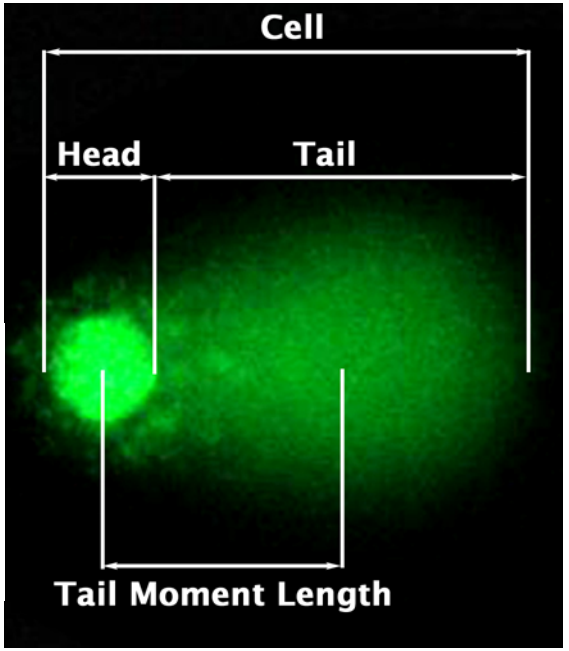
Stages in Cancer Development



- Compelling evidence RF radiation acts as both initiator and promoter based on human, animal and cellular studies
- If true, this finding is critically important in advancing cancer control efforts.

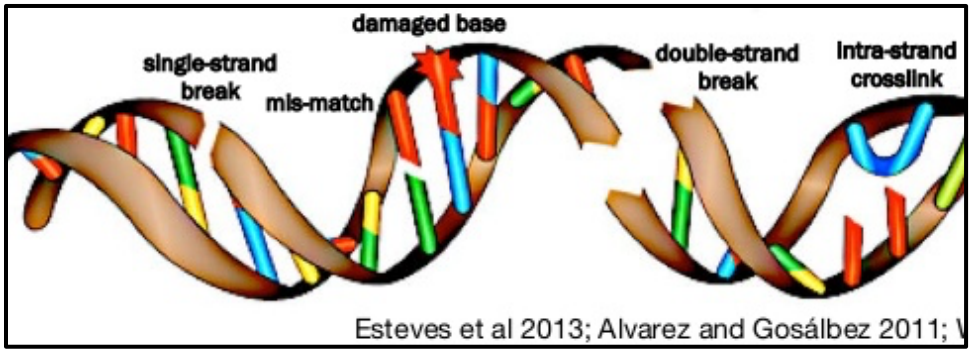
Comet Assay: DNA Strand Breakage

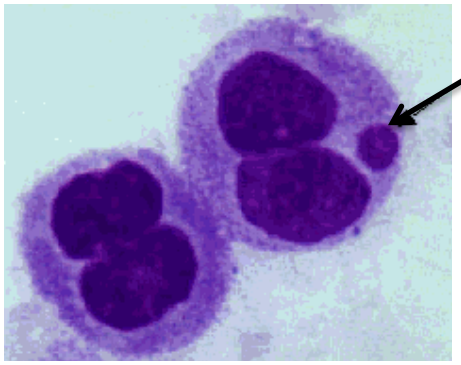




- Extremely sensitive: 10 cGy of X-rays
- Difficult to master: proteinase K treatment to digest proteins is vital; use of antioxidants

Genotoxic Effects of RF-EMF





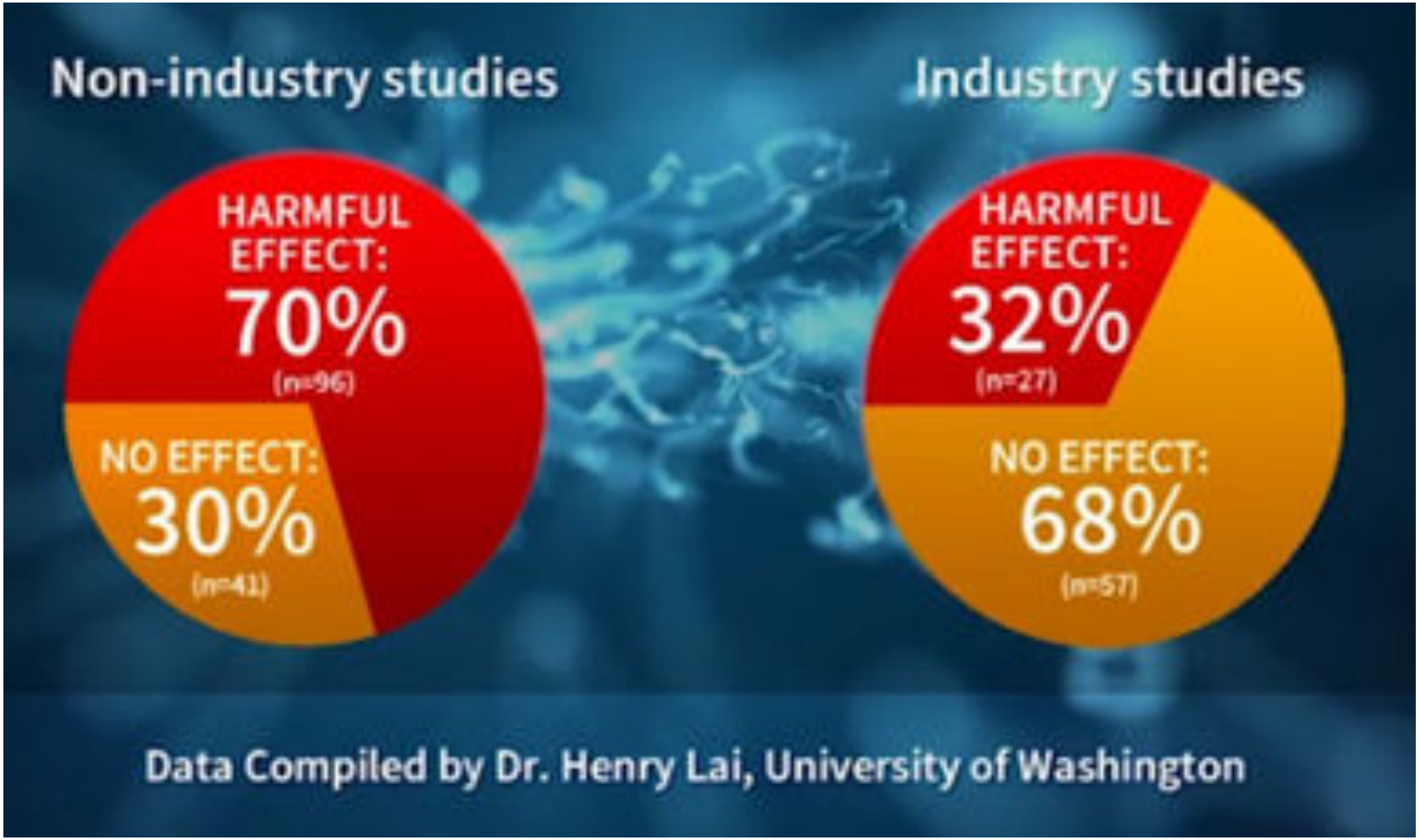
Sham	Gamma-irradiaation, 0.5Gy (1,600 chest x-rays)	24h mobile phone, RF-EMF, 1800MHz at SAR = 1.3W/kg. ICNIRP/WHO = 2W/kg

Comet Assay - a typical picture after RF-EMF-exposition of HL60 leukaemia cells Image source: Adlkofer (2004).

- **Review of 101 published studies (SAR: below 0.05 up to 100 W/kg)**
- **GT(+) 49; GT(-) 42; enhanced genotoxic effects of other agents (8)**
- **Results independent of RFs from 300 MHz-7.7 GHz**
- **'Ample evidence RF-EMF alters genetic material of exposed cells in many ways.'**

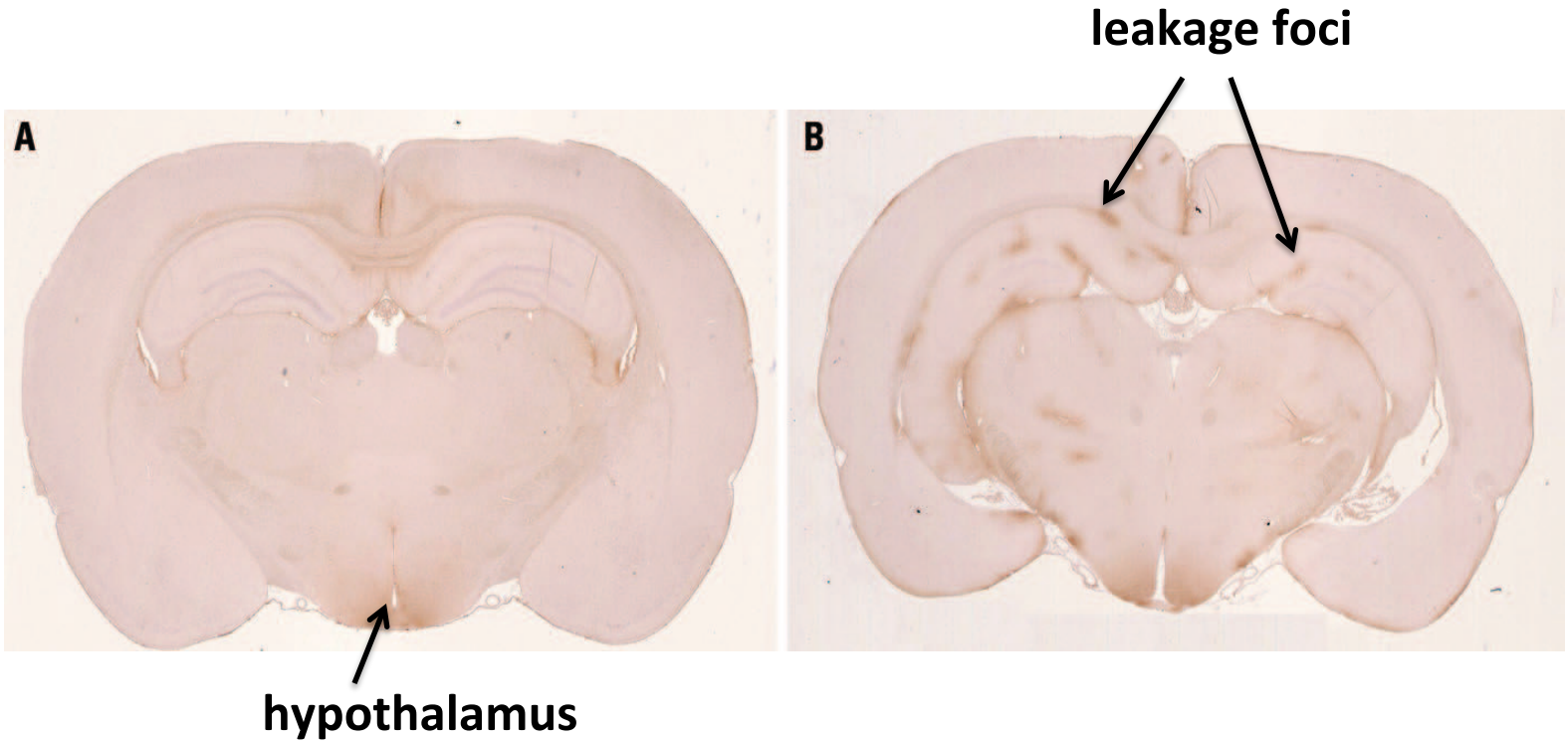
H W Ruediger Pathophysiology 16: 89 (2009)

RF Research: Does Funding Source Matter?



- **Clearly, it does.**

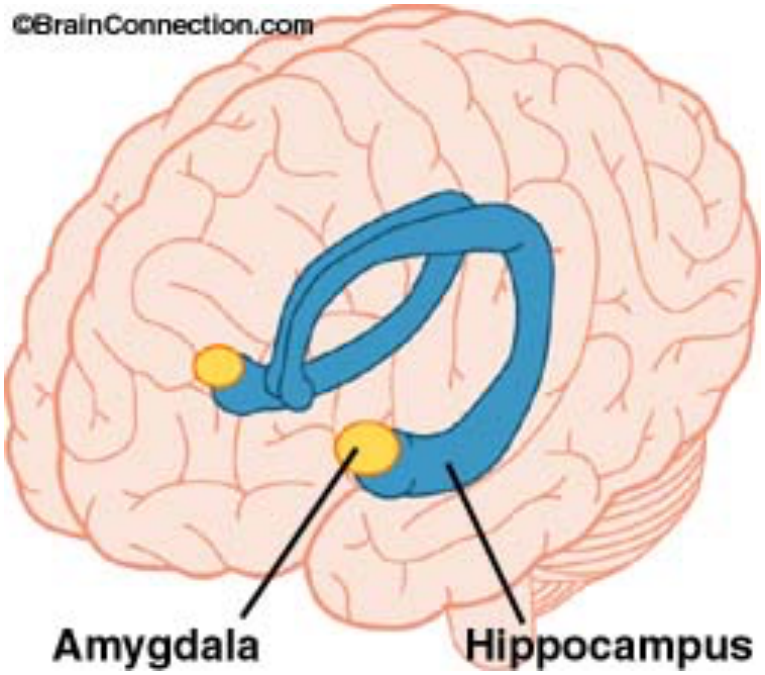
Leakage of Blood-Brain Barrier from GMS Cell Phone Exposure in Rat



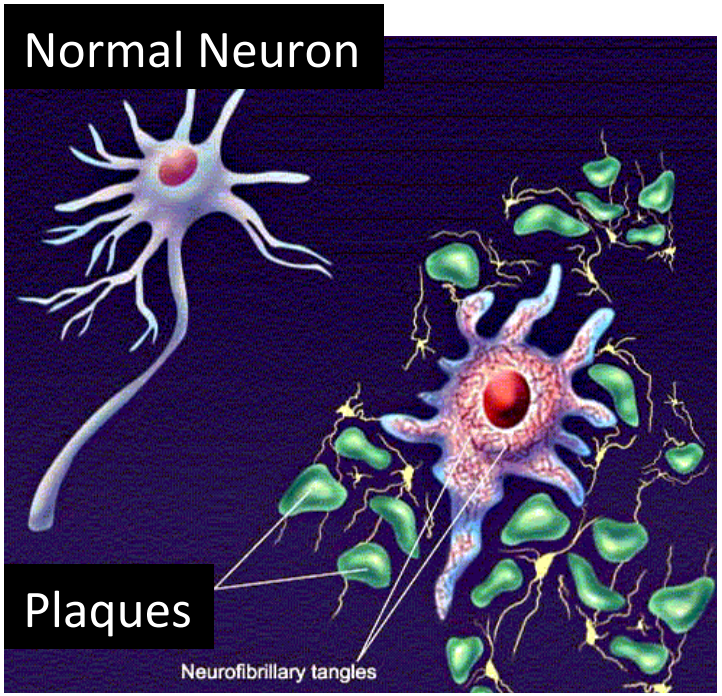
Cross-section of central part of brain stained for albumin (brown)
A. Sham-exposed (control) animal B. Exposed animal (2 mW/kg for 2 hr)

LG Salford *et al*. Environ. Health Persp. 111:882 (2003)

Alzheimer's Disease – EMF Connection



(Emotional memories, reactions)



- AD linked to previous work in jobs with medium-to-high ELF-EMF exposures (2-10 mG)
- 3-5 fold increased risk for radio/TV and power plant workers, electricians, seamstresses
- EMF exposure can produce rise in intracellular Ca^{2+} levels, triggering production of peripheral amyloid beta, high levels in brain is risk factor for AD
- EMF exposure can lead to reduced melatonin levels & BBB leakage: 2 other AD risk factors.

BioInitiative 2012

A Rationale for Biologically-based Exposure Standards for Low-Intensity Electromagnetic Radiation

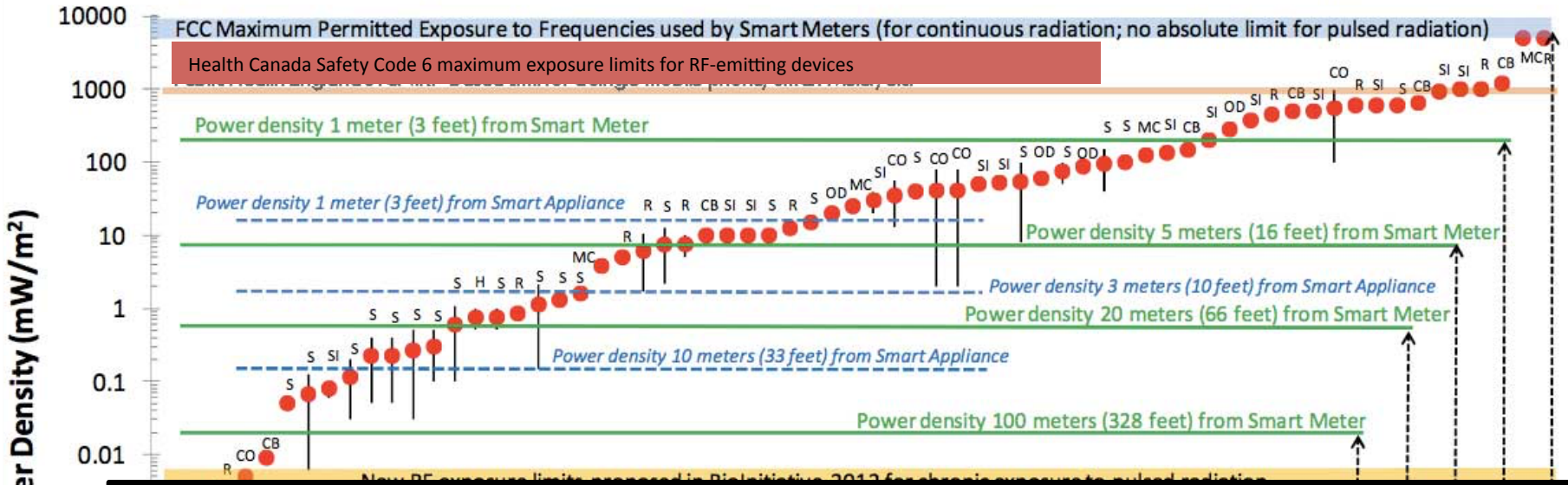
BioInitiative Working Group 2012

29 authors: 9 MDs, 21 PhDs
10 countries: USA (10); Sweden (6); Austria, Canada, Greece, Italy, India (2 each); Russia, Slovak Republic, (1 each)

- Documents "bio-effects, adverse health effects & public health conclusions about impacts of both ELF-EMF & RF-EMF"
- Billed as benchmark for good science & public health policy
- Advocates much lower exposure limits: 0.1 $\mu W/cm^2$

http://www.bioinitiative.org

Reported Biological Effects from RF Radiation at Low-Intensity Exposure in 67 Studies in *BioInitiative Report 2012*



CODE	CODE TRANSLATION	BIOLOGICAL EFFECTS CATEGORY
CB	Cancer, Brain	Brain tumors and blood-brain barrier
CO	Cancer, Other	Cancer (other than brain), cell proliferation
H	Heart	Cardiac, heart muscle, blood-pressure, vascular effects
MC	Metabolism , Calcium	Disrupted calcium metabolism
OD	Oxidation, DNA	Oxidative damage/ROS/DNA damage/DNA repair failure
R	Reproduction	Reproduction/fertility effects
S	Sleep	Sleep, neuron firing rate, EEG, memory, learning, behavior
SI	Stress, Immune	Stress proteins, HSP, disrupted immune function

RM Powell, 2013

Sensitive populations

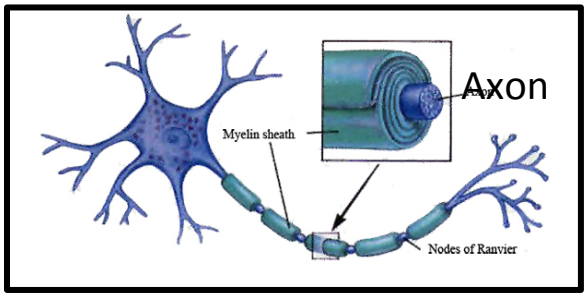
Need to protect: developing fetus, children, elderly, those with medical implants, chronic diseases or acquired electro-hypersensitivity

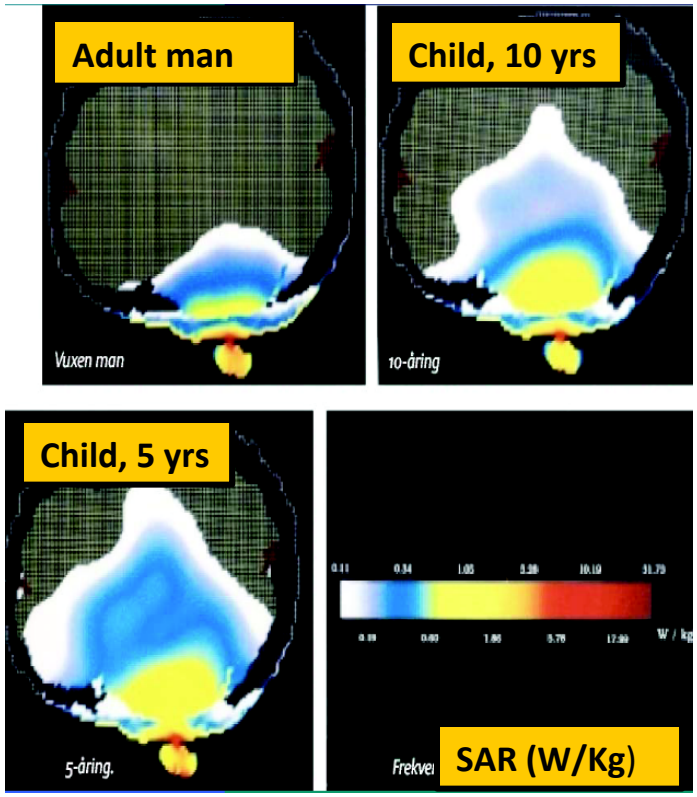
Children are not little adults

Family and Rainstorm 1955
Alex Colville

1. Different and unique exposures
2. Dynamic developing nervous and immune systems
3. Longer life expectancy
4. Politically powerless

Children Are More Vulnerable





Brain activity, GSM phone (900 MHz)

Abridged from OP Gandhi, 1996

- Smaller body mass; rapid physical development
- Brain not fully developed until early 20's; sensitive to toxins as protective sheath (myelin) around neurons still forming
- Smaller head & thinner, softer skull bone (bone marrow absorption 10X greater)
- Brain tissue has 2X higher conductance
- Thus absorb greater amount of RF energy deeper into their brain than adults
- Earlier age of phone use, greater glioma risk.

"It is essential that any new standards for cell phone or other wireless devices be based on protecting the youngest & most vulnerable ...."

American Academy of Pediatrics (2012)

Health Canada Santé Canada

Health Canada
www.hc-sc.gc.ca

Health Canada: "Busting Myths on Safety Code 6"

Myth: "Frequent users of cell phones, such as children and teenagers, are at an increased risk of adverse health effects caused by exposure to RF energy."

Fact: "There is no evidence that children and teenagers are at increased risk when Safety Code 6 exposure limits are respected."

…"**Health Canada encourages** parents to **limit** their **children's use** of **cell phones**, as **children** are often at **increased risk** from a **variety** of **environmental factors**."

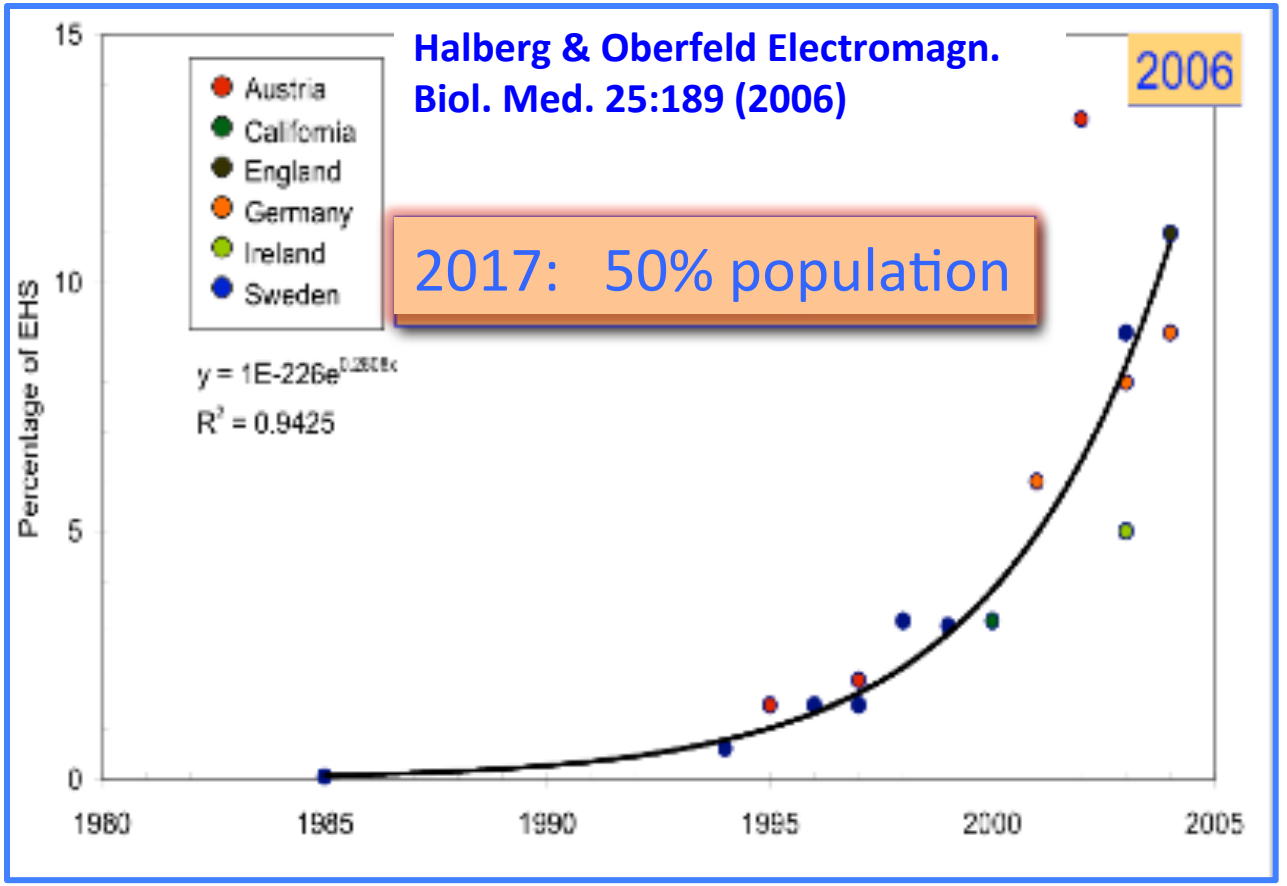
'Get your facts first, and then you can distort them as you please'. **Mark Twain**

Electro-Hypersensitivity (EHS)

- **Non-specific, multi-system, debilitating condition triggered by everyday levels (0.5% of existing Health Canada limits) of non-ionizing EMR**
- **Signs and symptoms include: fatigue, headache, memory loss, heart palpitations, sleep disorder, blurred vision, dizziness, muscle pain, tinnitus, chest discomfort, seizures, stroke**
- **Many rendered disabled and socially dysfunctional ('loner's disease')**
- **Imperceptible nature, lack of objective clinical markers; diagnosis often dismissed as psychosomatic, leaving individual annoyed and frustrated**
- **Treatment includes avoiding environmental triggers, reducing toxicant loads**
- **Few clinicians trained to diagnose and treat EHS persons.**

Estimated Prevalence of EHS in Various Countries

230,000 with EHS in BC?



- **Varies widely (4-10% population); rising rapidly**

E. Mallery-Blythe

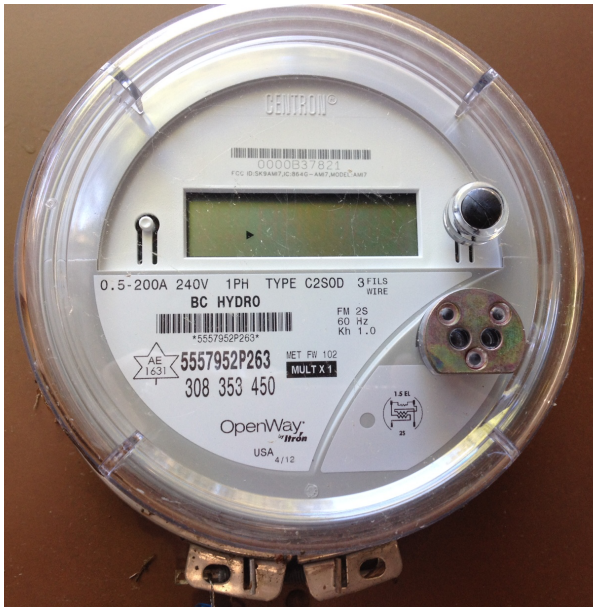

Take a
BREAK

Smart Meters are coming our way in RDOS

Itron

Knowledge to Shape Your Future

OpenWay



The evolution of energy

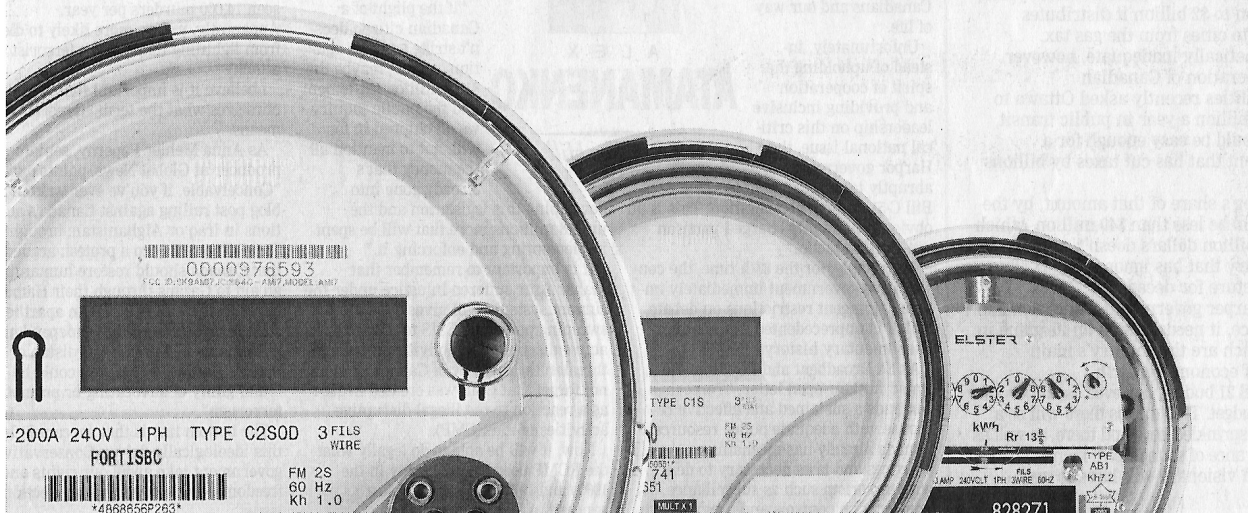
FortisBC will soon be exchanging electricity meters in your area

Advanced meters are just one way we're working to improve the efficiency and reliability of your electricity service.

Benefits of new advanced meters:

- Monthly billing
- Choose your billing date
- Fewer estimates
- Online tools to help you manage your electricity use

For more information, visit **fortisbc.com/ami** or call **1-866-436-7847**.



Penticton Herald, p. A7 Weds, 8 Apr 2015

Smart meter/grid technology

What are Smart Meters?

Analog (old) Meter

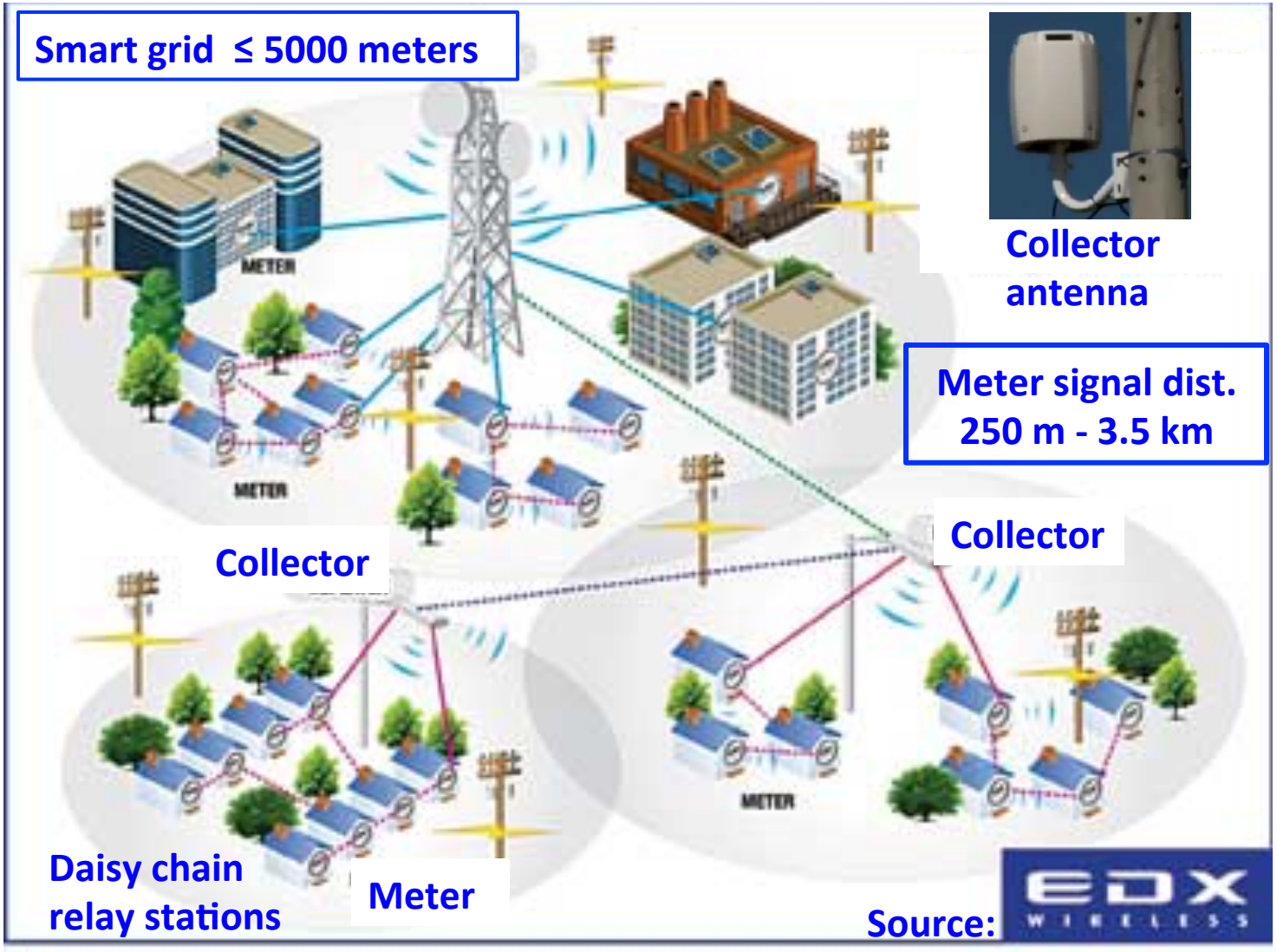
Digital (Smart) Meter

Itron

OpenWay

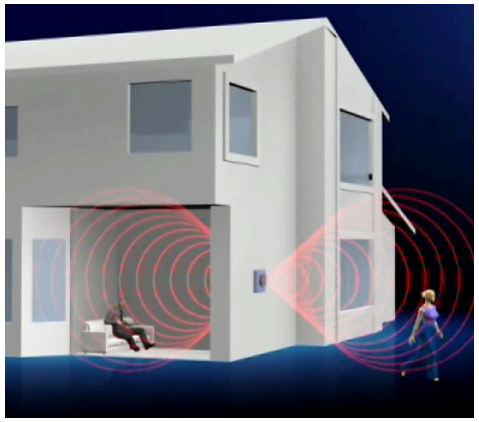
- Measure properties of electricity, natural gas or water delivered to consumers & transmit info digitally to utility companies
- Advanced meters transmit detailed, real-time usage data; equipped with 2-way transmitter/receiver antenna (902-928 MHz; 64 channels) to ‘talk’ to utilities
- Fitted with WiFi (ZigBee) chip (2.4 GHz) to link appliances and devices wirelessly
- Once fully operative, as many as 15 smart appliances & devices in smart home will be able to exchange info with utilities 24/7.

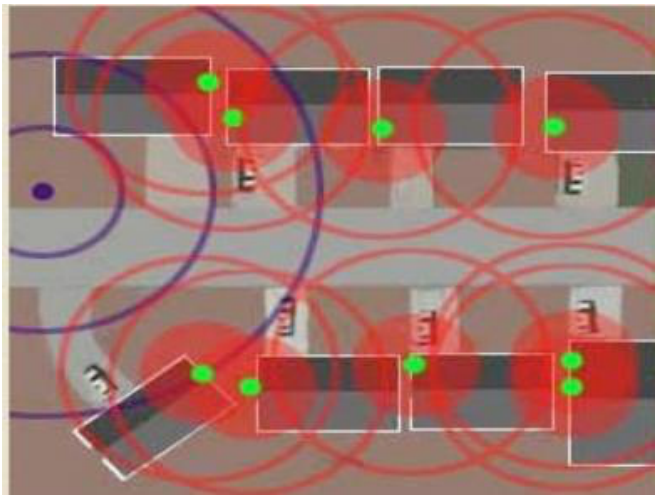
AMI Smart Grid



- Smart meters form mesh network exchanging info with utility access point.
- EM waves travel in straight line; topography & buildings interfere with data flow.

Mesh Network





- **Regardless of where signal ends up, smart meters transmit in all directions**
- **Significant amounts can penetrate walls into living area even from other meters**
- **Banks of meters in condos of particular concern (e.g. if against bedroom wall)**
- **Exercising option to decline smart meter installation may be irrelevant, depending upon housing density and landscape**
- **‘Community-level opt out’ to installation is only practical solution.**

Itron OpenWay Smart Meter Transmissions in a 24-Hour Period

	Duty Cycle	Time (Sec/Day)
Mean	0.06%	53.14
Maximum	0.58%	497.8
Minimum	0.02%	18.31
Median	0.06%	49.81

- Transmit time statistics for ~ 7,000 meters
- Each transmit burst less than 150 mSec; more than 350 bursts per day.

https://www.itron.com/na/PublishedContent/OpenWay%20Wireless%20Transmissions_24%20Hour%20Duty%20Cycle.pdf

Residential Smart Meter Transmission Frequency in 24-Hour Period

Electric system message type	Transmission frequency per 24-hr period: Average	Transmission frequency per 24-hr period: Maximum (99.9th percentile)
Meter read data¶	6	6
Network management	15	30
Time sync	360	360
Mesh network message management£	13,000	240,000
Weighted average duty cycle§	61.4 sec	1,262 sec

¶ Billing purposes; 50 msec per transmission

£ Function in network; 'repeater'; do not emit at same time; transmit randomly

§ Average 'on air' time for each meter across mesh network

Source: Sacramento Municipal Utility District at www.smud.org

Time-averaging RF Emissions Erase Peak Spikes

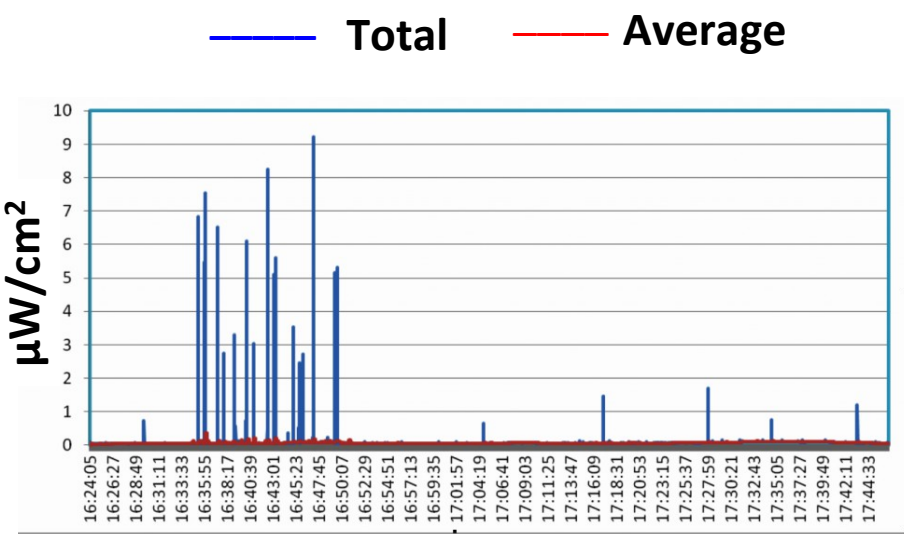
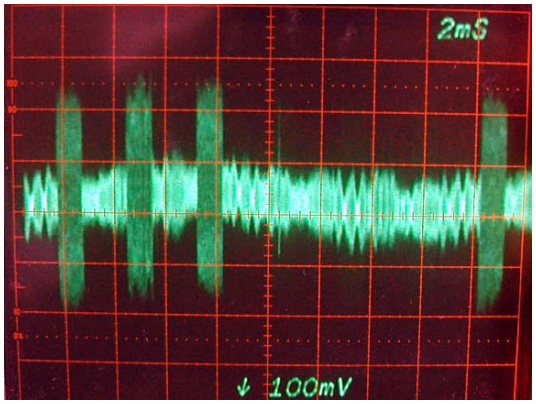


Chart illustrating stark difference between averaged (red) and actual (blue) RF power density levels measured from a smart meter

Source: EMF&RF Solutions, www.EMFRF.com

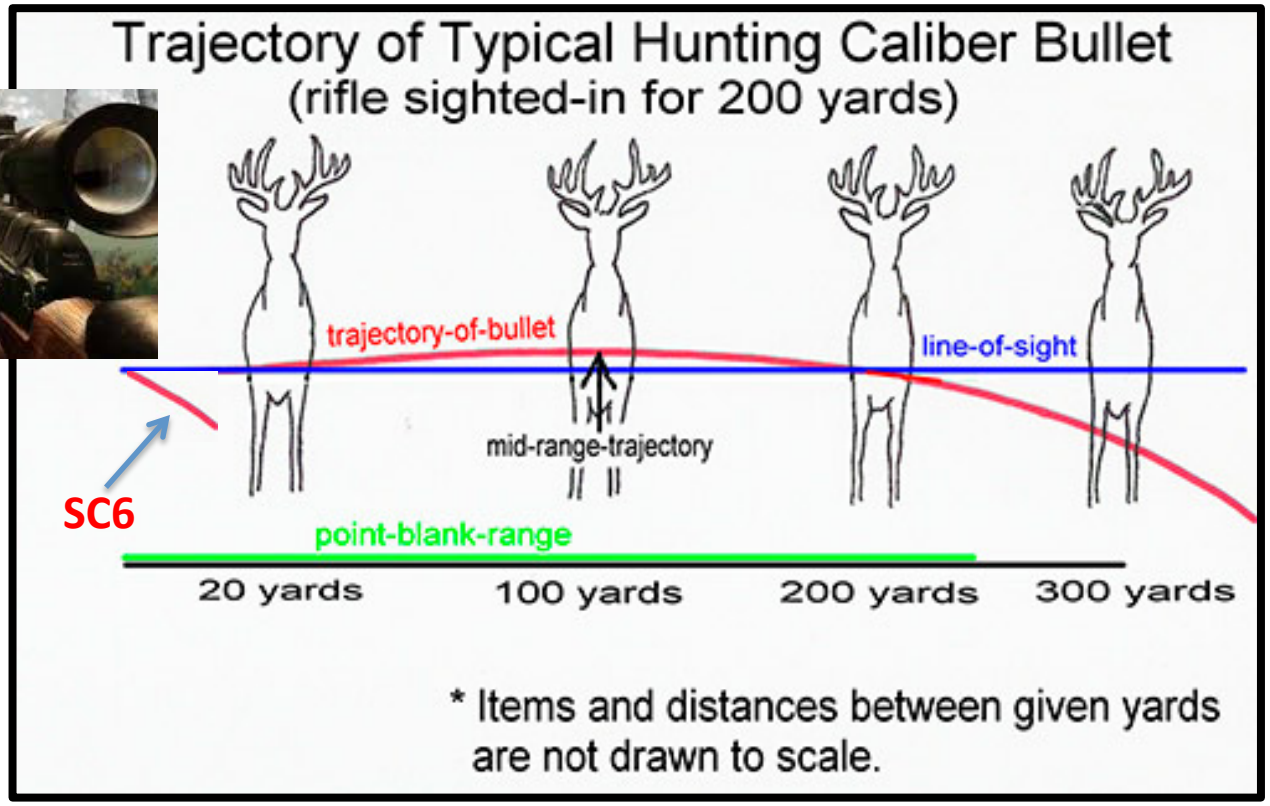
- **Smart meter's mSec pulses at peak probably violate Health Canada safety limit¶, yet when averaged over 6 min appear to be far below it.**

- **But a person in field actually faces intense bursts of RF energy at levels shown to have biological effects.**



¶Assessment of Radiofrequency Microwave Radiation Emissions from Smart Meters, p.30. Sage Associates, 2011

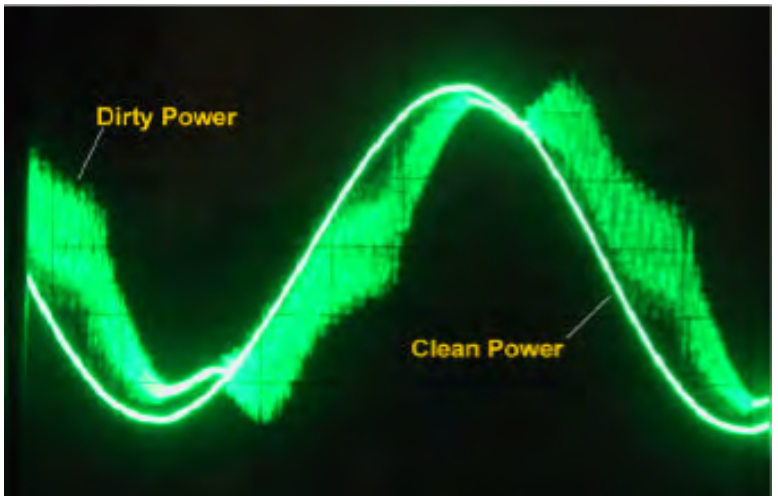
Effect of Applying Safety Code 6 Time-Averaging to Deer Hunting



- **Muzzle velocity of high performance cartridge from modern rifle is 1200 m/sec.**
- **If averaged over 6 min, velocity would be 3.33 m/sec or 200 m/min.**
- **At this velocity bullet would quickly fall to the ground without ever reaching its target.**

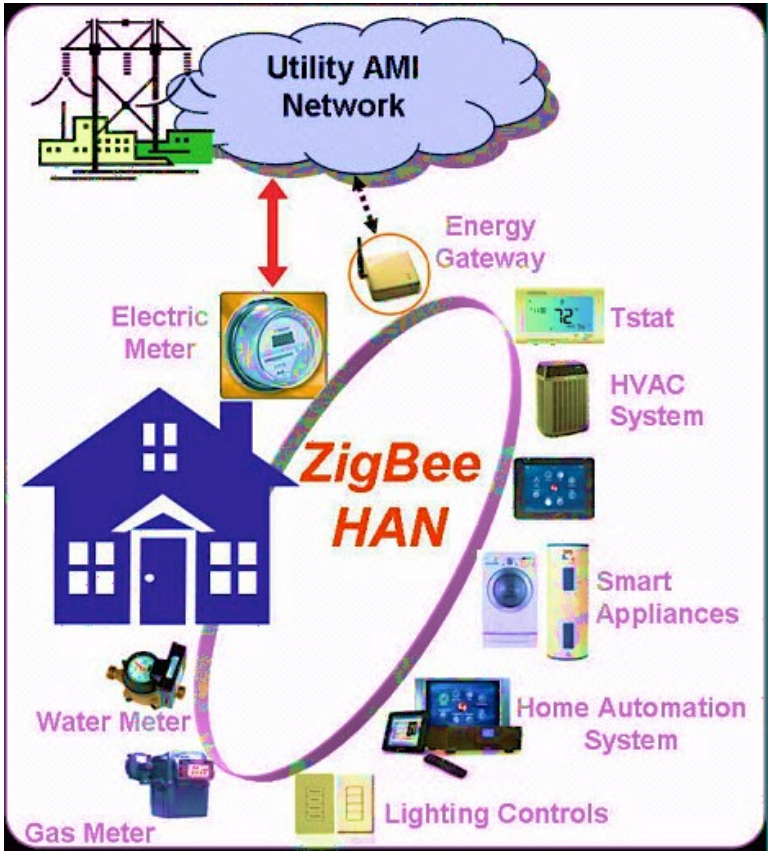
Switching Mode Power Supply: 'Dirty Electricity'

Label on side of smart meter

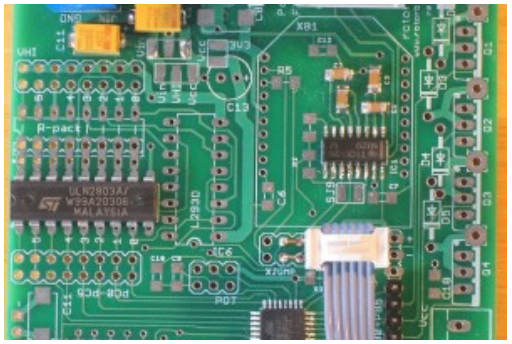


- 'Step-down' from 120 v (AC) to 2-10 v (DC); run digital electronics to record usage data; both wireless & wired options
- Emits high freq. transients as sharp mSec spikes (4kHz – 60KHz); constant (24/7)
- May contribute to reported negative health effects after meter installation.

Integration of AMI with Home Automation (Utility's Sales Pitch)



ZigBee®
Control your world



ZigBee chip
(0.22 W; 2.4 GHz)

- **Dynamic environment to meet resident's needs & lifestyle, conserving energy**
- **Consolidates & coordinates all home automation activities**
- **Control & monitoring capabilities with single touch screen**
- **Detailed usage info to enable load reduction during peak periods.**

Residential Smart Meter Transmission Statistics (24-hour period)¶

	Average daily no. of transmissions	Average daily transmission time	Maximum daily transmissions£	Max. daily transmission time (sec)
RF LAN radio	1,268	53 sec	25,916	68.3 min
ZigBee radio	5,768§	9.9 sec	No change	No change

¶ Derived from deployment sample of over 6,800 Itron OpenWay meters

£ 97% transmit fewer than 2,500 times in 24-hr period

§ Currently, zero or 1 device/meter; in future ~50,000 (864 sec) based on 8 devices

- Transmit amongst each other to monitor communication paths & topography
- 90% 'chatter' for network command and control (synchronization, security, data integrity, self-healing)
- 10% for meter data (scheduled and/or on-demand)

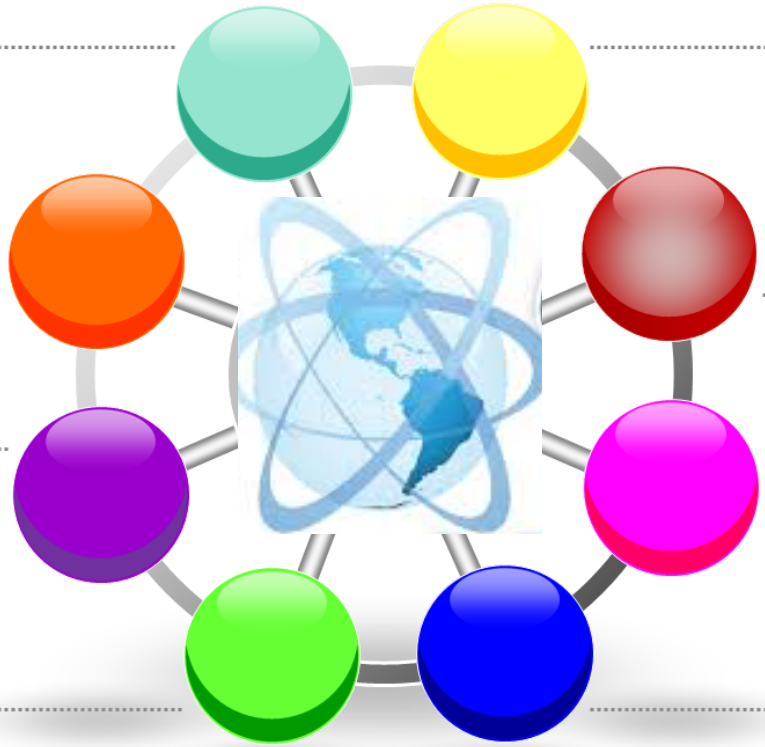
Source: Southern California Edison Company's Response to Administrative Law Judge's Ruling Seeking Clarification, Nov 2011 (Before Public Utilities Commission, State of California)

Internet of Things

A *dynamic global network infrastructure*

with *self configuring capabilities*

based on *standard and interoperable communication protocols*

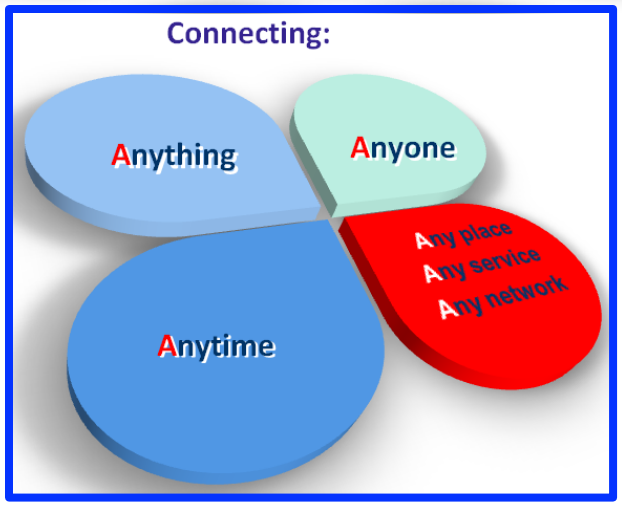


have *identities, physical attributes, and virtual personalities*

use *intelligent interfaces*,

and are *seamlessly integrated*

where *physical and virtual "things"*



into *the information network.*

Smart Home Ecosystem

“With the Internet of Things (IoT) finding its way into the homes, there are lots of new devices that can connect to the same network.”

Public health impact of smart meter/grid networks

Health Canada Santé Canada

Your health and safety… our priority.

Smart Meters Pose No Public Health Risk

"Since **RF energy exposure levels** are **far below Canadian** and international safety **limits, Health Canada does not consider** that any **precautionary measures** are **needed** to **reduce** RF energy **exposure** from **smart meters.**

In cases where **multiple smart meters** are **installed** together**,** as in some **townhouses** or **high-rise buildings,** the **total exposure levels** from **multiple smart meters** will still be **far below Health Canada's** RF energy **exposure limits,** due to the **infrequent nature** of **transmissions.**"

http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/prod/meters-compteurs-eng.php

Industry's Position on Smart Meters: Health Threat

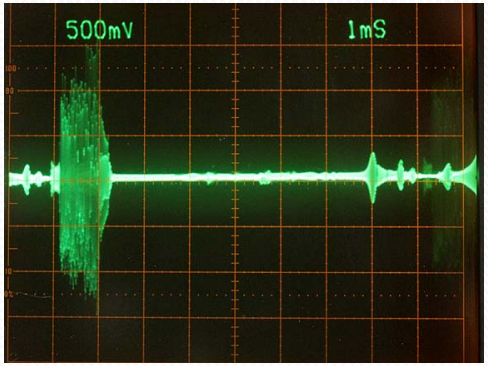
'So when **confronted** with **complaints** that say **smart meters cause** … **health effects**, ask the **complainant** to **produce** the **science** to **support** the **claim**. The **conversation should end shortly thereafter.**'

Klaus Bender, PE
Director of Standards & Engineering
UTC

UTC
UTILITIES TELECOM COUNCIL

Source: ***No Health Threat from Smart Meters*** **in Fourth Quarter 2010 Issue, UTC JOURNAL**

Effects of Pulsed RF Radiation



- **Causes leakage in blood-brain barrier**
- **Affects opiate-dopamine neurotransmitters**
- **Alters heart rate and heart rate variability**
- **Decreases sperm production in men**
- **Causes impairment in memory and thought processing**
- **Lowers melatonin levels**
- **Pulsed radiation estimated to be 2.5 times more destructive than continuous radiation**
- **Pulsating, amplitude modulating nature of signal new to all life forms**

International Health & Scientific Bodies Advising Review/Revision of Safety Guidelines for RF EMF

- Bioinitiative Report (2007, 2012)
- Seletun Scientific Panel (Seletun, Norway, 2009)
- European Environmental Agency (2007-2011)
- European Parliament (2007, 2011)
- PACE (Parliamentary Assembly of Council of Europe) (2011)
- **American Academy of Environmental Medicine (2012)‡**
- American Academy of Pediatrics (2012)
- Austrian Medical Association (2012)

‡ Calling for **immediate moratorium** on **smart meter installation**

Moratorium on Smart Meter Installation

AMERICAN ACADEMY OF ENVIRONMENTAL MEDICINE

AAEM Board letter to California Public Utilities Commission, 19 Jan 2011.

- "**Chronic exposure** to wireless **RF radiation** is **preventable environmental hazard** that is sufficiently **well-documented** to warrant **immediate** preventable **public health action**....
- Given the **widespread, chronic** and ... **inescapable RF exposure** of everyone **living near** a **smart meter**, the **Board** finds it **unacceptable** ... to **implement** this **technology** until these **serious medical concerns** are **resolved**....
- **Moratorium** on **installation** ... issue of **highest importance**."

…and here in Canada

Declaration: (56 international) Scientists call for Protection from Radiofrequency Radiation Exposure
We are **scientists** engaged in the **study** of **electromagnetic fields (EMF) radiofrequency radiation (RFR) health** and **safety. We** have **serious concerns** regarding **Health Canada's Safety Code 6 Guideline.** **9 July 2014**

Declaration: Doctors¶ Call for Protection from Radiofrequency Radiation Exposure
Physicians Call for Health Canada to Provide:
i) Wireless safety standards … more protective … health of Canadians;
ii) Guidelines and **resources** to **assist Canadian physicians** in **assessing** and **managing health problems** related to **microwave radiation.**
(similar to: **2012, "Guideline** of the **Austrian Medical Association** for the **diagnosis** and **treatment** of **EMF related health problems** and **illnesses."**)
¶ 55 in total

Why the Anxiety Over Smart Meters?

1. **Their installation is mandatory. Would you mandate lead, DDT, engine exhaust and other 'possible carcinogens' in every home?**

2. **Emit sporadically in high intensity bursts (≤ 150 msec); signal is foreign to all life forms.**

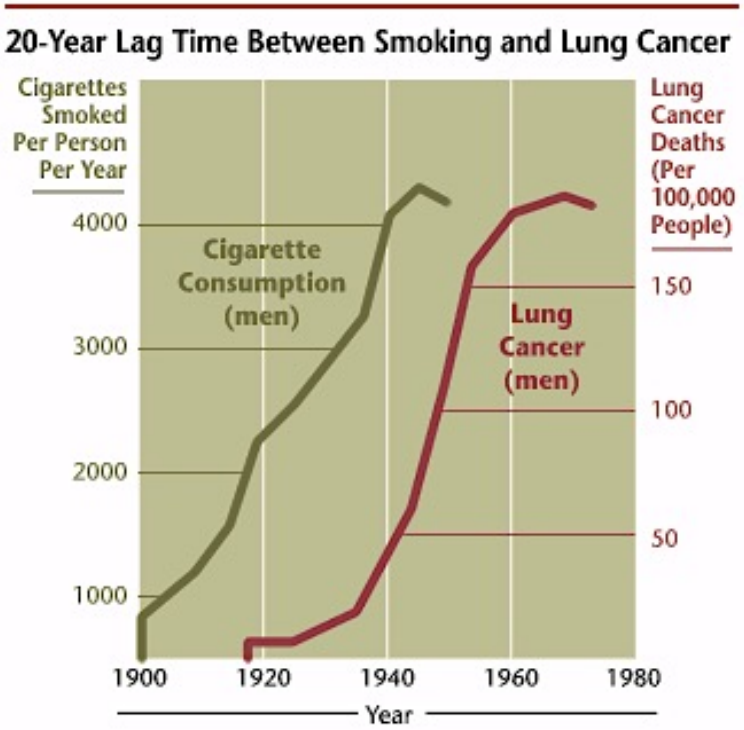
3. **When HAN operational, transmission will be in effect continuous, adding greatly to RF radiation in family living space.**

4. **Potential adverse health effects have never been studied by utility industry prior to deployment.**

Late lessons from early warnings

“ Those who cannot remember the past are condemned to repeat it.” **G. Santayana** ***The Life of Reason*** **(1905-06)**

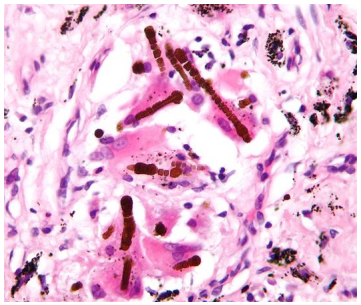
Tobacco : Textbook Case of Governments Ignoring Precautionary Principle

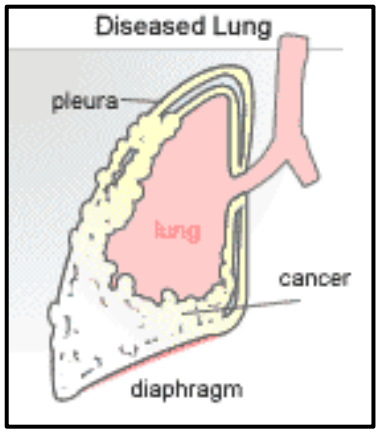


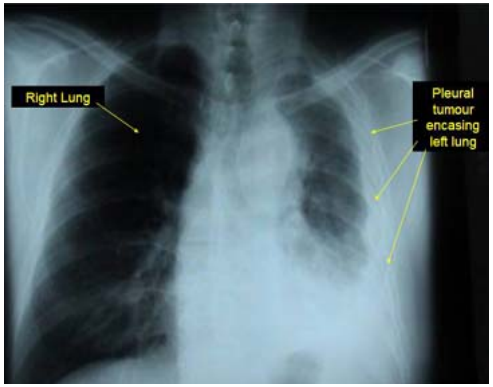
- Sir Richard Doll identified smoking as major cause of increase in lung cancer in late 1940's; upsurge in motor traffic during war was suspected cause.
- Tobacco industry demanded proof, including precise mode of action.
- Due to 20-yr lag, irrefutable population-based studies took decades to complete.
- Governments waited far too long before launching tobacco tax, advertising ban, smoke-free public buildings & anti-smoking ads.
- How many of ~ 100 million people killed by tobacco in 20th century might have been saved if action were taken earlier?
- Since smoking is addictive, even today many suffer from various tobacco-related, life-threatening diseases.

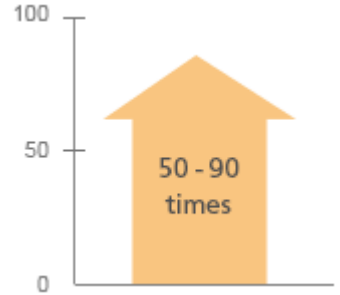
- **On average, 45 Canadians die each day of tobacco-related lung cancer.**

Asbestos Exposure: Industry & Government Downplay Health Risk





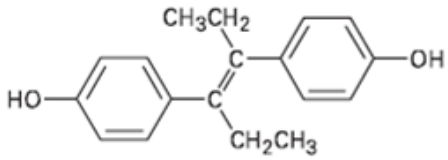




↗ lung cancer risk if person smokes & exposed to asbestos

- Gained widespread use as fire-retardant & insulation material
- Reported to cause serious ailments as early as 1898 (Lucy Deane, London)
- Despite early warnings, industry continued production, failed to protect workers & insisted no substitute for it.
- Not until 1998 was it banned totally in UK
- Former workers developed debilitating diseases: asbestosis, mesothelioma & lung cancer.
- Long latency period between asbestos exposure & disease appearance: asbestosis (10 yrs); lung cancer (15-25 yrs)
- Smoking or second-hand smoke, together with asbestos exposure, greatly increases risk of lung cancer.
- Mechanism of action still uncertain.

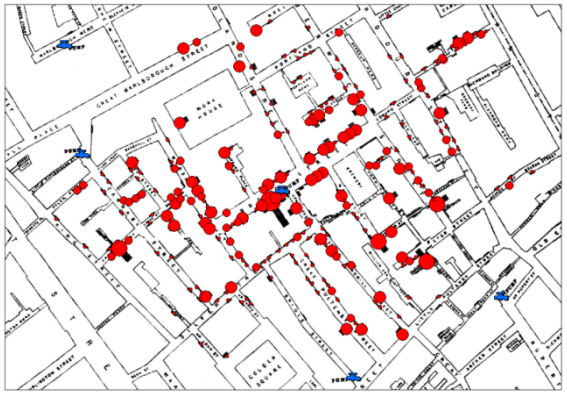
Diethylstilbestrol: World's First Drug Disaster

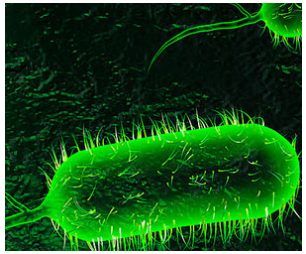


- DES: synthetic estrogen developed in late 1930's to prevent miscarriage.
- First danger signs: breast cancer link in animal studies & severe GI issues at clinical trials stage
- Yet prescribed to millions of pregnant women for 3 decades in US & 4.5 decades elsewhere
- Transplacental carcinogen, causing abnormal reproductive organs, infertility & cancer in offspring of women exposed during pregnancy
- Despite 20,000 articles on DES, mechanism of action still uncertain
- No sign of toxicity in newborn offspring
- Timing of dose, not amount, determines toxicity.

- *DES story should remind us that 'we will never know the long-term safety of a product until long term safety of the product is proven.'* (Elizabeth Watkins)

London's Cholera Outbreak of 1854: Benefit in Heeding the Precautionary Principle





- Dr. John Snow mapped the location of deaths & found them to be clustered around the Broad Street Drinking Pump.
- His findings suggested that cholera is conveyed by water polluted with sewage.
- Royal College of Physicians rejected his thesis as 'untenable', believing disease caused by noxious vapors (*miasma*).
- As precautionary measure, Snow removed pump handle & outbreak came to an end.
- College's certainty proved incorrect.
- The link between human feces-polluted water and cholera in 1854 and Robert Koch's isolation of *Cholera vibrio* as the causative agent in 1883 took 30 years.
- Lengthy interval between a compelling association and conclusive causality is a common feature of scientific inquiry.

Game changer: Precautionary principle in science-based risk management

Considerations for Warranting Call to Action

- **EMR is here to stay – serves to define modern society.**
- **These RF-emitting devices cause many adverse health-related effects, many at exposures well below those required for thermal injury.**
- **Potential ill-health effects have slow onset; causality difficult to prove.**
- **RF radiation designed as Group 2B agent ('possibly cancer-causing')**
- **Standard of evidence for judging the science should be precautionary; requiring conclusive evidence is indefensible; to do so can delay avoidance action at early stage when health risks are still preventable.**
- **Prior failures to take preventive action early enough are well-known.**

Wingspread Statement: Precautionary Principle

Defined at Wingspread Conference, Johnson Foundation, Racine, Wisconsin, 15 January 1998.

- "**When** an **activity raises threats** of **harm** to **human health…, precautionary steps** should be **taken** even if some **cause** and **effect relationships** are **not fully established scientifically.**
- **… proponent** of an **activity, rather than** the **public**, should **bear burden of proof.**
- **Process** of applying **precautionary principle** must be **open, informed** and **democratic** and must **include potentially affected parties.**
- It must also **involve analysis** of **full range** of **alternatives, including no action.**"

Urgent Need for Paradigm Shift in Decision-making

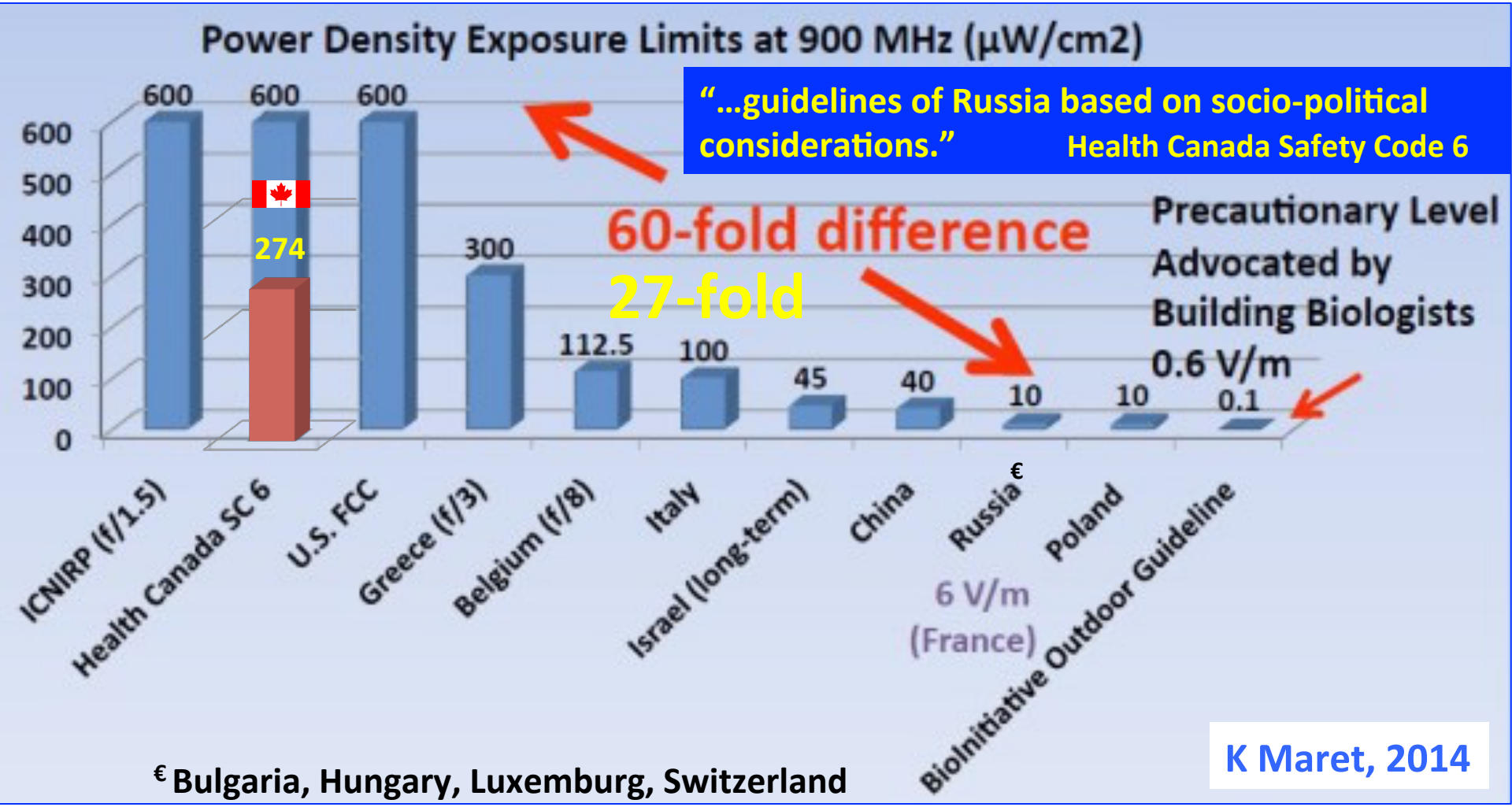
Cost-Benefit Analysis

Too Little, Too Weak, Too Late

- We must shift away from asking, " what level of harm is acceptable?" to "how can we prevent harm?"
- Fundamental change in how we manage EMF regulation, from cost (risk)-benefit analysis to precautionary approach
- Sufficient scientific evidence on EMR-induced health risks (~7000 papers to date) to initiate this paradigm shift.

The problem very often is that long before the science does come in, the harm has already been done. Michael Pollan

Exposure Limits at Smart Meter Radiofrequencies Vary Widely by Countries



- Bioinitiative Working Group 2012 calls for much lower limits: 0.1 µW/cm^2 (2700-fold difference).

Health Canada limits revised Mar 2015

Concluding remarks

Why Living Is Hazardous to our Health

Radiation

Sun

Electro-Smog

Cigarette smoke

Food

Oxygen

Electro-Smog: New Class of Pollutants

The Best Way Forward

- **EMR is not going away– need to create smarter and safer ways to harness it.**
- **There exists solid science-based evidence for the potential for non-thermal health impacts (latent cancers) from EMF-emitting devices.**
- **Given the enormity of the health risk, time to act decisively is now.**
- **Effecting a paradigm shift in how we manage EMF exposure (societal & personal), shifting from cost (risk)-benefit analysis to precautionary approach, is the best way forward.**

Steps in Call to Action

1. **Set new, biologically-based public exposure limits, in line with best practises of other precautionary-adherent nations.**

2. **Introduce practical measures to reduce EMF exposures, including creating wireless-free learning and sleeping environment for children and public places ('white zones') for EHS subjects.**

3. **Halt mandatory installation of smart-meter mesh networks until complexities of their EMF pulsed signals and attendant health impacts are better understood.**

4. **Provide adequate arms-length funds for focused, high quality research into underlying mechanisms and health impacts of EMF.**

Advice for Reducing Personal Risk from EMF Exposures

Practice prudent avoidance by following two basic rules:

1. **Minimize your use of EMF-producing technologies**

2. **Maximize your distance from these technologies when in use**

M. Blank *Overpowered*, p.242. Seven Stories Press, New York 2014

Importance of Maximizing Distance from WiFi-emitting Devices

Radiation levels in contact with device = 90,000
Radiation levels at 3 m (10 ft) = 2,000
Radiation levels at 30 m (100 ft) = 1
(units in μW/m²)

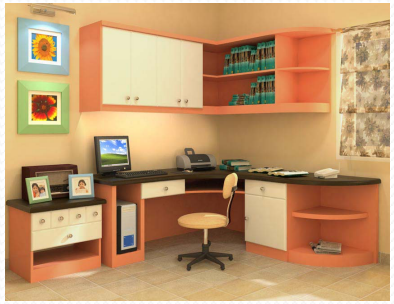
INVERSE SQUARE LAW

$$\text{Radiation Level} = \frac{1}{(\text{DISTANCE})^2}$$

Understanding The Inverse Square Law

METRES	1	2	3	4	5	6	7	8	9	10
POWER	1	1/4	1/9	1/16	1/25	1/36	1/49	1/64	1/81	1/100
%	100%	25%	11%	6%	4%	3%	2%	2%	1%	1%

Practical Steps to Reducing EMR Risk

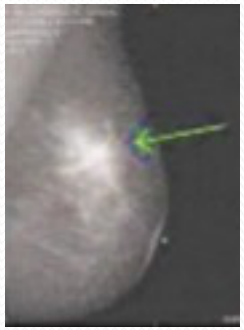


1. **Create safe (WiFi-free) learning and sleeping environment for our kids.**

- **Many schools have 'industrial grade' WiFi systems with 'killer coverage'.**
- **~13,000 exposure hrs by grad day**
- **No scientific studies on long-term biological effects of WiFi on children**
- **Easy solution: 'hard-wire' computers to internet: safer, faster, more secure**

M. Blank *Overpowered*, p. 196-210. Seven Stories Press, New York 2014

Practical Steps to Reducing EMR Risk



2. **Bras aren't for cell phones.**

3. **Neither are pockets. Carry phones in handbags, briefcases or backpacks.**

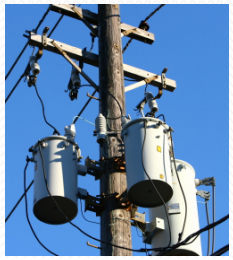
4. **Airplane mode isn't only for airplanes.**

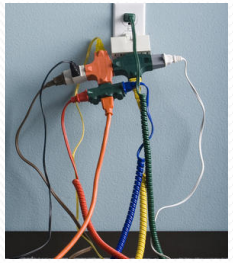
5. **Use 'air-tube' headset with cell phone.**

6. **Laptop tablets aren't for laps. Keep ≥20 cm from body. In China, pregnant women wear protective apron.**

M Blank *Overpowered*, p. 196-210.
Seven Stories Press, New York 2014

Practical Steps to Reducing EMR Risk

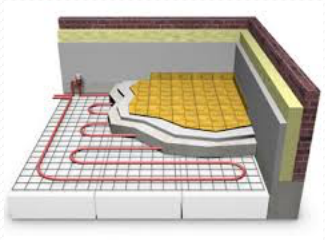




7. Reduce concurrent exposures (adverse health effects unknown).
8. Do not live near high-voltage power lines.
9. Stay away from transformers.
10. Live as far away from cell phone towers as possible.
11. Do not use electric blankets or heated waterbeds.
12. Run extension cords clear and away.

M Blank *Overpowered*, p. 196-210.
Seven Stories Press, New York 2014

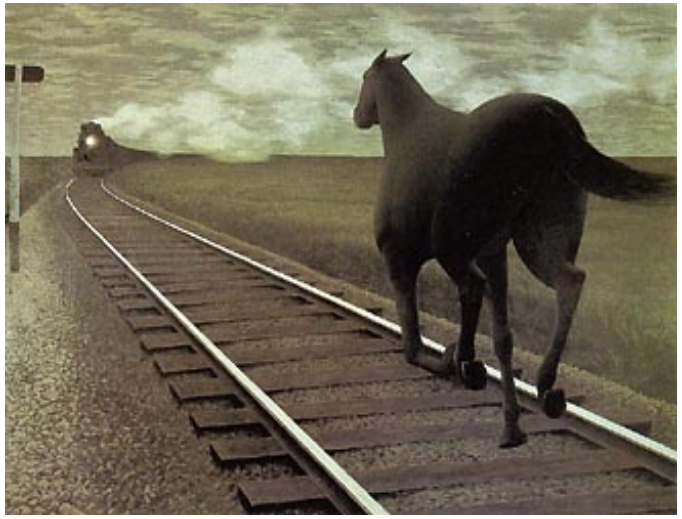
Practical Steps to Reducing EMR Risk



13. **Use battery, not electric, alarm clocks.**
14. **Use energy-efficient appliances.**
15. **Do not use dimmers or three-way switches.**
16. **Do not use radiant electrical floor heating.**
17. **If use microwave oven, leave kitchen when on and service regularly.**
18. **Place high EMF appliances against outer walls.**

M Blank *Overpowered*, p. 196-210.
Seven Stories Press, New York 2014

Status Quo is Not an Option



Horse and Train, 1954 Colville

"No man is an island, entire of itself; every man is a piece of the continent, a part of the main; … and therefore never send to know for whom the bell tolls; it tolls for thee."

John Donne, 1624

'If there is even a reasonable possibility that cell phone radiation is carcinogenic, the time for action … is upon us. Even though the financial and social cost of restricting such devices would be significant, those costs pale in comparison to the cost in human lives from doing nothing.... If the probability of carcinogenicity is low, but the magnitude of the potential harm is high, good public policy dictates that the risk should not be ignored.'

Supreme Court Judge FH Weisberg, 8 Aug 2014

Children and EMF

We hold the future in our hands
and it is our children.


THANK
YOU

Parking Lot: Follow-up for any unanswered questions

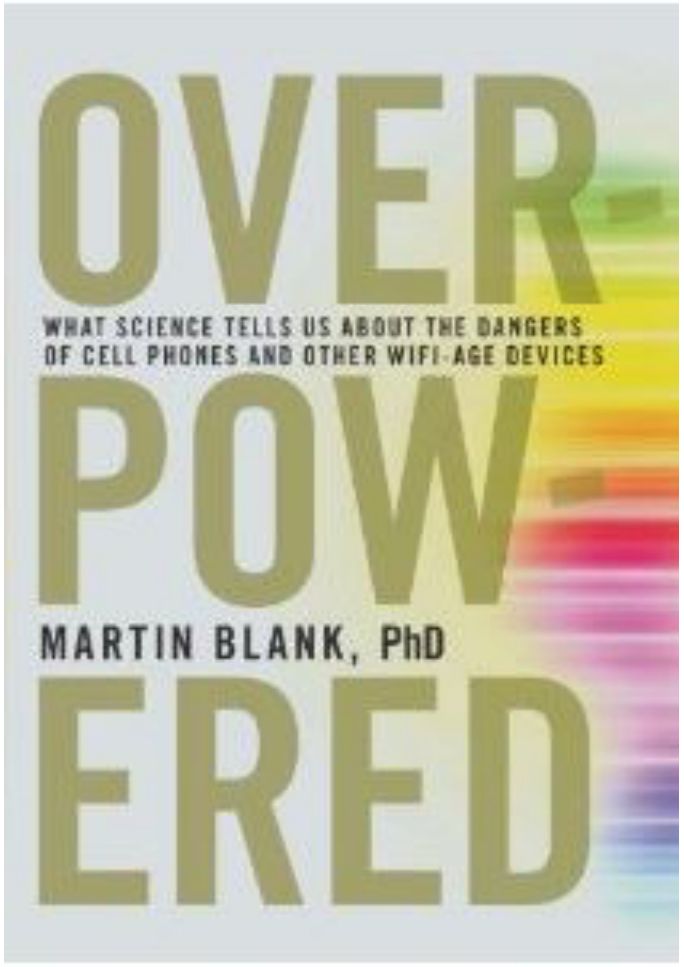
Clear Mandate of Local Governments

Bill 23-2008 of the **BC Public Health Act**, **section 83** states:
"(1) a **municipality** must **take action** when it learns of **something** that could be **harmful** to its **residents**. It must **notify** the **Minister of Health** or **take immediate action**".

More than **60 municipal, city and band councils** in **BC** have **passed motions** for a **moratorium** on the **mandatory installation** of wireless **"Smart" Meters**.

REGIONAL DISTRICT
RDOS
OKANAGAN·SIMILKAMEEN

Penticton



Overpowered **Martin Blank**

Seven Stories Press New York 2014

A Cautionary Note

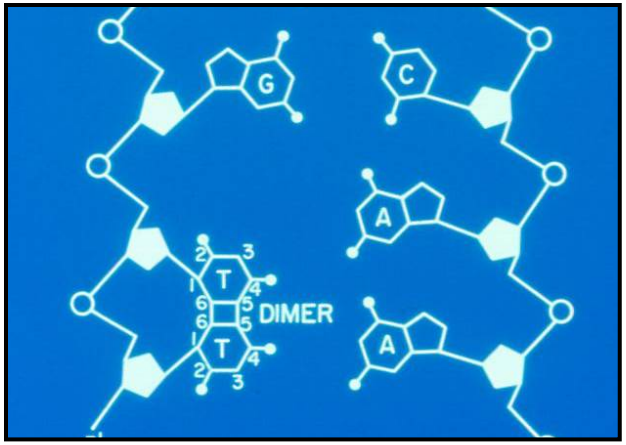
- **WHO and IARC Reports, however august, were not sent out for blind scientific peer-review, reducing their level of scrutiny and credibility.**
- **The review panels contain overlap in membership so their deliberations should not be taken as independent.**
- **Authors of policy-related documents should not be the same people as those who write the cited scientific papers.**
- **The statutory status of these bodies does not mean they are infallible.**
- **Recent experiences in other high profile areas (e.g., climate change) suggest that these bodies often serve a political process.**
- **The potential impact of adverse health effects associated with ELF EMF exposures related to electricity supply is systematically downplayed in these 'official' reports.**

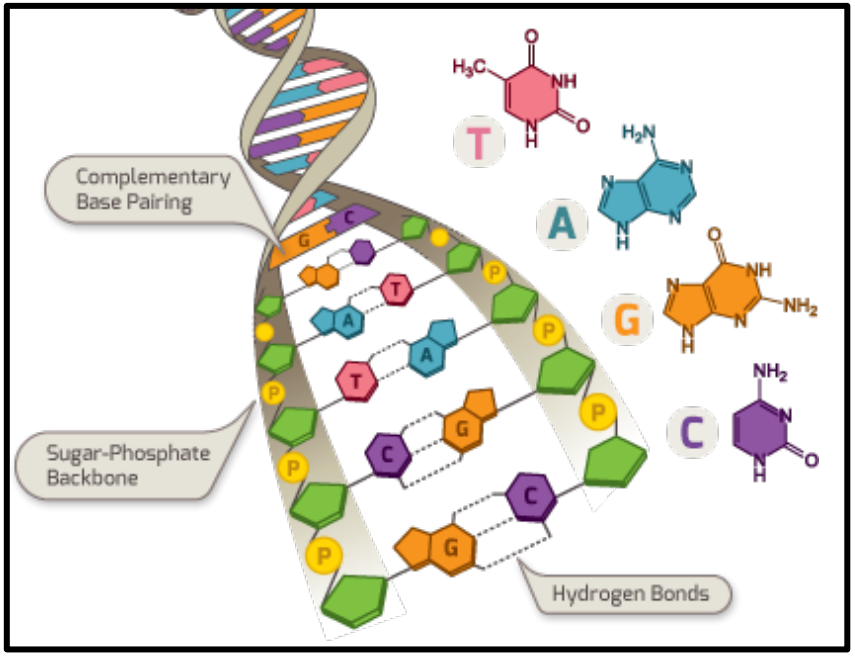
DL Henshaw & MJ O'Carroll, 2002

Natural Damage to Human Cell Genome¶

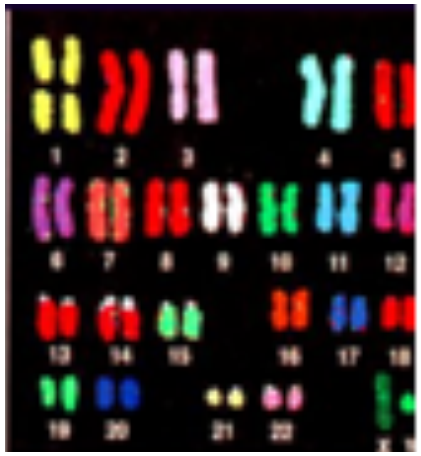
Class	Induction Rate (no./hr)	Repair Rate (no./hr)
Purine (A,G) loss	580	
Pyrimidine (C,T) loss	29	
Deamination of cytosine	8	
Single-strand breaks	2,300	20,000
O^6– Methylguanine	130	50,000
Pyrimidine dimers§	50,000	50,000

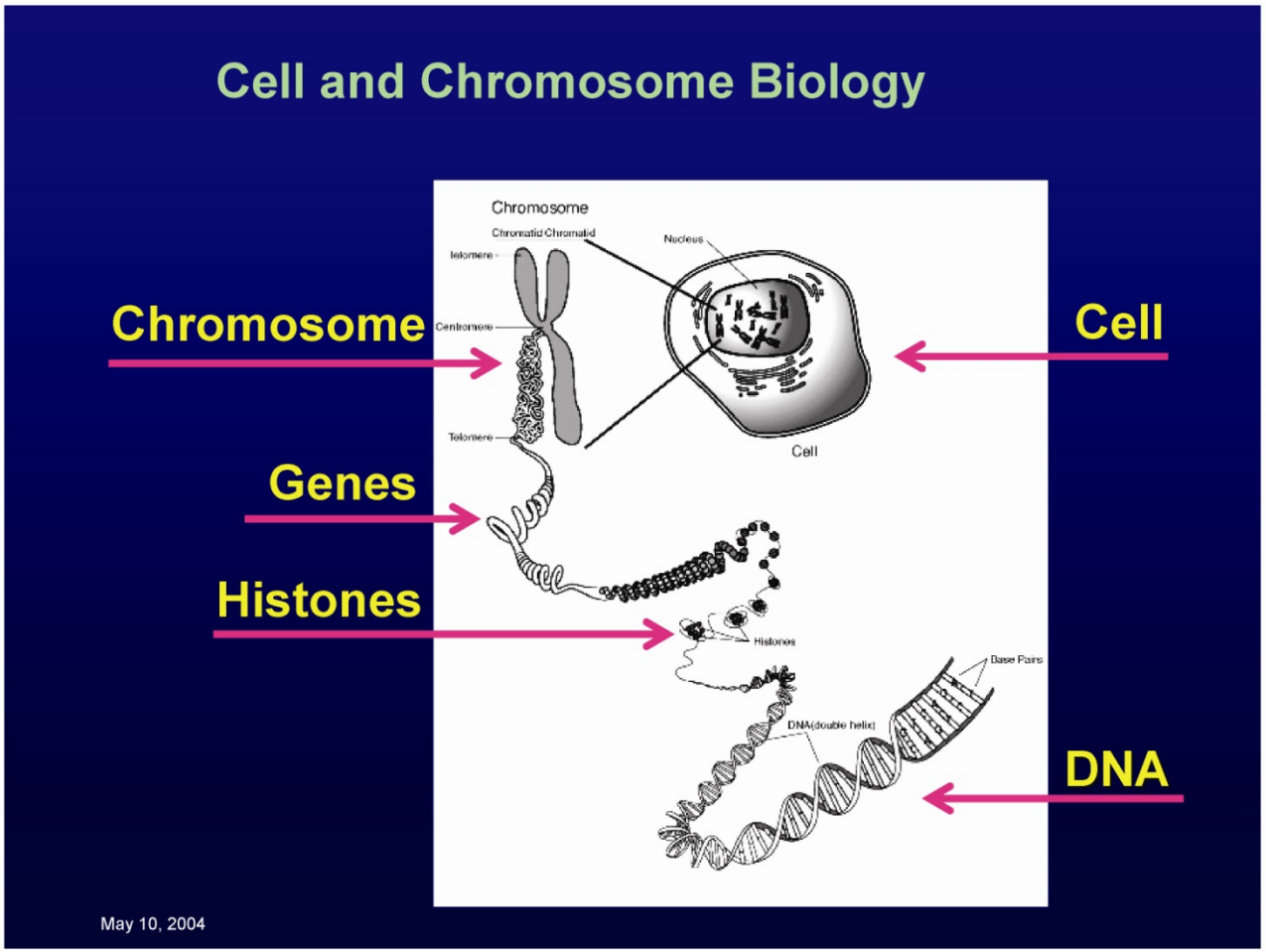
¶3.1×10^9 base pairs in human genome
§Dimer induction rate for Austin, Texas at midday



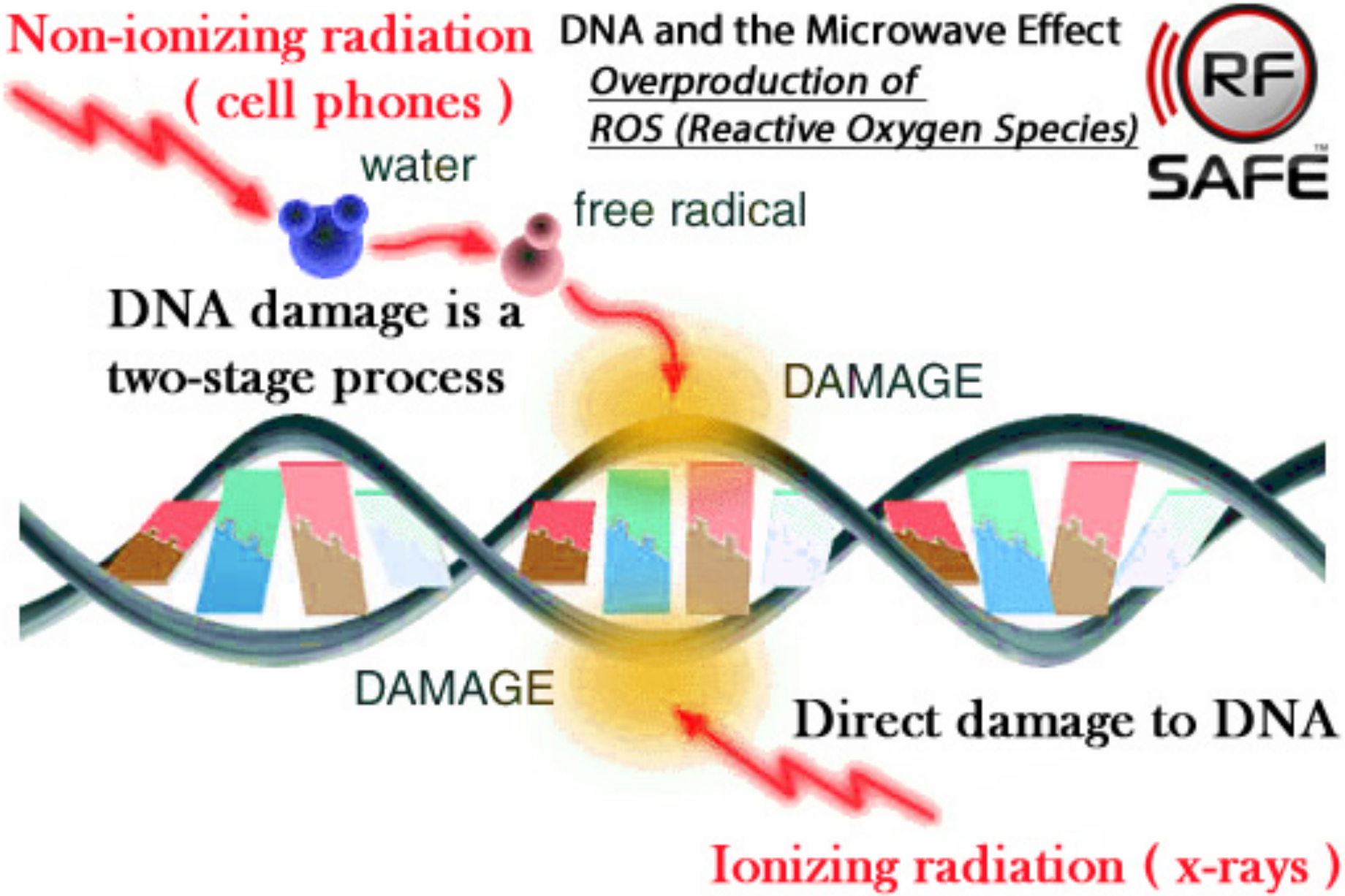


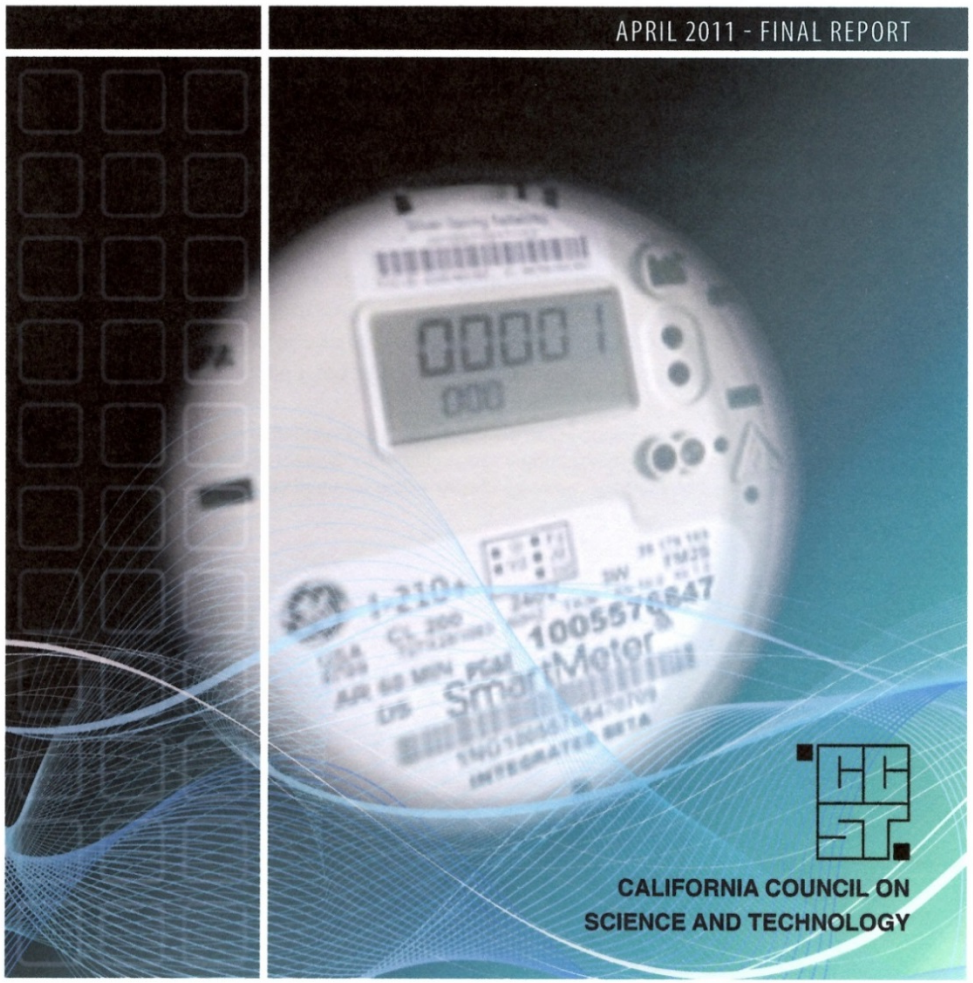
Anatomy of the Book of Life





- **3.16 billion DNA base pairs** containing **20,000 protein-encoding genes (750 MB)**
  (**gene**: stretch of DNA that forms most **basic unit** of **heredity**; **avg. size: 3,000 bps**)
- If unwound & tied together, **DNA strands** in **23 chromosome pairs** would **stretch** more than **5 ft** but be only **50 trillionth of inch** wide)


Non-ionizing radiation
(cell phones)
DNA and the Microwave Effect
Overproduction of
ROS (Reactive Oxygen Species)
RF
SAFE
water
free radical
DNA damage is a
two-stage process
DAMAGE
DAMAGE
Direct damage to DNA
Ionizing radiation (x-rays)



- **CCST: appointed advisory panel** for **state** representing **industry, university** & **government interests**

- **Legislative request** to perform **'independent, science-based study'** to assess whether:

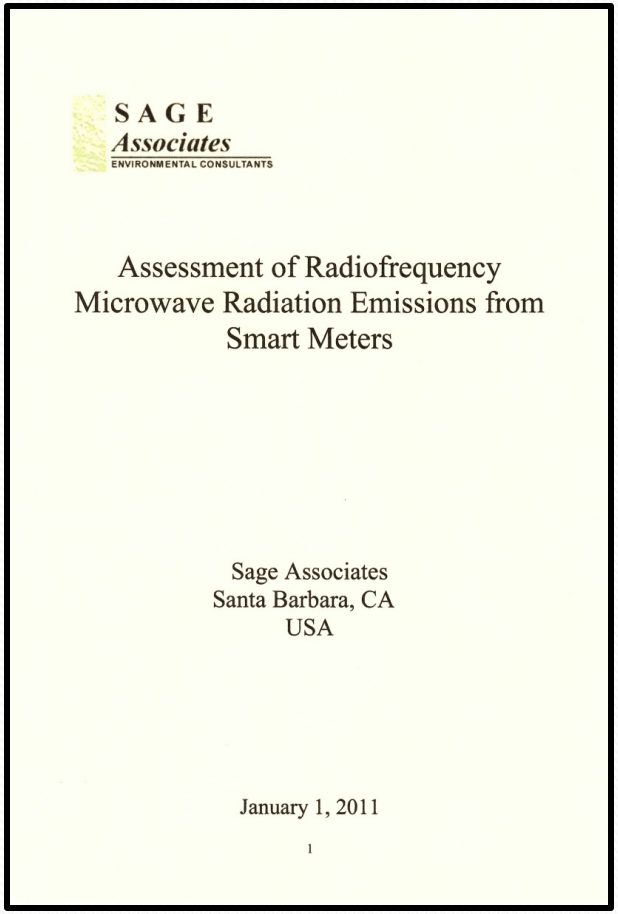
  1. **National (FCC) standards** for **smart meters** are **sufficiently protective** of **public health**

  2. **Additional technology-specific standards** are **needed** for **smart meters …** to **adequately protect** from **adverse health effects.**

Conclusion: FCC guidelines protective for **thermal impacts; non-thermal impacts unknown, further standards not advised.**

Source: California Council on Science & Technology
www.ccst.us/publications/2011/2011smart-final.pdf

Cautionary Report On Smart Meters



SAGE
Associates
ENVIRONMENTAL CONSULTANTS

Assessment of Radiofrequency Microwave Radiation Emissions from Smart Meters

Sage Associates
Santa Barbara, CA
USA

January 1, 2011

1

Purpose: document **RF levels** from **smart meters** in various **installation** & **operational scenarios.**

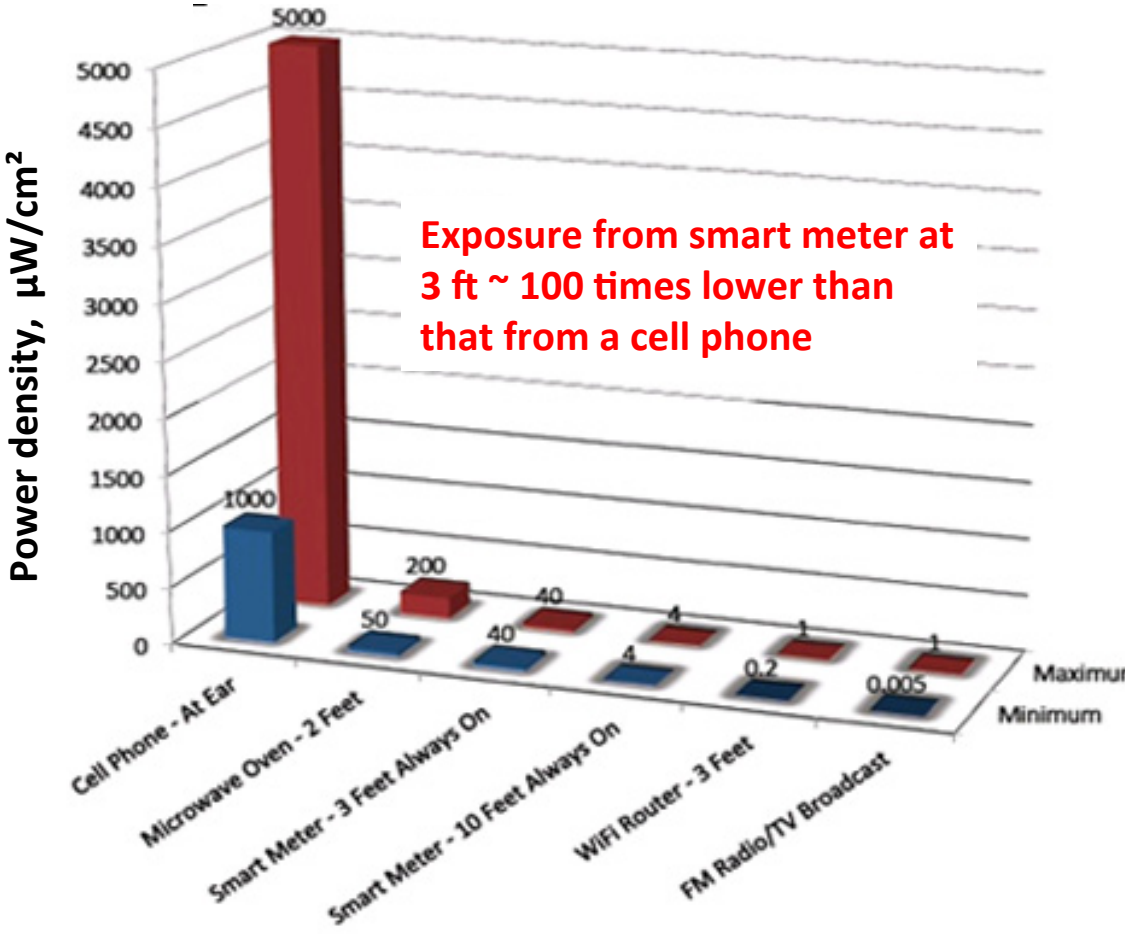
Conclusions:

- **No positive assertion** of **safety** can be **made** by **FCC** regarding **pulsed RF** in which **exposures** are **chronic** & **occur** in **general populations.**
- **Indiscriminate exposure** to **ubiquitous pulsed RF** from **rollout** of **millions** of **smart meters** will mean **far greater general population exposure,** and **potential health consequences.**
- **Uncertainty** about **existing RF energy levels, how interior space** is **utilized** near **walls, peculiarities** of **residents (age, medical conditions, metal implants)** & **unrestricted access** to **areas** where **meters** are **located all argue** for **caution.**

http://sagereports.com/smart-meter-rf/docs/Smart-Meter_Report.B-Tables.pdf

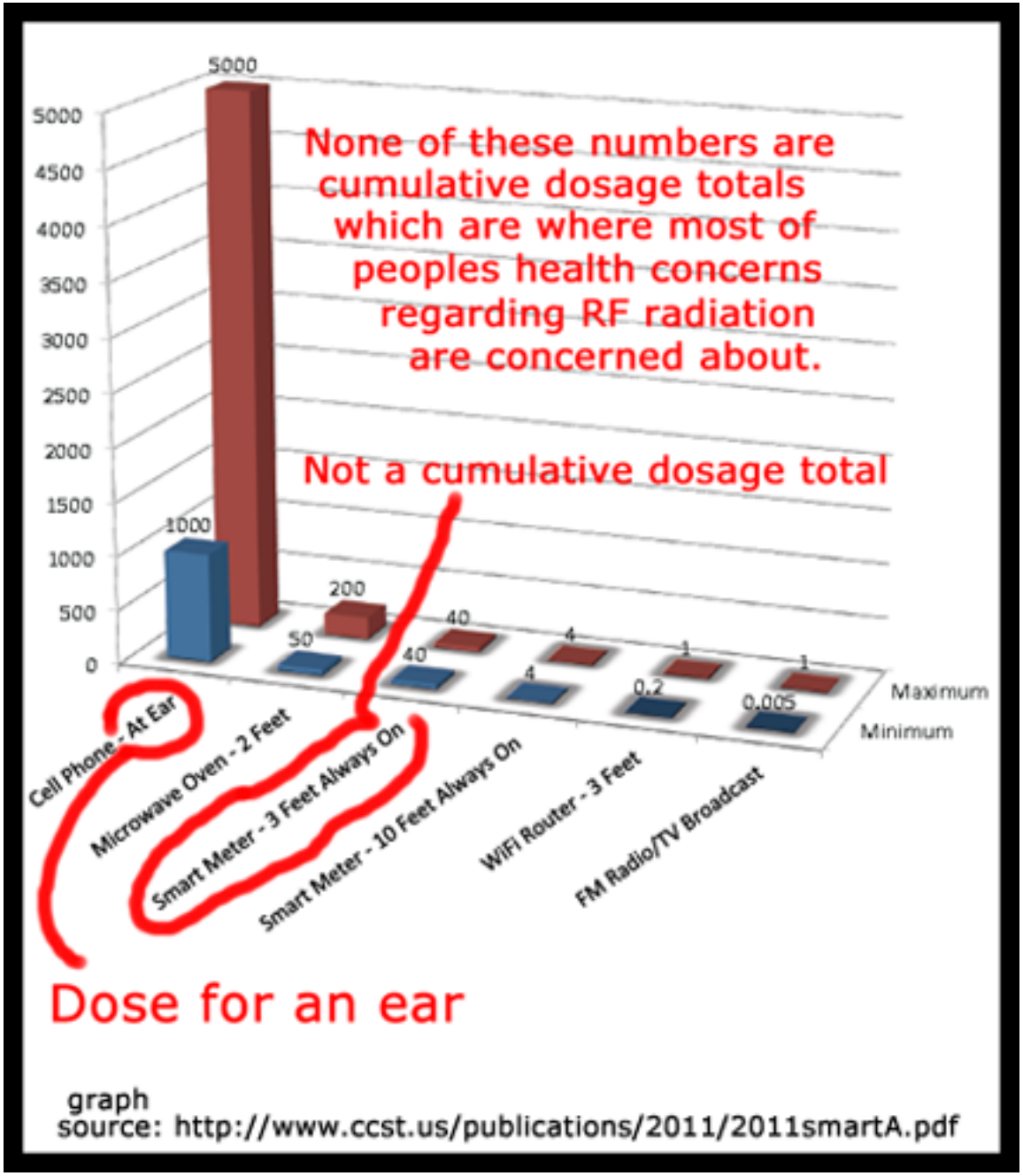
Instant Power Density Levels of Common RF Devices

'Go –to' figure for utility companies



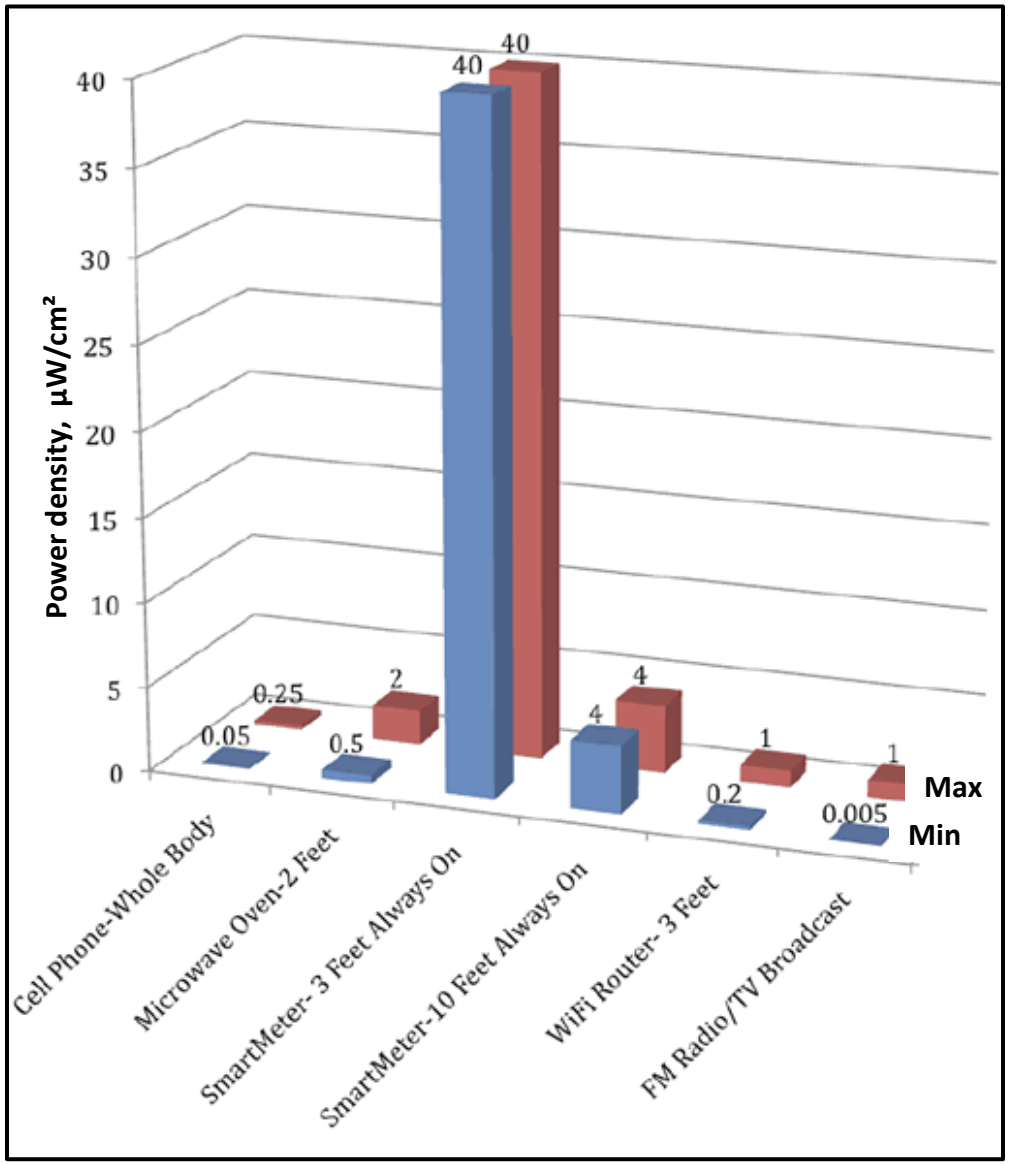
Source: Electric Power Research Institute (industry advocate group)

- Assumes distances in far-field, where power density falls off as square of distance from source (inverse square law)
- Smart meter power density scaled to obtain output for 50% duty cycle ('on' 50% of time)
- Smart meter RF pulses are 'time-averaged' over 30 min, instead of providing 'peak power'.



graph
source: http://www.ccst.us/publications/2011/2011smartA.pdf

Comparison of Power Density Levels to Whole Body from Common RF Devices Over Time



Corrected for **2 critical errors** in **CCST report:**

- **failure** to **factor in duty cycles** of **cell phones** & **microwave ovens**
- **failure** to **compare** using **same units (average whole body exposure)**

Estimated effect of these **corrections:**

- at **3 ft, smart meter produces 53-160 times cumulative whole body exposure** of **cell phone.**

Exposure levels still **differ** by **100 times** but now **higher, rather than lower,** for **smart meter** compared to **cell phone.** **10,000-fold shift**

From: D. Hirsch (nuclear policy expert; UCLA lecturer; President, Committee to Bridge the Gap)

http://www.ccst.us/projects/smart2/documents/letter8hirsch.pdfsch

Statement from Dr. De Kun Li, MD, PhD, MPH Senior Research Scientist with Kaiser Permanente

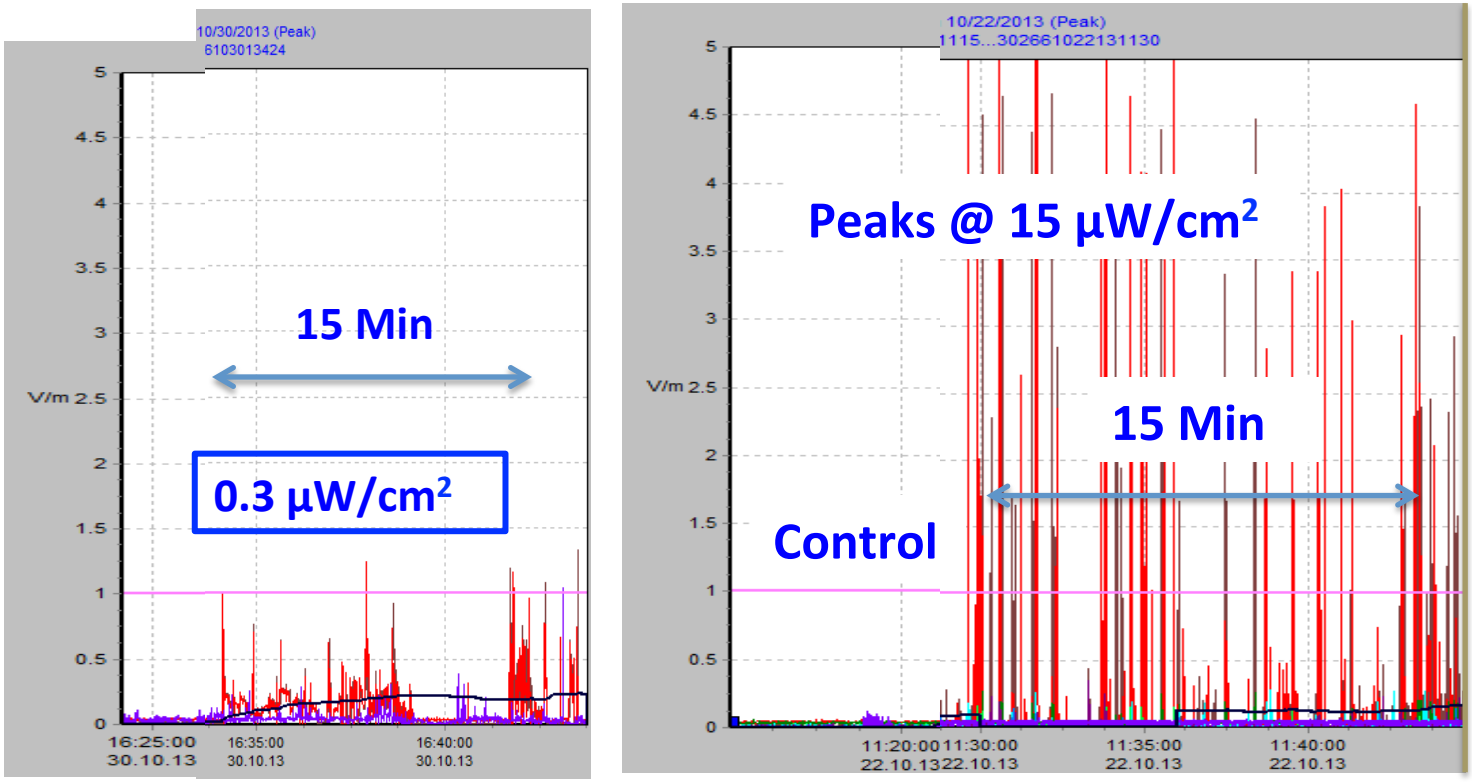
Response to California Council on Science and Technology (CCST) (Posted 3/31/11)
http://www.ccst.us/publications/2011/2011smartresources.php

"Currently there are no national or international "standards" for safety levels of radiofrequency devices. What the FCC is currently using are "guidelines" which have much lower certainty than a "standard".

The bottom line is that the safety level for RF exposure related to non-thermal effects is unknown at present and whoever claims that their device is safe regarding non-thermal effects is either ignorant or misleading."

(Excerpted from full statement)

iPhone in use vs. 2.5 m from 5 Smart Meters



- Whole body exposure for both iPhone and 5 smart meters
- ~ 8000 pulses/day; actual rate depends on duty cycle and other meters close by
- Short burst pulsed EMFs new to living systems, never tested prior to deployment.

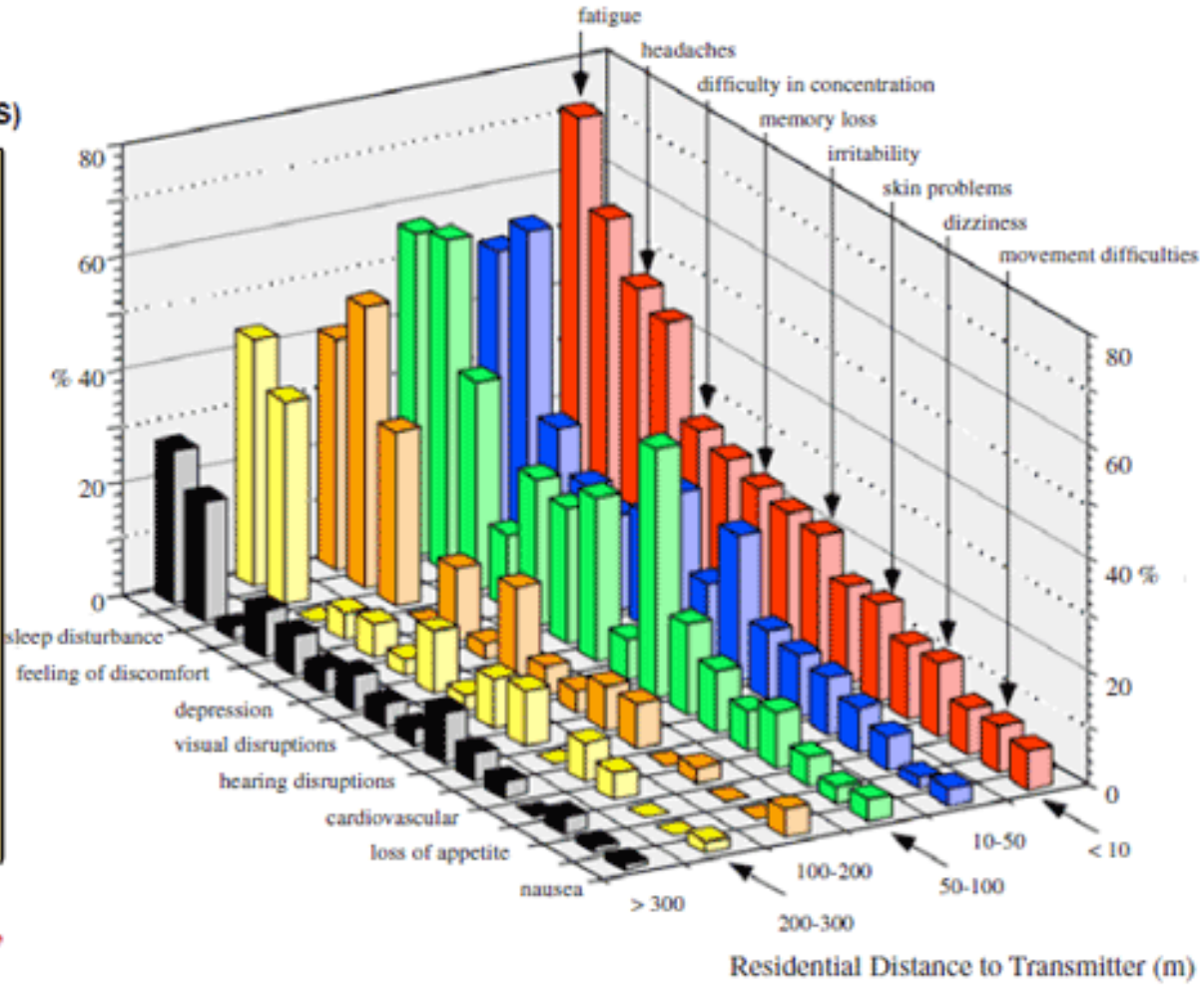
Source: K Maret: Address to Commonwealth Club, San Francisco, 28 Jan 2014

Frequency of EHS Symptoms Based on Distance to Cell Phone Base Station

Electro-Hyper-Sensitivity (EHS)

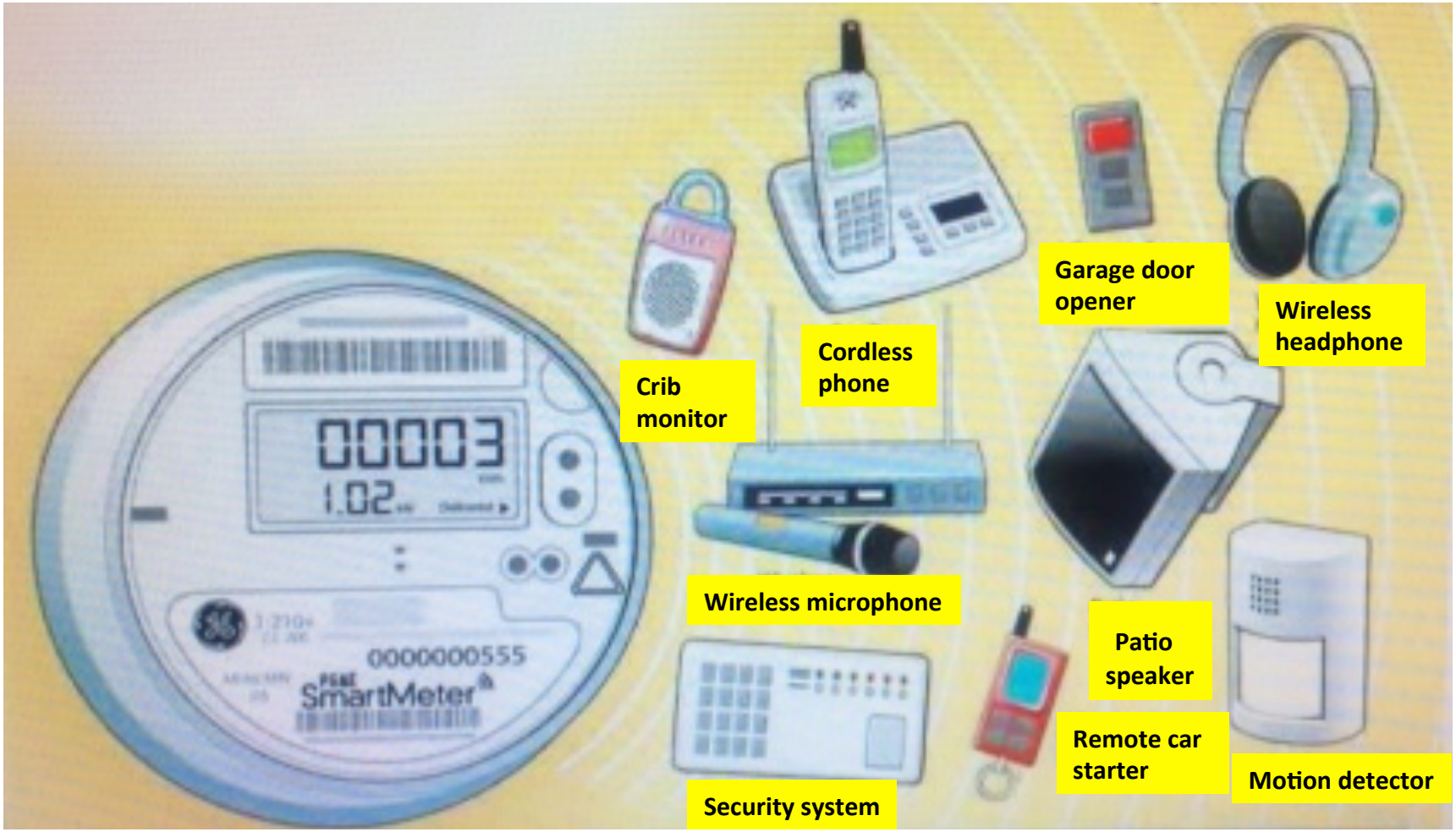
1. Fatigue *
2. Sleep disturbance *
3. Headaches
4. Feeling of discomfort
5. Difficulty in concentrating *
6. Depression *
7. Memory loss *
8. Visual disruptions *
9. Irritability *
10. Hearing disruptions *
11. Skin problems
12. Cardiovascular *
13. Dizziness *
14. Loss of appetite *
15. Movement of difficulties *
16. Nausea

* Associated with Aging: "Rapid Aging Syndrome"



Source: M. Havas derived from Spanish study in La Presse Medicale, 2001

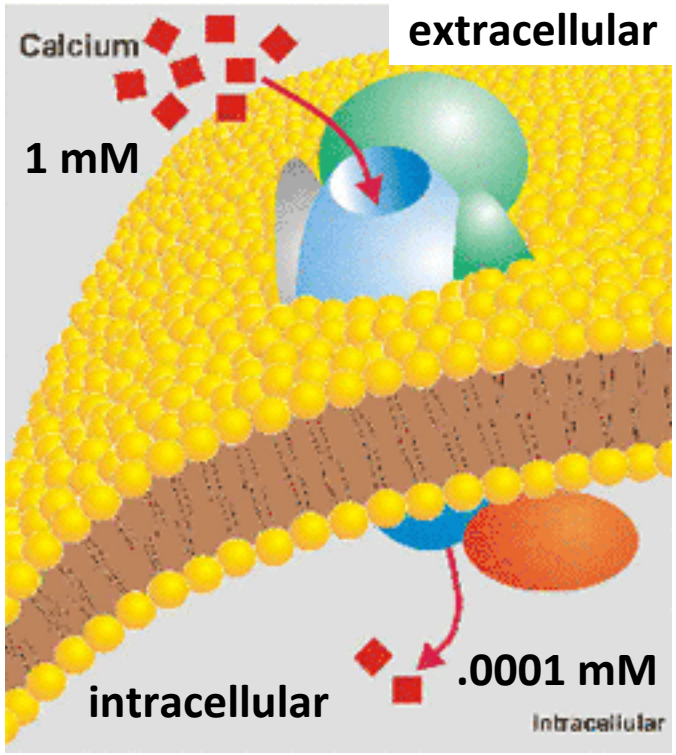
Other Household RF Devices

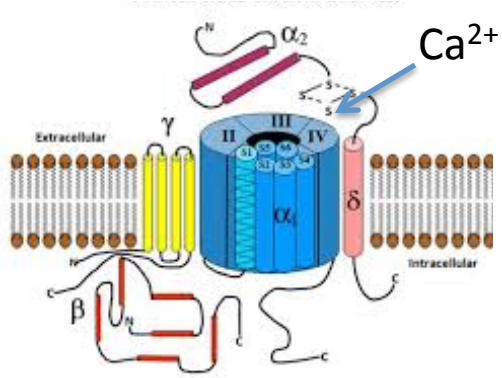


- We are being increasingly subjected to EMF from a diverse array of RF-emitting devices in our everyday living and sleeping space.
- The total cumulative EMR burden is not being monitored by Health Canada.

Plausible Mechanism Underlying Bio-effects from Pulsed RF Radiation

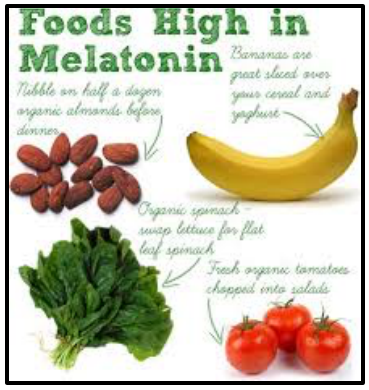
Voltage-gated Calcium Channels





- Membrane proteins in electrically excitable cells
- Channels open when cell excited by depolarizing stimulus
- Ca^{2+} ions flow into cell from extracellular space
- This activates various calcium-dependent processes to trigger (or modulate) cellular responses
- Neurons release neurotransmitters or change functional properties (memory and learning)
- Muscle cells contract; pancreatic β cells release insulin (lower blood glucose)

Melatonin (MT) Disruption Hypothesis

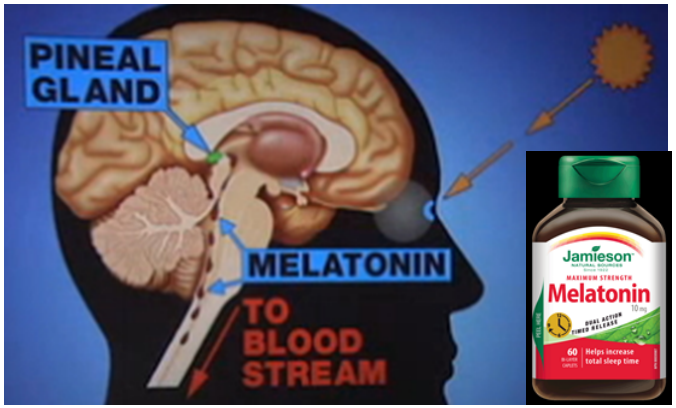


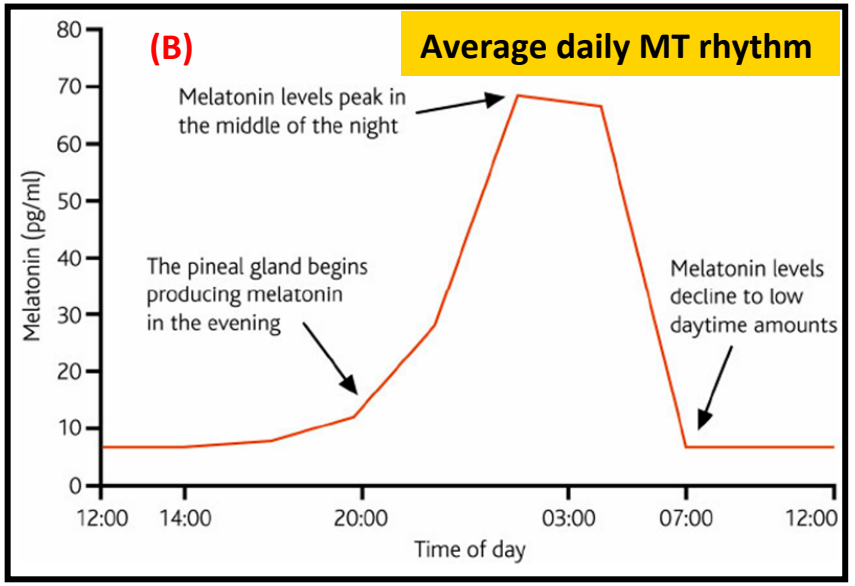
- Power-line magnetic fields (MFs) increase risk of cancer & other illnesses by disrupting nocturnal MT synthesis
- MT: powerful antioxidant, more effective than vitamin C or E; crosses blood-brain barrier; high levels in mitochondria
- MFs suppress blood plasma and pineal MT levels in rats, hamsters and baboons
- MFs suppress MT production in humans; seen in 11 studies, both laboratory controlled & observational (population)
- MT protects against radiation-induced oxidative damage to human lymphocytes
- MT protects against oxidative damage to fetus in animals; significant as initiating event in childhood cancer appears to occurs in utero
- Plausible mechanisms underlying MT disruption:

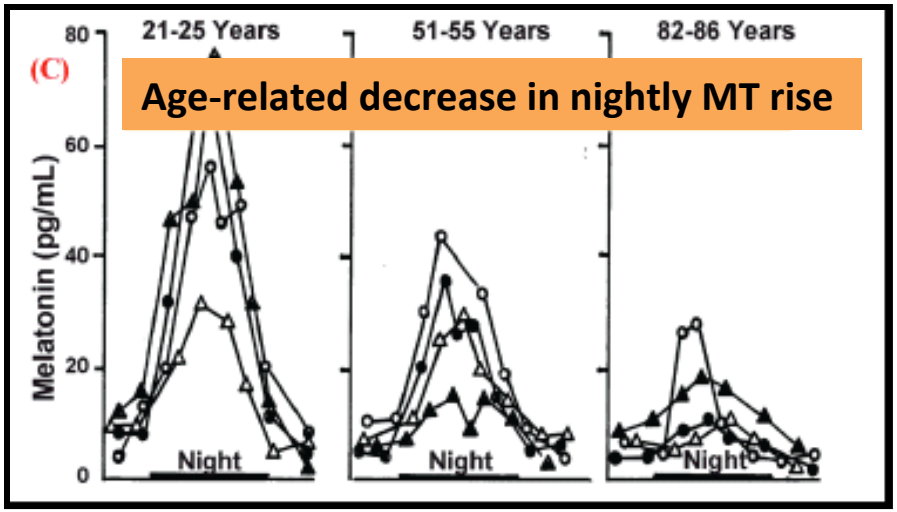
(i) reduced activity of rate-limiting enzyme for MT synthesis;
(ii) generation of free radicals by MFs, increasing demand on MT for free radical scavenging.

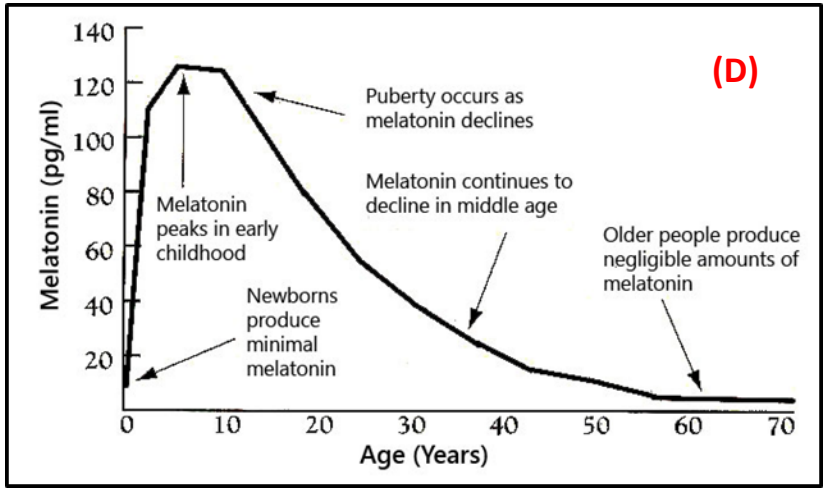
Melatonin (MT) Production in Humans

(A)



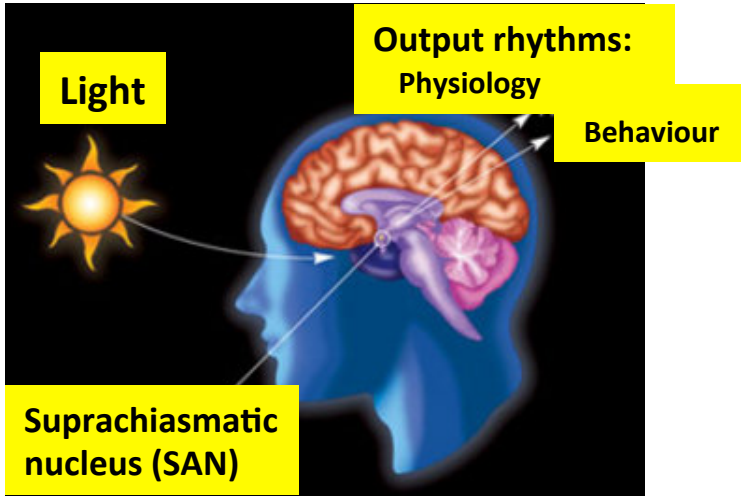




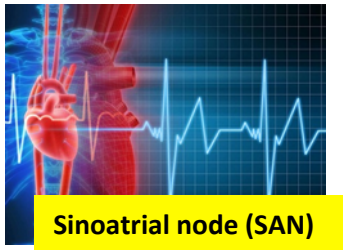


MT production: (A) release from pineal gland during night time; (B) nightly rise in plasma MT; (C) decline in nightly plasma rise with increasing age; and (D) plasma levels as function of age.

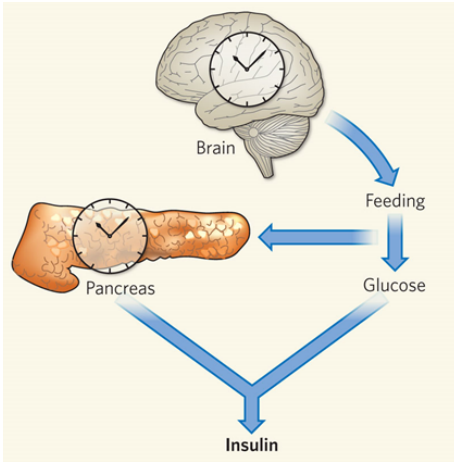
Specialized Cellular Clocks: Pacemaker Cells



Circadian rhythms



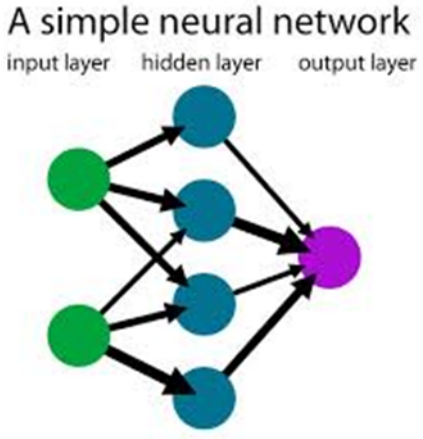
Heartbeat regulator



Metabolic co-regulating clocks in brain & pancreas

- **Humans** are **biochemically dynamic**
- **Constantly subjected** to **time-varying conditions** from **extrinsic forces** & **intrinsic rhythms** from **specialized circadian 'clocks'**
- **Clocks** reside in our **brain, heart** & **pancreas** & **regulate critical functions: body temperature, hormone production, heart rate, blood pressure** & **digestive metabolism**
- Comprised of **populations** of **biologically oscillating (pacemaker) cells** with distributed **natural EM frequencies**
- **Cells** act **co-operatively** to pull one another into **synchrony** & generate **electrical rhythms**
- Their **actions** are dependent upon **exquisitely timed cues** from **environment forces** at **vanishing small levels.**

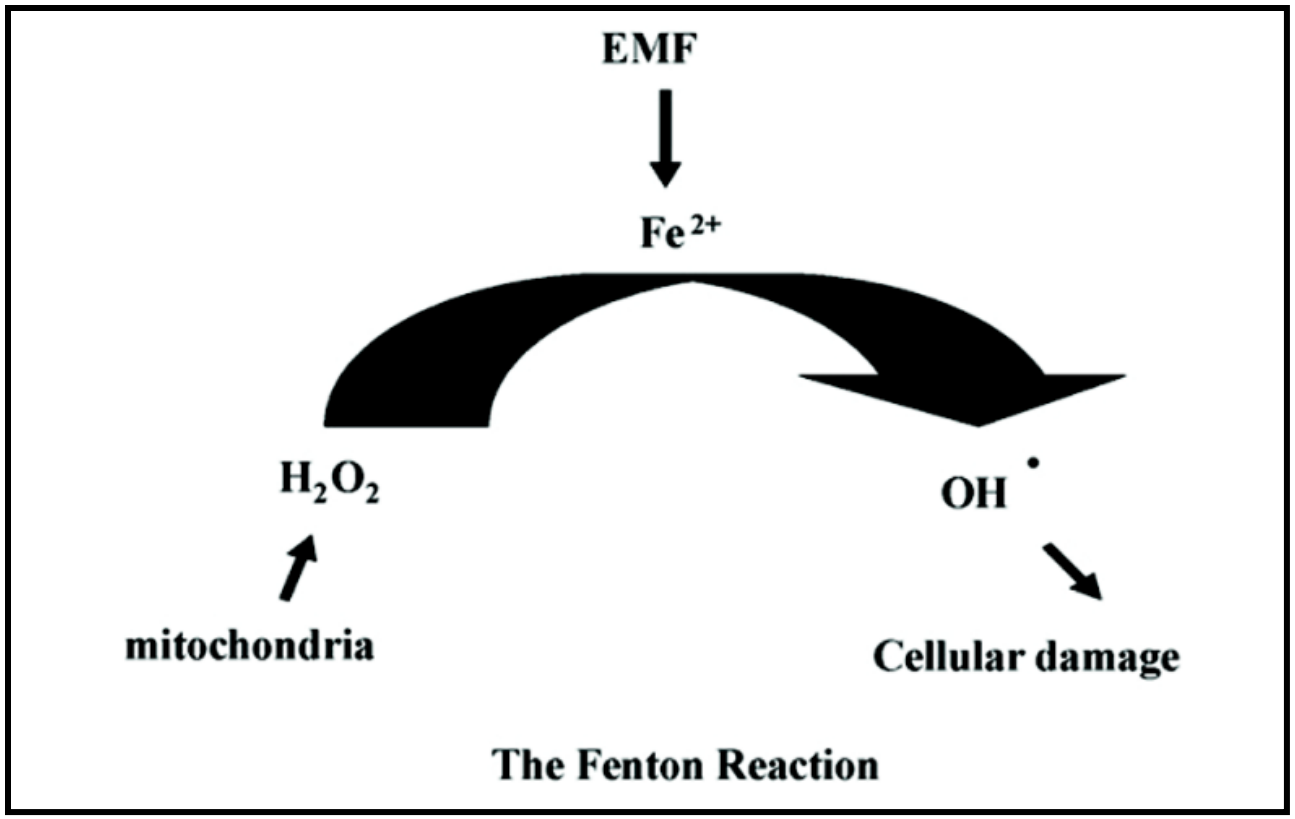
Unifying Hypothesis: Pulsed RF EMF as Disrupter of Synchronized Neural Activity



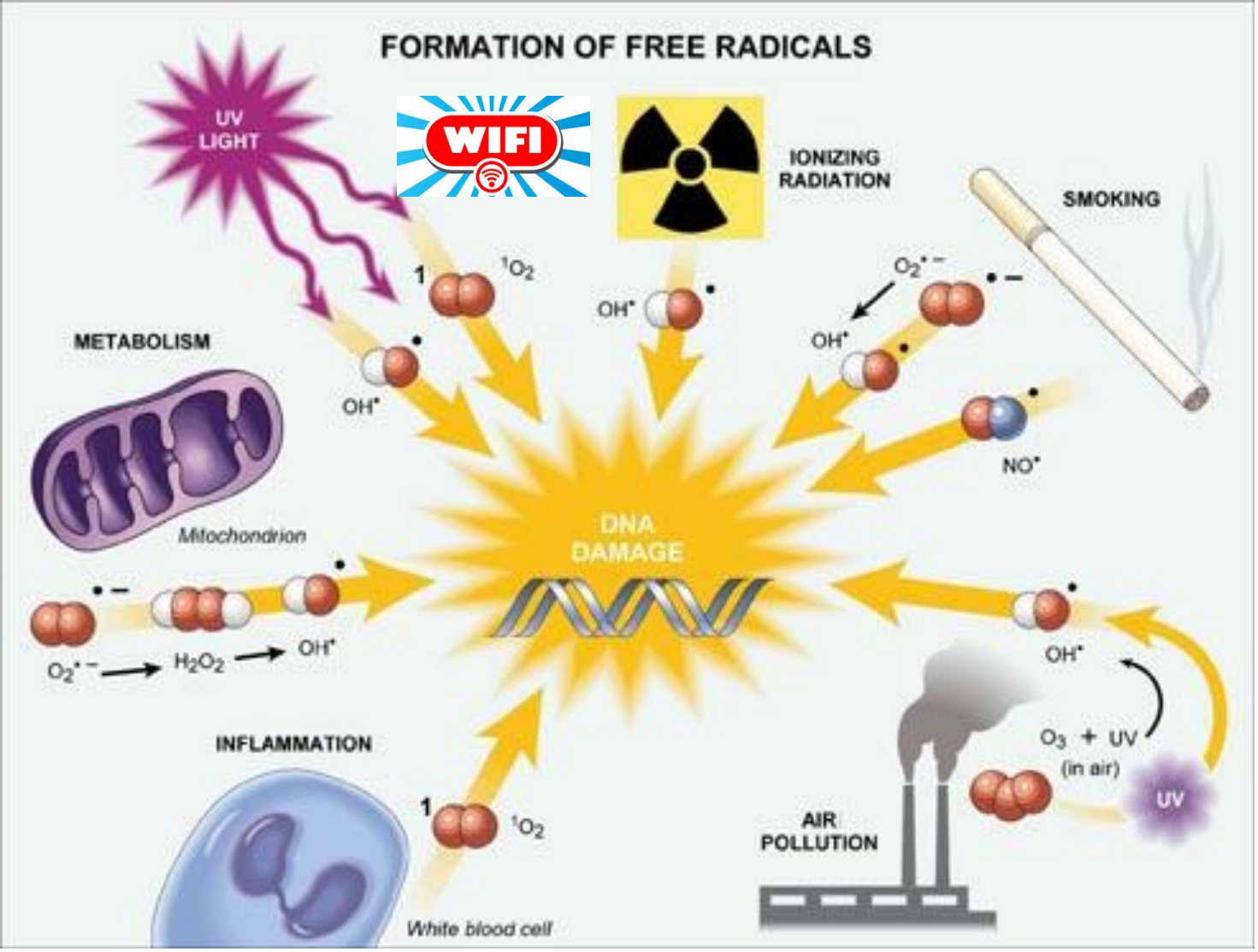
Neural network

- **Synchronized** biological **oscillations** in **pacemaker cells** can be **disrupted** by **artificial, exogenous signals,** resulting in **de-synchronization** of **neural activity.**
- **Weak field interactions** of **pulsed RF radiation** & **ELF-modulated RF radiation** may **disrupt electrical rhythms** by which **circadian clocks regulate critical functions** in **neural, cardiac** & **digestive systems.**
- **Increasing reports** from **electro-sensitive persons** suggest **pulsed RF-emitting devices** may have **adverse health effects.**
- **The** emerging **smart meter/grid infrastructure** represents the **largest commercial saturation** of **living space** of **pulsed RF radiation** yet **rolled out** by the **wireless industry.**

Plausible Mechanism for EMF-Induced DNA Strand Breaks



- DNA may be damaged by free radicals formed inside cells – Fenton reaction
- Reaction catalyzed by iron in which hydrogen peroxide, product of oxidative respiration in the mitochondria, is converted into hydroxyl free radicals .



Reactive Oxygen Species (ROS)

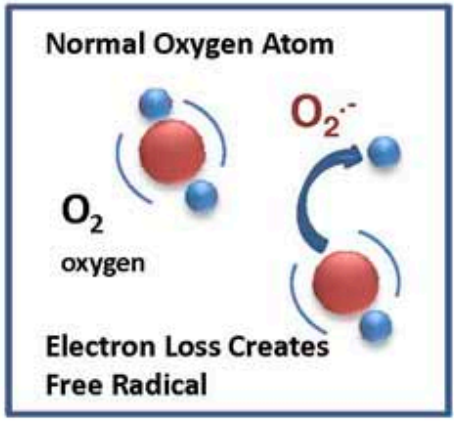
$^{\bullet}OH$

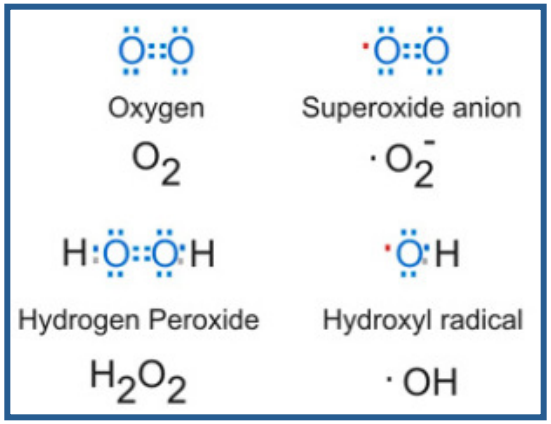
$^{\bullet}O_2^-$

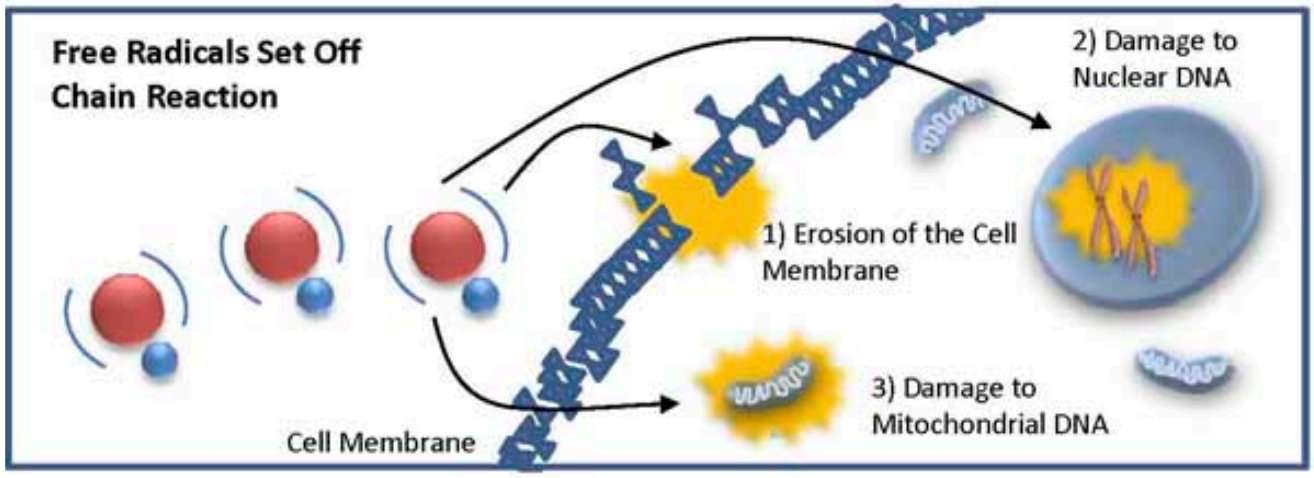
H_2O_2

- **Most free radicals are ROS formed as by-products of normal cell processes: use of oxygen (oxidation) for energy production and food metabolism; pathogen killing by phagocytes.**
- **Also formed by exposure to various environmental and life-style factors: radiation, solar UV rays, tobacco smoke, air pollution, poor diet, emotional stress**
- **And most recently, exponential proliferation of wireless devices and systems!**

Free Radical Damage

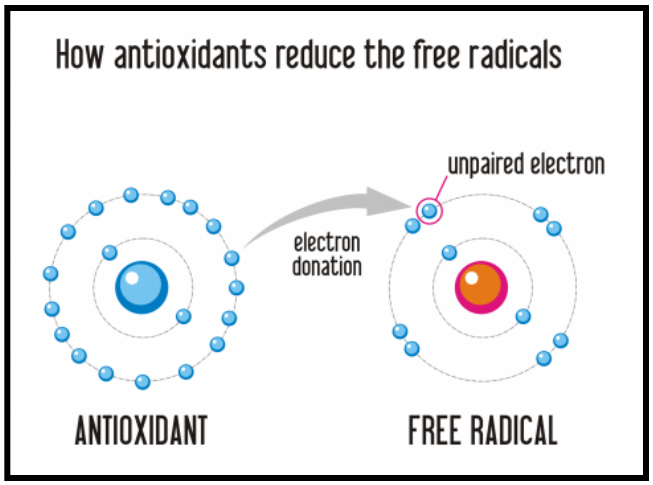






- **Sequential reduction of oxygen via addition of electrons leads to formation of various ROS.**
- **Free radicals erode cell membranes and damage nuclear & mitochondrial DNA.**
- **Many diseases linked to oxidative stress: cancer, diabetes, cardiovascular & neurodegenerative diseases, as well as the aging process.**

Antioxidants: Free Radical Scavengers



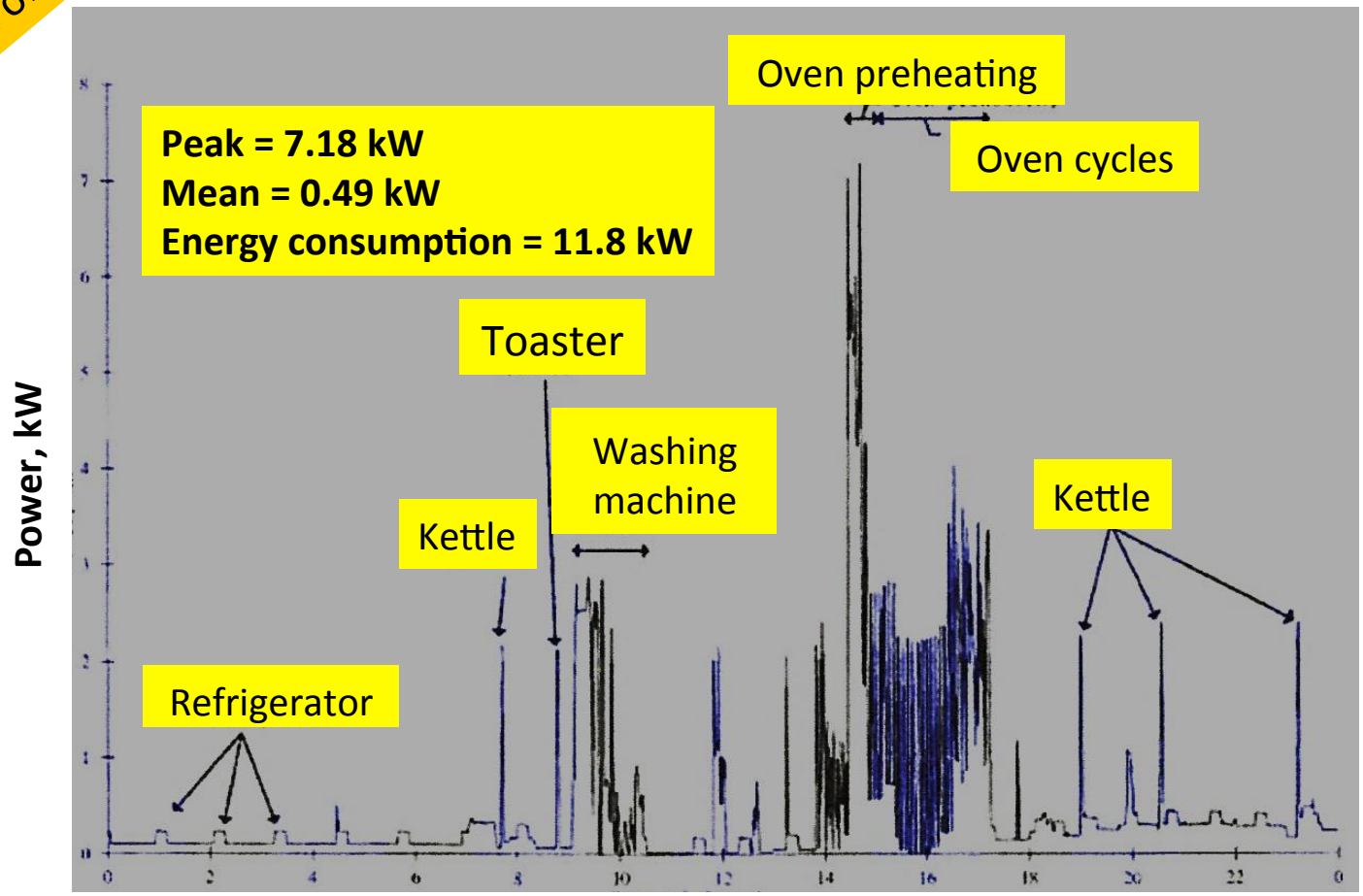
- Intracellular enzymes
  - Glutathione peroxidase
  - Catalase
  - Superoxide dismutase
- Exogenous and endogenous antioxidants
  - Vitamin A
  - Vitamin C
  - Vitamin E
  - Cysteine
  - Glutathione
  - Selenium

-melatonin

- **Antioxidants detoxify free radicals by donating an electron, thus creating stable molecules in which every atom is ringed by pairs of electron.**
- **Critical to cell health: maintain proper balance between ROS production and consumption, thereby preventing unrestrained ROS activity ('oxidative stress').**
- **Our body requires ~ 60 antioxidants, consisting of intracellular enzymes and numerous dietary constituents abundant in fruits, vegetables, grains, meats, poultry and fish.**
- **Natural sleep-inducing hormone, melatonin, is a powerful antioxidant, effective in both aqueous & lipid phases; crosses the blood-brain barrier; high levels in mitochondria.**

Invasion of Privacy

Man, you drink a lot of tea!

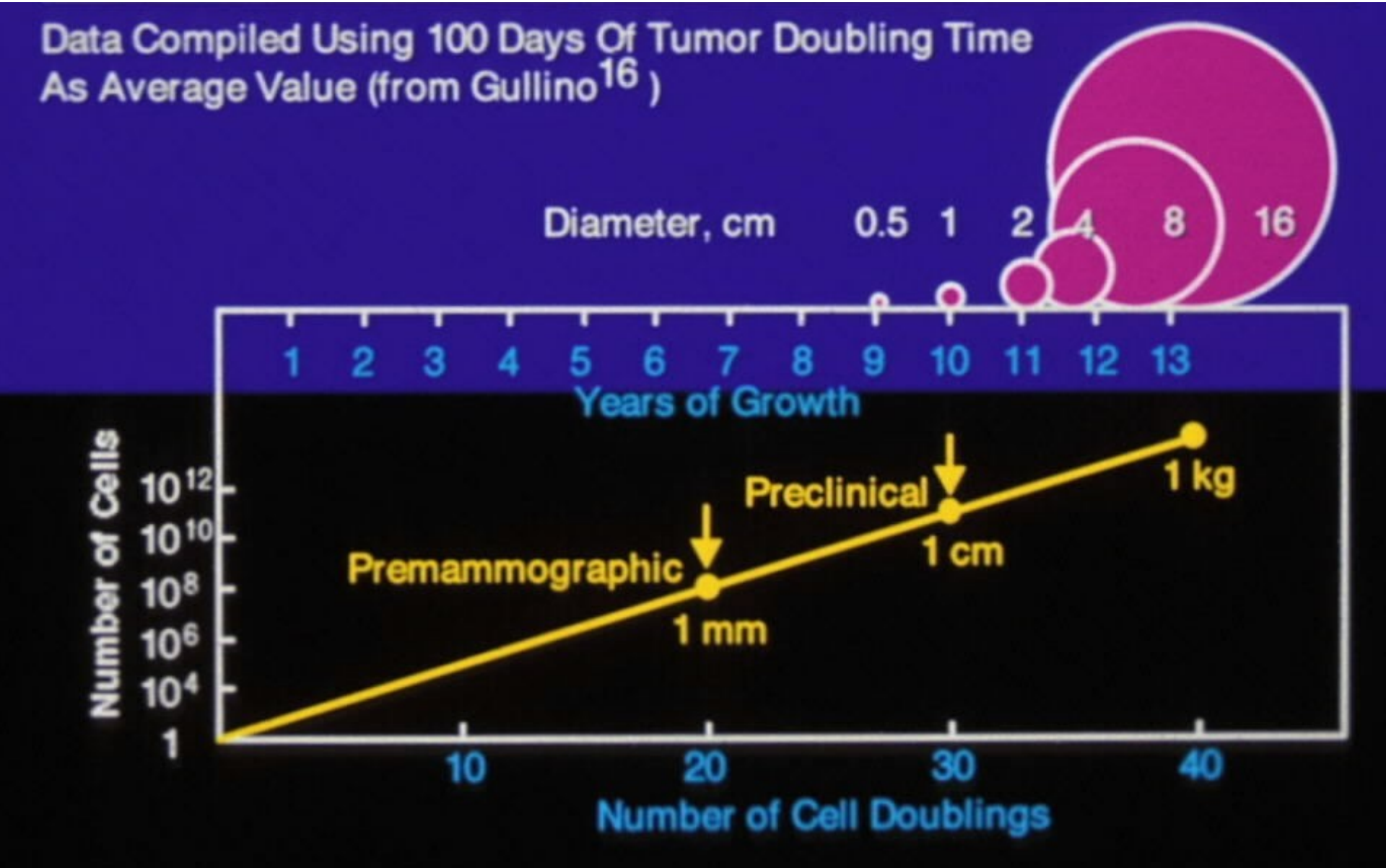


- Smart meters can collect detailed individual household's electricity demands
- Each appliance has its own energy fingerprint ('appliance load signature')
- Reveal types of appliances & how often used; when you get up, go to sleep & when out
- Technology that can 'pierce the blinds'.

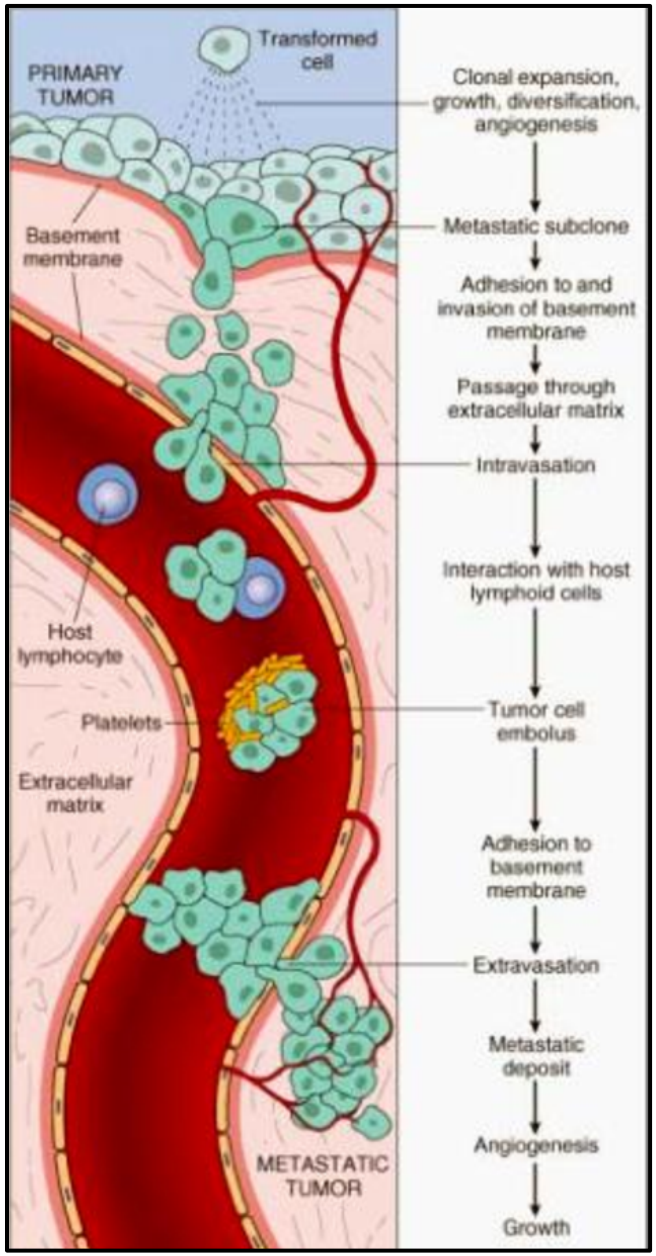
Who Wants Smart Meter Data?

Who wants smart meter data?	How could the data be used?
Utilities	To monitor electricity usage & load; to determine bills
Electricity usage advisory firms	To promote energy conservation & awareness
Insurance companies	To determine health care premiums based on unusual behaviours that might indicate illness
Marketers	To profile customers for targeted advertisements
Law enforcers	To identify suspicious or illegal activity
Civil litigators	To identify property boundaries, activities on premises
Landlords	To verify lease compliance
Private investigators	To monitor specific events
The press	To obtain information about famous people
Creditors	To determine behaviour reflecting creditworthiness
Criminals	To identify pricey appliances to steal, burglary timing

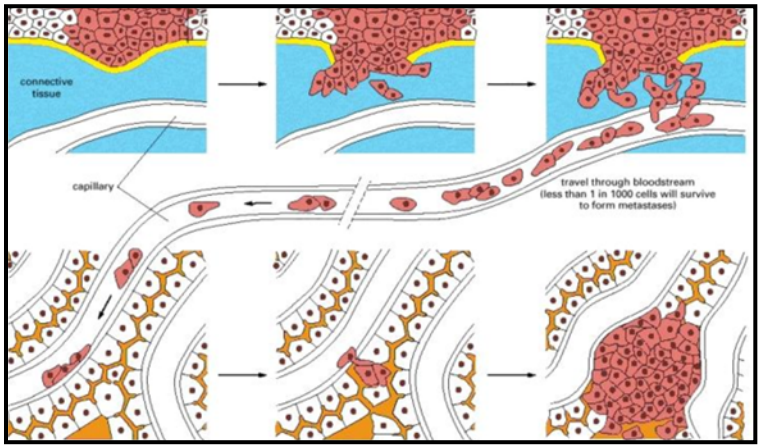
Long Preclinical Existence of Breast Cancer



Notes on Metastasis



- **Tumors** become **life-threatening** when they **evade** & **subvert** defense systems **confining** them to **origin.**
- **Spawn pioneer cells** that **colonize** sites where **space** & **nutrients** not limiting; **interfere** with **vital systems.**
- **Tumor cells** are **shed** from **primary** tumor **mass** at **earliest stages** of **malignant progression.**
- **Circulating tumor cells** (CTCs) must **evade immune cells in** lymphatics/blood stream & **adhere** to vessel **wall.**
- Less than **1 in 10,000** will **survive** to form **metastases.**
- Hidden **CTCs** are **source** of eventual **lethal metastases**, **major cause** of **treatment failure.**
- **Detection** & **characterization** of **CTCs** is promising for both **diagnosis** and **treatment monitoring.**
- **Novel microenvironment** must be **established** at **distant site** for **tumor cells** to **proliferate.**



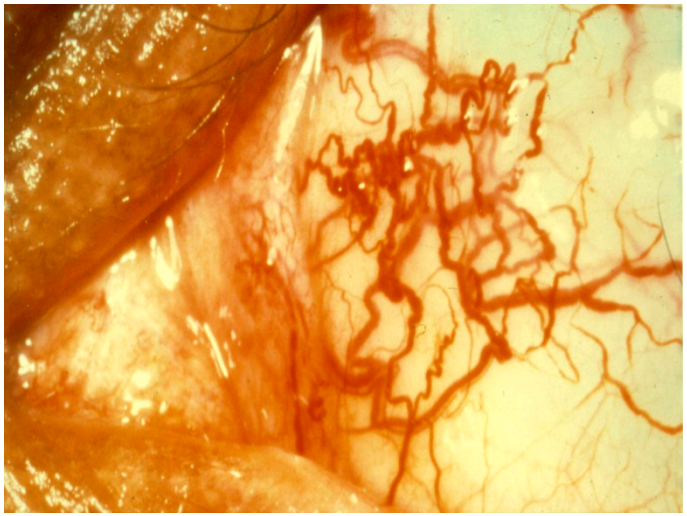
Ataxia - Telangiectasia

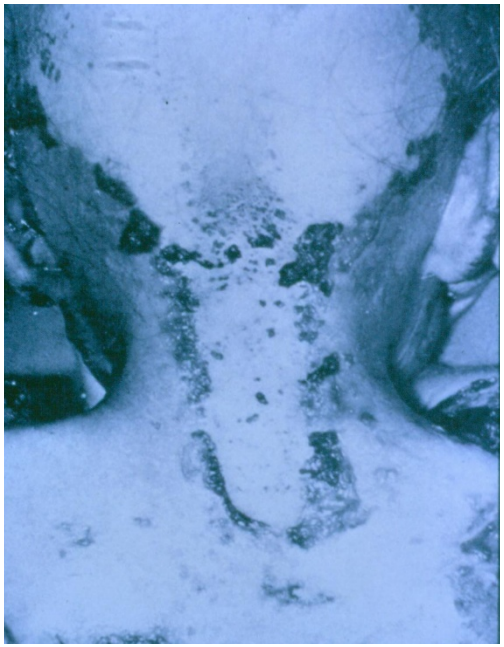
(complex, single gene trait; 1 per 40,000)

Clinical Features:

- Muscular incoordination
- Blood vessel dilation (eyes & skin)
- Defective immunity (respiratory infection)
- Cancer - prone (lymphomas & leukemias)
- Hypersensitivity to radiotherapy

Clinical Hallmarks of Ataxia-telangiectasia



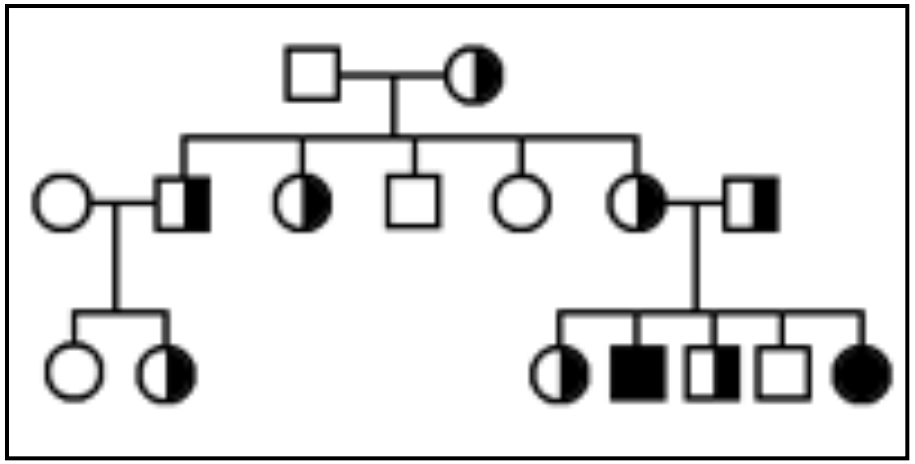


AT heterozygotes: a cancer-prone population

- **Swift studied incidence of cancer in families of AT patients**

- **Striking cancer excess in AT families, leading to prediction that ~ 5%* of all cancer deaths below age 45 arise in heterozygous carriers**

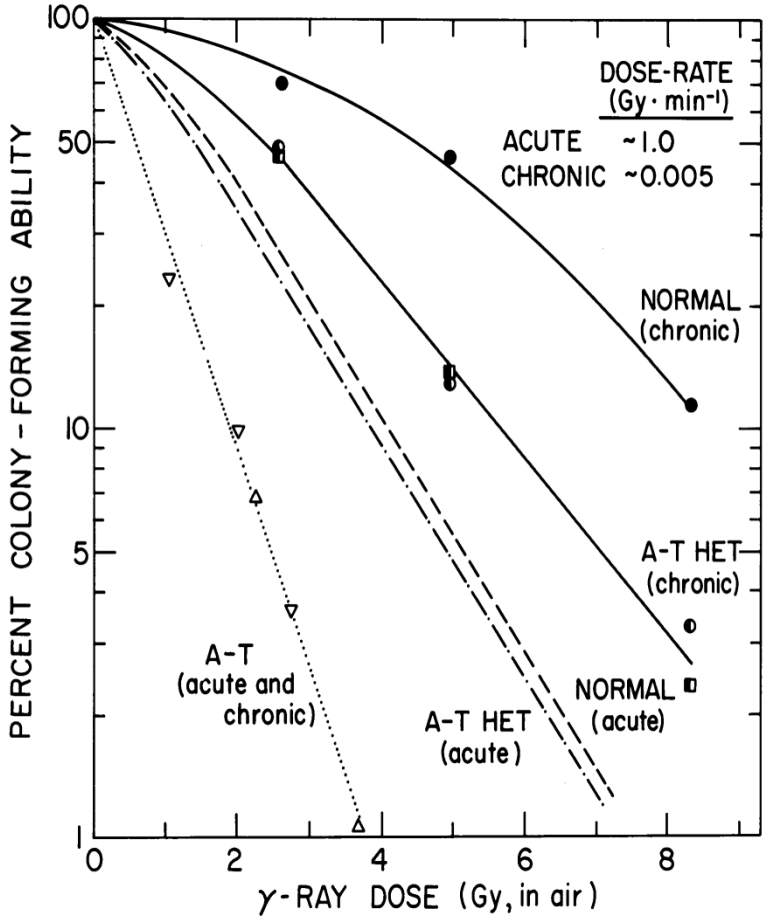
  *** estimated heterozygote frequency (1% of general population) X relative mortality risk (five times normal)**



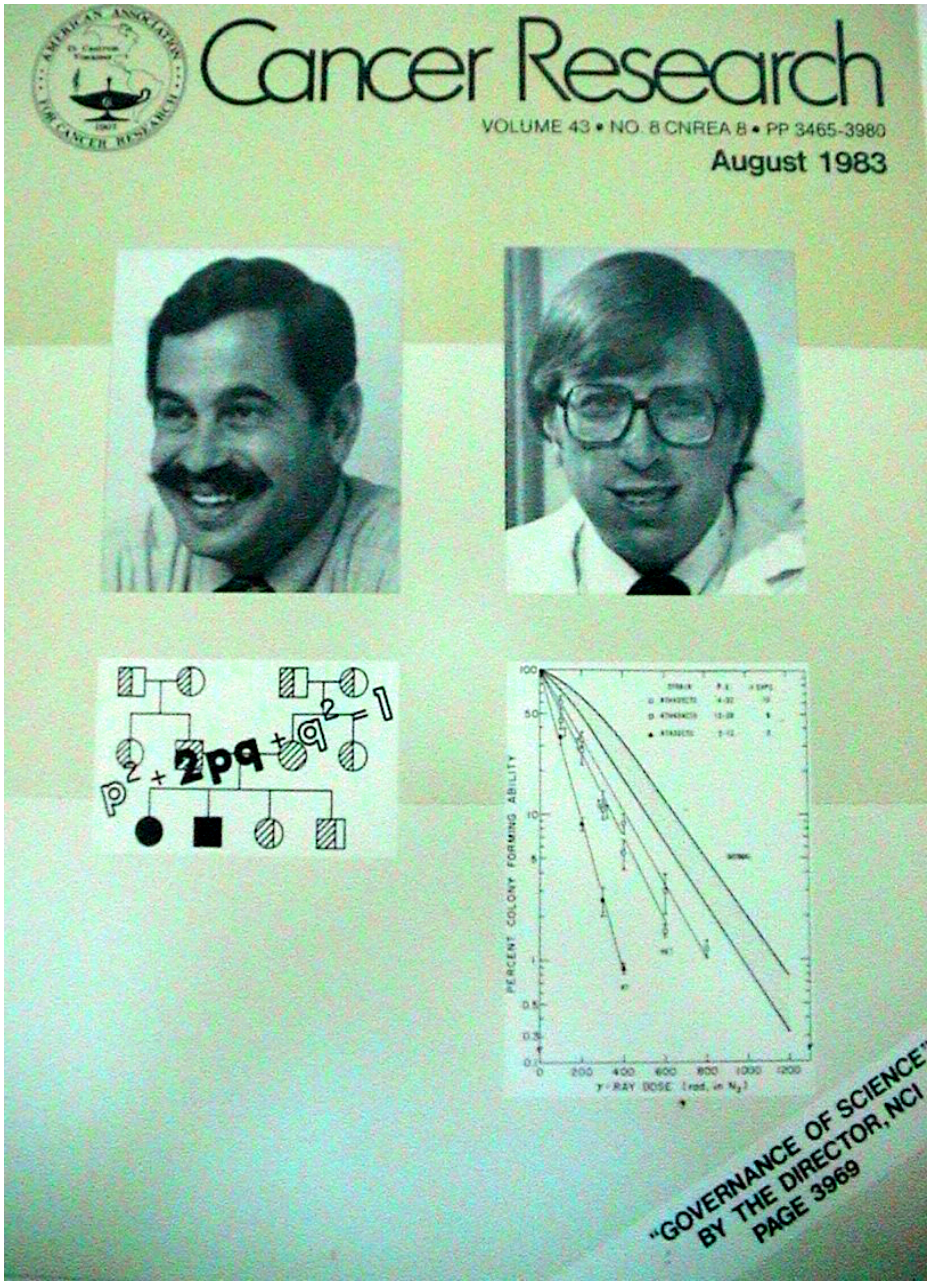
A-T heterozygotes also display enhanced radiosensitivity *in vitro*

- **In 1976, we showed that some, but not all, obligatory A-T heterozygotes displayed impaired colony-forming ability in response to radiation delivered under hypoxia**

- **These epidemiologic and lab findings demonstrated how genetic and environmental factors may interact in cancer pathogenesis**



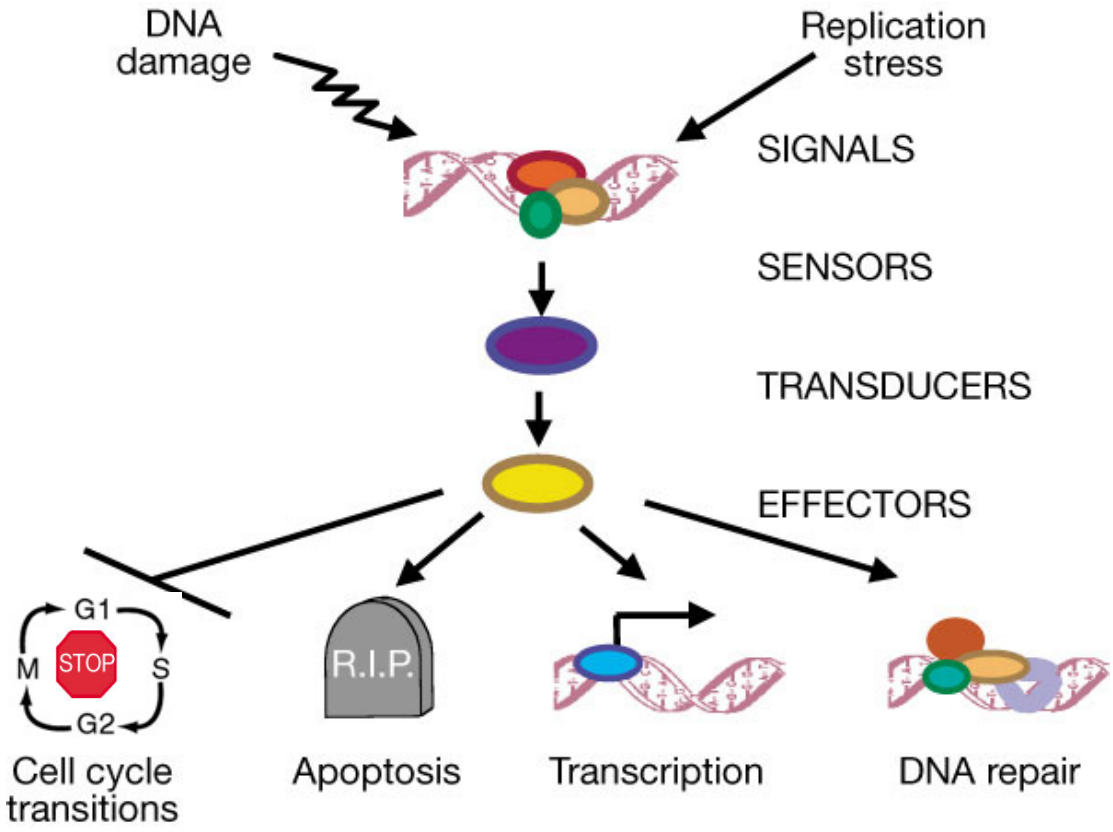
A-T heterozygotes: a cancer-prone population displaying enhanced radiosensitivity *in vitro*



Cited as *exemple par excellence* of genetic-environmental interactions in cancer development

Cancer Res 43(8), Aug 1983

General Outline of DNA-damage Response Network



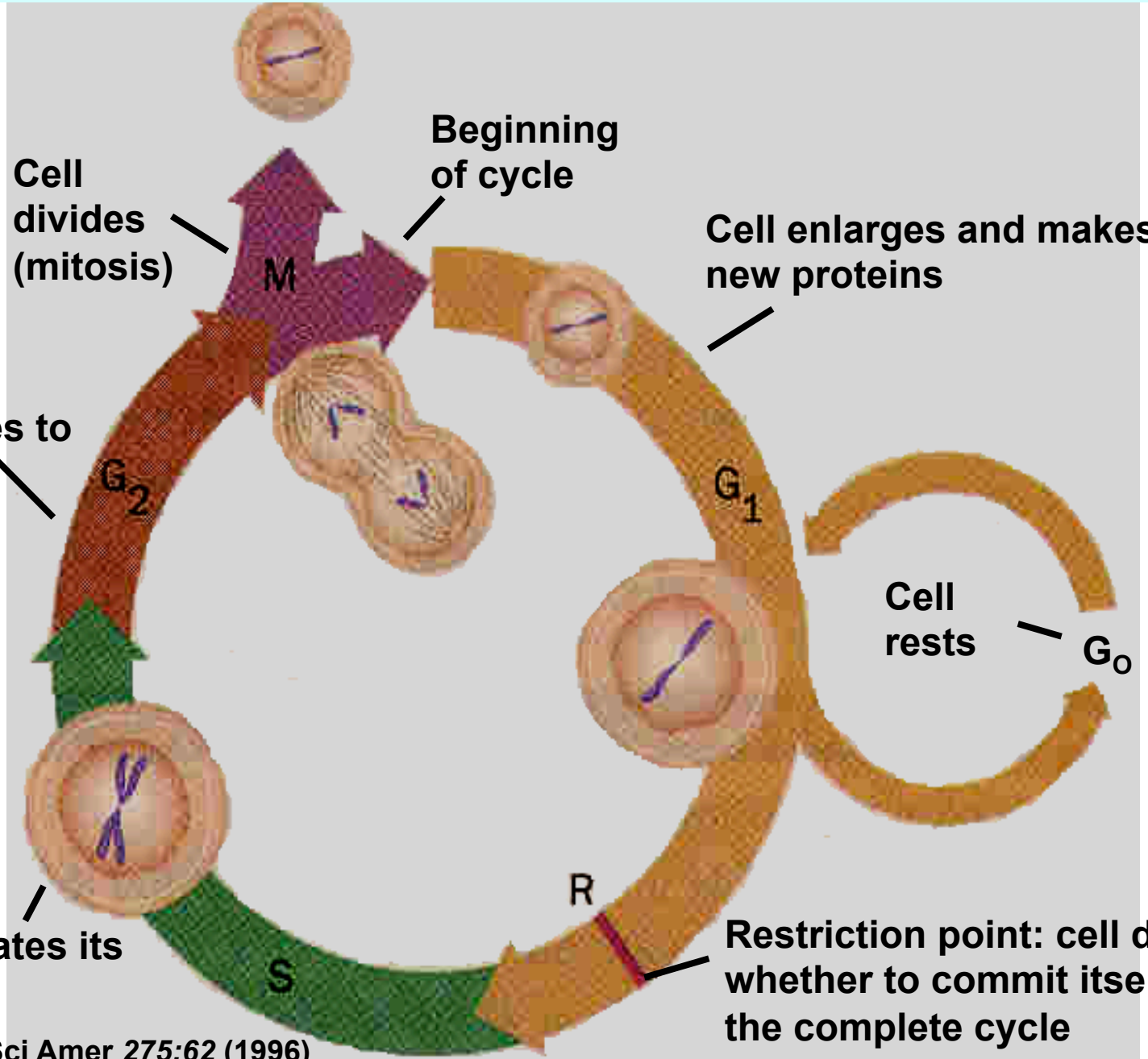
Genotoxic (DNA) damage 'turns on' stress-responsive signaling network [cell-cycle control, transcription, apoptosis (programmed cell death), and DNA repair].

Mutations in the genes encoding key network-mediating proteins lead to genomic instability - initiating and rate-limiting event in many forms of malignant growth.

Network regulated by ATM protein, product of gene underlying ataxia-telangiectasia.

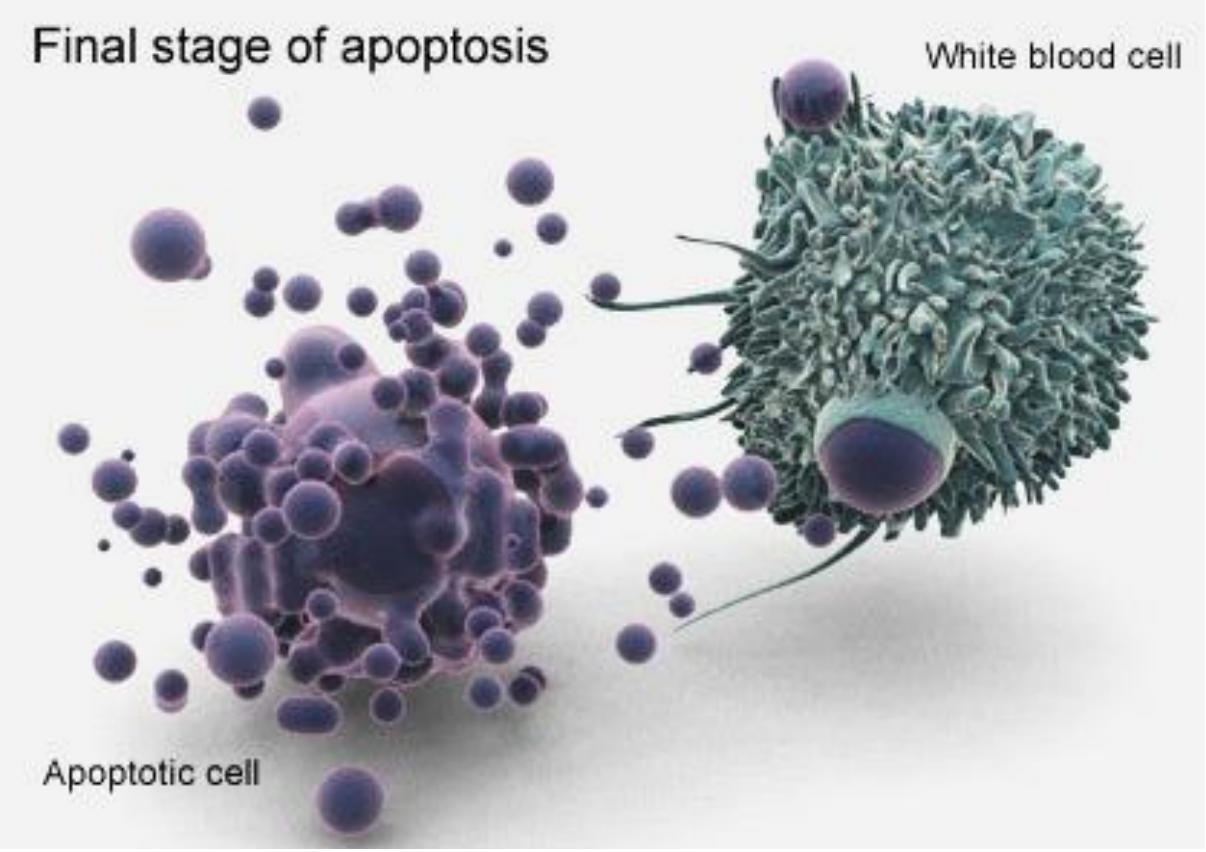
BS Zhou & SJ Elledge Nature 408: 433 (2000)

Stages of the Cell Cycle



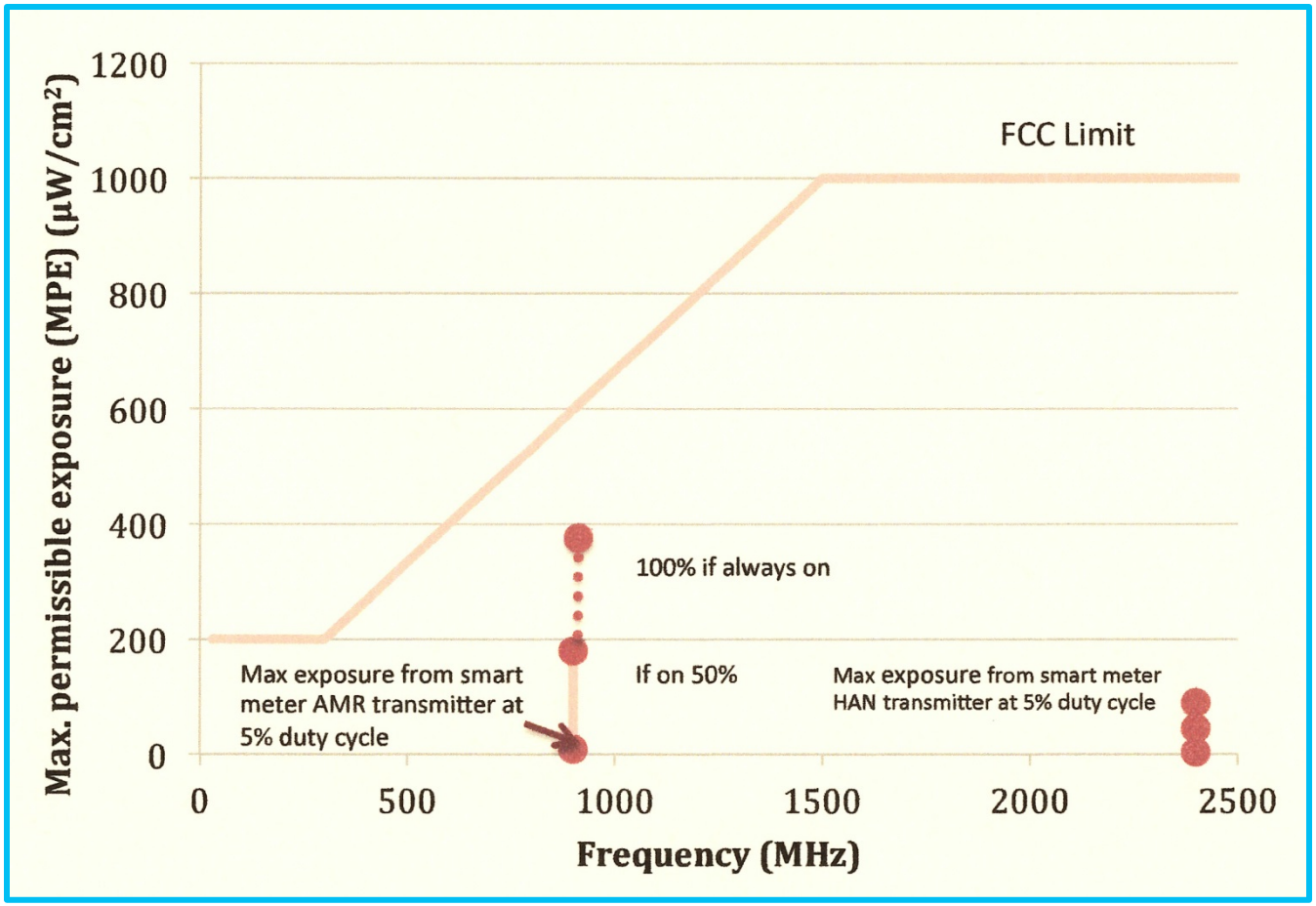
RA Weinberg. Sci Amer *275:62* (1996)

Cell Membrane 'Blebbing' in Apoptosis



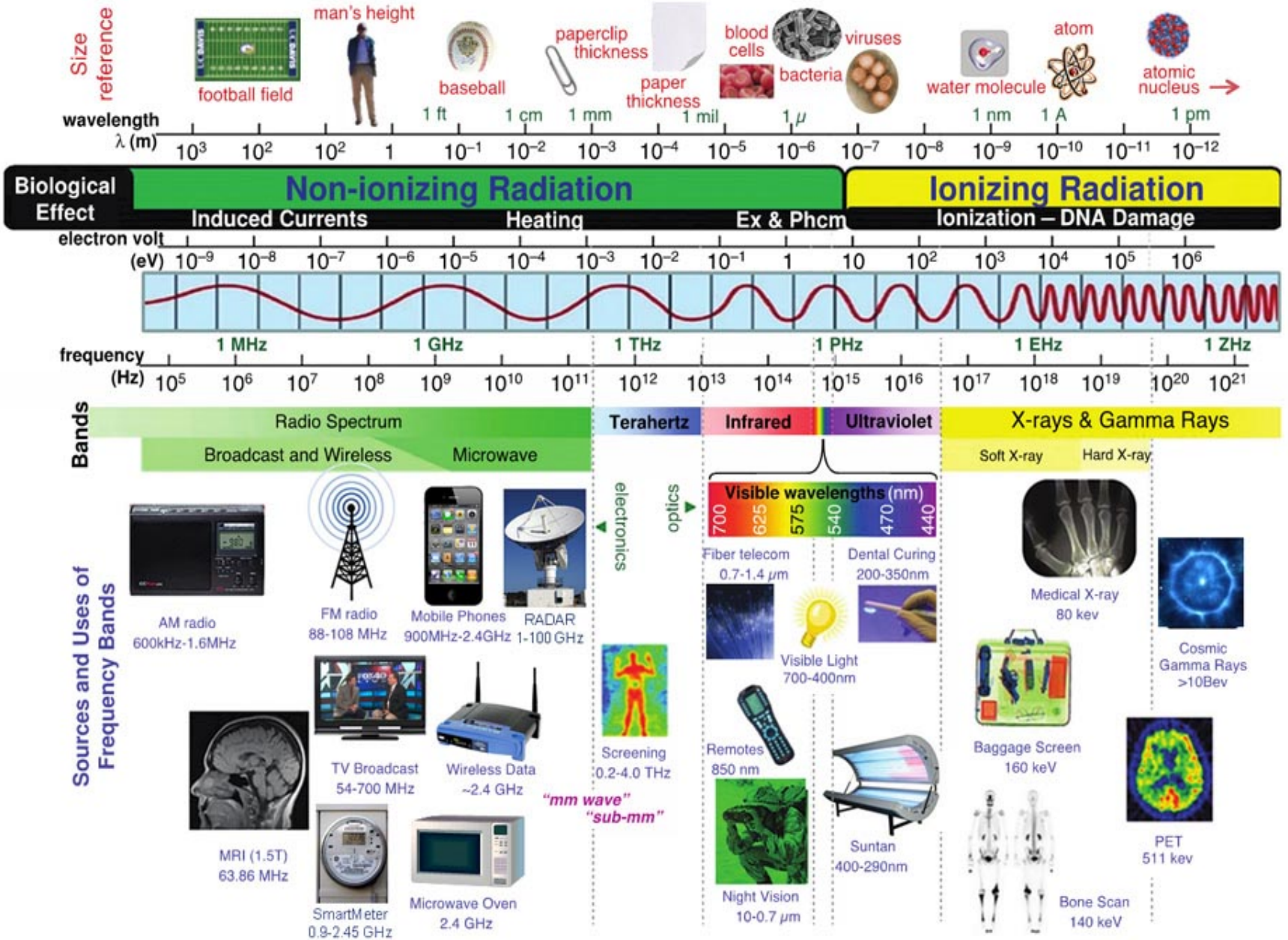
- **Apoptosis** (programmed cell death) used to **remove cells** that are either **badly damaged** or otherwise **no longer needed**
- In **adults**, **50-70 billion cells** are **destroyed** each **day** by apoptosis.

FCC Maximum Permissible Exposure Limits

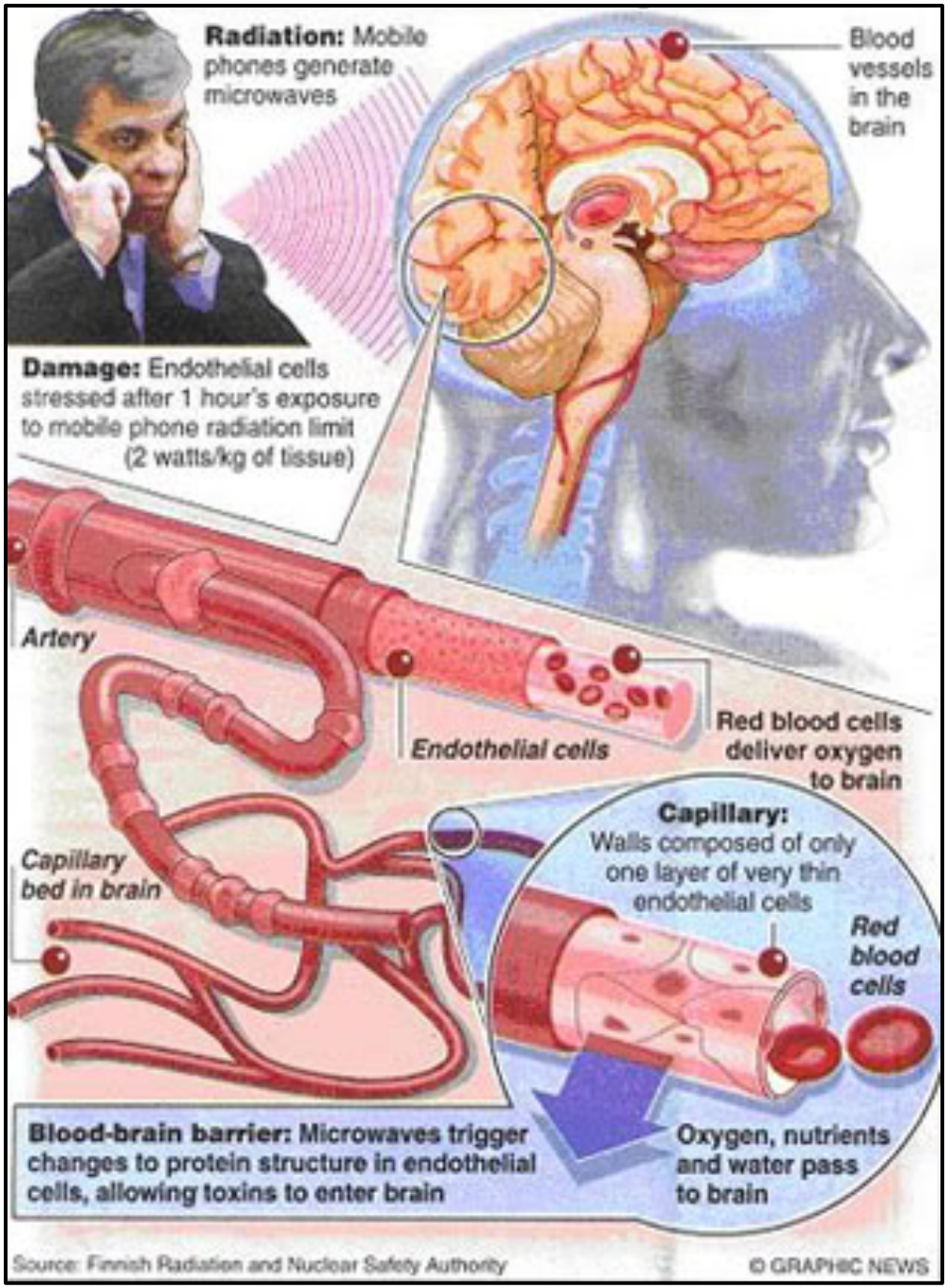


- **Power density limits rise with freq.; our body can safely absorb more energy at higher freq.**
- **Max. exposure from 1-W AMR transmitter at 5% duty cycle (72 min/day), 1-ft away is 18 µW/cm² or 3% FCC limit ; if faulty & always on (100% duty cycle) , level would be 60% limit**
- **For 250 mW HAN transmitter: 5% duty cycle, 3% of FCC limit; 100% duty cycle, 9% of limit.**

ELECTROMAGNETIC RADIATION SPECTRUM

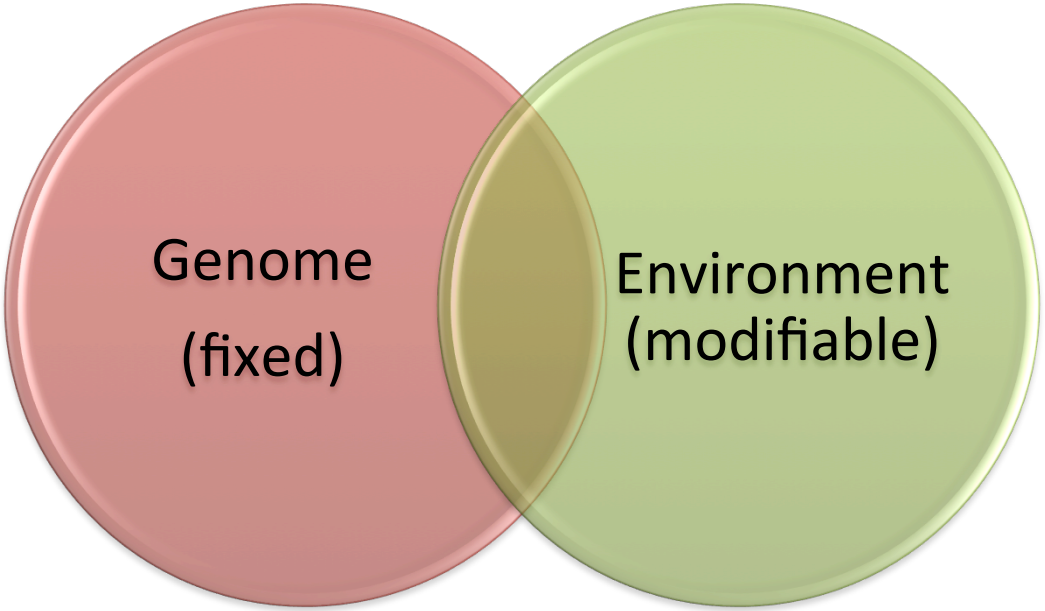


Leakage of Blood-Brain Barrier



Source: American Trial Lawyer Fall 2008

Cause of Chronic Illness



- **Interaction of genetic susceptibility factors and modifiable environmental factors (e.g. infectious, chemical, physical, nutritional and behavioral factors)**
- **Variations in genetic makeup associated with almost all disease**
- **Mediated by epigenetic mechanisms which regulate or modify gene expression**

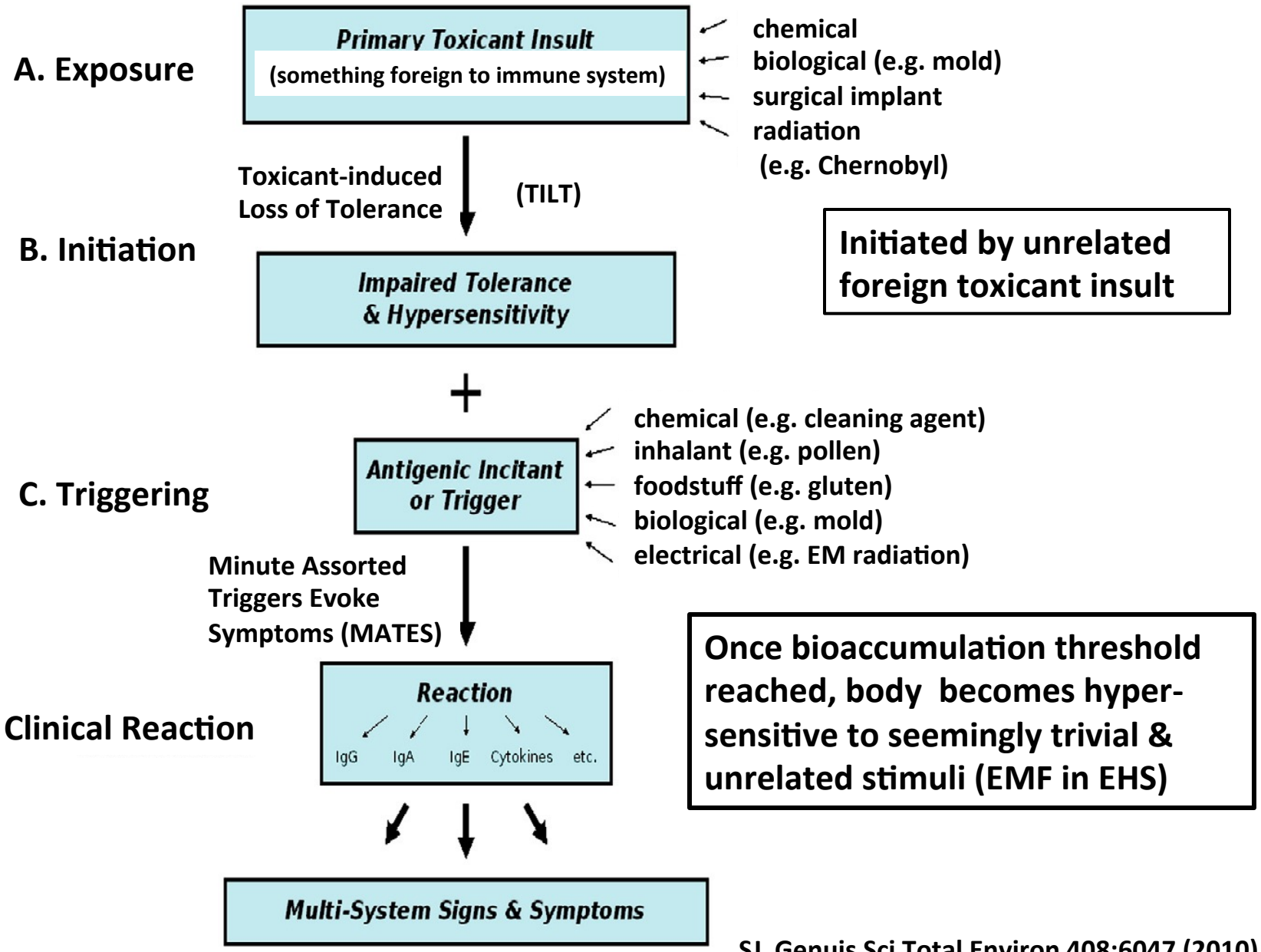
SJ Genuis Sci Total Environ 408:6047 (2010)

Features of EHS Syndrome

- **One aspect of Idiopathic Environmental Intolerance (IEI) ascribed to radiation from everyday RF-emitting devices**
- **Reflects person's total environmental burden, overall health & how their unique bioelectric cellular chemistry responds to external EMR.**
- **Afflicted persons may have associated biochemical deficiencies, toxicant bioaccumulation and genetic polymorphisms that affect cellular detoxification processes, neurocognitive biology and other determinants of health and illness.**

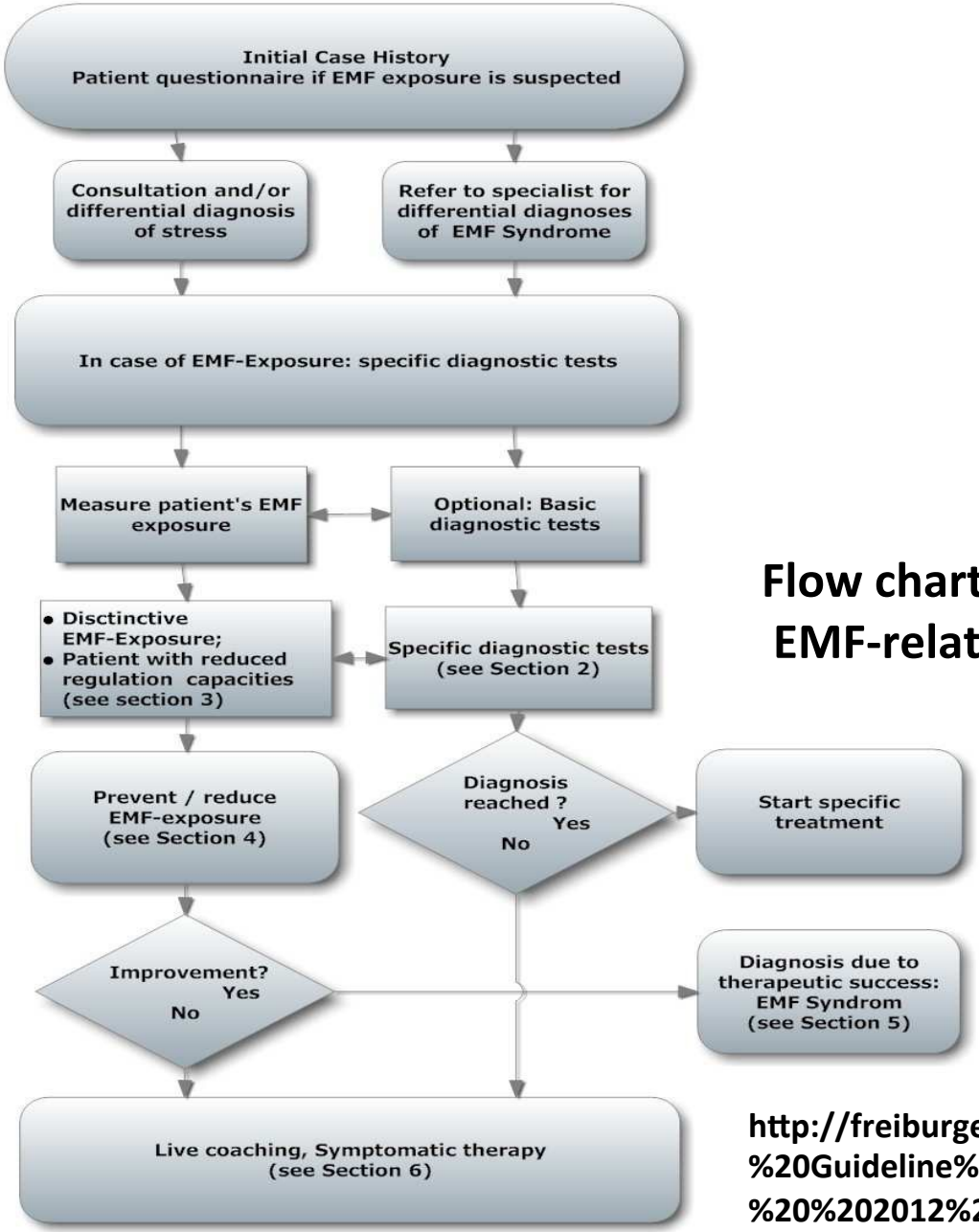
Genuis SJ, Lipp CT *Sci. Total Environ. 414: 103:12 (2012)*

Pathway to Sensitivity-related Illness



SJ Genuis Sci Total Environ 408:6047 (2010)

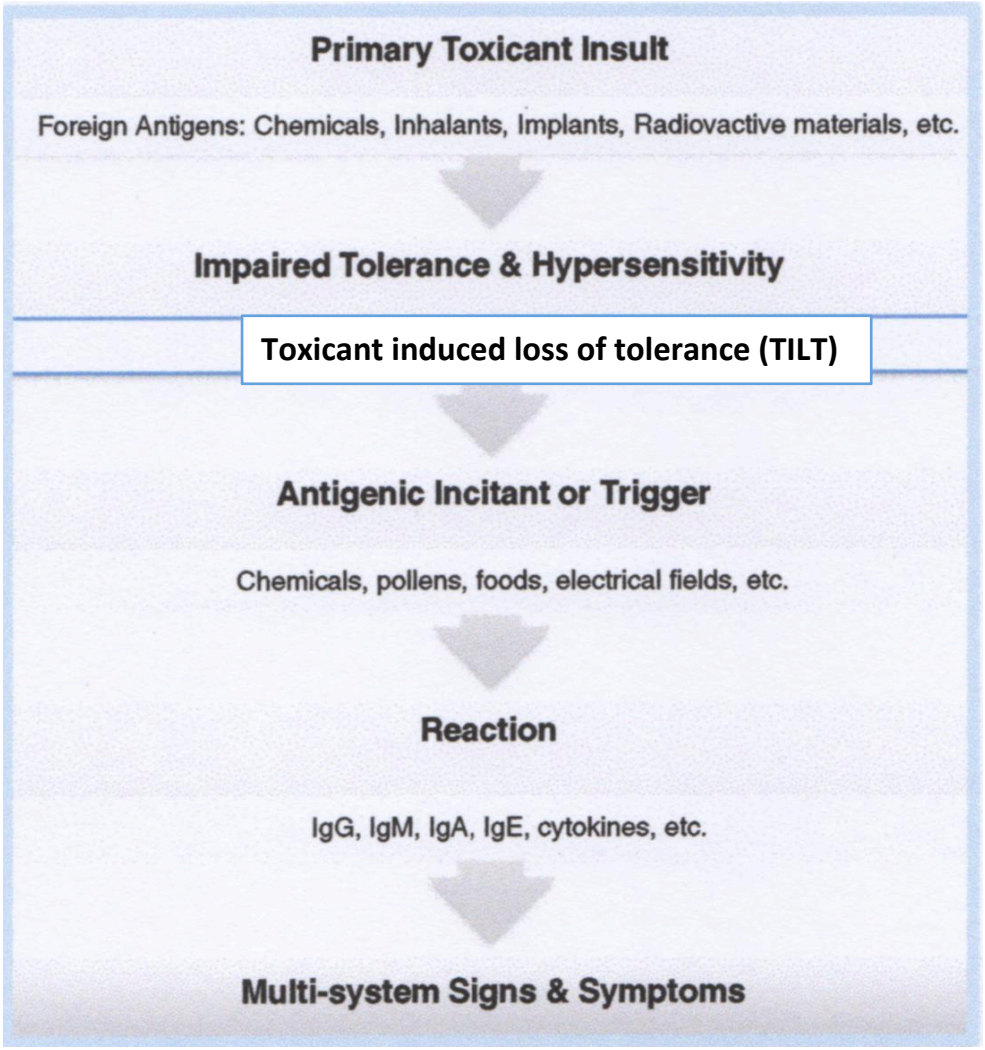
Guideline of the Austrian Medical Association for the diagnosis and treatment of EMF-related health problems and illnesses (EMF syndrome)



Flow chart for diagnosing EMF-related health problems

http://freiburger-appell-2012.info/media/EMF%20Guideline%20OAK-AG%20%202012%2003%2003.pdf

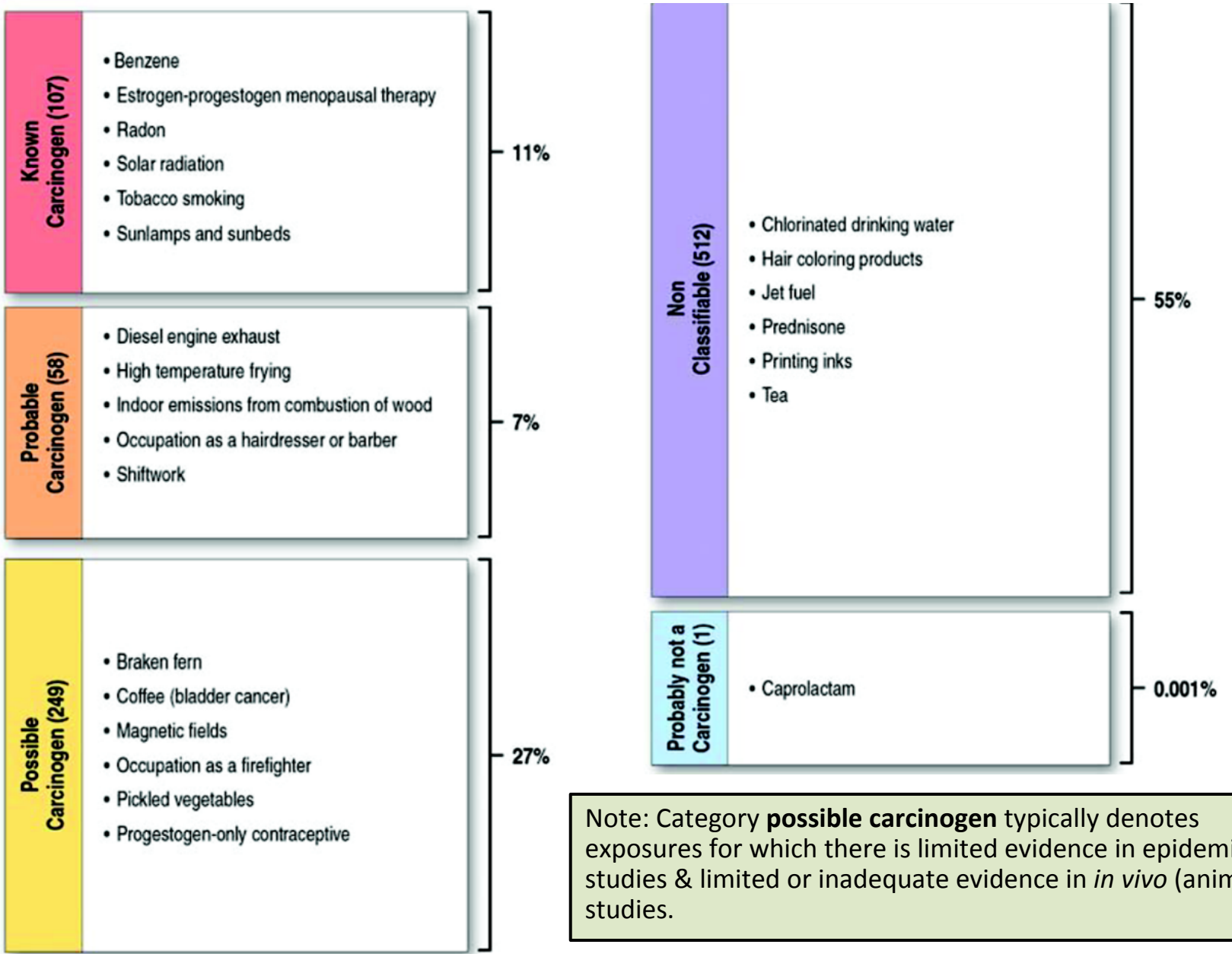
Pathogenic Mechanism for Development of Sensitivity-related Illness



- **Initiated by totally unrelated foreign toxicant insult**
- **Once bioaccumulation threshold reached, body becomes hyper-sensitive to seemingly trivial & unrelated stimuli (EMF in EHS)**
- **EHS: disruption of catecholamine production in response to EMR**
- **EHS based on person's total environmental burden, overall health & how their unique bioelectric cellular chemistry responds to external EMR.**

Genuis SJ, Lipp CT *Sci. Total Environ. 414: 103:12 (2012)*

Percentages of Substances Classified in Each Category with Examples



Note: Category **possible carcinogen** typically denotes exposures for which there is limited evidence in epidemiology studies & limited or inadequate evidence in *in vivo* (animal) studies.

Case-Control Checklist
Key Components

- **Study base – all people who would be in the study if they developed the disease**
- **Disease (case definition) – clear definition, newly diagnosed**
- **Controls – random samples of those without disease in study base**
- **Exposure – interview cases and controls**
- **Confounders – what could confuse the results?**
- **Analysis – how was the information handled?**
- **Selection bias - were the populations similar? Were they 'normal?'**

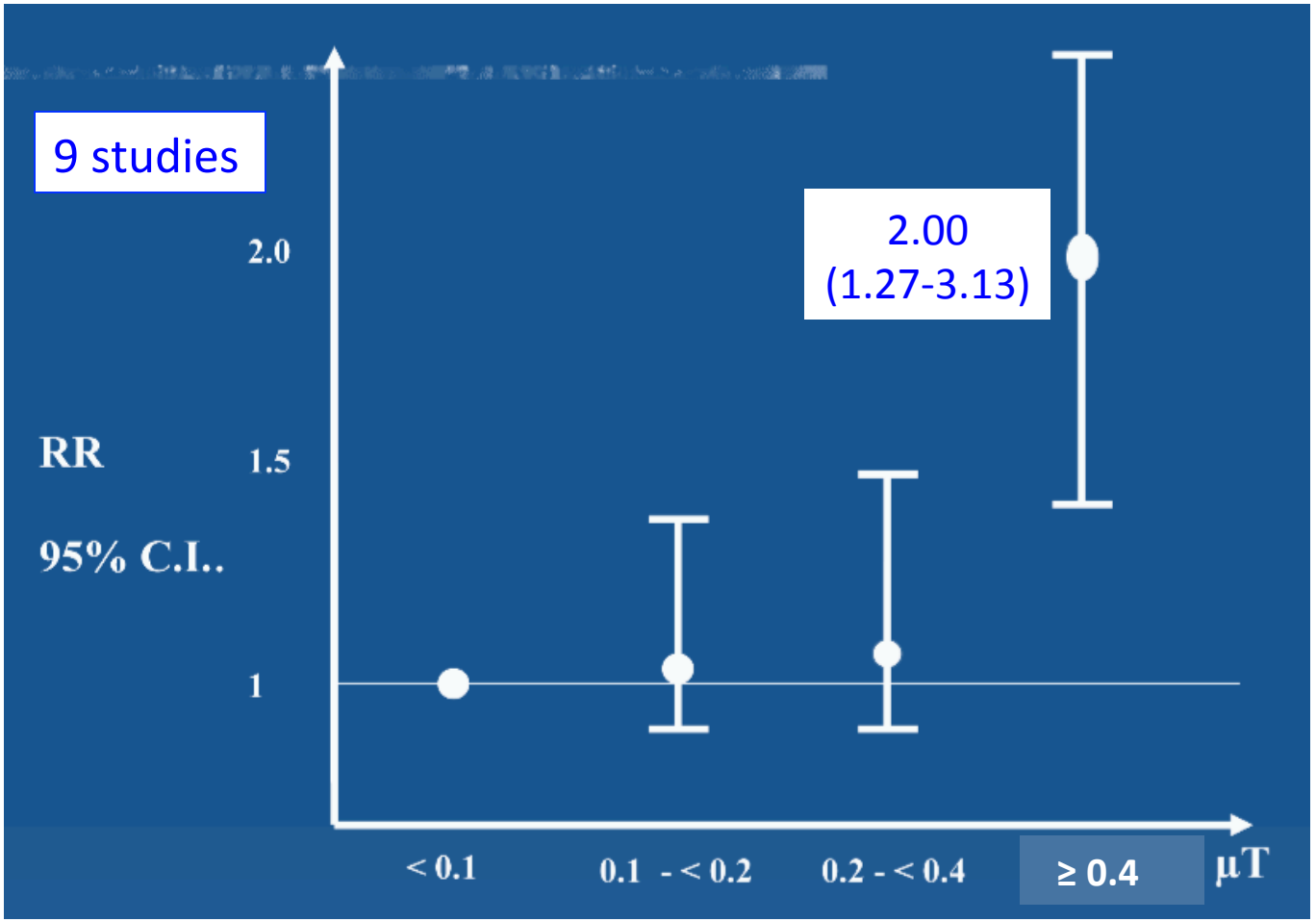
Summary – Case Control Studies

---Selection of an appropriate comparison group is the most challenging and important aspect of the study design.

---In population-based studies, incidence can be calculated when entire population is sampled.

---Hospital-based studies are often easiest and cheapest to conduct, but may be prone to biased exposure ascertainment.

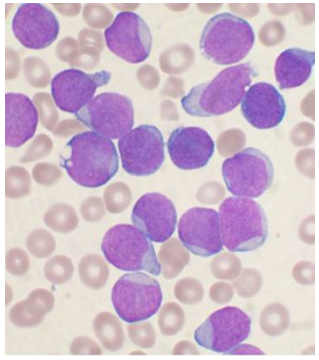
Pooled Data Analysis of Power Line Magnetic Fields and Childhood Leukemia



- RR increases with increasing exposure (dose-response)
- When exposure ≥ 0.4 µT (4 mG), RR = 2.0 ('doubling dose')

Strong evidence for causal association

Power Line MFs & Childhood Leukemia



- Power line MFs among most studied environmental factors (42 studies)
- Consistent link: childhood leukemia & power line MF exposures ≥ 3-4 mG
- Strong causal relationship as other factors (chance, selection bias) ruled out.

International Agency for Research on Cancer

World Health Organization

ELF magnetic fields classified as:
Group 2B 'Possibly carcinogenic'