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MOBILE PHONE RADIATION & BLOOD-BRAIN BARRIER

EFFECTS OF MOBILE PHONE RADIATION ON HUMAN ENDOTHELIUM

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WHO I AM... EDUCATION AND WORK

- Two doctorates and docentship in biochemistry
- Independent expert; actively advising and lecturing
 - 2014 – e.g. Norway, South Africa, USA, India, Australia
 - 2015 – e.g. Switzerland, USA, Serbia, Turkey, *Australia*
- 22 years (1992-2013) at STUK – Radiation and Nuclear Safety Authority
 - 2003-2007 as Head of Radiation Biology Laboratory
 - 2000-2013 as Research Professor
- Assistant Professor at Harvard Medical School, USA; 1997-1999
- Guangbiao Prof. at Zhejiang Univ., Hangzhou, China; 2006-2009
- Visiting Prof. at Swinburne Univ. Technology, Melbourne, Australia; 2012-2013

WHO I AM... EXPERT EXPERIENCE

- 18 years of experimental work on EMF and health
- Testified
 - In the Canadian Parliament's House of Commons' hearing on cell phones and health in 2015
 - before Minister of Health and Family Welfare of India in 2014
 - In the US Senate Appropriations Committee hearing on cell phones and health, in 2009
- Member of 2011 IARC Working Group for classification of the carcinogenicity of cell phone radiation
- Advised e.g.: Parliament of Finland; National Academies, USA; World Health Organization; Bundesamt für Strahlenschutz, Germany; International Commission on Non-Ionizing Radiation Protection (ICNIRP); Swiss National Foundation; The Netherlands Organization for Health Research and Development;

WHY STUDY HEALTH EFFECTS OF CELL PHONE RADIATION?

NO PRE-MARKET TESTING OF HEALTH EFFECTS OF CELL PHONE RADIATION

- Commercialization of cell phone technology, developed for the US Department of Defense
- US Food and Drug Administration
- Permitted sales of cell phones without pre-market safety testing
- Rationale: “low power exclusion” when compared with microwave ovens
- Only thermal effects known at that time and considered

RESEARCHING HEALTH IMPACT OF CELL PHONE RADIATION

- Acute effects
 - Immediate health effect – not known
 - Safety standards based on lack of acute effects
- Delayed effects
 - Change in physiology that may later affect health
 - Health effect (brain cancer?; individual sensitivity?)
 - Physiology adapts and develops resilience
 - Safety standards do not take into account possible delayed effects

Health effect



Physiological effect on organ/organism



Physiological effect on cellular level



Biochemical effect on cellular level



Biophysical interaction

Epidemiology

Human studies

Animal studies

In vitro studies



RESEARCH OF LESZCZYNSKI'S BioNIR/FunProt GROUP IN FINLAND (selected examples)

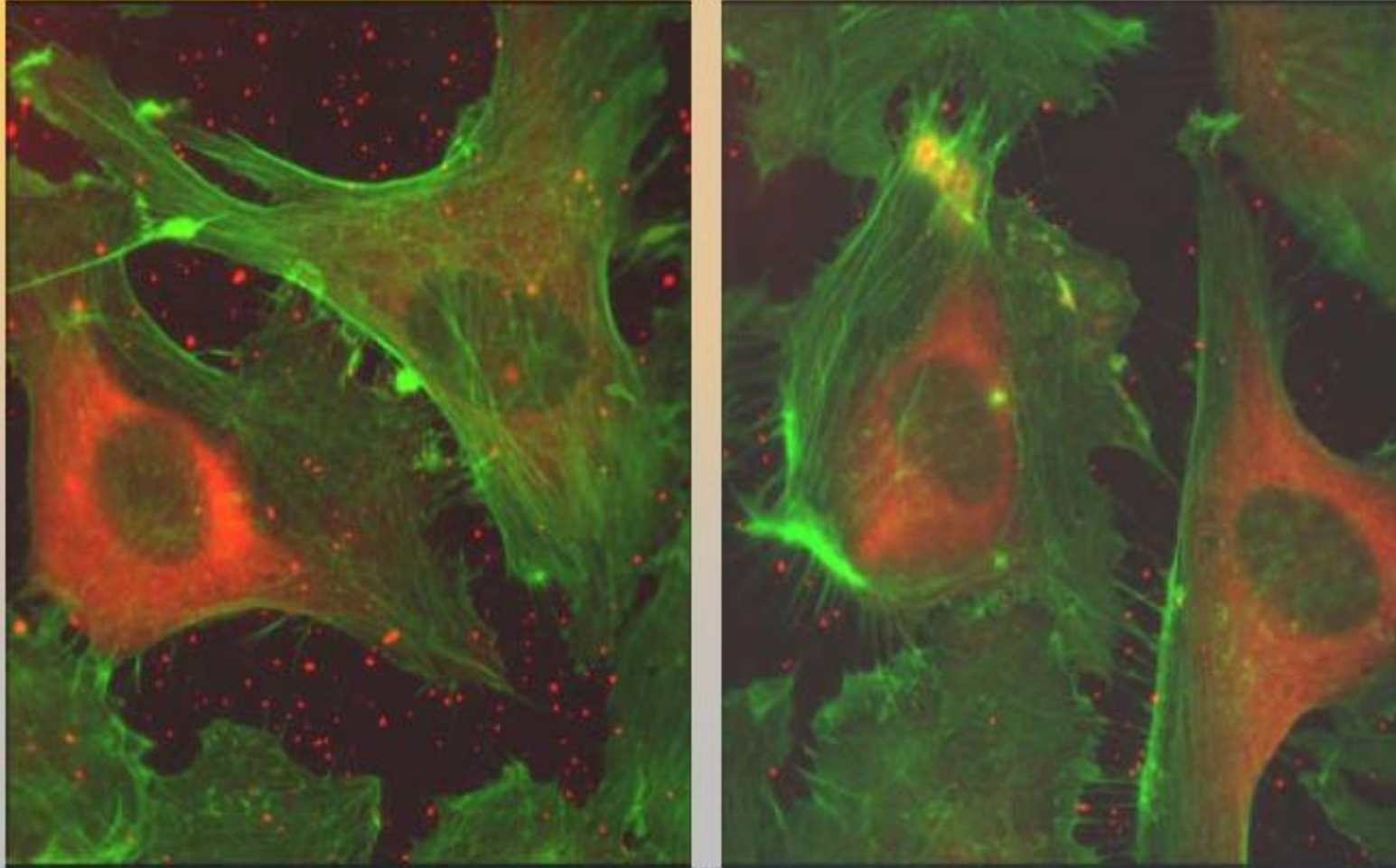
Stress response, proteome & transcriptome

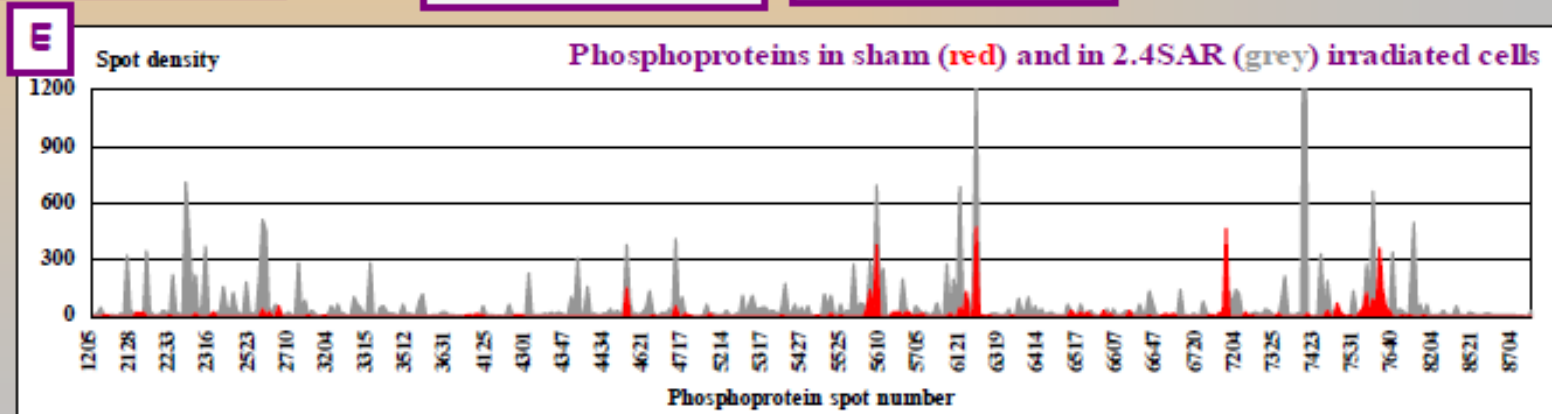
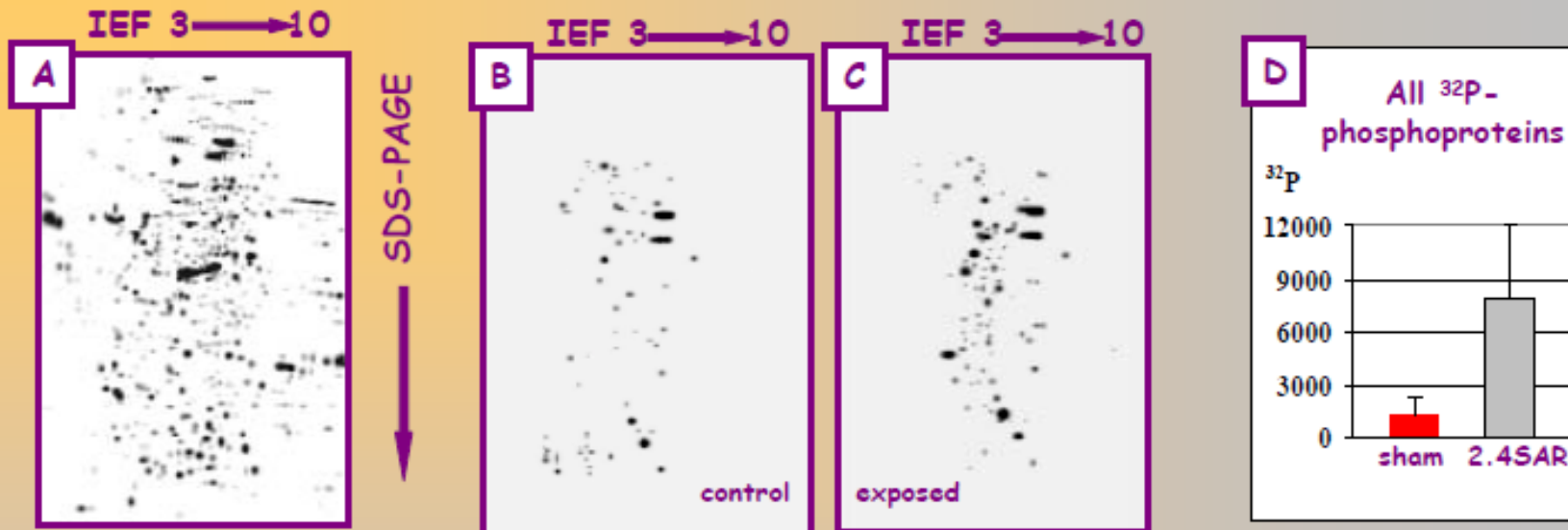
- Nylund et al. Proteome Sci 2010, 8:52
- Nylund et al. J. Proteomics & Bioinformatics 2, 2009, 455-462
- Karinen et al. BMC Genomics 9, 2008, 77-
- Nylund & Leszczynski Proteomics 6, 2006, 4769-4780
- Nylund & Leszczynski Proteomics, 4, 2004, 1359-1365
- Leszczynski et al. Proteomics 4, 2004, 426-431
- Leszczynski et al. Differentiation 70, 2002, 120-129

RESEARCH OF LESZCZYNSKI'S BioNIR/FunProt GROUP IN FINLAND

- Is cell phone radiation inducing physiological effects in human endothelial cell line in vitro?
- Yes – stress response – activated Hsp27/p38MAPkinase pathway (2002)
- Is activation of Hsp27/p38MAPK causing cellular responses?
- Yes – stabilization of F-actin stress fibers, shrinkage of cells, changes in gene expression, changes in protein expression (2002-2008)
- Are cell phone radiation effects occurring in humans?
- Yes – changes in expression of proteins in human skin in vivo (2008)

cells with high expression of hsp27 (red color) have prominent stress fibers-network (green color) and stress fiber components are present also in the ruffles of the cells...

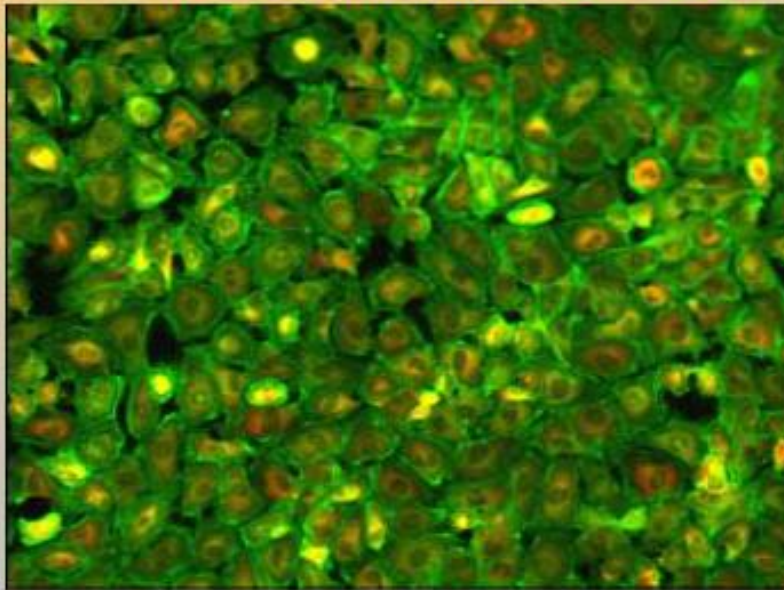




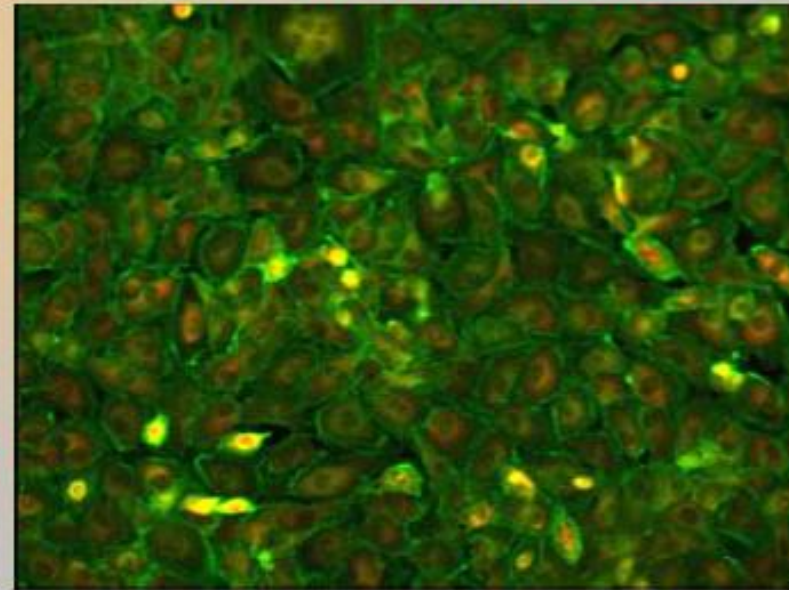
Active hsp27 regulates stability of stress fibers in EA.hy926

SB203580 - inhibitor of p38MAP kinase

1h 2.4SAR without SB203580

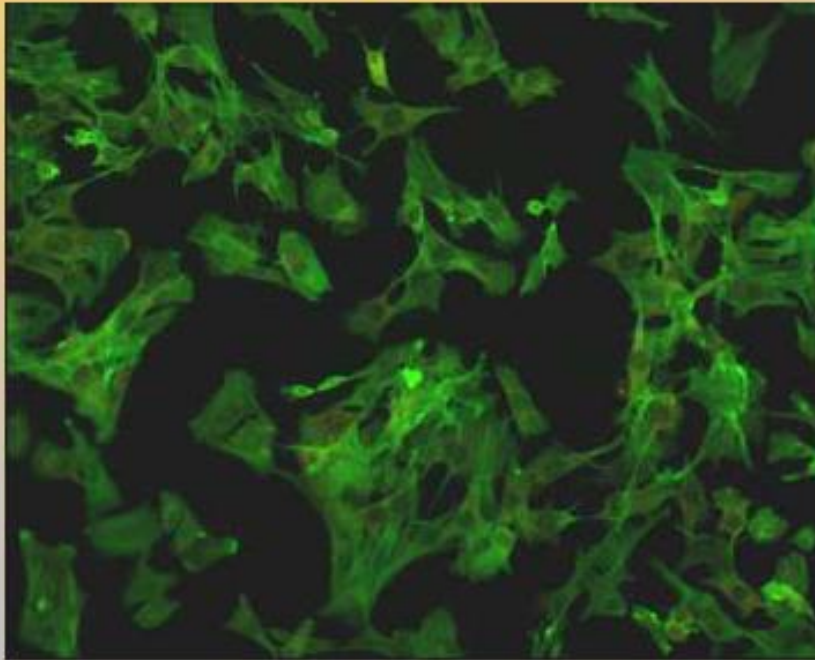


1h 2.4SAR with SB203580

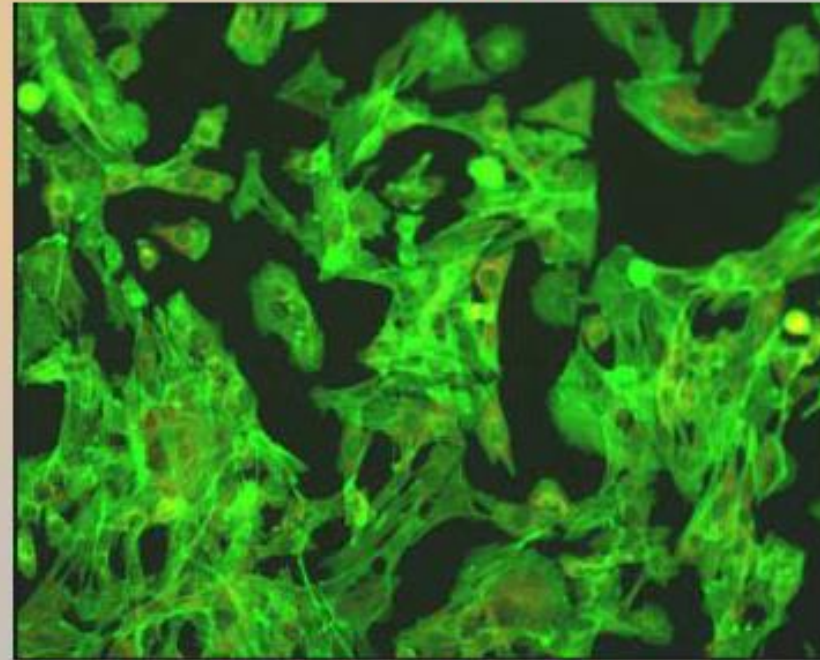


hamster cell line CCL39
over-expressing human wild-hsp27

sham

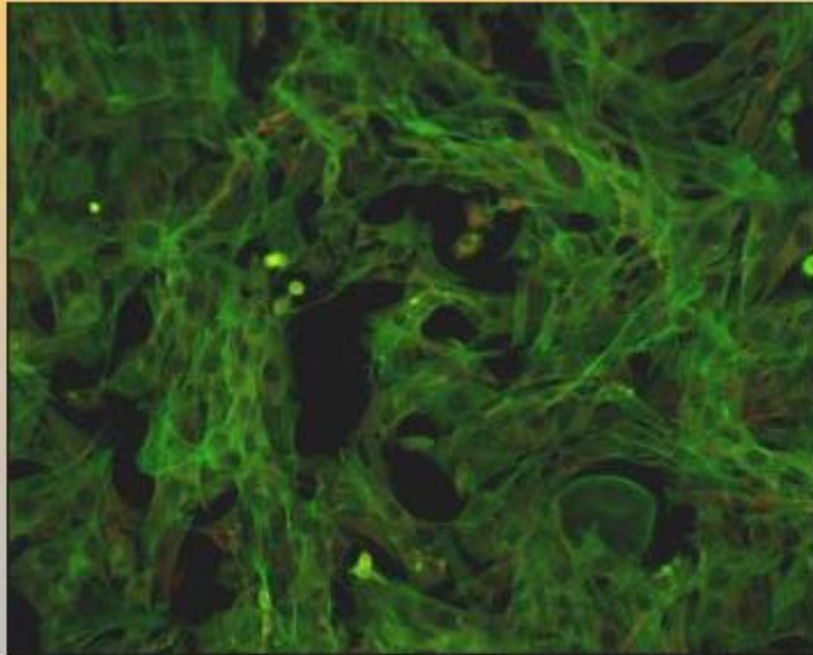


1h 2.4SAR

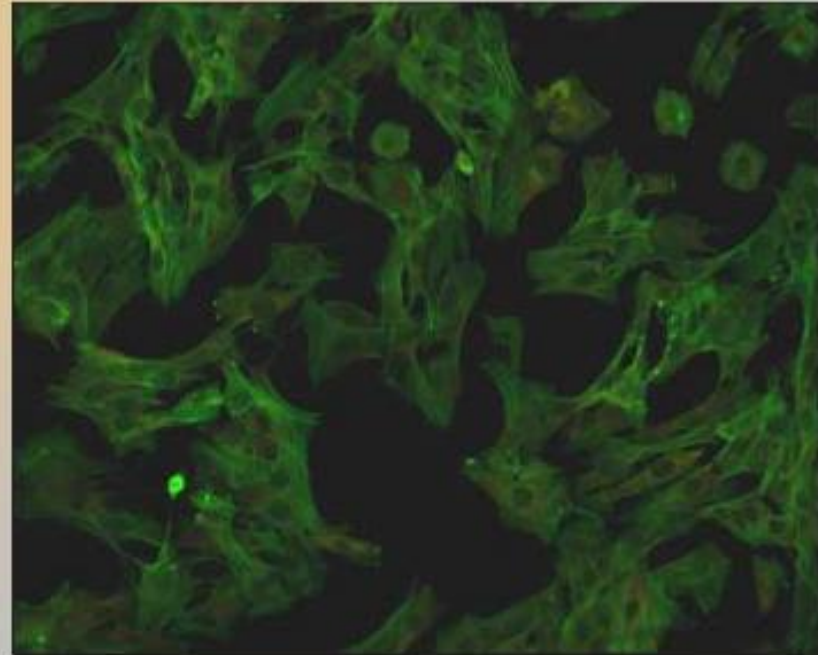


hamster cell line CCL39
over-expressing human mutant-hsp27

sham



1h 2.4SAR



POTENTIAL MECHANISM: CELLULAR STRESS RESPONSE

Leszczynski et al. 2002

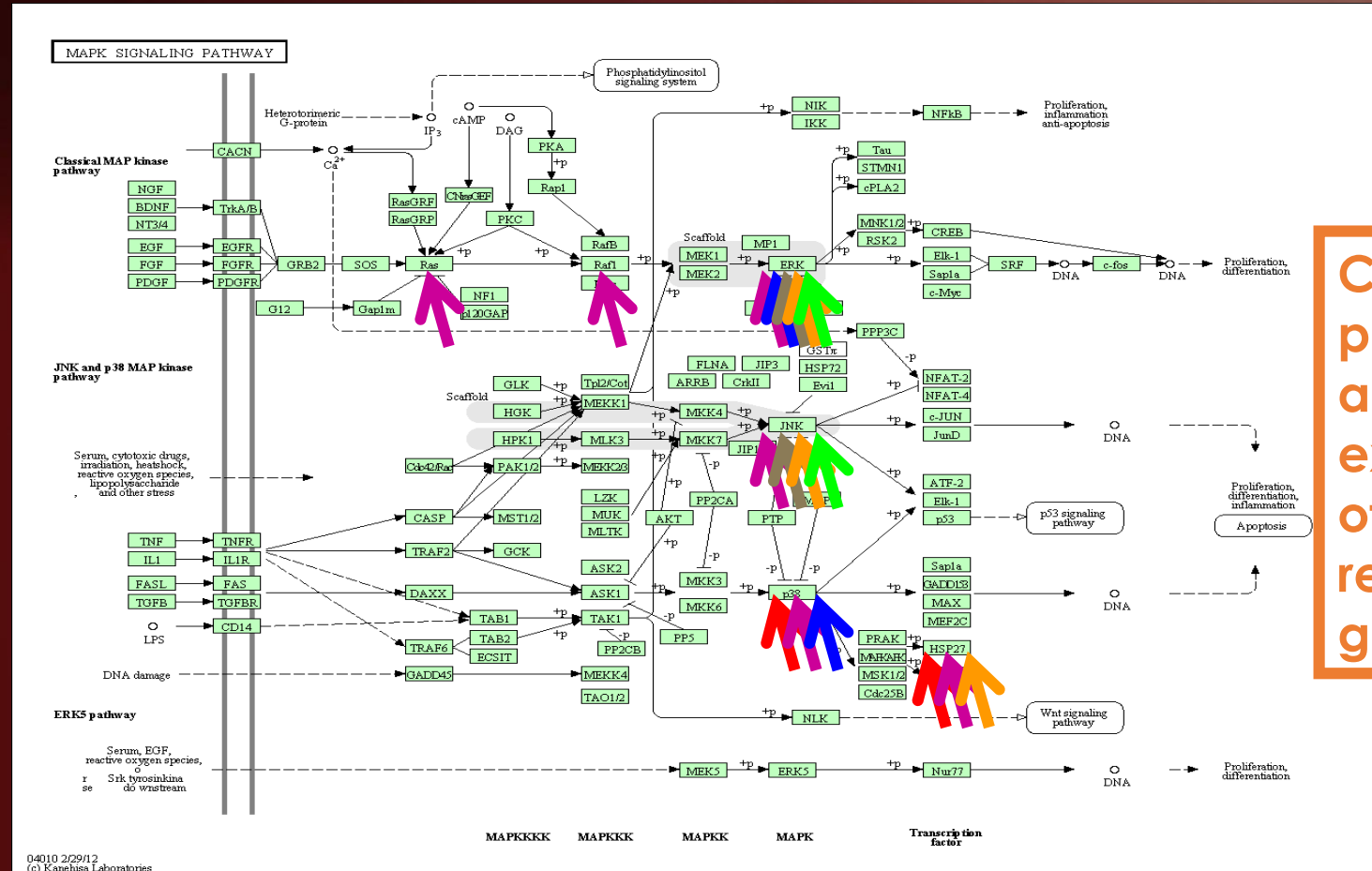
Caraglia et al. 2005

Friedman et al. 2007

Buttiglione et al. 2007

Yu et al. 2008

Lee et al. 2008



Cell proliferation and expression of cancer regulatory genes

HUMAN HEALTH EFFECTS

- Possible health effects
 - Cancer – brain and non-brain
 - Electromagnetic hyper sensitivity (EHS)
- Problems with the scientific evidence
 - Lack of the conclusive proof
 - Significant shortcomings in design of the studies
- Ever changing arena
 - Smart phones changed exposure patterns
 - Fast spread and omnipresence of wi-fi

BRAIN CANCER

IARC evaluation in 2011

- 30 invited experts divided into four sub-groups
 - Dosimetry
 - Epidemiology
 - Animal studies
 - Mechanistic laboratory *in vitro* studies
- Decisions by a consensus or by a simple majority
- The vast majority of 30 experts voted for the classification of cell phone radiation as a possible carcinogen (Group 2B)

IARC 2011: EPIDEMIOLOGY

- Interphone & Hardell studies
 - no reliable exposure data based on person's memory
 - risk increase in long-term avid users
- Children – only CEFALO
 - exposures for 2-4 years
 - has no statistical power to detect small risk
- Bruce Armstrong, Australia
- Maria Blettner, Germany
- Elisabeth Cardis, Spain
- Lennart Hardell, Sweden
- Peter Inskip, USA
- David Richardson, USA
- Martin Roosli, Switzerland
- Jonathan Sammet, USA
- Malcolm Sim, Australia
- Jack Siemiatycki, Canada, Chair

EPIDEMIOLOGY AFTER IARC 2011

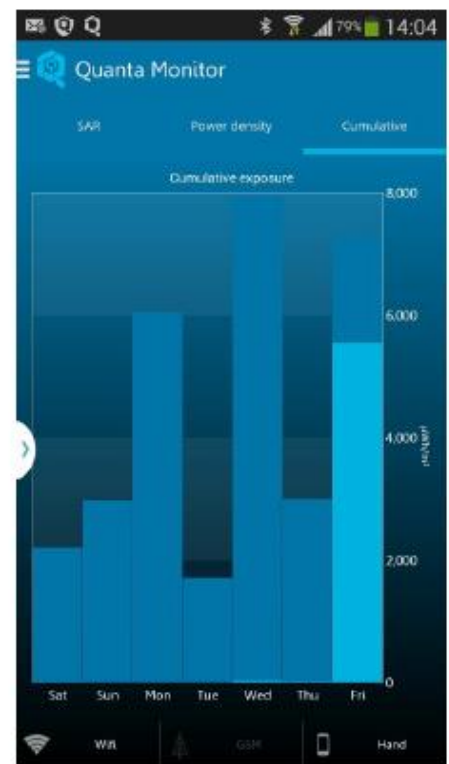
- Trend-data - Little et al. 2012: slow rise of brain cancer cases in USA
 - trend is similar to Interphone “prediction” but not Hardell “prediction” but...
 - trend data is useless for cancer predictions of a single “carcinogen” because of simultaneous impact on population of other cancer-causing/preventing measures
- Danish Cohort update study 2011 – no effect
 - no exposure data but just the length of phone subscription with service provider
- Million Women study 2014 - no effect but exposure data inadequate
 - use of cell phone: ‘never’, ‘less than once a day’, ‘every day’
- CERENAT study from France 2014 – effect as in Interphone & Hardell
 - no reliable exposure data based on person’s memory

ALL EPIDEMIOLOGY STUDIES HAVE UNRELIABLE EXPOSURE DATA

- Length of calls or length of phone subscription with service provider or saying whether you ever or never used cell phone, does not inform about the real exposure of the cell phone user
- Using the above "exposure data", persons with very different radiation exposures are placed in the same exposed group for statistical evaluation
- This leads to **underestimation of the possible risk**
- Bad exposure data are continued to be collected – the ongoing COSMOS study collects exposure data as length of calls!
- **An inexpensive way to collect real exposure data is by designing apps for smart phones**



RF EXPOSURE MONITOR



EPIDEMIOLOGICAL EVIDENCE SUPPORTS CANCER RISK

- IARC classification was based on the results of Interphone and Hardell studies
- In 2014, a new epidemiological study was published - the French CERENAT
- The French study reached similar conclusions as Interphone and Hardell previously – long term avid use of cell phone increases a risk of developing brain cancer
- Now, there are three replications of the same epidemiological type of study, the case-control study, that all suggest the cell phone radiation might increase risk of developing brain cancer but, even if this observation is correct...
- NOT EVERYONE will develop brain cancer

“In my opinion, the currently available scientific evidence is sufficient to upgrade the carcinogenicity of cell phone radiation from the possible carcinogen (Group 2B) to the probable carcinogen (Group 2A)”

Dariusz Leszczynski

IARC evaluation: Animal studies

- No classical toxicology possible
 - Not possible to overdose cell phone radiation because of heating effect
 - By classical toxicology standards RF would be judged as harmful to humans
 - Life-time exposures to radiation at doses similar to those emitted by cell phones show no effect – result is useless for human health risk estimation
- Misleading claims that because animal studies, performed with cell phone radiation levels, do not show effects, it means that people are safe – wrong!
- Co-carcinogen studies show some effects – cell phone radiation might potentiate effects of carcinogenic chemicals or radiation
 - Just now published: Tillmann 2010 confirmed by Lerchl 2015!

IARC 2011: Mechanistic studies

Laboratory evidence was considered, by voting (no consensus) as insufficient to support/show mechanism of cell phone radiation effects

- Igor Belyaev, Slovakia
- Carl Blackman, USA
- Rene de Seze, France
- Jean-Francois Dore, France
- Jukka Juutilainen, Finland
- Dariusz Leszczynski, Finland
- James McNamee, Canada
- Junji Miyakoshi, Japan
- Christopher Portier, USA, Chair
- Luc Verschaeve, Belgium
- Vijayalaxmi

ELECTROMAGNETIC HYPER-SENSITIVITY

INDIVIDUAL SENSITIVITY

- A fundamental trait found in most organisms is the ability to register, process, and respond to environmental factors
- Environmental sensitivity is critical for adapting successfully to external conditions
- Individuals tend to differ in their sensitivity to the environment - some more sensitive than others
- Differences in environmental sensitivity can be seen across species, including humans
- Without the individual sensitivity there would be no evolution of species

DOES EHS EXIST?

- Yes
- EHS must exist because otherwise, EMF would be the only chemical or physical factor without the more sensitive human subpopulation
- Sensitive subpopulation results from the genotype- and/or phenotype-dependent individual sensitivity
- The unanswered question is: what is the radiation level causing EHS and below which symptoms do not manifest anymore

PROBLEMS OF THE EHS RESEARCH

- Studied by psychologists = inadequate methodology
- Mechanism of a disease, with physiological manifestations, cannot be discovered by only psychological methods
- Only acute effects studied; lack of delayed response studies
- Lack of radiation dosimetry, as in majority of human studies
- Study subjects asked how they feel = **unreliable subjective data**
 - Experiments are done under duress - health concerns of EHS volunteers – stress can interfere with manifestation of EHS symptoms
- **Lack of objective data**
- Nocebo effect confirms the subjectivity of the data
- **Subjective data on EHS are useless for decision making**

EVER CHANGING ARENA

SMART PHONES - CHANGED EXPOSURE PATTERNS

- Besides the head, other parts of body are exposed
- Exposure from phone kept in pocket does not comply with safety standards (over-exposure)
- Data traffic increases and relocates radiation exposures
- Authorities and industry do not sufficiently inform users about the change in exposure pattern and exposure intensity, brought by the smart phones

WHY THE FCC'S SAFETY GUIDELINES FOR WI-FI NEED TO BE RE-EVALUATED

“... FCC guidelines for maximum allowed transmit power of Wi-Fi Access Points are based on the assumption that Wi-Fi signals are received by a human body from a distance for one transmitting Wi-Fi antenna. However, we are not exposed to just one transmitting Wi-Fi antenna anymore...”

Ajay Malik, Opinion in NETWORKWORLD, Nov. 12, 2015

www.networkworld.com

WI-FI EXPOSURES

- Lack of research on wi-fi – mere few tens of studies
- No scientific data to answer health risk question
- Limiting unnecessary exposures is currently “impossible”
- Schools should have only wired internet connections as a precautionary measure
- Wide and untamed spread of wireless networks should be limited to a necessary minimum as a precautionary measure

PRECAUTIONARY PRINCIPLE

REASONS FOR INVOKING THE PRECAUTIONARY PRINCIPLE

- Scientific information is insufficient, inconclusive, or uncertain
 - IARC classification as possible carcinogen (Group 2B)
- There are indications that the possible effects on human health may be potentially dangerous
 - epidemiological studies from Interphone, Hardell and CERENAT show an increased risk of brain cancer in long-term avid users
- Inconsistent with the chosen level of protection
 - epidemiological studies, showing increased risk in long-term avid users, were generated in populations using regular cell phones, meeting current safety standards = current safety standards are insufficient to protect users

FUTURE RESEARCH NEEDS

Unlike the genome, **the transcriptome and the proteome** are highly dynamic and change rapidly and dramatically in response to perturbations or even during normal cellular events

strong stimulus



robust response

weak stimulus



response will very much depend on the transcriptome and proteome expressed by the cells at the time of exposure

Nylund R. & Leszczynski D.

Mobile phone radiation causes broad changes in gene and protein expression in human endothelial cell lines and the response appears to be genome- and proteome-dependent.

Proteomics 6, 2006

THE FUTURE

HEALTH RESEARCH THROUGH PROTEOMICS

L.Hood et al. PROTEOMICS, 12, 2012, 2773–2783

- **The Proteome** is the operating system for nearly all biological functions. It is the link between the genome and phenotypes
- It undergoes dynamic changes in different cells and organs, during development, in response to environmental stimuli, and in disease processes
- Understanding the dynamics of protein interactions with other proteins, nucleic acids, and metabolites is the key to delineating biological mechanisms and understanding disease

CONCLUSIONS

- Currently available scientific evidence, although inconclusive, indicates that health of the 'to-be-determined' part of the population is possibly affected
- Radiation dosimetry needs to be significantly improved in epidemiological and EHS studies
- Objective data on effects of radiation on human body should be collected using screening approaches of transcriptomics, proteomics and metabolomics
- While waiting for the conclusive evidence, what will take several tens of years, Precautionary Principle should be implemented as broadly as possible and feasible
- Whenever possible and feasible, wired connections should be promoted over wireless