Chronic Radiation Exposure Induces Cellular Adaptive Response in Interventional Cardiologists

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BASIC SCIENCE

Cellular adaptive response to chronic radiation exposure in interventional cardiologists

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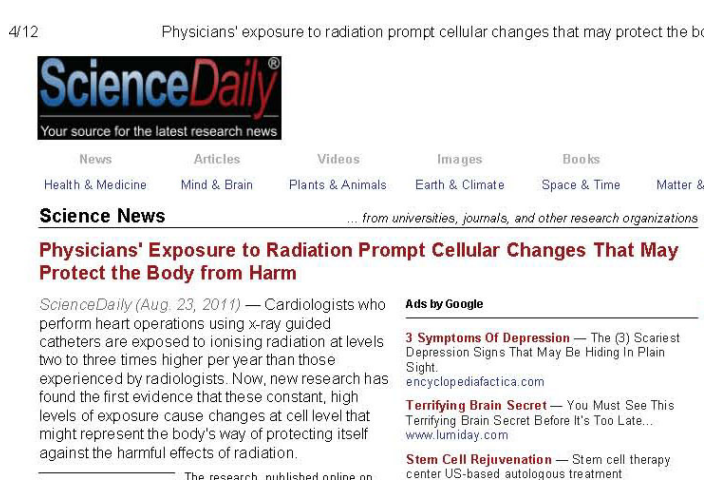
Surgeons may be adapting to 'safe' X-ray doses

00:05 24 August 2011 by Jessica Hamzelou

Hospital workers exposed regularly to "safe" levels of X-rays have experienced changes at the cellular level that might prove beneficial.

PRINT


4/12 Physicians' exposure to radiation prompt cellular changes that may protect the bo

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Physicians' Exposure to Radiation Prompt Cellular Changes That May Protect the Body from Harm

ScienceDaily (Aug. 23, 2011) — Cardiologists who perform heart operations using x-ray guided catheters are exposed to ionising radiation at levels two to three times higher per year than those experienced by radiologists. Now, new research has found the first evidence that these constant, high levels of exposure cause changes at cell level that might represent the body's way of protecting itself against the harmful effects of radiation.

The research, published online on

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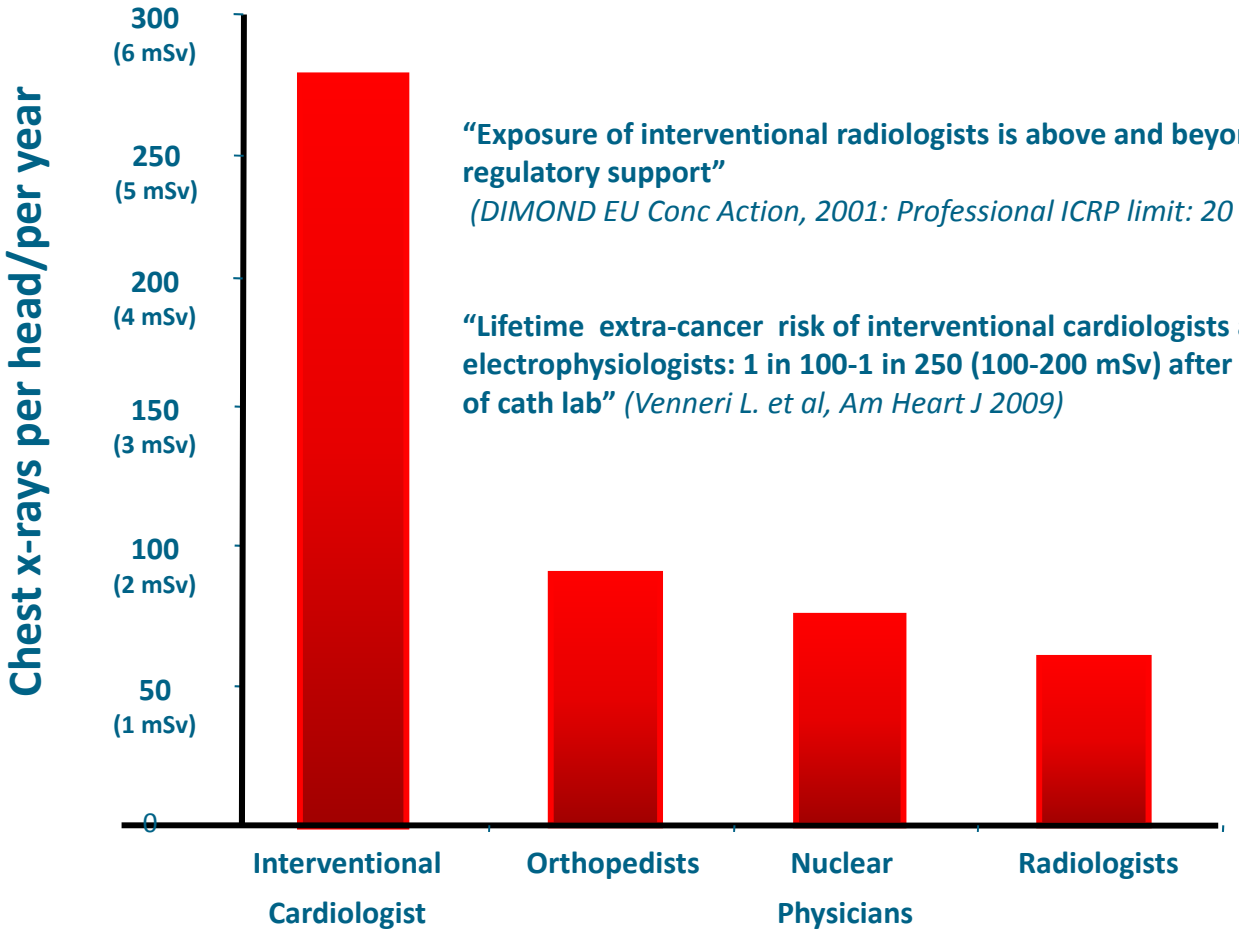
“Friendly fire” on Interventional Cardiologists

“Not infrequently, there is a machismo disregard for radiation protection”

Rita Watson, Sayonara ALARA, Cath Cardiov Diagn, 1997

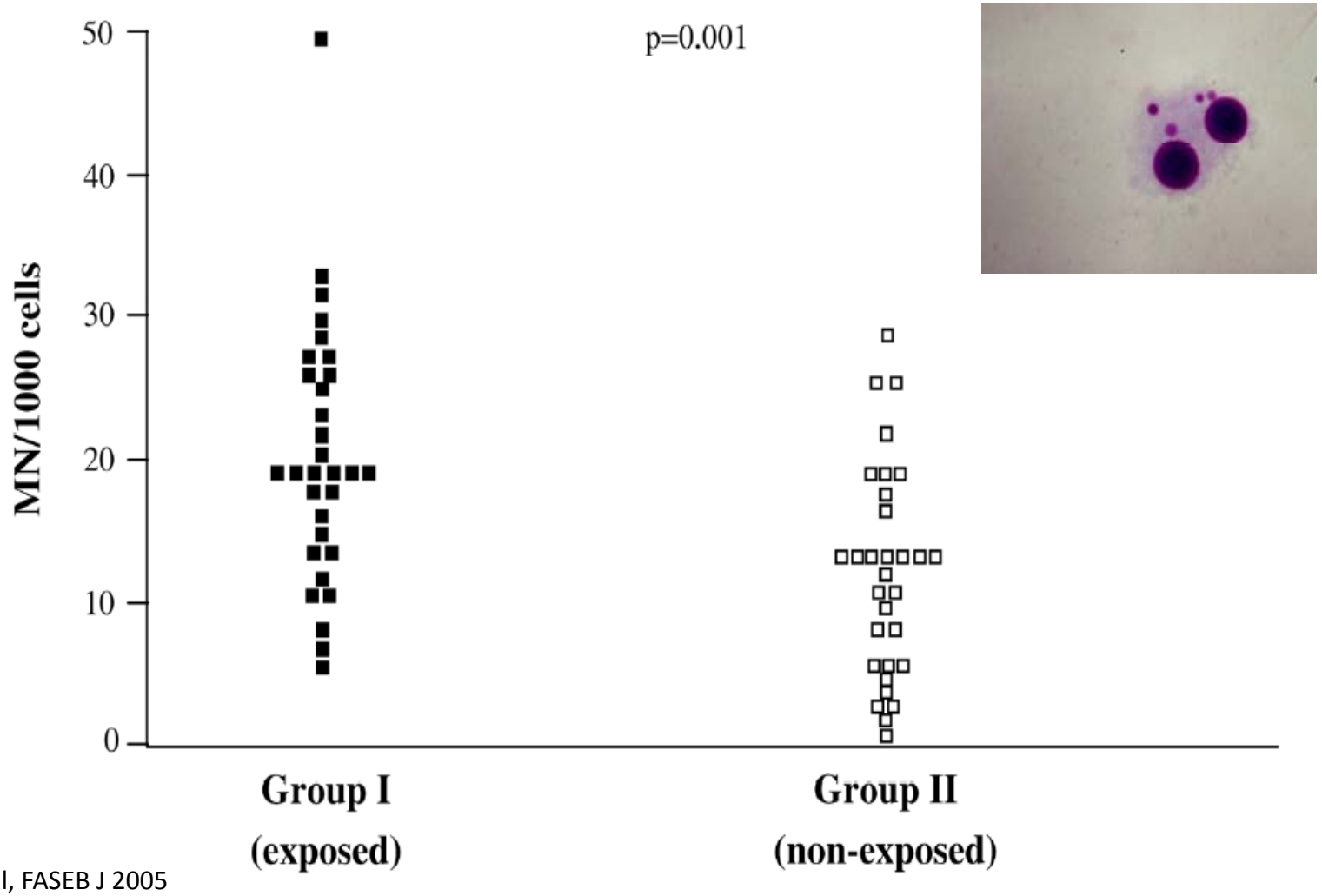


“Exposure of interventional radiologists is above and beyond every regulatory support”
(DIMOND EU Conc Action, 2001: Professional ICRP limit: 20 mSv/year)

“Lifetime extra-cancer risk of interventional cardiologists and electrophysiologists: 1 in 100-1 in 250 (100-200 mSv) after 11-25 years of cath lab” *(Venneri L. et al, Am Heart J 2009)*

Vano E et al, BJR 1998

DNA Damage in Interventional Cardiologists



Andreassi et al, FASEB J 2005

DNA Damage in Interventional Cardiologists

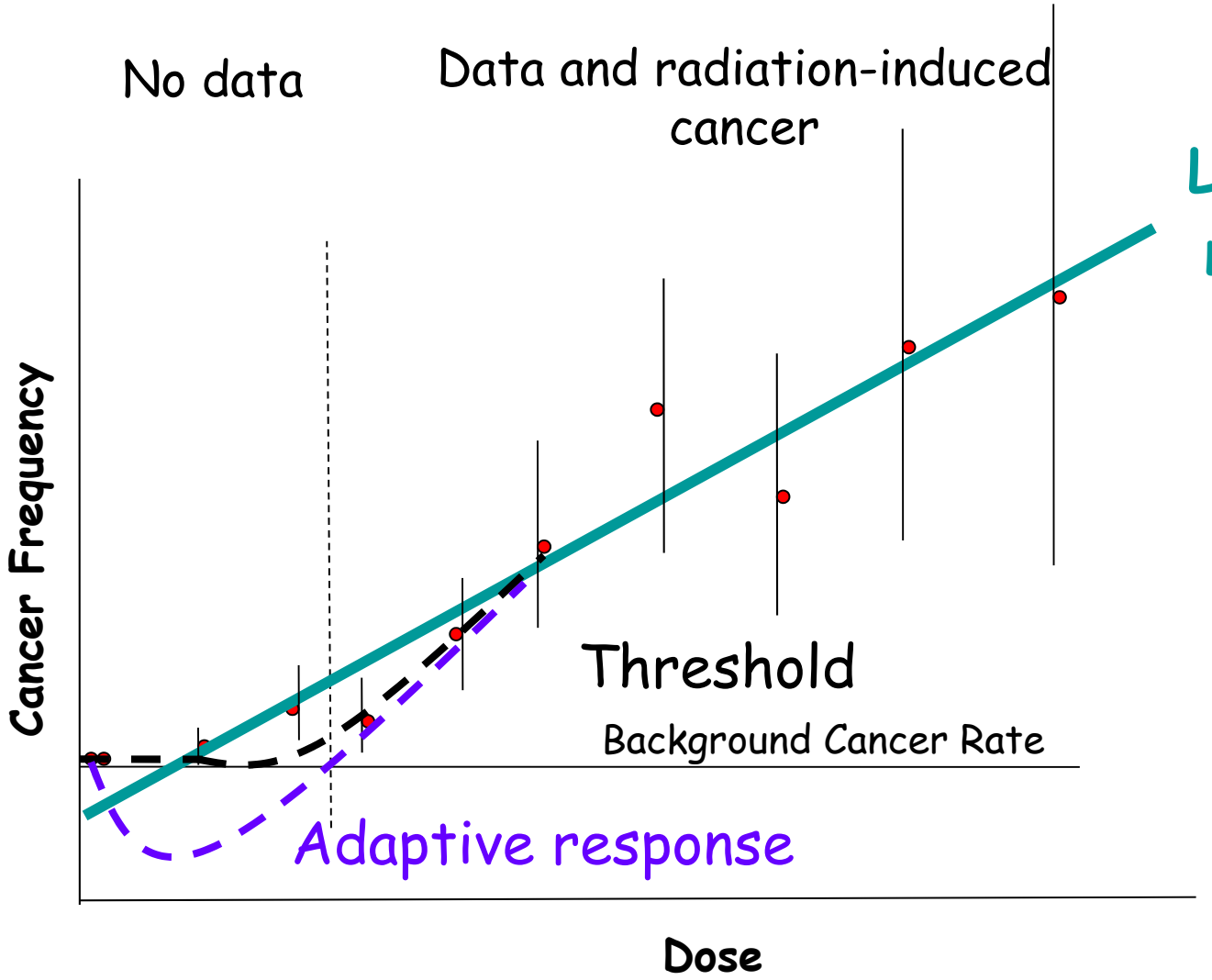
A)

B)

Chromosomal alterations	Twin 1 (unexposed)	Twin 2 (exposed)
Chromatid breaks	5	3
Chromosome breaks	1	7
Acentric Fragments	/	2
Exchanges (quadriradial)	/	1
Dicentric chomosome	/	3
Total aberrant cells/500	6	16
Frequency (%)	1.2	3.2

Fig. 1. (A) Photographs of monozygotic twins. (B) Type of structural chromosomal aberrations/500 metaphases for each twin.

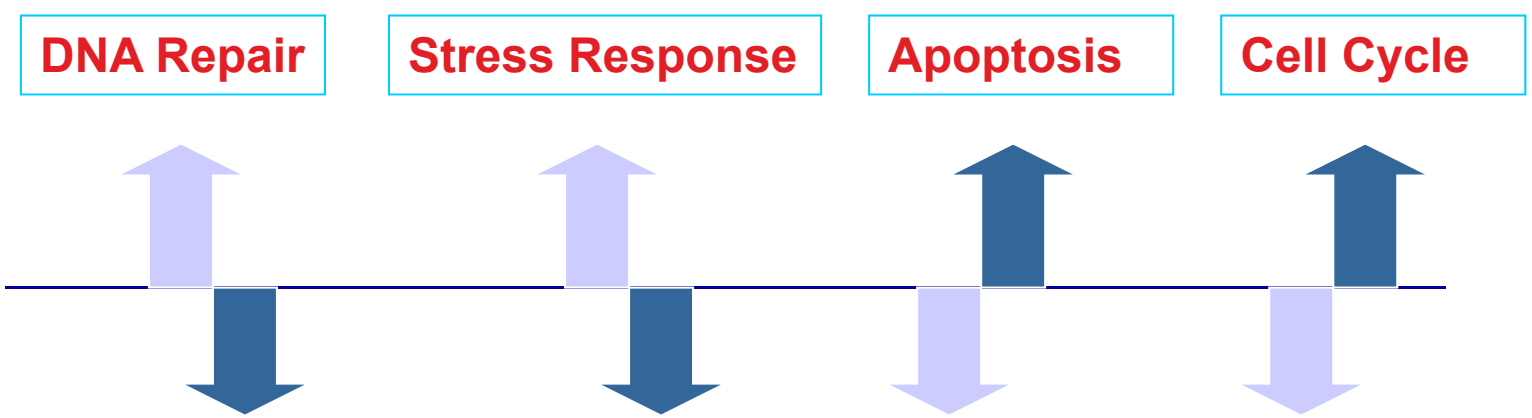
Radiation Dose-Response Models



"LDR generate risk factors that are lower than predicted by the LNT, that these risks do not exist, or even that low doses of radiation may even be beneficial (**linear model with a threshold**)"

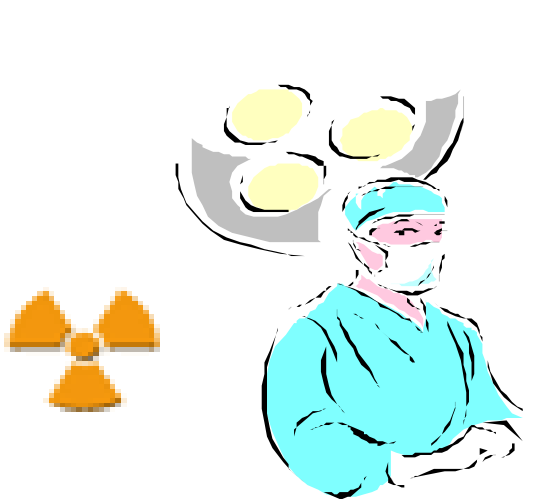
Gene Response

Adaptive vs Non-Adaptive

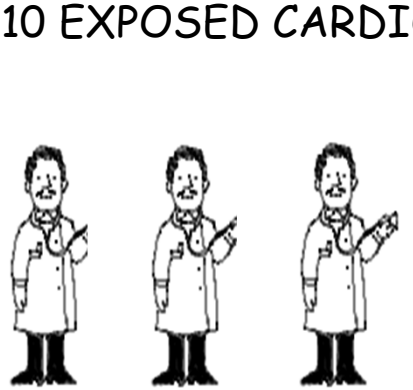


Coleman et al 2005

Study Design



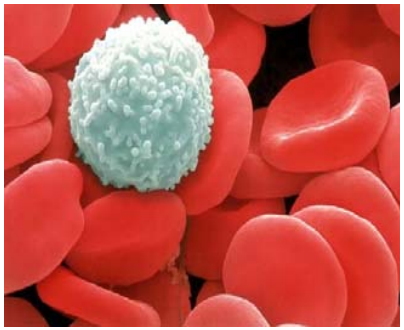
10 EXPOSED CARDIOLOGISTS



10 UNEXPOSED SUBJECTS

Oxidative stress markers

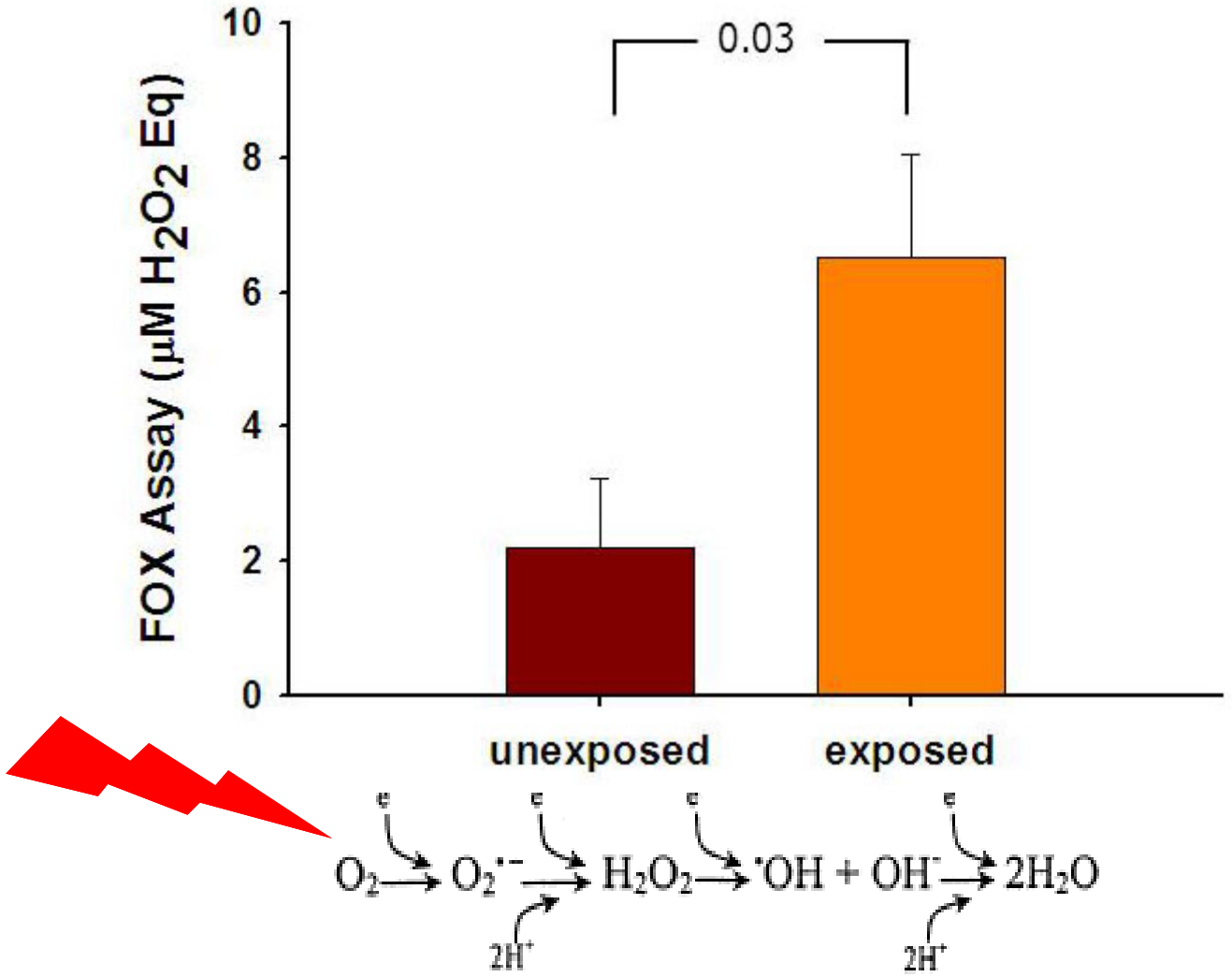
Apoptotic markers



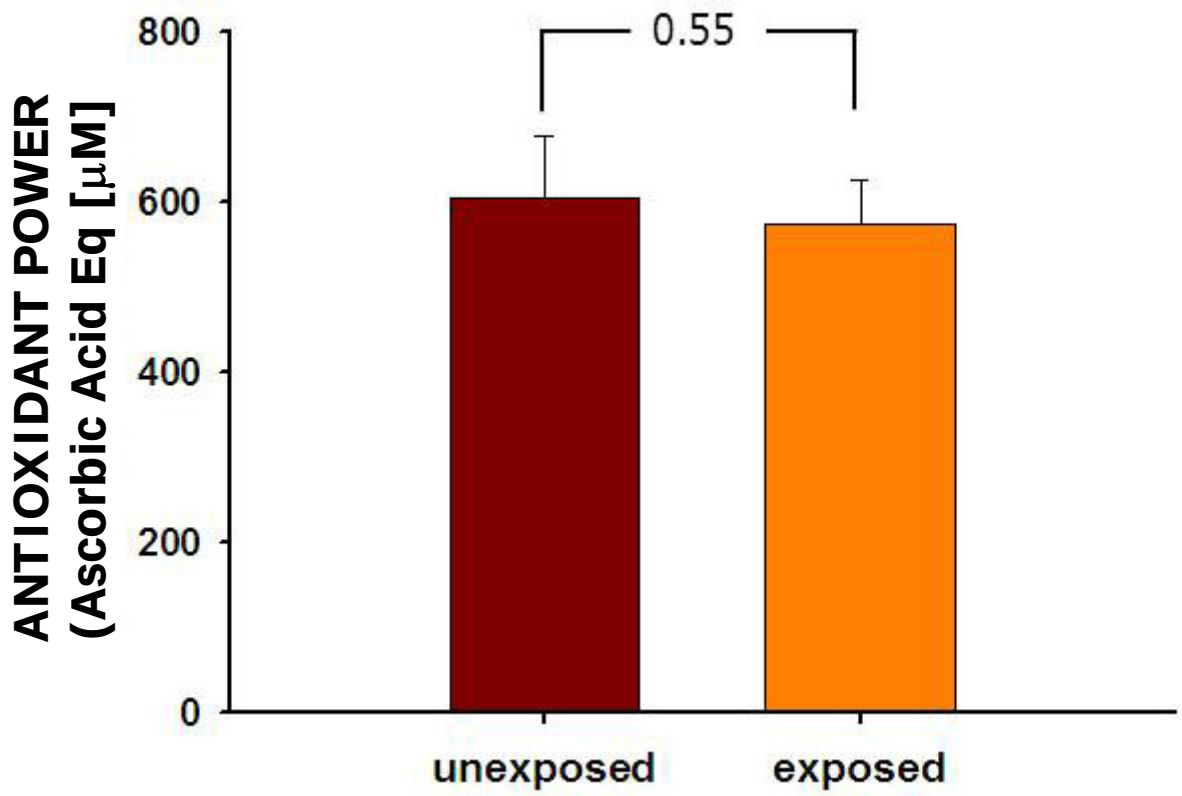
Characteristics of the Examinees

	Unexposed (Group I)	Exposed (Group II)	*P*-valu
Mean age (years)	35 ± 3	38 ± 5	0.530
Gender [*n* (%)]			
Male	8 (80)	10 (100)	1.00
Female	2 (20)	0 (0)	
Body mass index	22 ± 2	26 ± 2	0.010
Alcohol consumption	0/10	1/10	1.00
Smoking habit	1/10	2/10	1.00
Dietary style	National cuisine	National cuisine	
Supplements	No	No	
Dose (mSv/year)	0	4.7 ± 3.2	
Range	0	1.2–8.3	
Years of exposure	0	10 ± 6	
Range	0	3–19	
Number of procedures	0	525 ± 100	
Range	0	250–750	

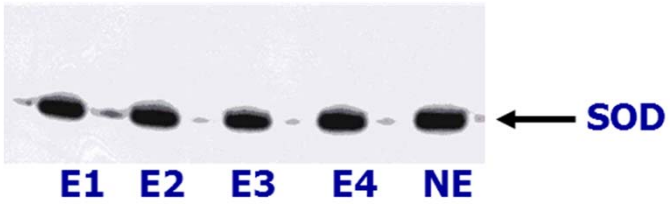
Oxidative Stress in non-Exposed *vs* Exposed

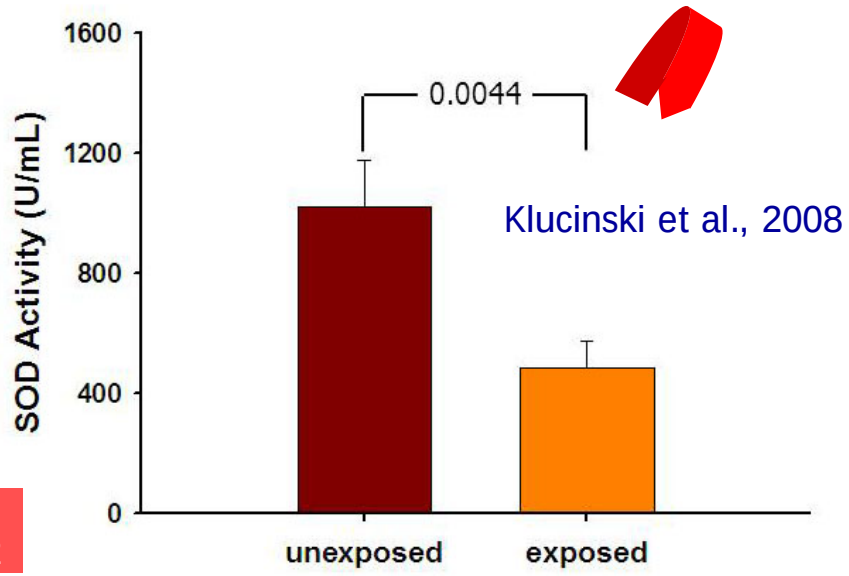


Antioxidant Power in Serum



SOD in non-Exposed vs Exposed





Klucinski et al., 2008

O_2^- —*SOD*→ H_2O_2

$2H^+ + 2O_2^- \rightarrow H_2O_2 + O_2$

Fe^{2+} *Metal Chelators*

OH^-

ROO• → RO•

Oxidative damage
DNA
Lipids
Proteins

SOD in non-Exposed vs Exposed

ROS

O_2^- —*SOD*→ H_2O_2 —*catalase*→ $H_2O + O_2$

$2H^+ + 2O_2^- \rightarrow H_2O_2 + O_2$

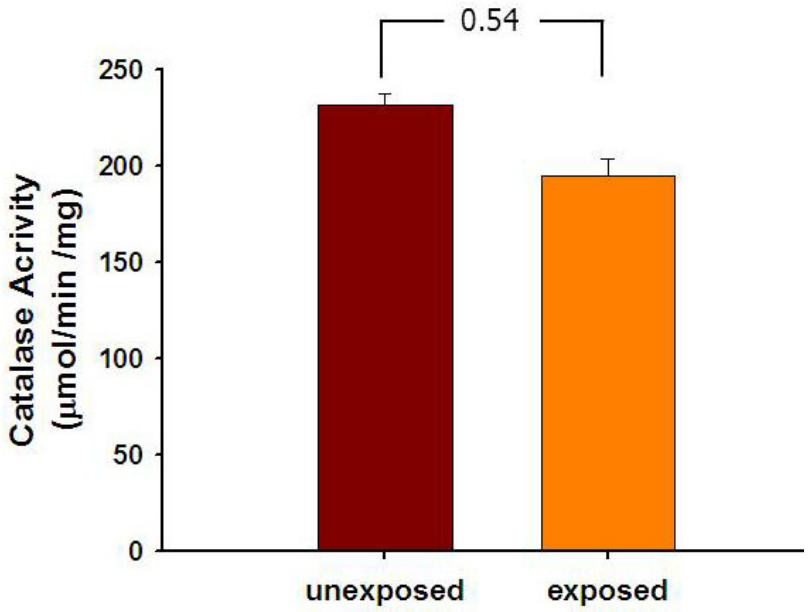
$2H_2O_2 \rightarrow O_2 + 2H_2O$

Fe^{2+} *Metal Chelators*

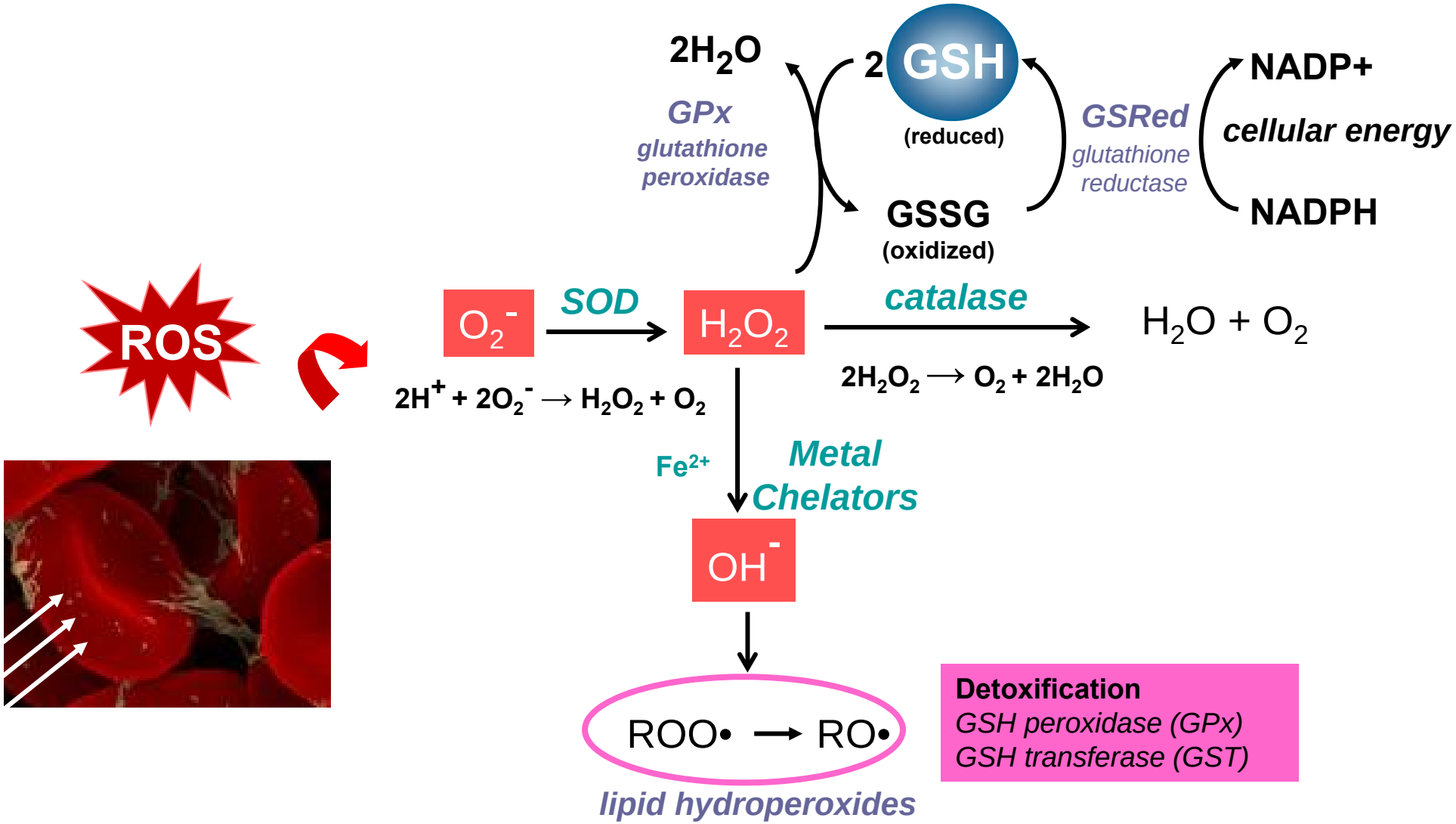
OH^-

ROO• → RO•

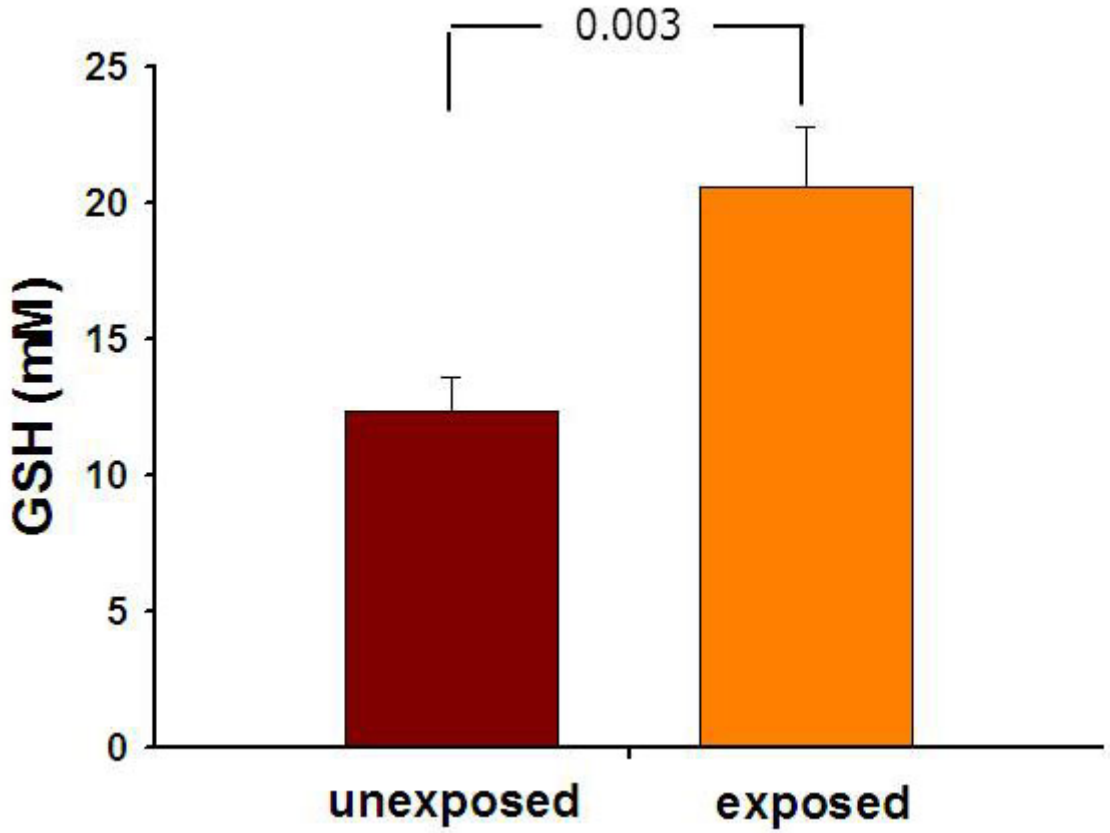
Oxidative damage
DNA
Lipids
Proteins



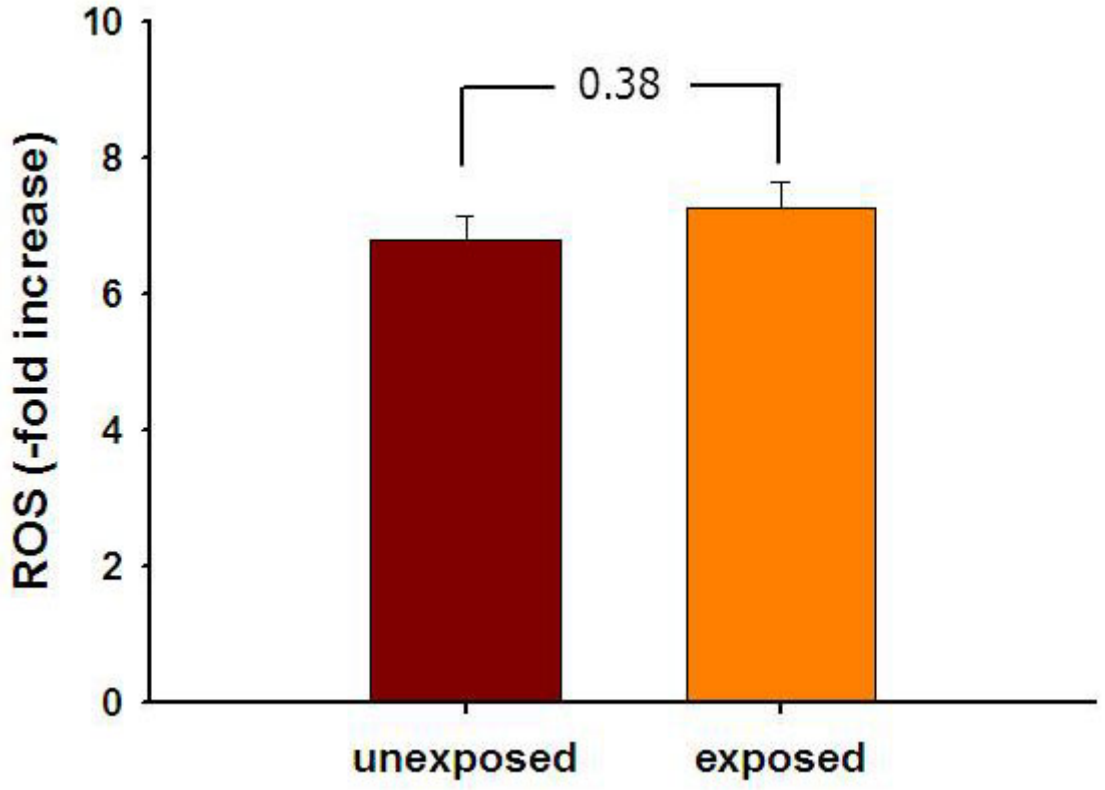
GSH in Erythrocytes of non-Exposed *vs* Exposed



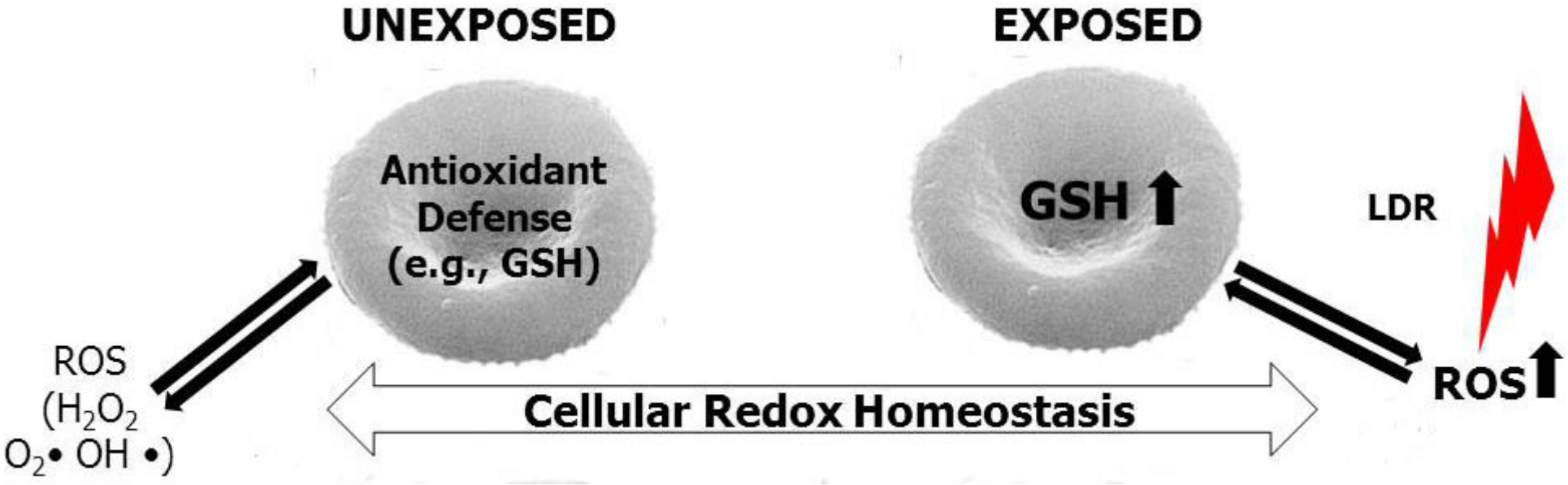
GSH in Erythrocytes of non-Exposed *vs* Exposed



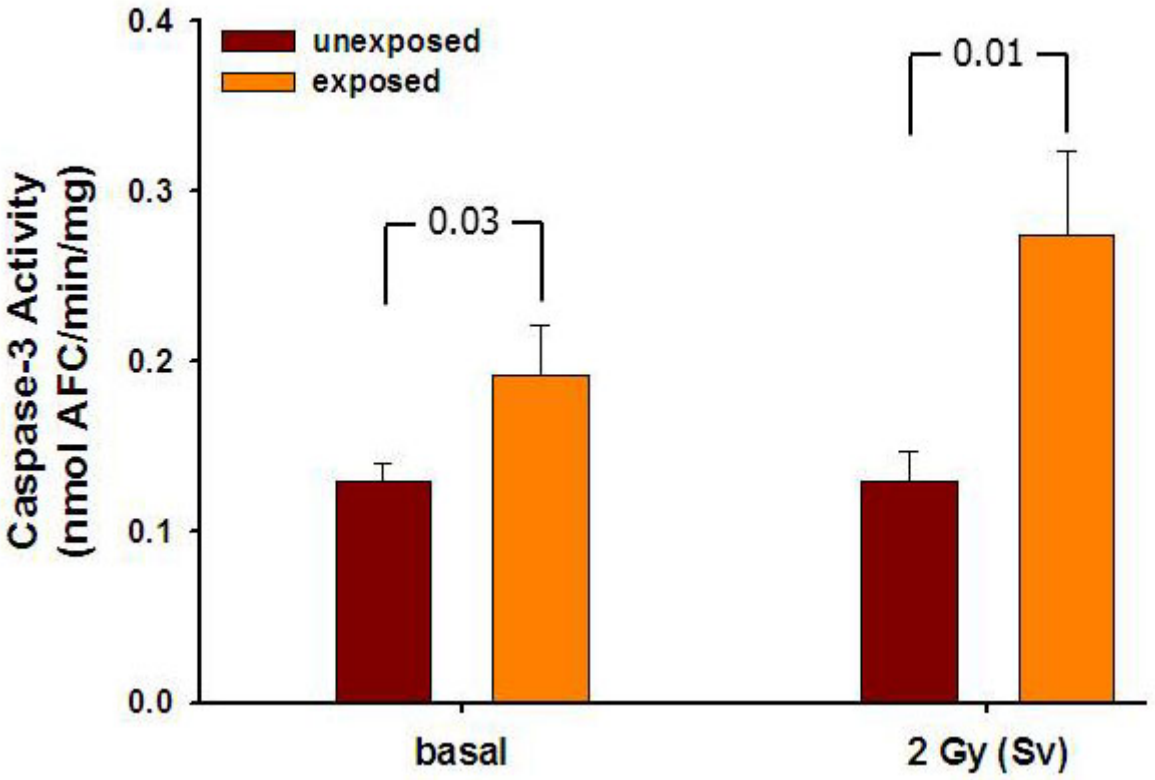
ROS in Erythrocytes of non-Exposed *vs* Exposed



Conclusion - 1

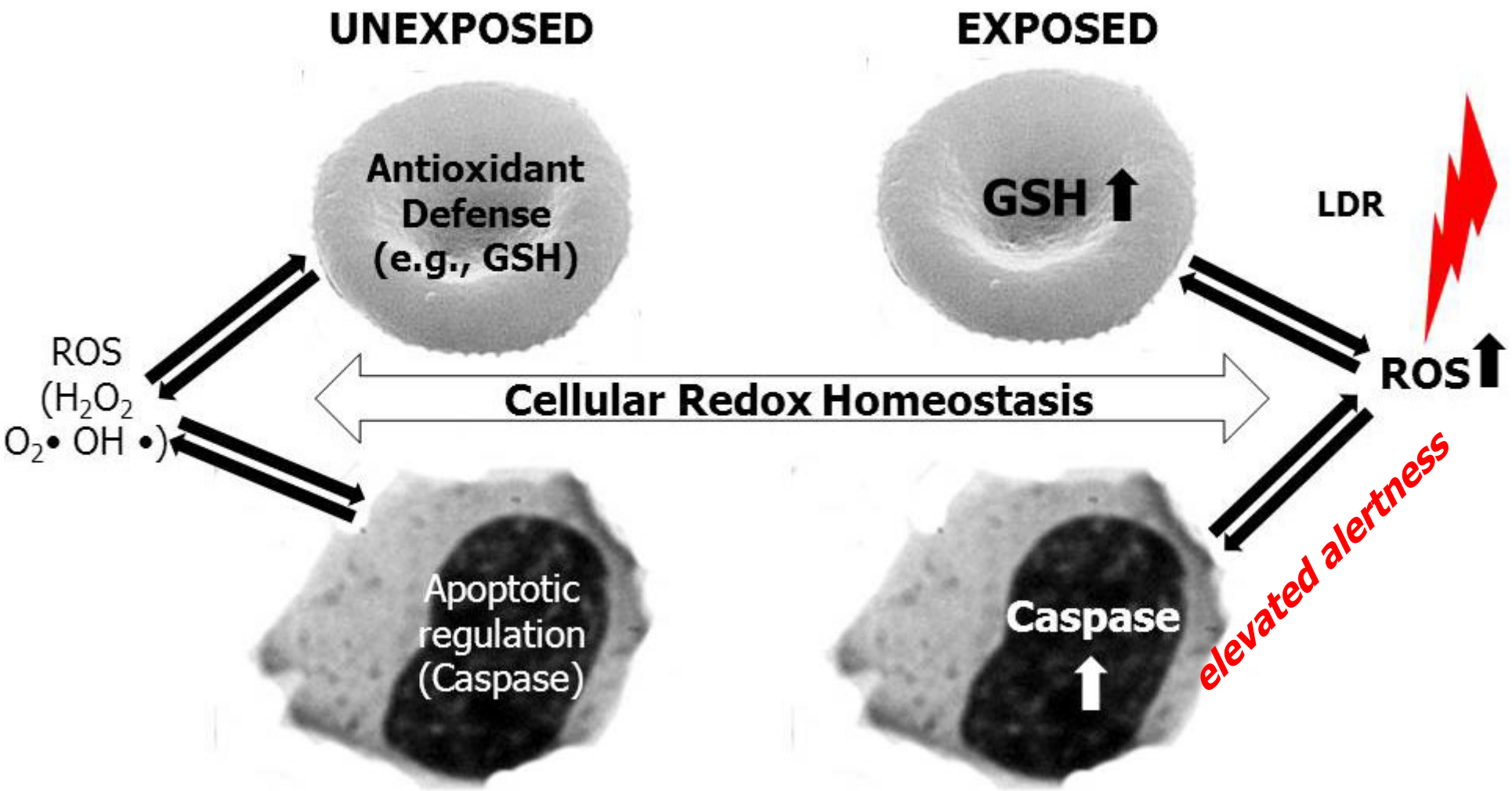


Apoptotic Response in Interventional Cardiologist s



Louagie et al., Cell Biol Int. 1999; 23:611-7

Conclusion - 2



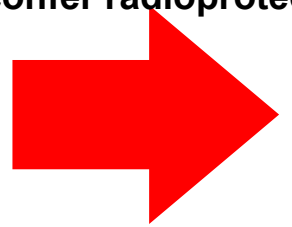
Overall Conclusions - 1

- In interventional cardiologist chronic exposure to LDR induces at least two physiological adaptive responses: enhanced antioxidant defence (GSH levels), increased baseline level of caspase-3 activity .

- The biochemical remodelling induced by chronic LDR exposure in interventional cardiologists might even overturn into a survival advantage

- The biochemical remodelling induced by chronic LDR exposure might contribute to generate new guidelines in interventional cardiology, which are currently based, almost exclusively, on minimizing radiation exposure by implementing safety measures and protection devices.

Dietary antioxidants may confer radioprotection.



Future Studies

Healthy Cath Lab STUDY

- Invasive cardiologists today have a unique opportunity to clarify the effects of chronic LDR.
- This large study is being conducted in Italy to address this question.
- It is done by interventional cardiologists on interventional cardiologists and for interventional cardiologists
- The aim is to clarify the cancer and non-cancer effects of chronic low dose radiation exposure

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CASA DI CURA MONTEVERGINE

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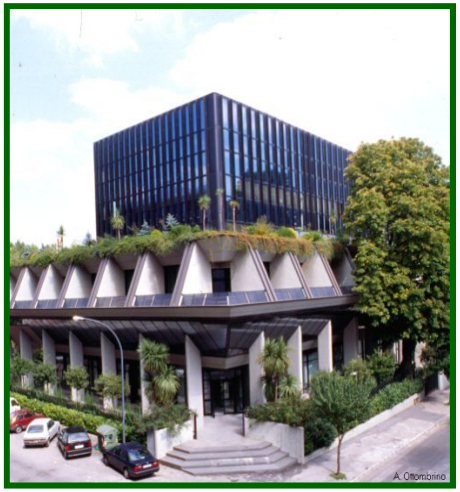

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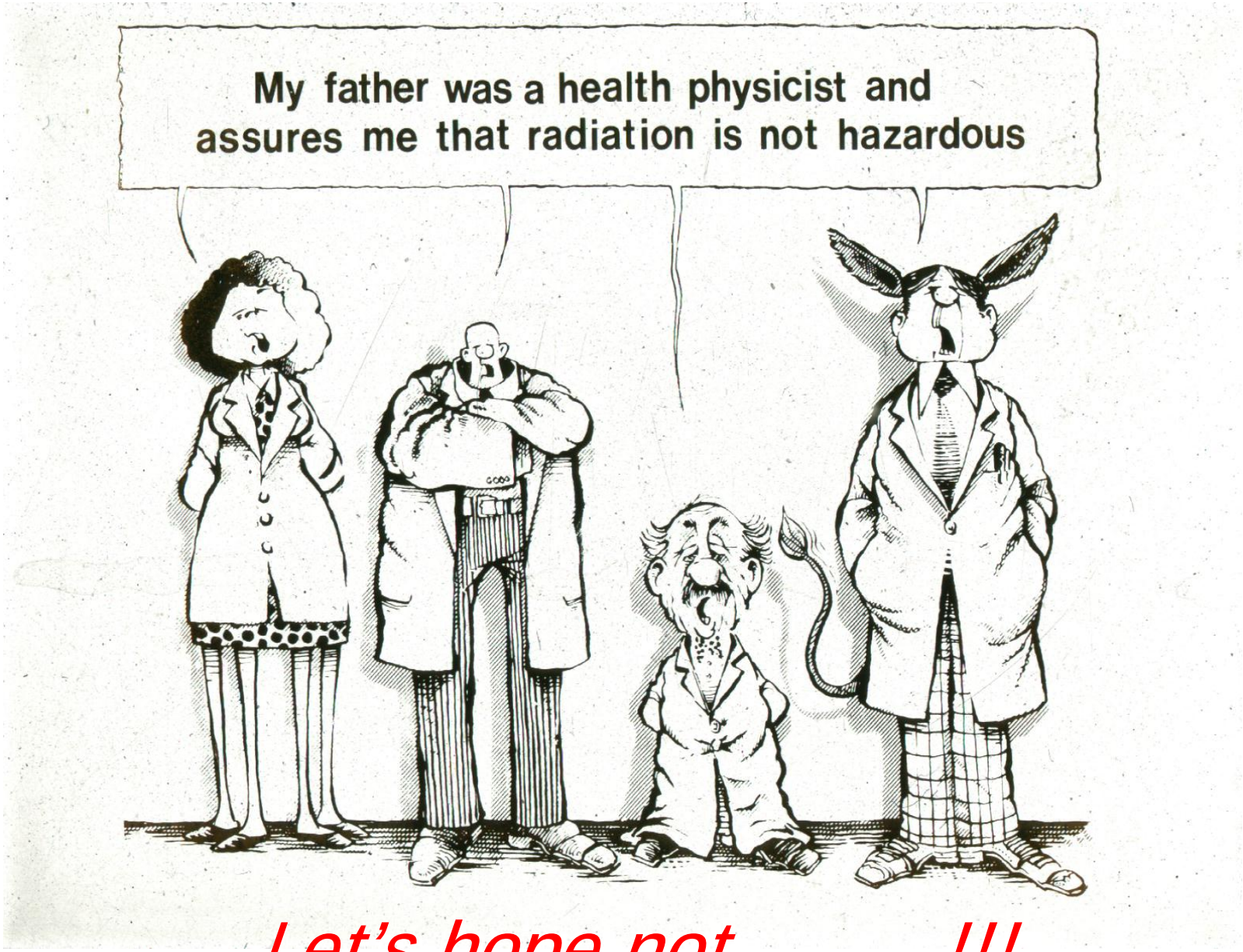

....Let's hope not ..... !!!