

Skin Analysis: Is the Future Catching Us?

The impact of science on consumer decisions

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UK National Innovation Centre for Ageing,
Dermatological Sciences, Medical School, Newcastle University, UK



Research Interests: Mark Birch-Machin Group

- Effects of UV & Environmental Stress on Skin: Ageing and Facial Imaging
- Nutritional Intervention; Botanicals
- Relationship between Oxidative Stress, Ageing, Nutrition
- Mitochondrial DNA (MtDNA) as a UV biomarker in Skin
- Skin Microbiome
- Pigmentation
- Cosmetic Actives & External Skin Stressors: Action, Mechanism & Bioenergy
- Behavioural Intervention & Sun Protection
- Facial changes in Mitochondrial Myopathy Patients
- 3-D skin using Adult Human Induced Pluripotent Stem Cells
- Skin Bioprinting
- MtDNA damage in NMSC, Prostate (USA test) and Oral Cancer
- Insulin resistance impact on Ageing using sleep as a model system
- Commercialisation (3 entities: Mitomics, PB Biosciences, Skin Life Analytics)

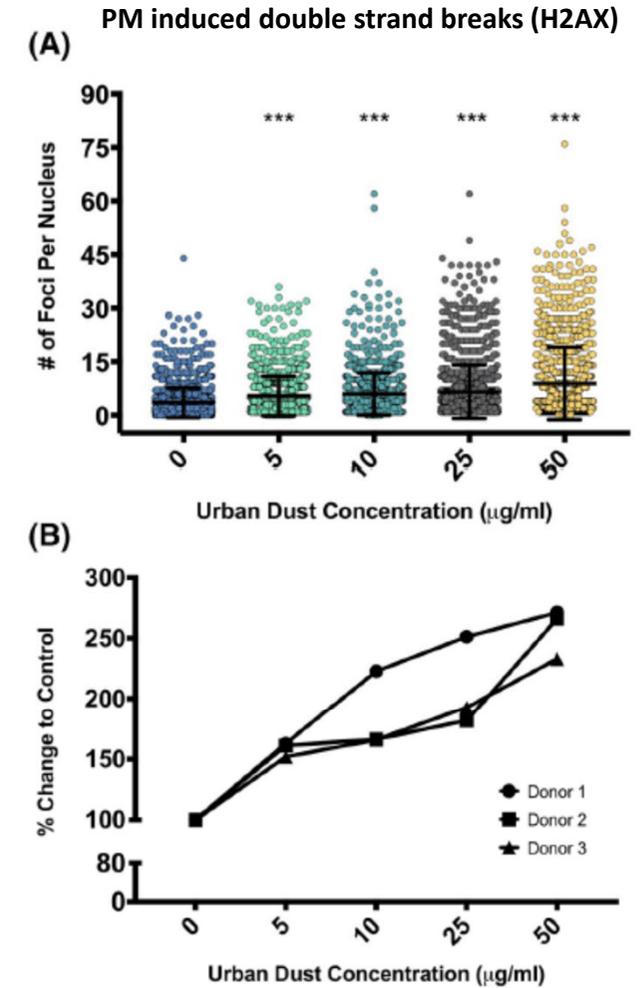
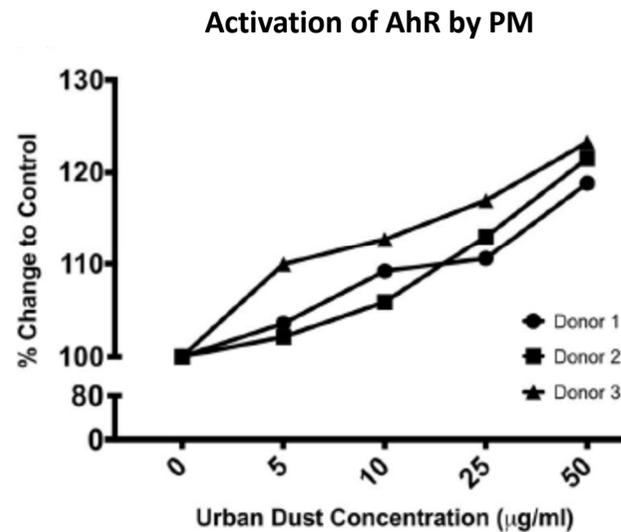
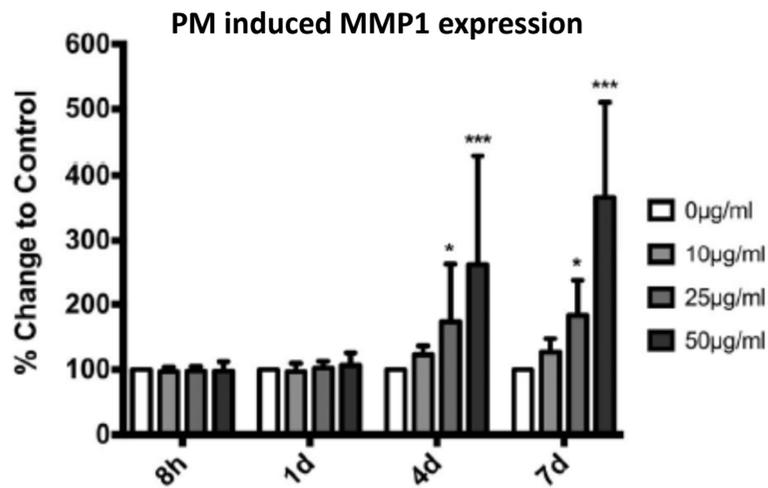
21st Century Factors that accelerate skin ageing



RESEARCH ARTICLE

Exposing human primary dermal fibroblasts to particulate matter induces changes associated with skin aging

Wil J. Reynolds¹ | Peter S. Hanson² | Adam Critchley³ | Ben Griffiths³ |
 Bhaven Chavan⁴ | Mark A. Birch-Machin¹



Biochemical and biological effects of air pollution on the function of human skin.

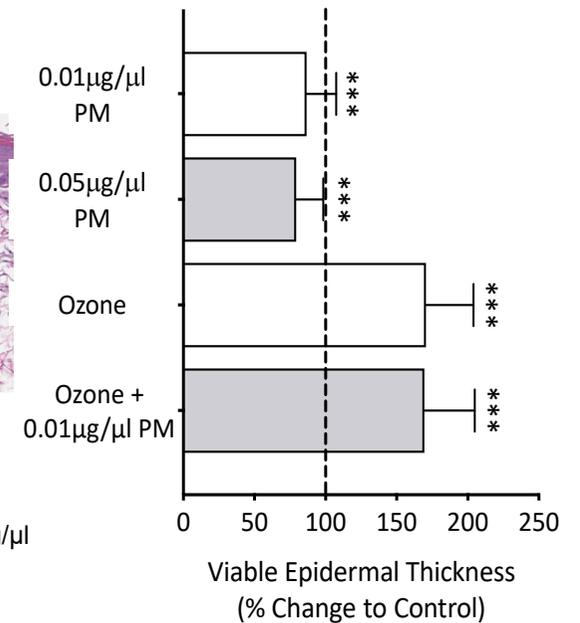
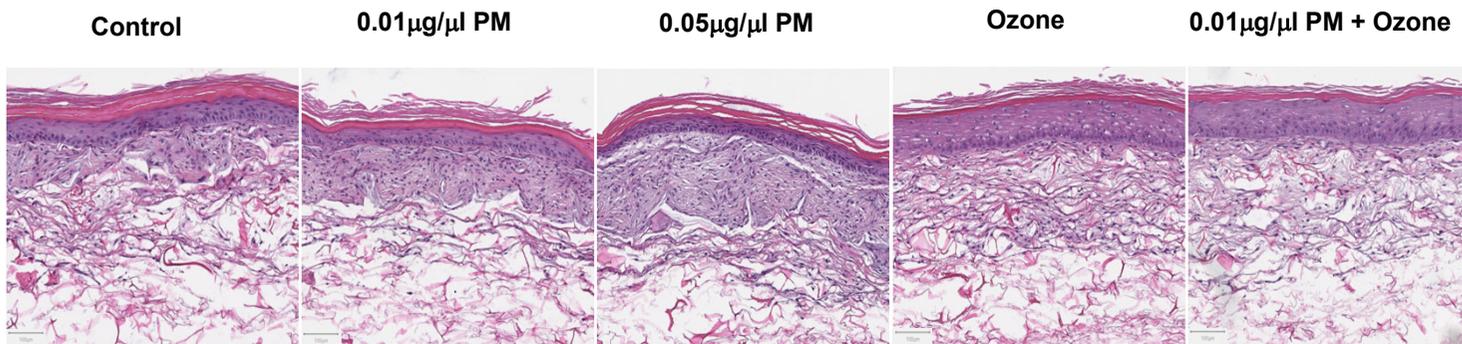


Reynolds, Wil¹; Chavan, Bhaven²; Christensen, Paul³; Birch-Machin, Mark^{1*}.

¹ Dermatological Sciences, Translational & Clinical Research Institute, Newcastle University, UK. ²

Croda Europe Ltd., Snaith, UK. ³ Bedson Building, School of Engineering, Newcastle University, UK.

ID: 153

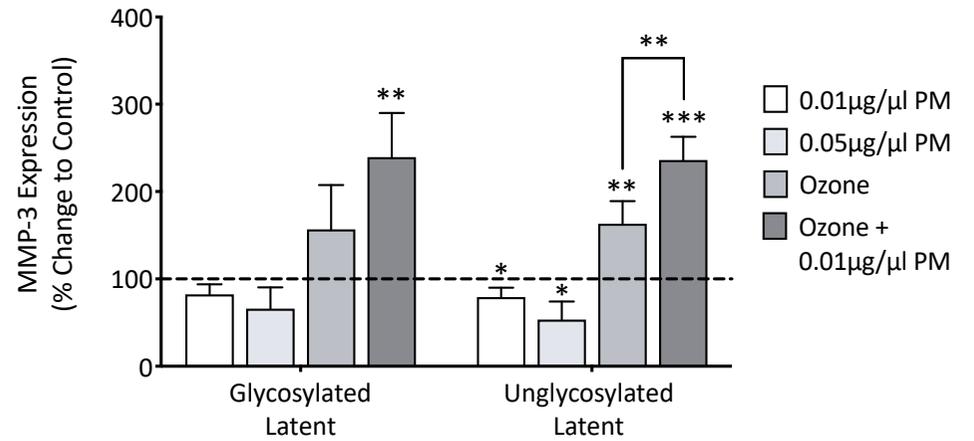
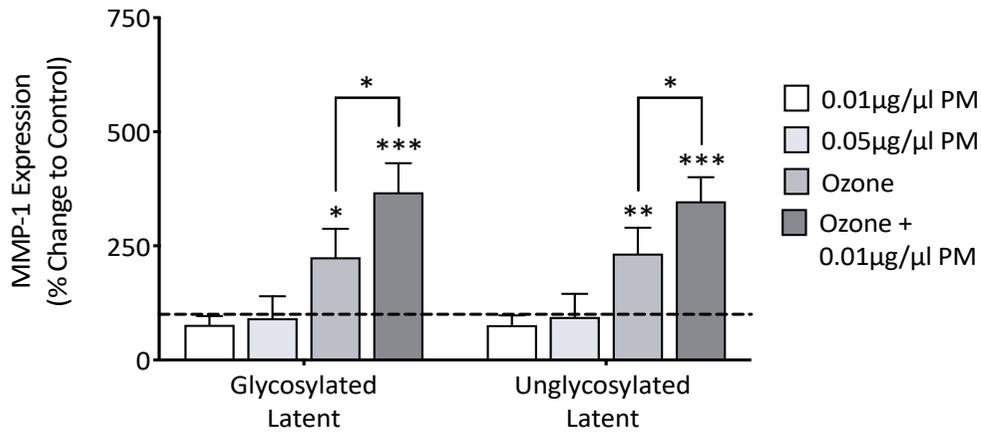
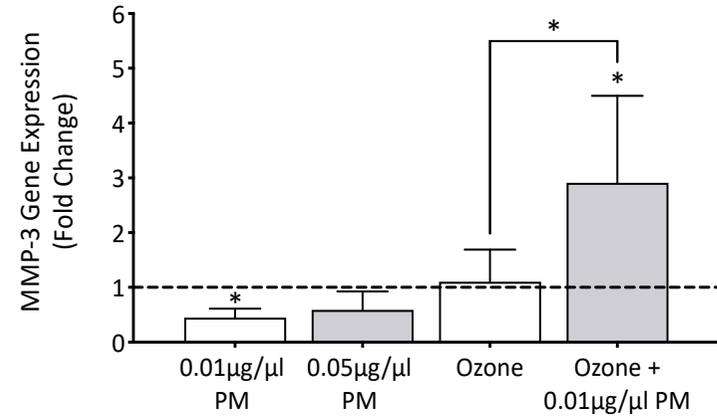
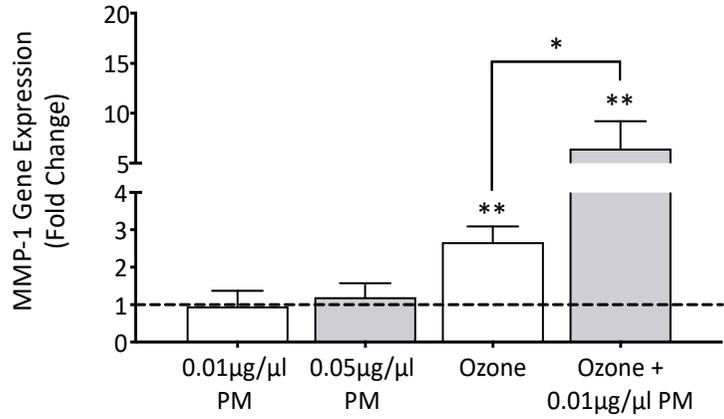


Haematoxylin and eosin staining of skin equivalents after single and combination pollutant exposure for seven days.

PM induced a small but significant concentration-dependent decrease of 13 and 21% in viable epidermal thickness for 0.01 µg/µl PM and 0.05 µg/µl PM, respectively.

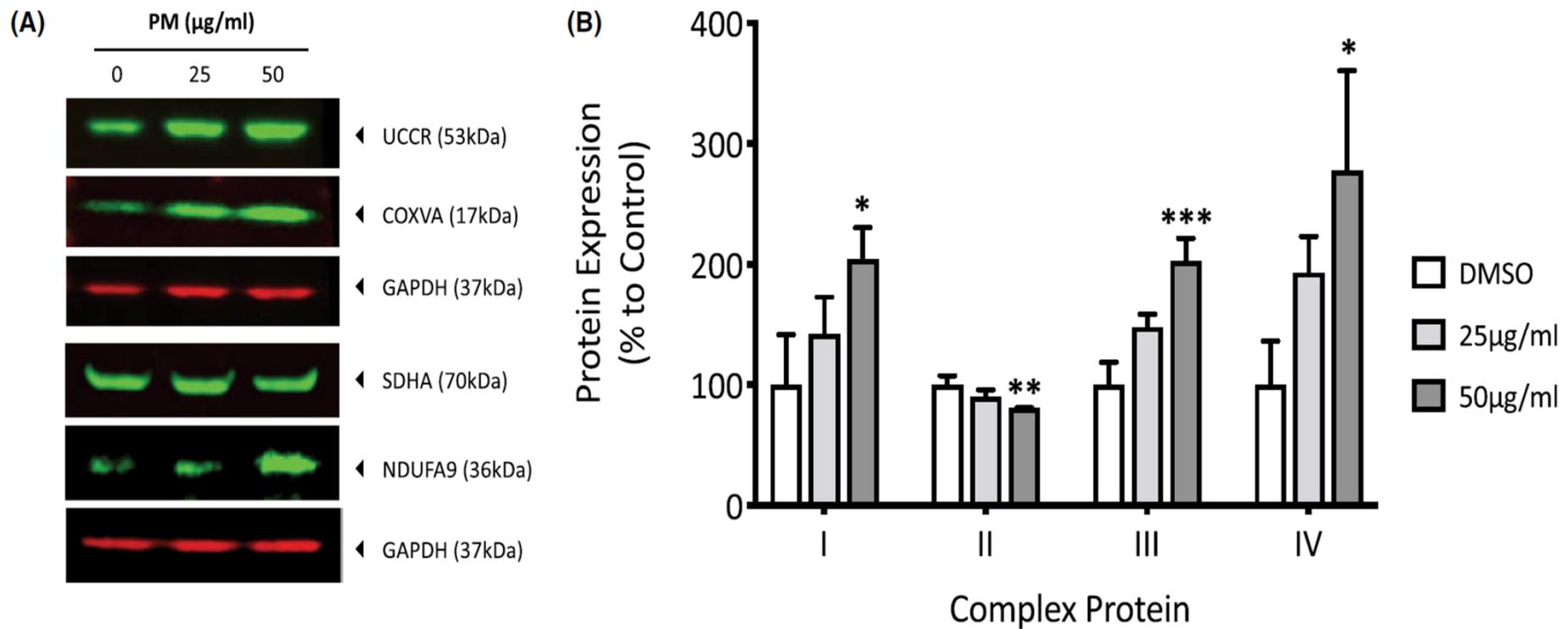
In contrast, ozone and a combination of ozone and PM induced an increase of around 70% in viable epidermal thickness.

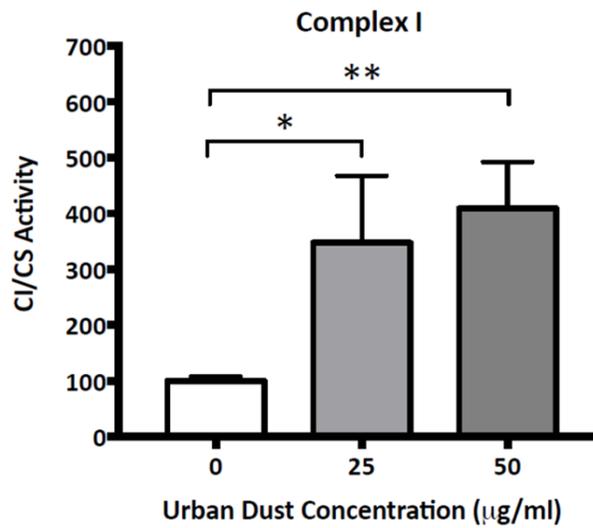
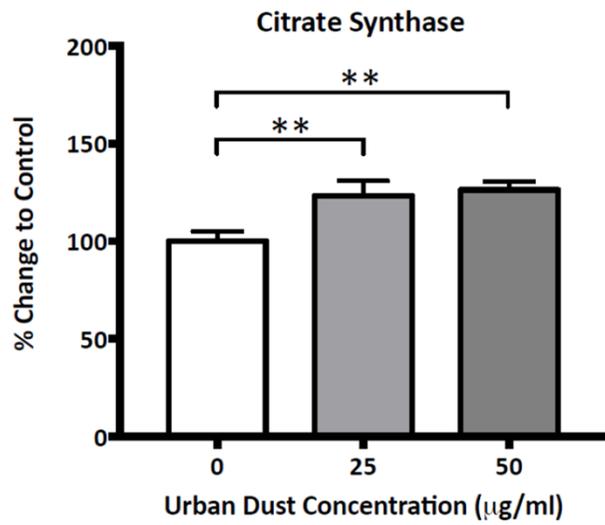
MMP gene expression in skin equivalents after single & combination pollutant exposure for 7 days.



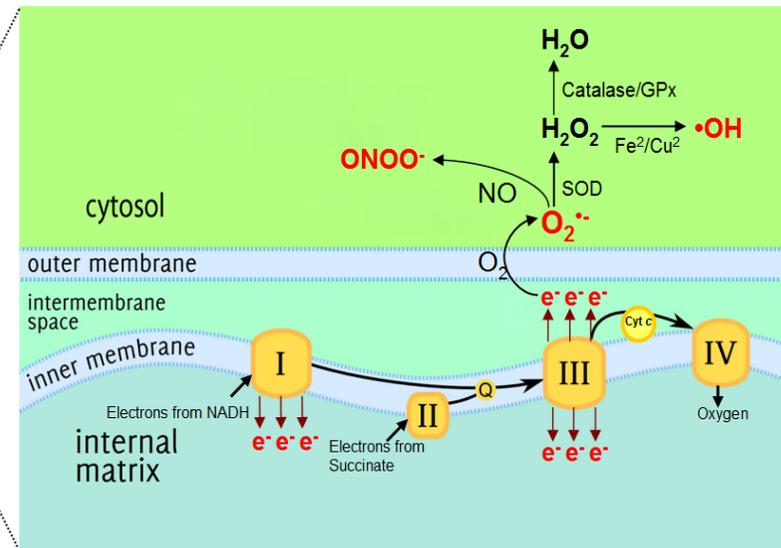
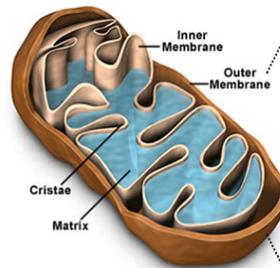
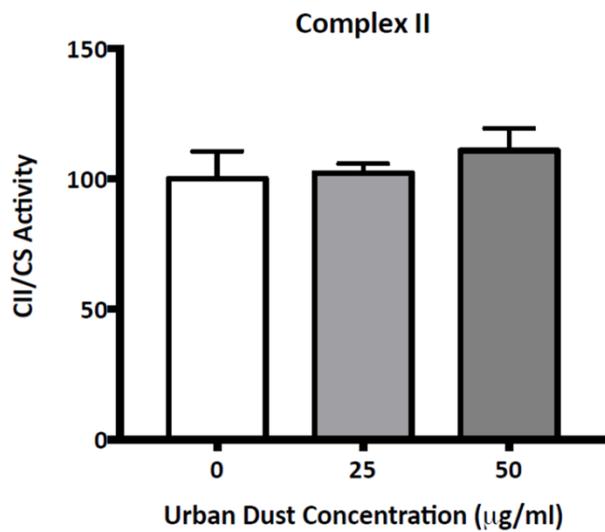
Adaptive responses to air pollution in human dermal fibroblasts and their potential roles in aging

Wil J. Reynolds¹ | Amy Bowman¹ | Peter S. Hanson² | Adam Critchley³ | Ben Griffiths³ | Bhaven Chavan⁴ | Mark A. Birch-Machin¹





PM-induced changes of mitochondrial respiratory complex activity

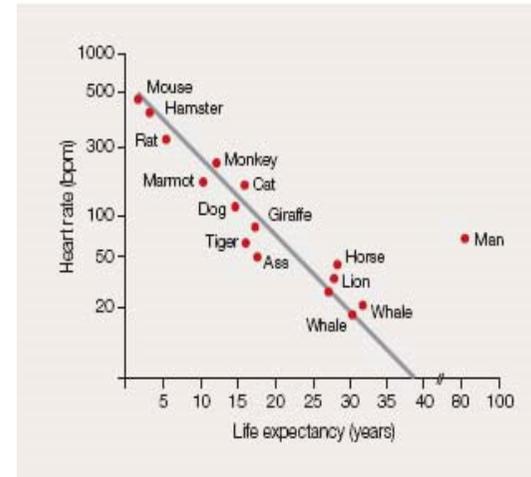


Theories of ageing

The wear and tear theory (Weismann, 1882)

The rate of living theory (Pearl, 1928)

Free radical theory (Harman, 1956), (e.g. pigeons vs rats: longer life span despite similar metabolic rates)



Mitochondrial theory of ageing (bioenergy↓ free radicals↑)
(Tired or Fatigued Skin)

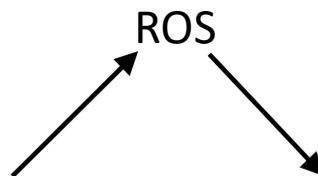


Mitochondrial
Dysfunction
(low bioenergy)

ROS

Vicious Cycle Theory

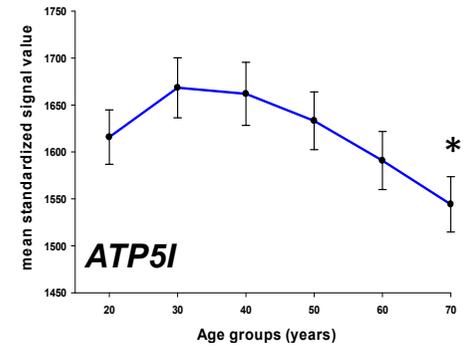
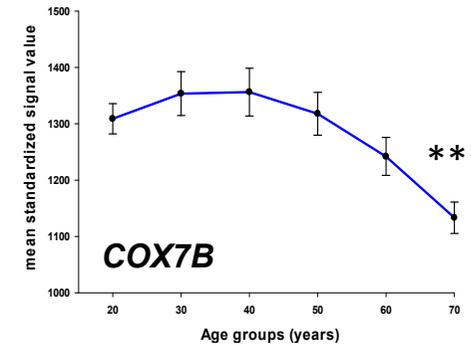
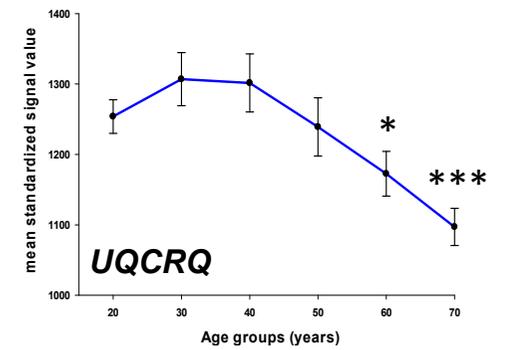
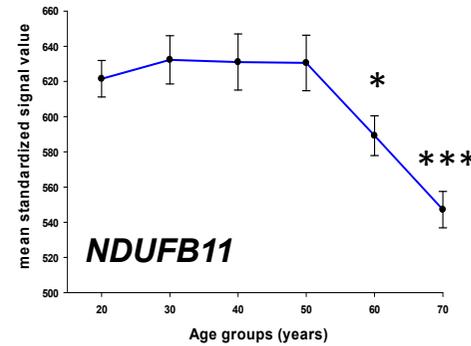
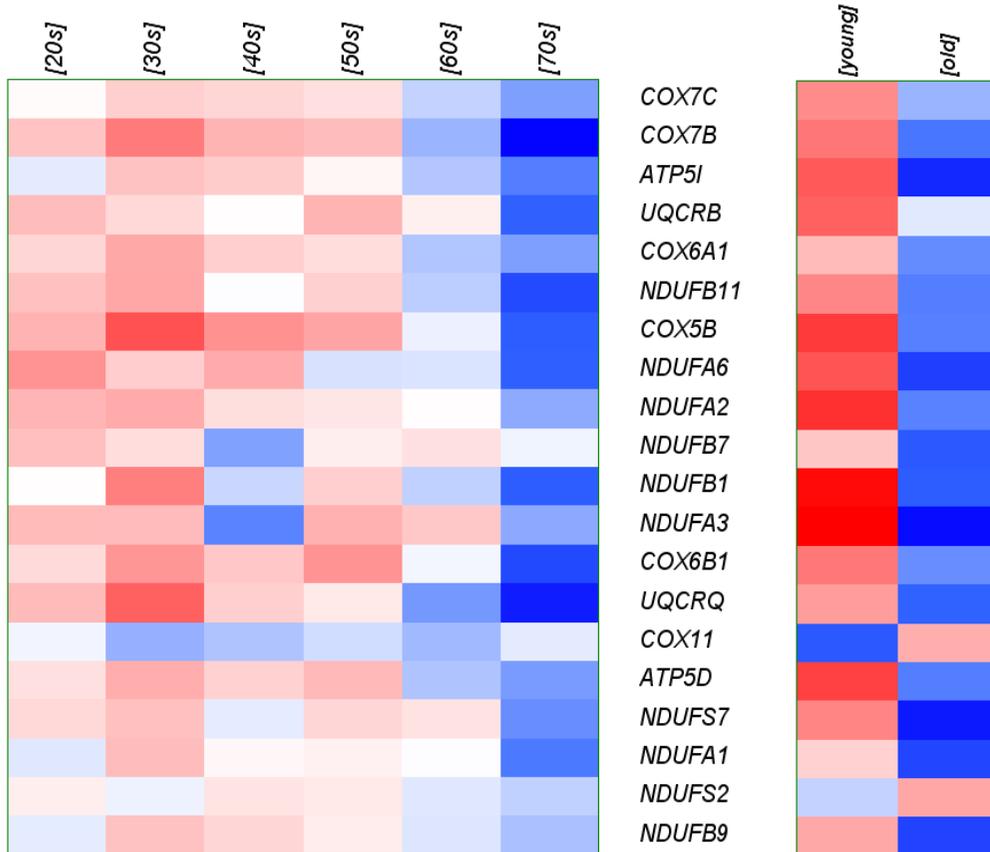
Mitochondrial DNA
(mtDNA) Damage



Gene expression of mitochondrial ETC subunits decreases with age in human dermal fibroblasts as determined via transcriptomics

John E. Oblong, Amy Bowman, Holly A. Rovito, Bradley B. Jarrold, Joseph D. Sherrill, Markaisa R. Black, Glyn Nelson, Alexa B. Kimball, and Mark A. Birch-Machin

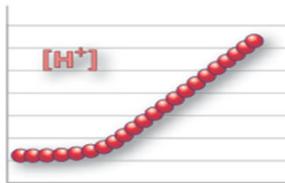
Aging Cell 2020



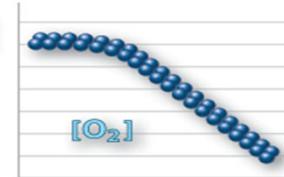
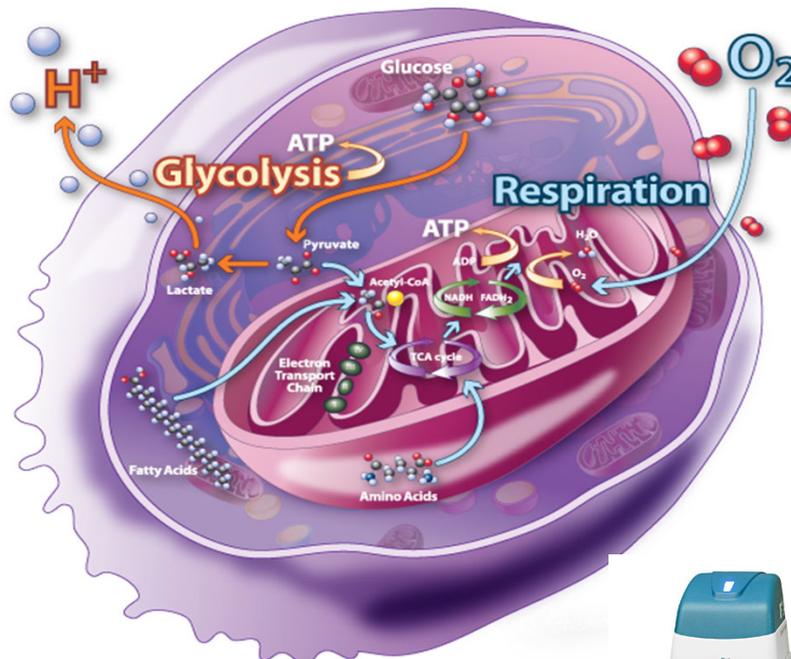
Seahorse XFAnalyzers Measure the Two Major BioEnergy Pathways of the Cell

Glycolysis

.....
Measured by the
Extracellular
Acidification Rate
(ECAR)



Glycolysis



Mitochondrial Respiration

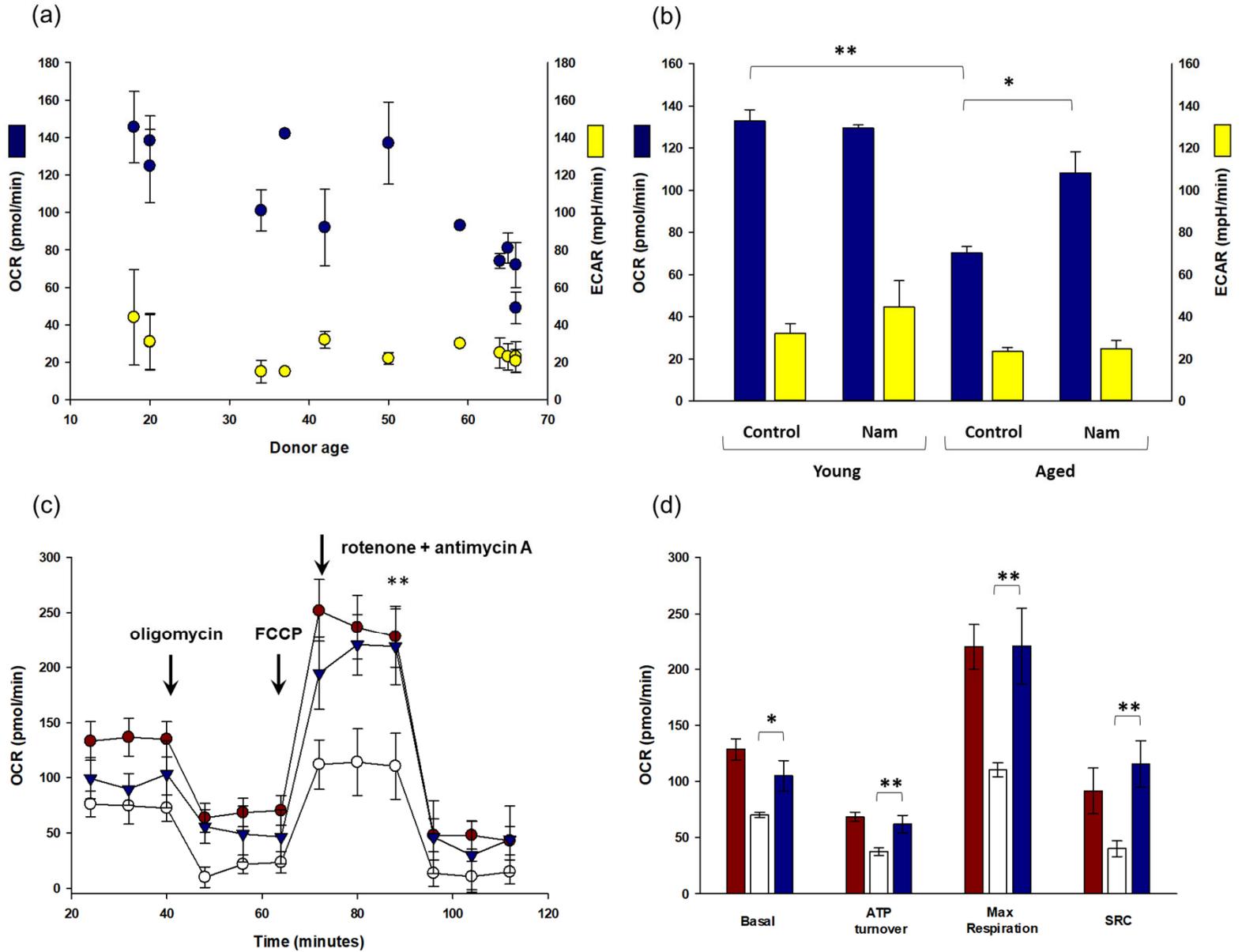
Mitochondrial Respiration

.....
Measured by the
Oxygen Consumption
Rate (OCR)

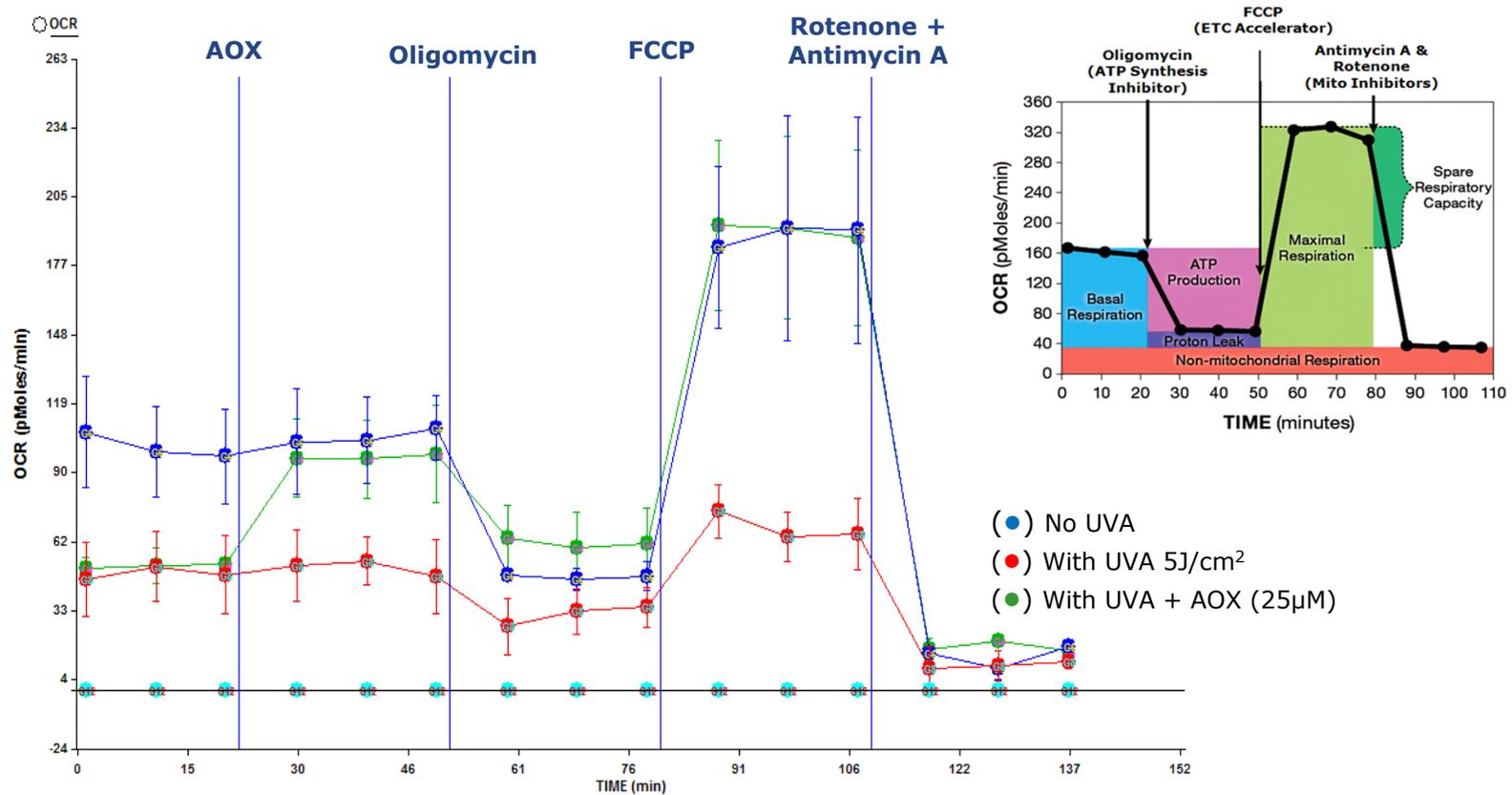
Seahorse XF analyser
(Mito gym)



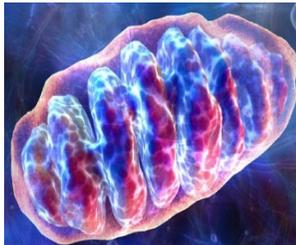
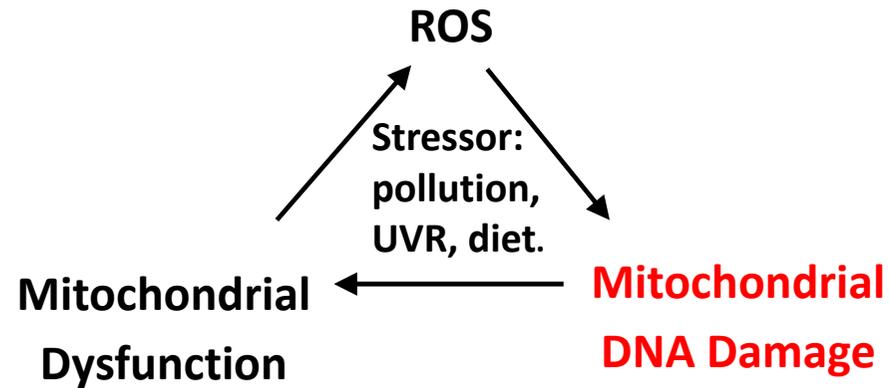
OxPhos and mt efficiency decline with age in fibroblasts and are restored after treatment with Nam



AOX can reverse the effect of UVA on mitochondrial respiration and ATP production in skin fibroblasts



Mitochondrial theory of ageing- Vicious cycle



- 1000's copies of mt genome per cell
- Accumulate mutations: limited repair

Mitochondrial Myopathies to Dermatology (1995)



MtDNA damage and Sun-Exposure in Human Skin

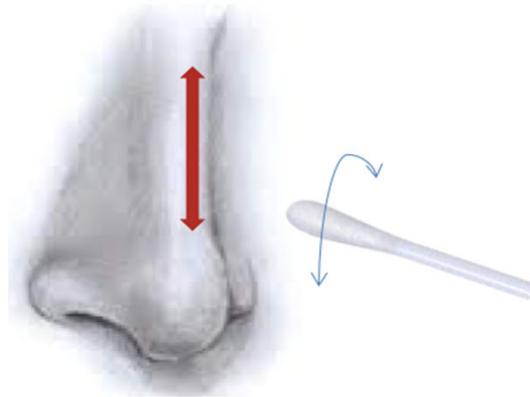
UVR → mtDNA damage → Limited repair
→ Accumulation of damage →
biomarker of Sun-damage in skin (**Sunburnt DNA**)

Increasing tower of UV-induced mtDNA damage

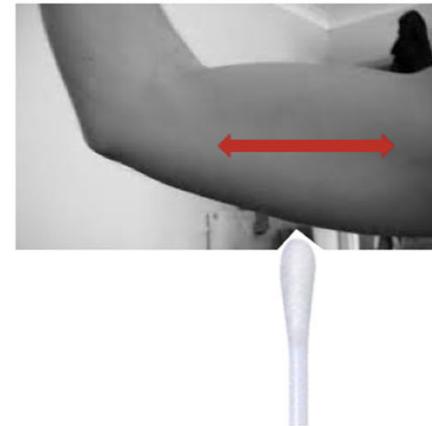


Simple cotton swab test measures damaged mtDNA in human skin

Sample site 1



Sample site 2



Mitochondrial theory of ageing (bioenergy ↓ free radicals ↑ DNA damage ↑)



‘IT’S DIFFICULT FOR PEOPLE TO STAY WITH SKINCARE ROUTINES WHEN THEY DON’T SEE THE BENEFITS’.

- Invisible damage
- No current measurement
- Treatments take time
- No way of monitoring damage
- Invasive measures
- Solution- making the invisible visible

 **Skin Life Analytics**





Sample site 1

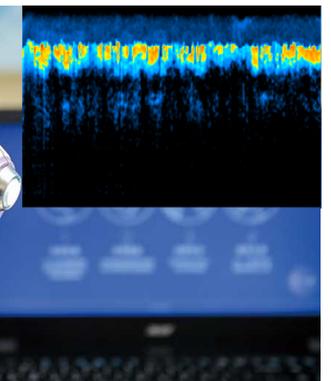
Sample site 2



**Non-invasive Skin DNA
damage Swab test**

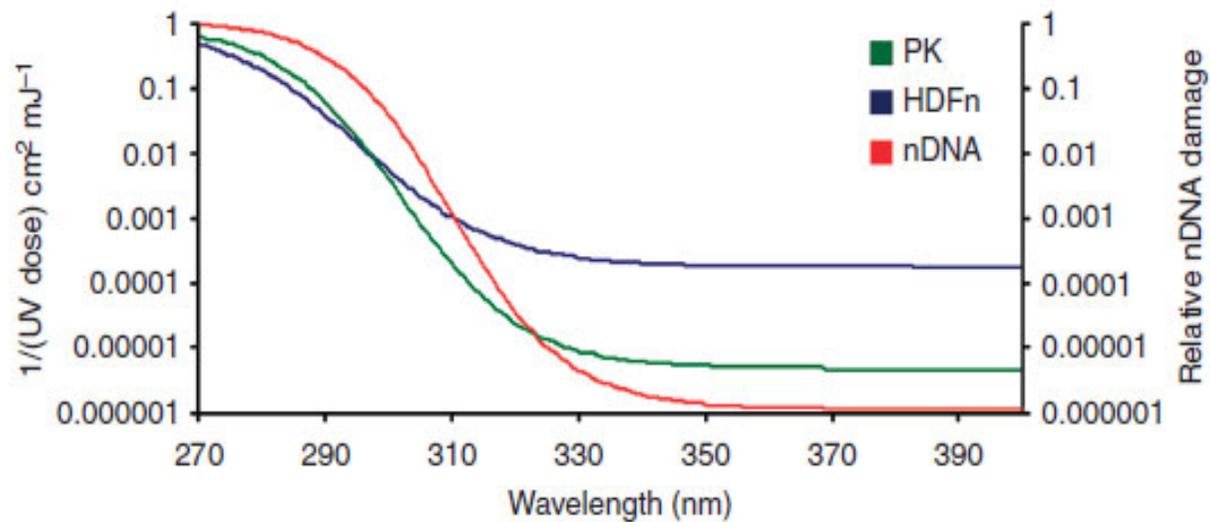


- Personalised in vivo monitoring of interventions (making the invisible visible)
- Product/active Testing and Research
- Bioenergy



Determination of the Action Spectrum of UVR-Induced Mitochondrial DNA Damage in Human Skin Cells

Jennifer A. Latimer^{1,2}, James J. Lloyd³, Brian L. Diffey¹, Paul J. Matts² and Mark A. Birch-Machin¹
Journal of Investigative Dermatology (2015) 135, 2512–2518; doi:10.1038/jid.2015.194; published online 25 June 2015



What about
Infrared,
Visible light?

March 2020

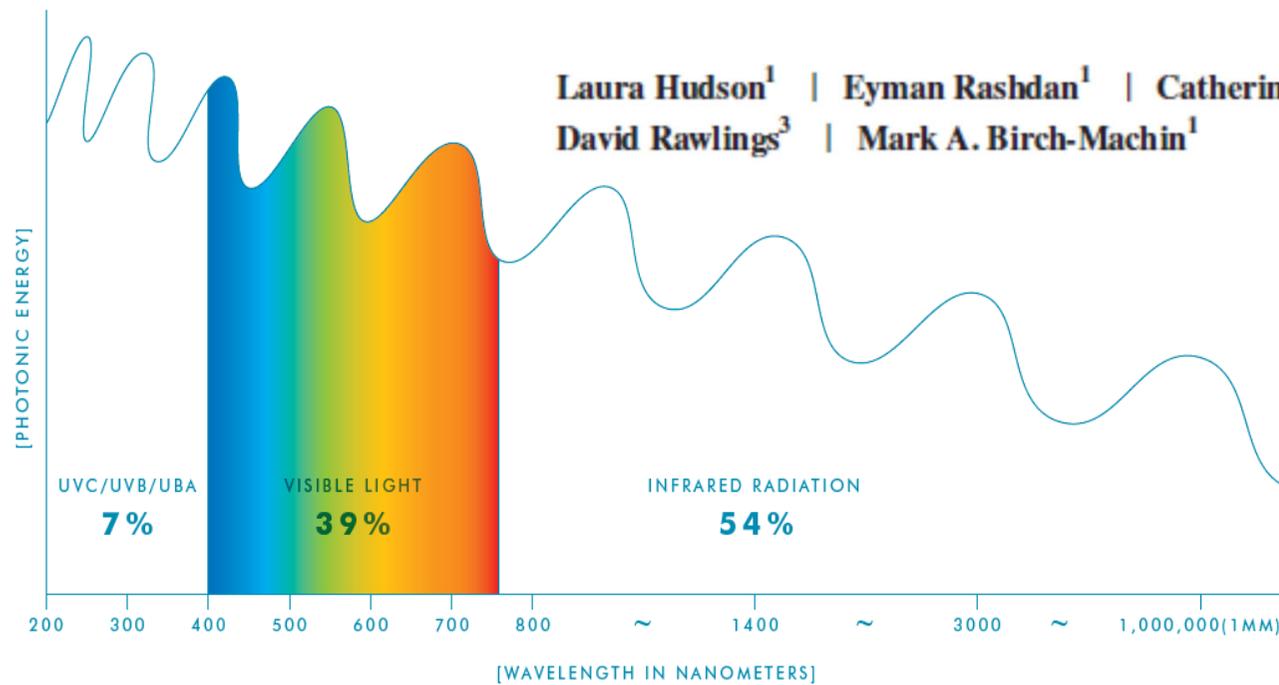
Received: 2 October 2019 | Revised: 18 December 2019 | Accepted: 23 December 2019

DOI: 10.1096/fj.201902351RR

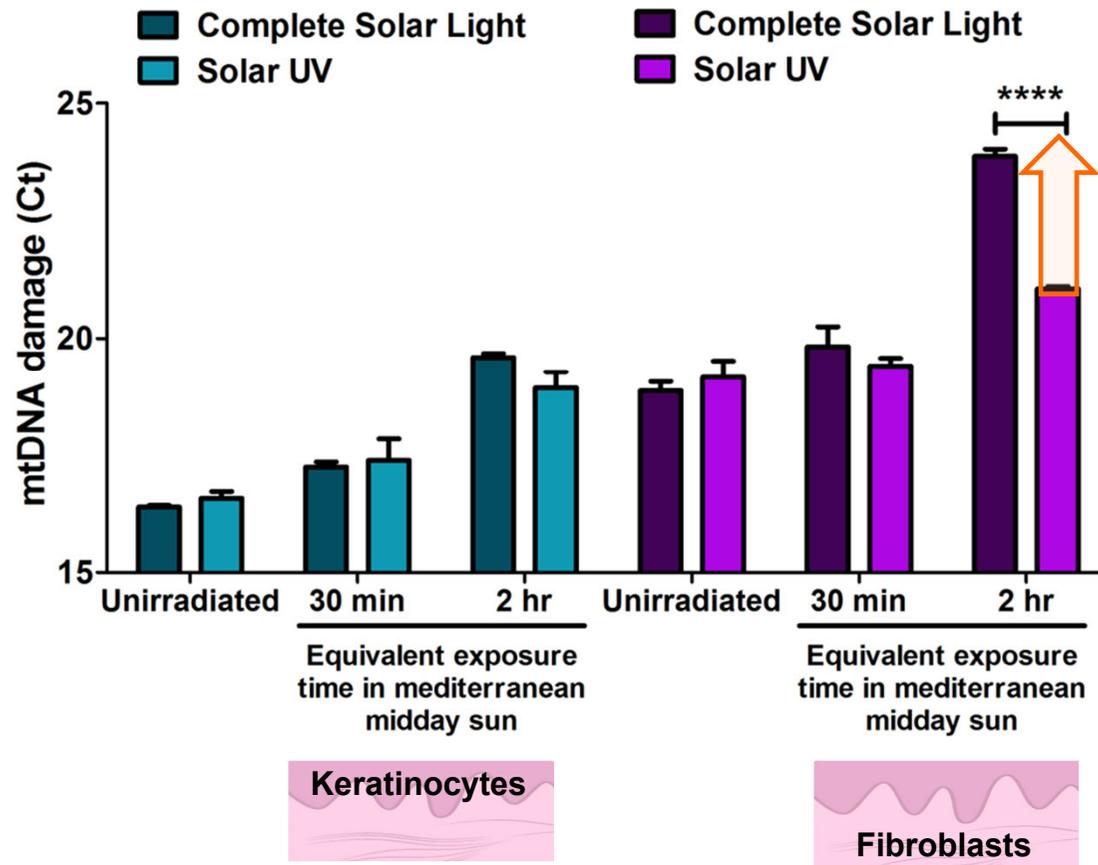
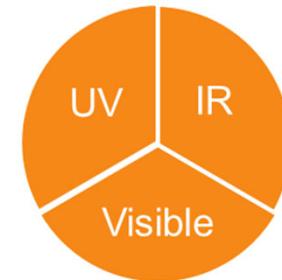
RESEARCH ARTICLE

Individual and combined effects of the infrared, visible, and ultraviolet light components of solar radiation on damage biomarkers in human skin cells

Laura Hudson¹ | Eyman Rashdan¹ | Catherine A. Bonn¹ | Bhaven Chavan² | David Rawlings³ | Mark A. Birch-Machin¹



mtDNA - Effect of IR and Visible

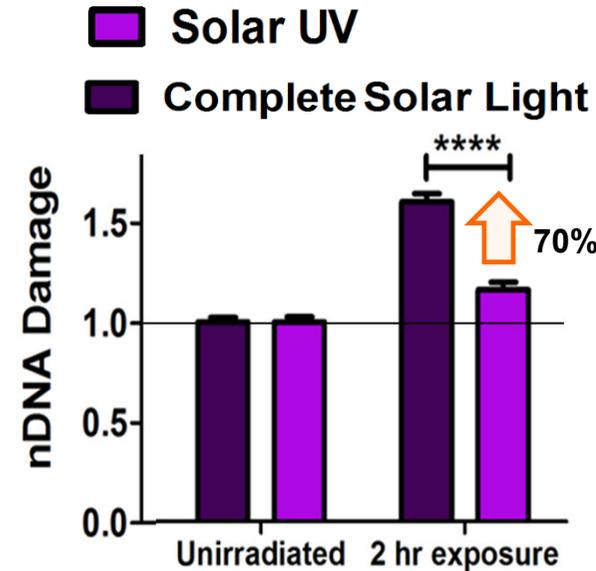
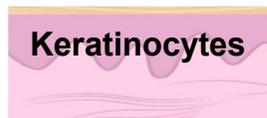
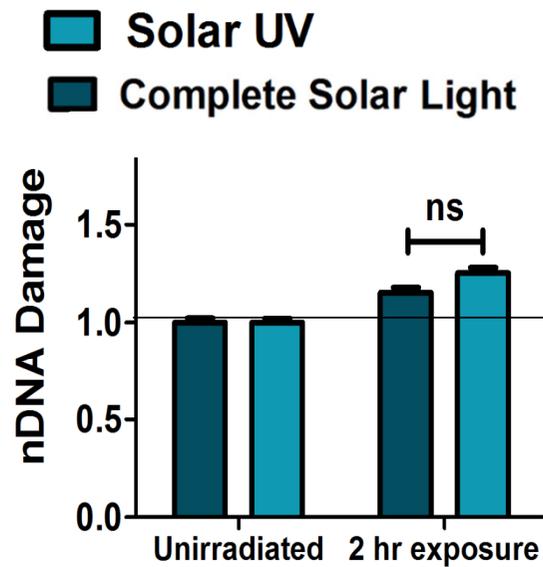
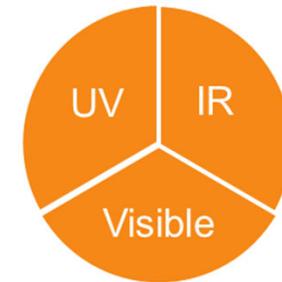


- UV damages both keratinocytes and fibroblasts
- IR & visible radiation increase mtDNA damage in Fibroblasts

FASEB J March 2020:-

addition of IR & visible increases mtDNA damage in fibroblasts but not in keratinocytes

nDNA - Effect of IR and Visible



- UV induces nDNA damage in both keratinocytes and fibroblasts
- IR & visible radiation **increase nDNA damage** in fibroblasts

Similar pattern to the MtDNA (and ROS findings):

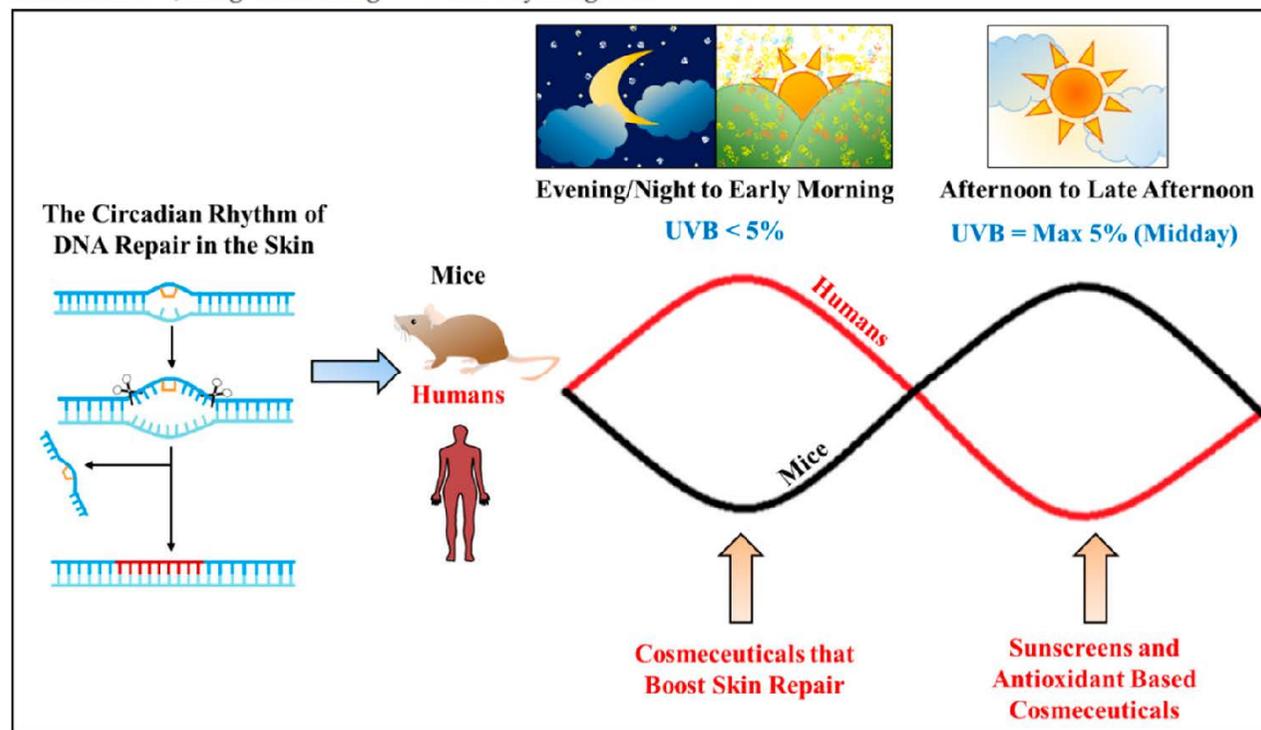
addition of IR & visible increases nDNA damage in fibroblasts but not in keratinocytes



Review

Cosmeceutical Therapy: Engaging the Repercussions of UVR Photoaging on the Skin's Circadian Rhythm

Camille Keisha Mahendra ¹, Hooi-Leng Ser ², Priya Pusparajah ³, Thet Thet Htar ¹, Lay-Hong Chuah ¹, Wei Hsum Yap ^{4,5}, Yin-Quan Tang ^{4,5}, Gokhan Zengin ⁶, Siah Ying Tang ^{7,8,9}, Wai Leng Lee ¹⁰, Kai Bin Liew ¹¹, Long Chiau Ming ^{12,*} and Bey Hing Goh ^{1,13,14,*}

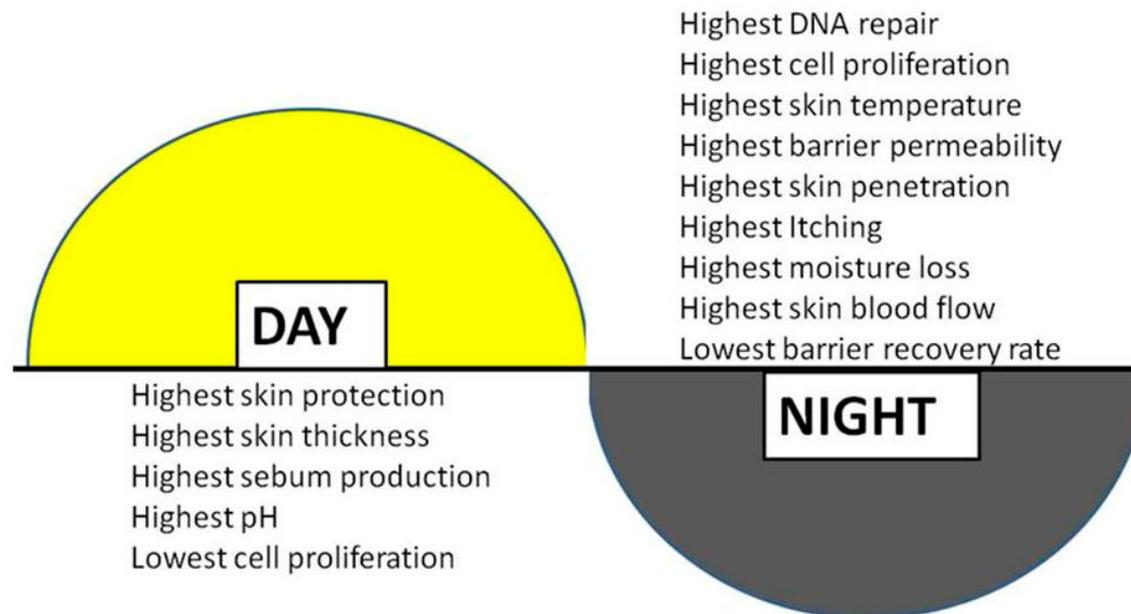




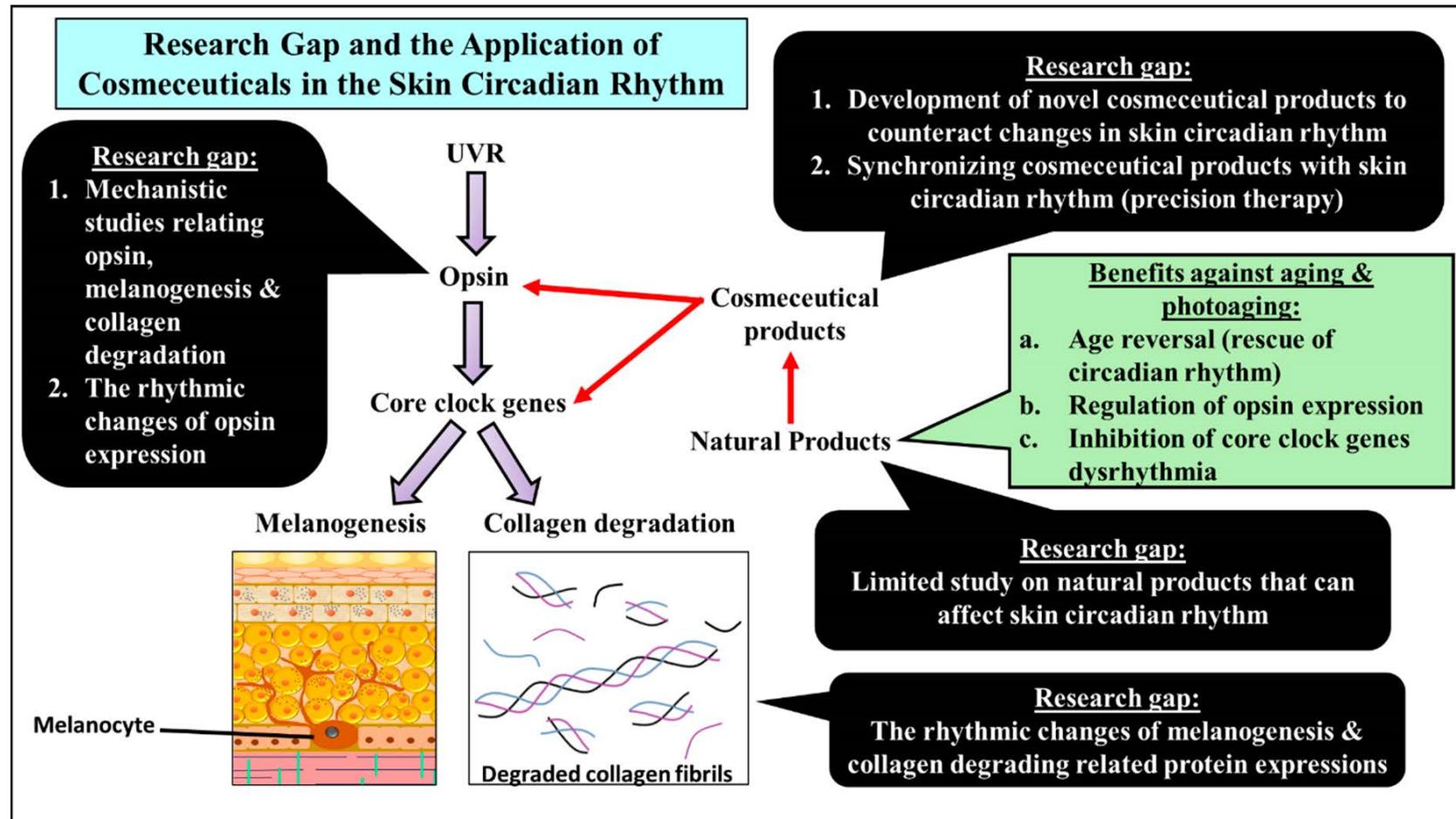
Review

Biological Rhythms in the Skin

Mary S. Matsui ^{1,2,*}, Edward Pelle ^{1,3}, Kelly Dong ¹ and Nadine Pernodet ^{1,4}



Summary of the research gap and the potential use of intervention products



Mark Birch-Machin group

Dr Amy Bowman

Dr Eyman Rashdan

Current PhD students:

Jessica Moor

Catherine Bonn

Gewei Zhu

Lizzie Ruddy

Wil Reynolds

Roisin Stout

Maria Crespo Cuadrado

Dominic Pangilinan

Rachel Dixon

MRes student:

Pratyush Pradeep

Undergrad. Students

Gunkavee Saengkrajang

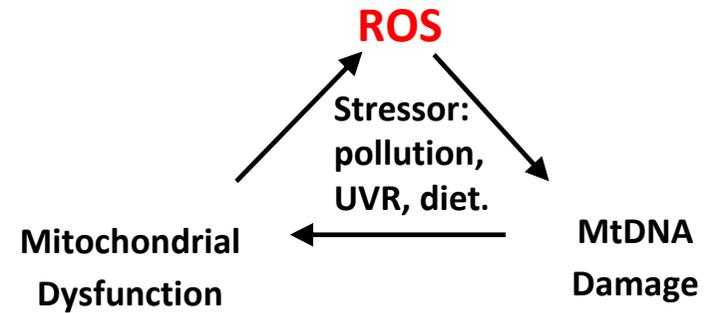
Deyva Priya

**Thank you
for your attention**



What about AOX and Skin?

Tomato diet: reduction in biomarkers incl. erythema, mtDNA damage, MMP1.
Rizwan et al. BJD 2011, Grether-Beck et al., BJD 2016.



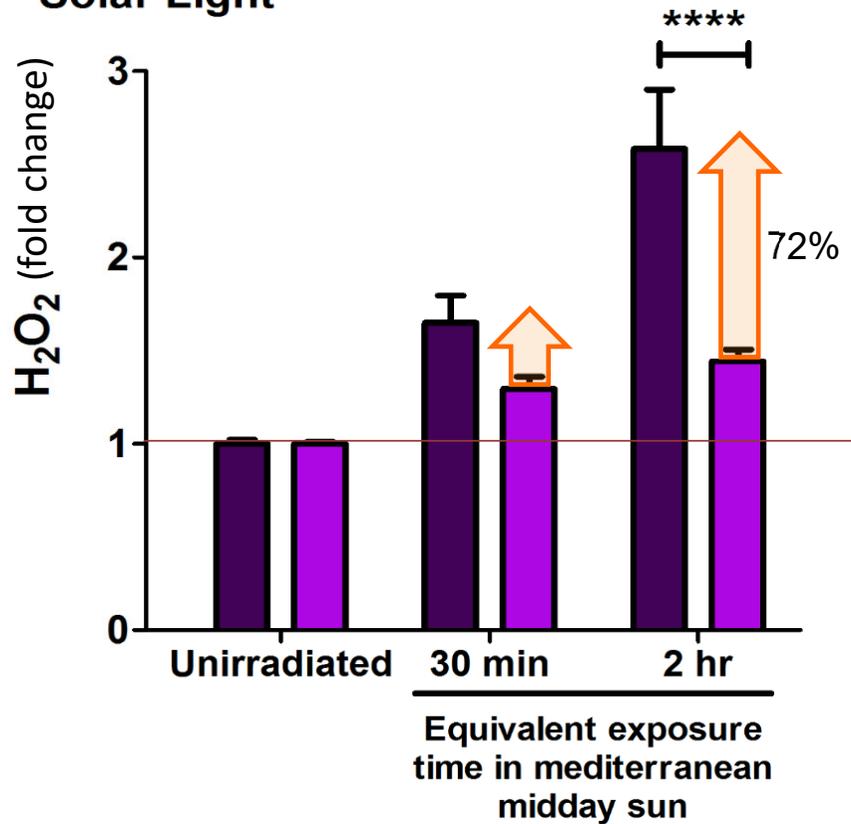
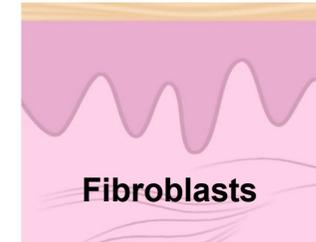
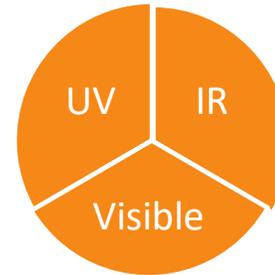
Antioxidant	H ₂ O ₂ (%)	P values	UVA (%)	P-Values
Tiron	100	*** (P<0.001)	100	*** (P<0.001)
Resveratrol	22	* (P<0.05)	22	*** (P<0.001)
NAC	20	n/s	8	n/s
Curcumin	16	* (P<0.05)	8	* (P<0.05)

Skin Ageing: surface and below



ROS - Impact of IR and Visible

■ Solar UV
■ Complete Solar Light



- The addition of IR and visible to the UV radiation has a **large impact** on ROS generation
- Suggests IR & Visible light significantly increase ROS production in Fibroblasts