Inspiration

- *physiology*: inhalation
- *stimulation of creativity or intellect*: spark, flash, eureka

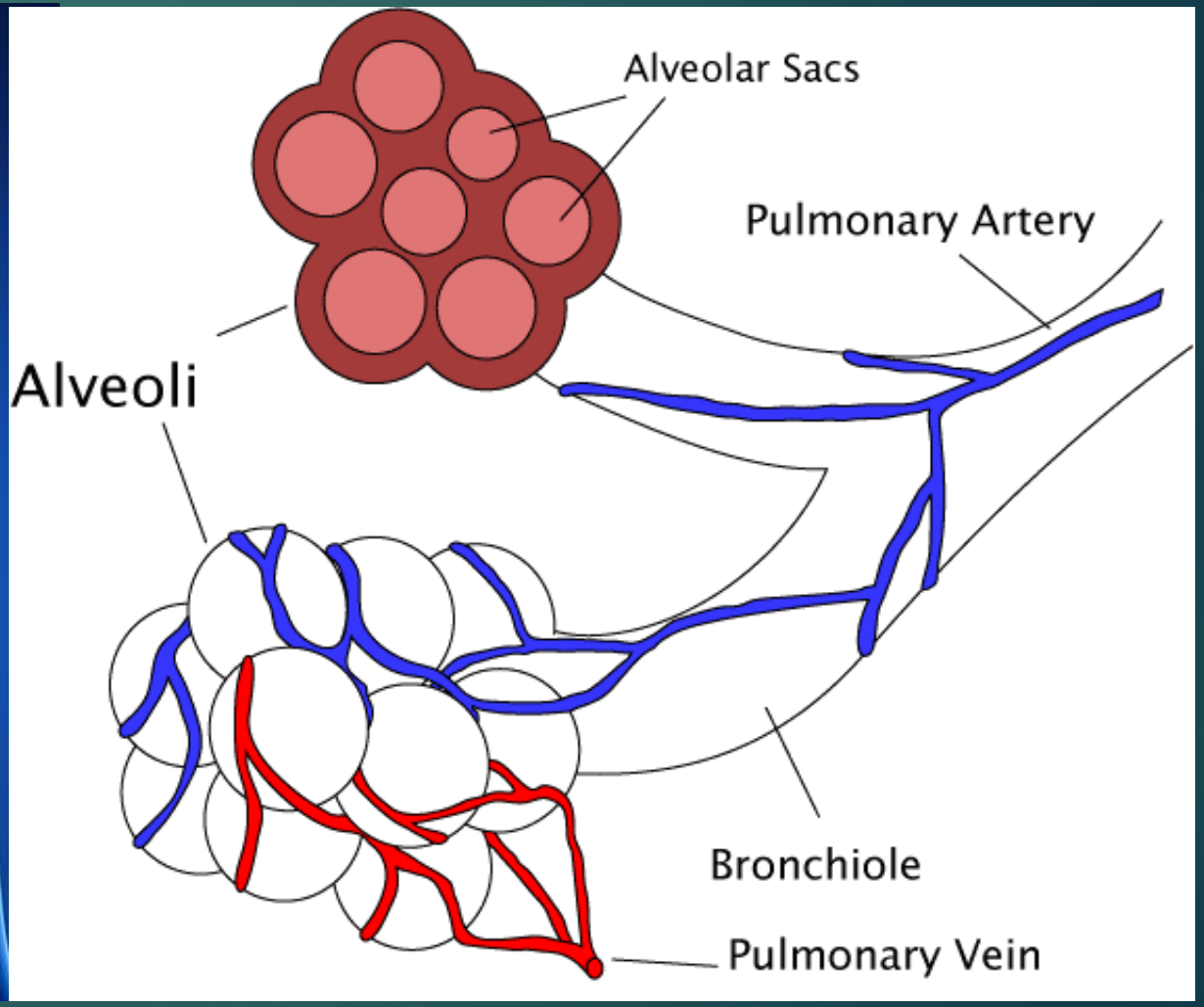
Inspire - Ancient Greek πνέω (pnéō, “breathe”)

SCIENCE

The Science behind the Wim Hof Method

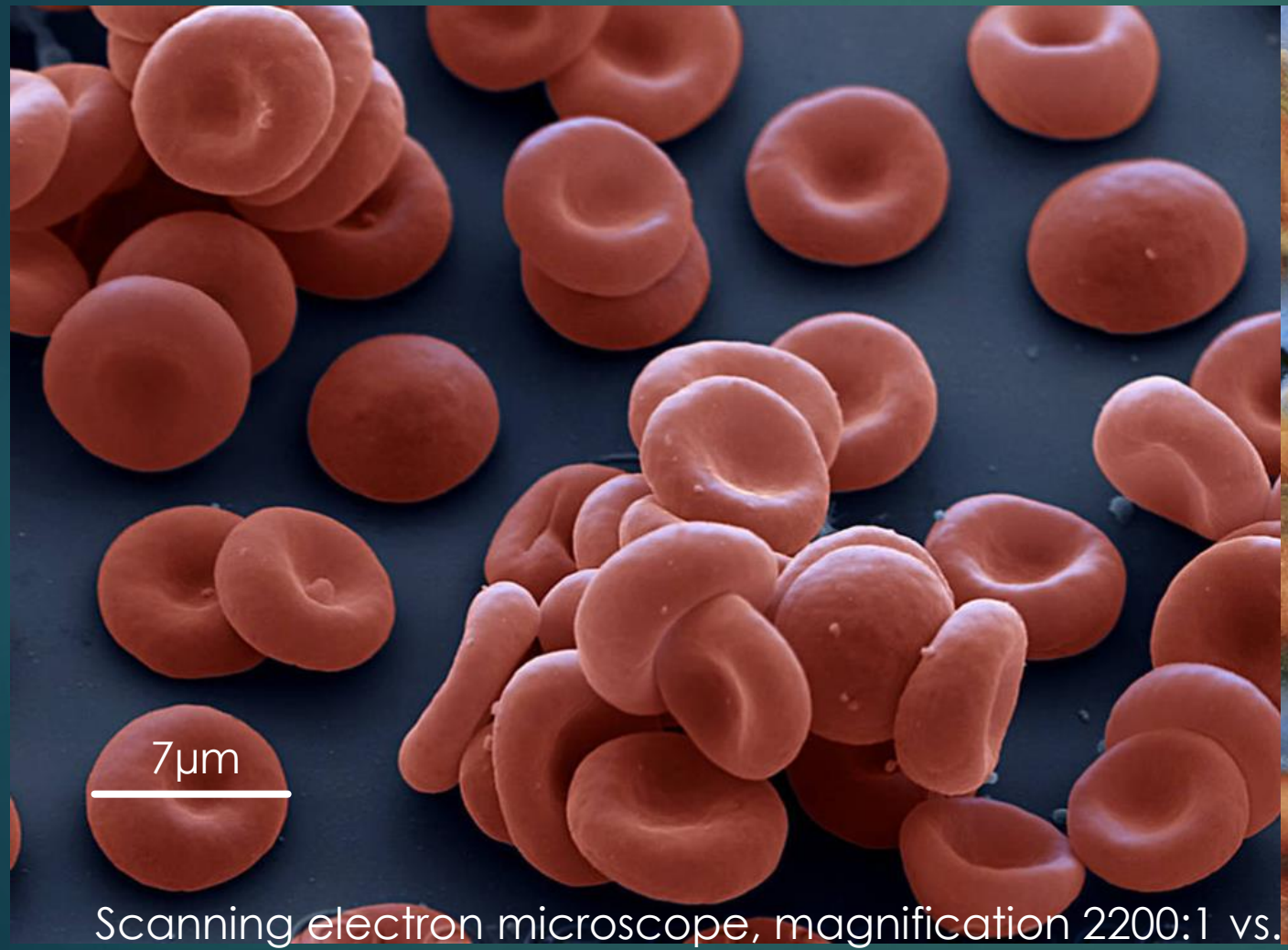
DR. JOSEPHINE WORSECK

Respiratory System



http://www.medpmr.com
https://www.globalhealingcenter.com https://en.wikipedia.org

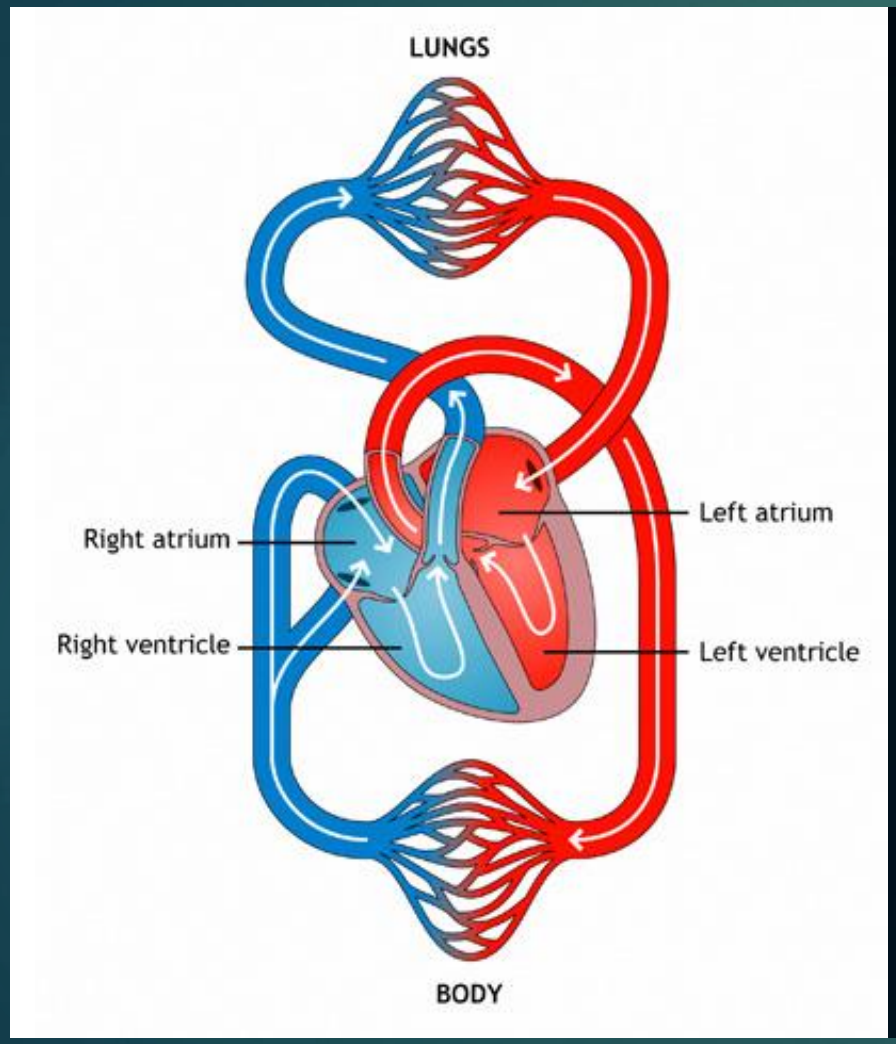
Erythrocytes & Alveoli

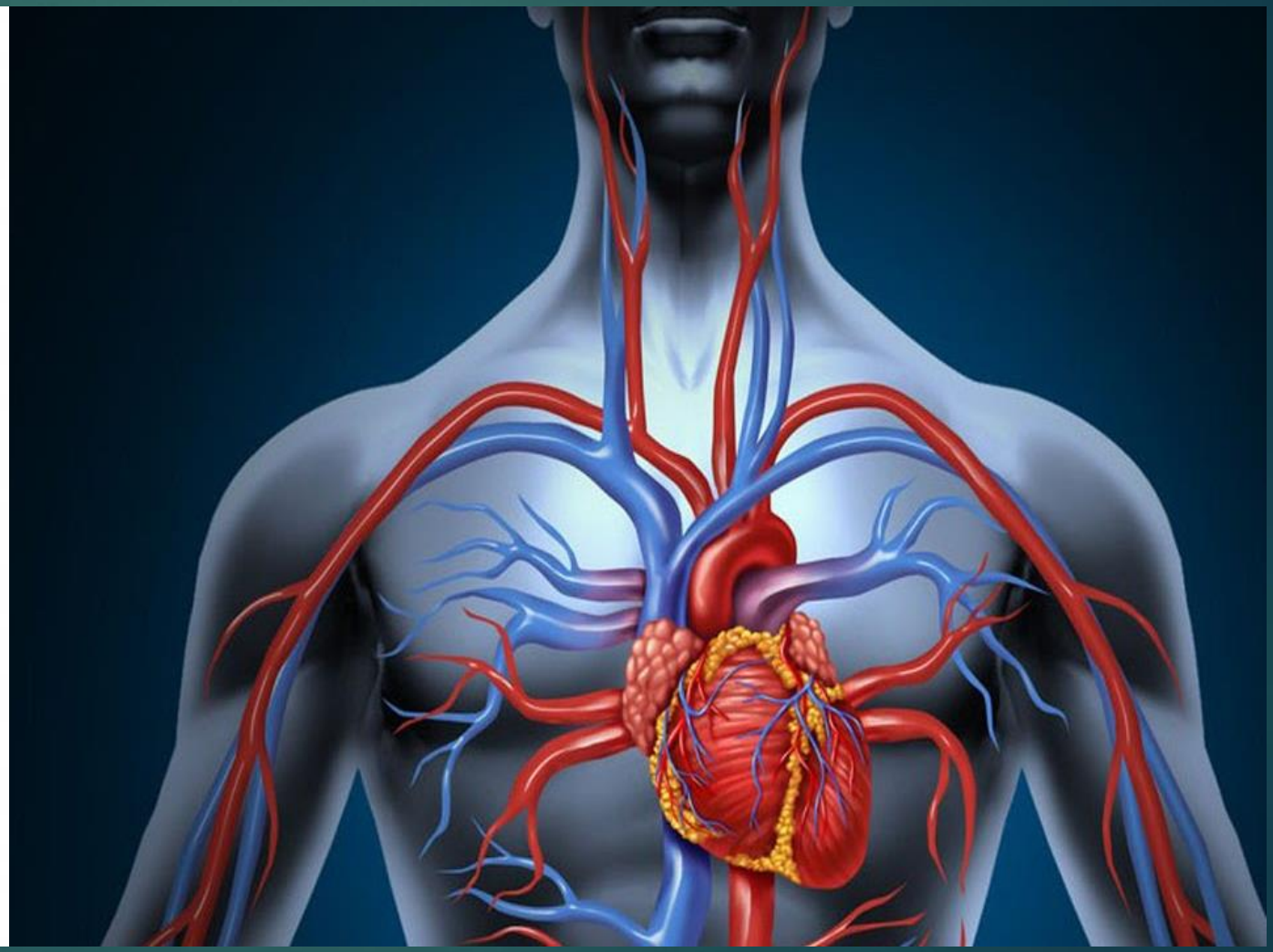


Scanning electron microscope, magnification 2200:1 vs. 1800:1

http://www.eyeofscience.de/en/medicine

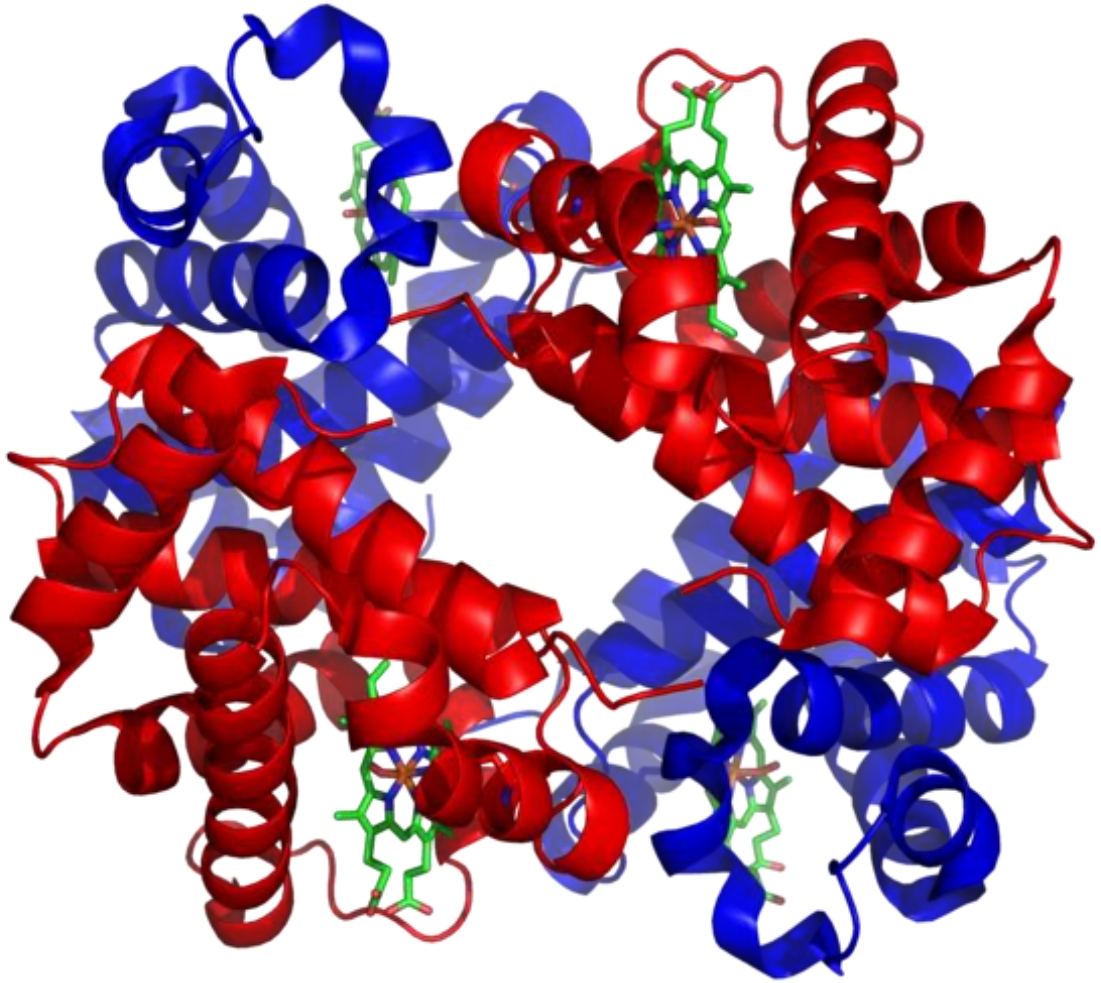
Cardiovascular System





The Royal Children's Hospital Melbourne https://www.rch.org.au
http://www.abcmedicus.com

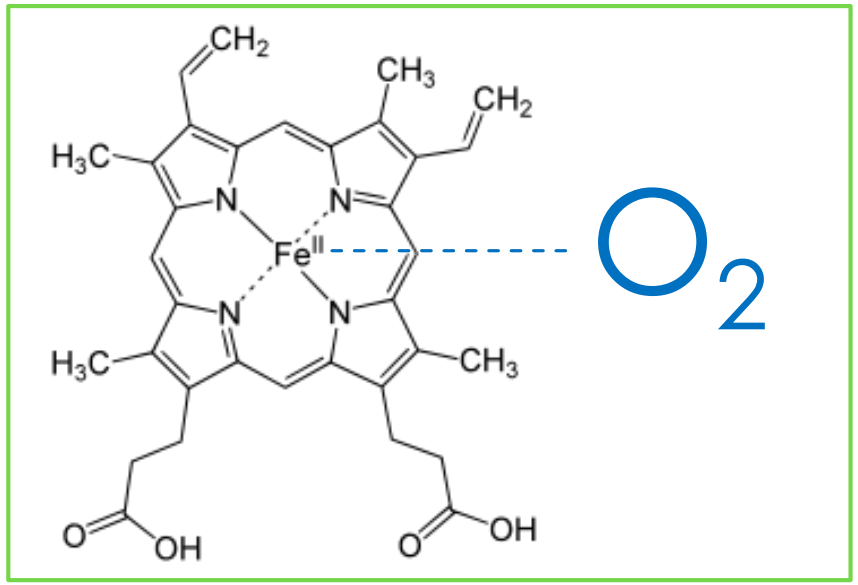
Structure of human Haemoglobin



a subunits

β subunits

Iron-containing heme group



https://en.wikipedia.org

Published Research

- PubMed Hits:
  - 12740 – Cold Exposure
  - 10629 – Hyperventilation (2334 – Respiratory Alkalosis)
  - 4567 – Meditation (4146 – Yoga)

Voluntary activation of the sympathetic nervous system and attenuation of the innate immune response in humans

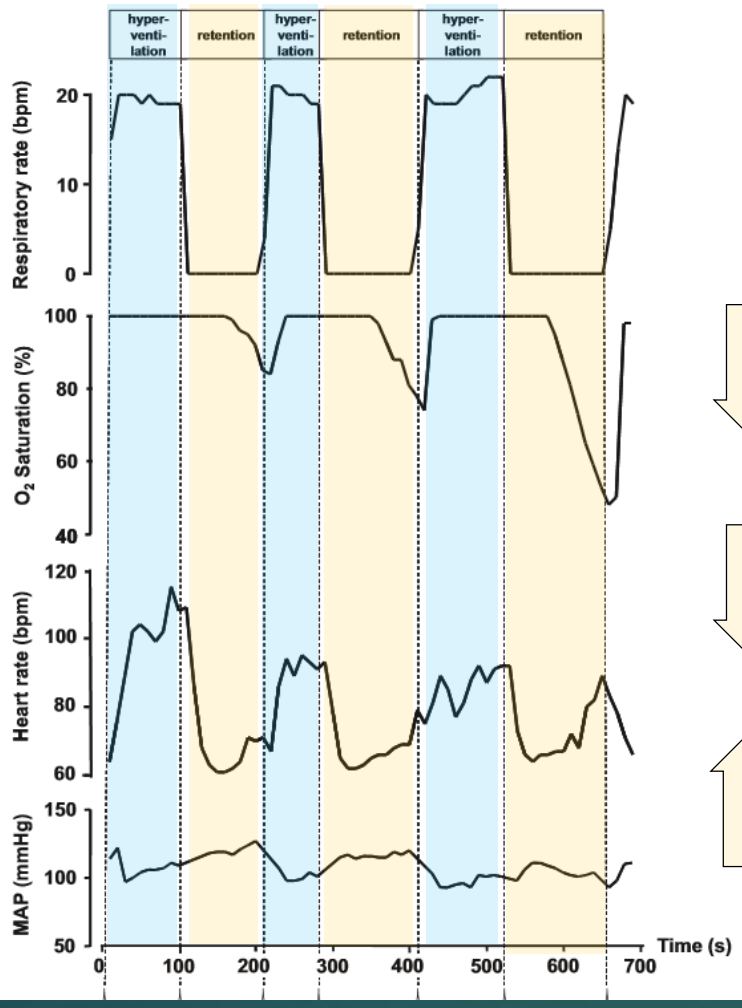
Matthijs Kox[a,b,c,1], Lucas T. van Eijk[a,c], Jelle Zwaag[a,c], Joanne van den Wildenberg[a,c], Fred C. G. J. Sweep[d], Johannes G. van der Hoeven[a,c], and Peter Pickkers[a,c]

Kox et al., PNAS 2014

Kox et al., 2014

Retention
Ø 0 breaths

Hyperventilation
Ø 20 breaths



Respiratory Rate
Ø 12 breaths per minute

O_2 Saturation
Ø 100% saturation

Heart Rate
Ø 60-80 beats per minute

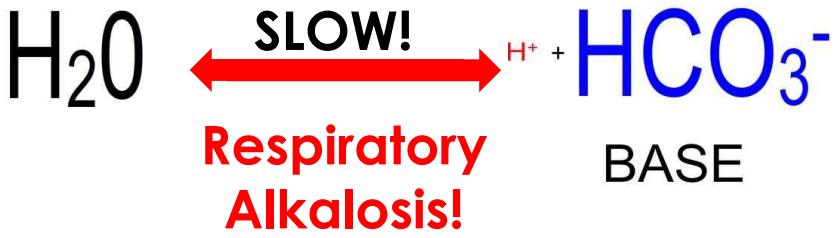
Mean arterial pressure (MAP)
Ø 65 -110 mmHg

Kox et al., PNAS 2014

Kox et al., 2014

Retention
Ø 0 breaths

Hyperventilation
Ø 20 breaths



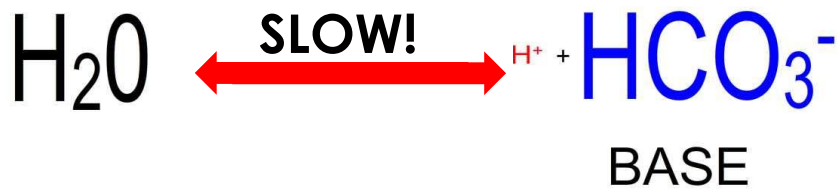
?

pH	7.40	7.66
pC02 (kPa)	4.49	2.11
pO2 (kPa)	16.5	22.0
HCO3- (mmol/l)	20.9	18.0
Lactate (mmol/l)	0.69	0.86

Kox et al., PNAS 2014

Kox et al., 2014

Retention
Ø 0 breaths
Hyperventilation
Ø 20 breaths



pH	7.40	7.66	7.44
pC02 (kPa)	4.49	2.11	4.01
pO2 (kPa)	16.5	22.0	5.6
HCO3- (mmol/l)	20.9	18.0	20.3
Lactate (mmol/l)	0.69	0.86	0.69

Where comes the CO_2 from?

Kox et al., PNAS 2014

Aerobic Fermentation

$C_6H_{12}O_6$

+

12 H_2O

+

6 O_2

↓

6 CO_2

+

24 H_2O

+

28 - 38 ATP

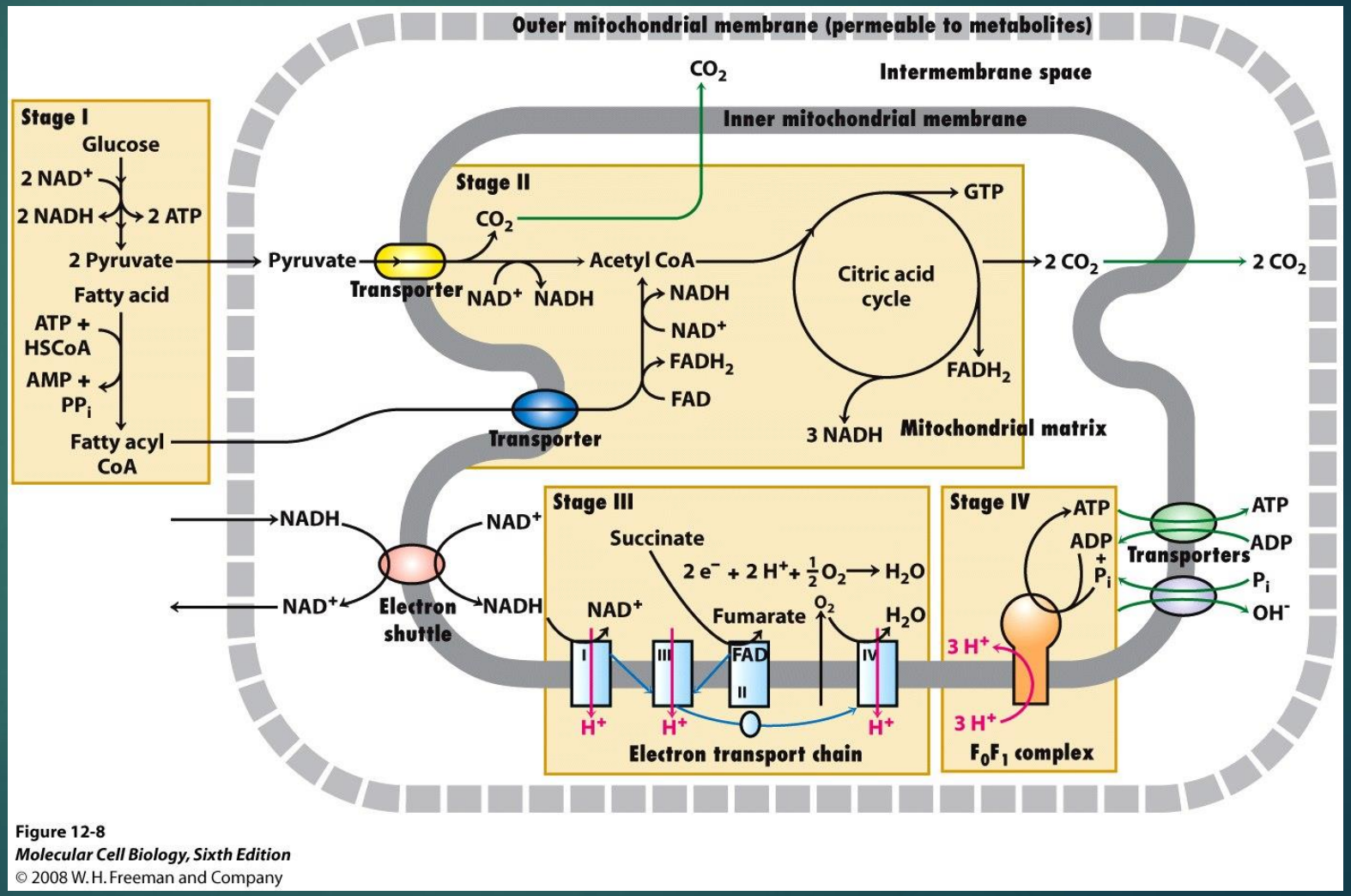
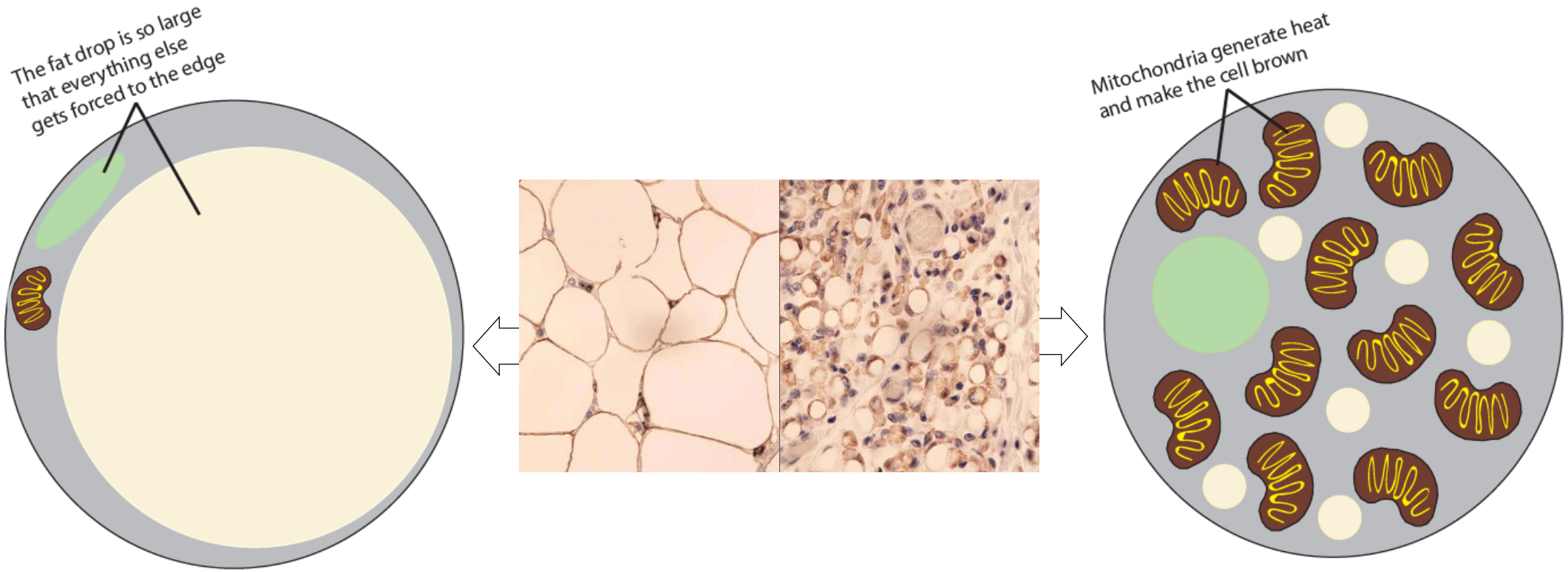


Figure 12-8
Molecular Cell Biology, Sixth Edition

Molecular Cell Biology, 2008

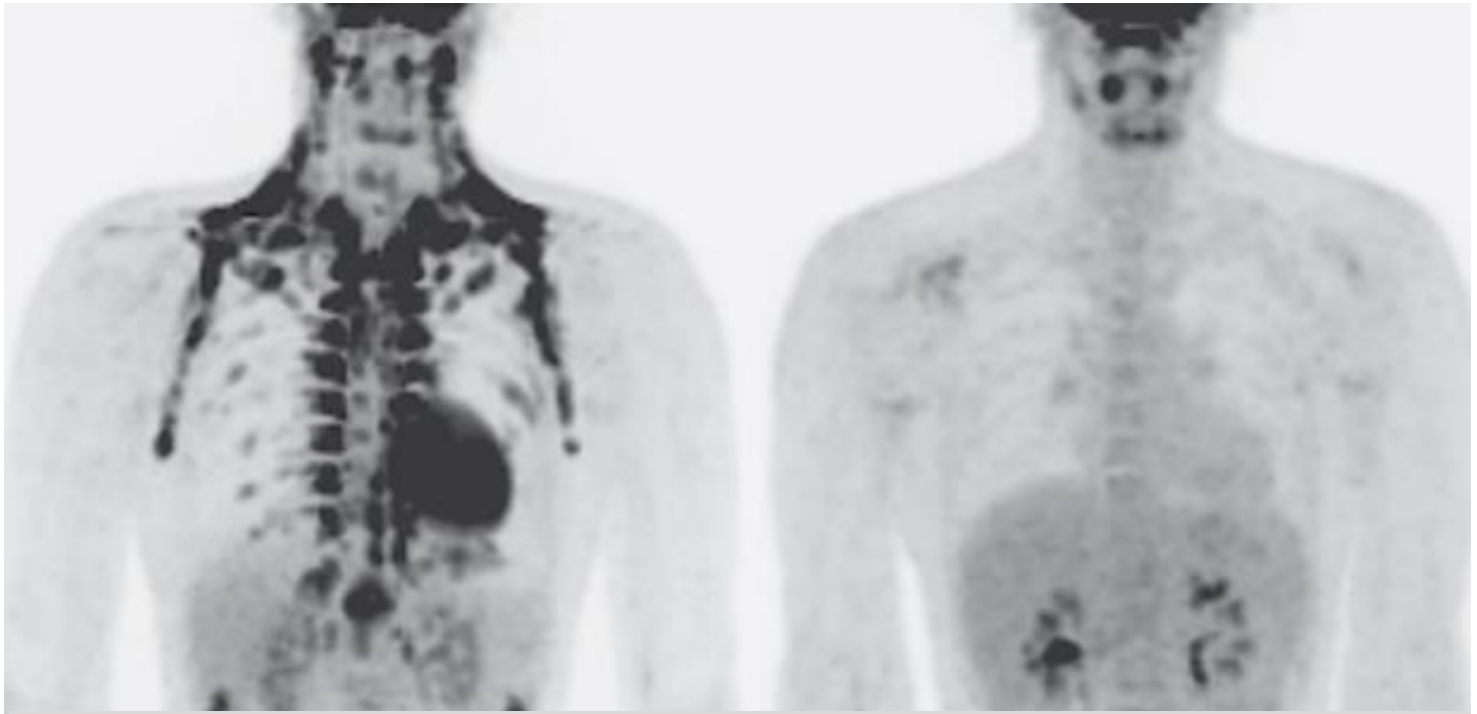
Brown Fat Tissue



http://www.sciencemag.org/
https://socratic.org/

Brown Fat Tissue Activity

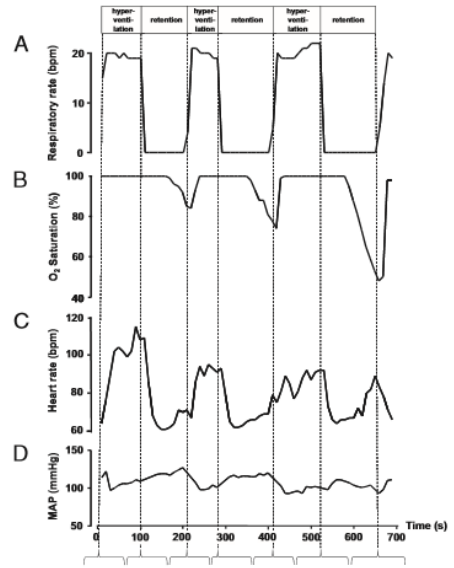
PET–CT
scan shows physiologic uptake and distribution of ^{18}F-fluorodeoxyglucose



Cold Exposure 16° C vs. Thermoneutral Conditions 22°C

Wouter D. van Marken Lichtenbelt et al., 2009

Kox et al., 2014



	Start	End hyperventilation	End retention	End hyperventilation	End retention	End hyperventilation	End retention
pH	7.40	7.66	7.44	7.67	7.46	7.75	7.50
pC02 (kPa)	4.49	2.11	4.01	2.03	3.76	1.69	3.48
pO2 (kPa)	16.5	22.0	5.6	22.9	4.8	22.6	3.4
HCO3- (mmol/l)	20.9	18.0	20.3	17.6	20.2	17.4	20.4
Lactate (mmol/l)	0.69	0.86	0.69	1.03	0.77	1.16	0.91

Fig. 2. Cardiorespiratory and biochemical changes during cyclic hyperventilation and breath retention in a representative subject of the trained group. (*A*) The respiratory rate alternately increased to around 20 breaths per minute (bpm) for several minutes, and then dropped to zero during voluntary breath retention. These cyclic changes in respiration resulted in profound changes in (*B*) oxygen saturation, (*C*) heart rate, and (*D*) mean arterial pressure. The data depicted were sampled from the monitor every 10 s. At the end of each hyperventilation phase and breath retention phase, an arterial blood sample was drawn for arterial blood gas analysis, of which the results are listed in the table below *D*. The cycles of hyper/hypoventilation in this particular subject can be viewed in Movie S2.

Voluntary activation of the sympathetic nervous system and attenuation of the innate immune response in humans

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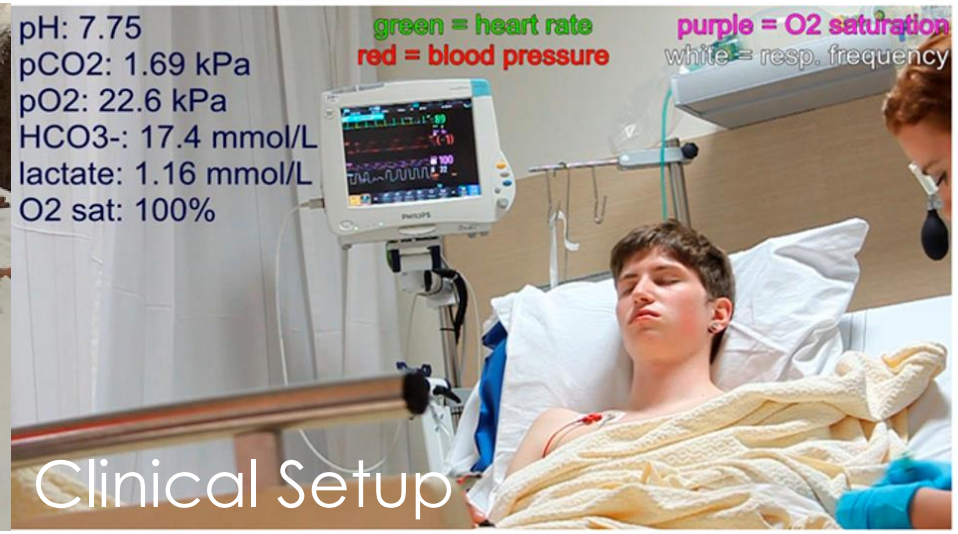
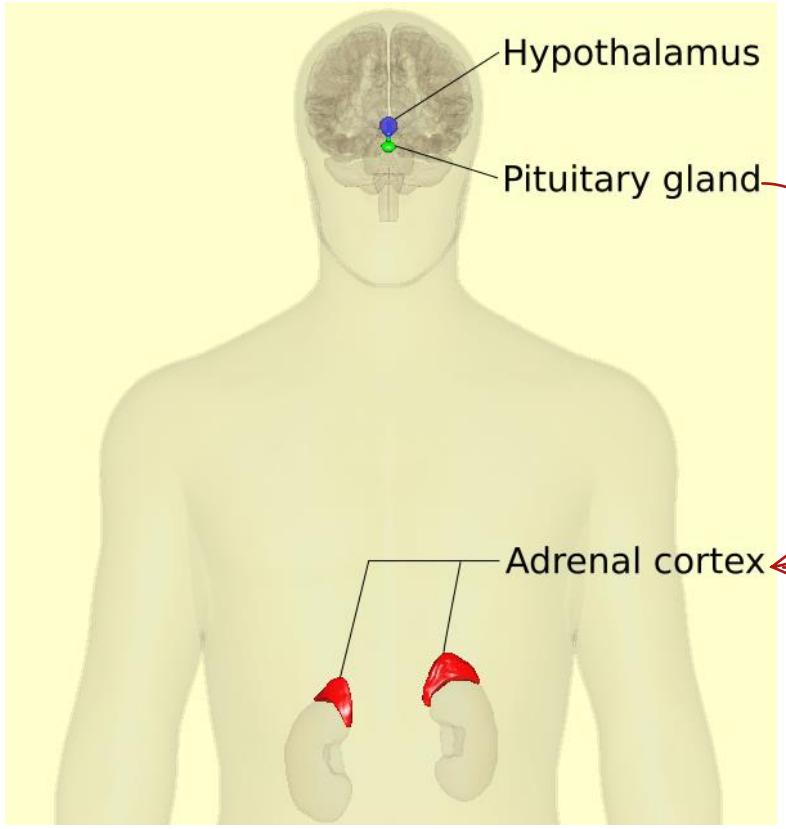
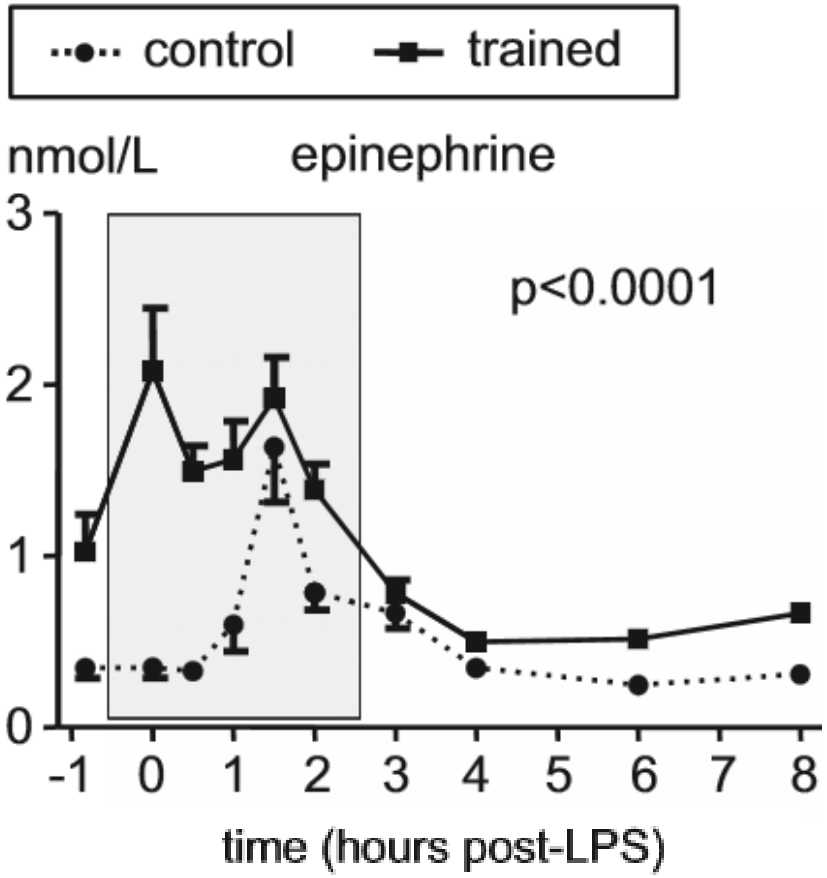


Kox et al., PNAS 2014

Sympathic Nervous System

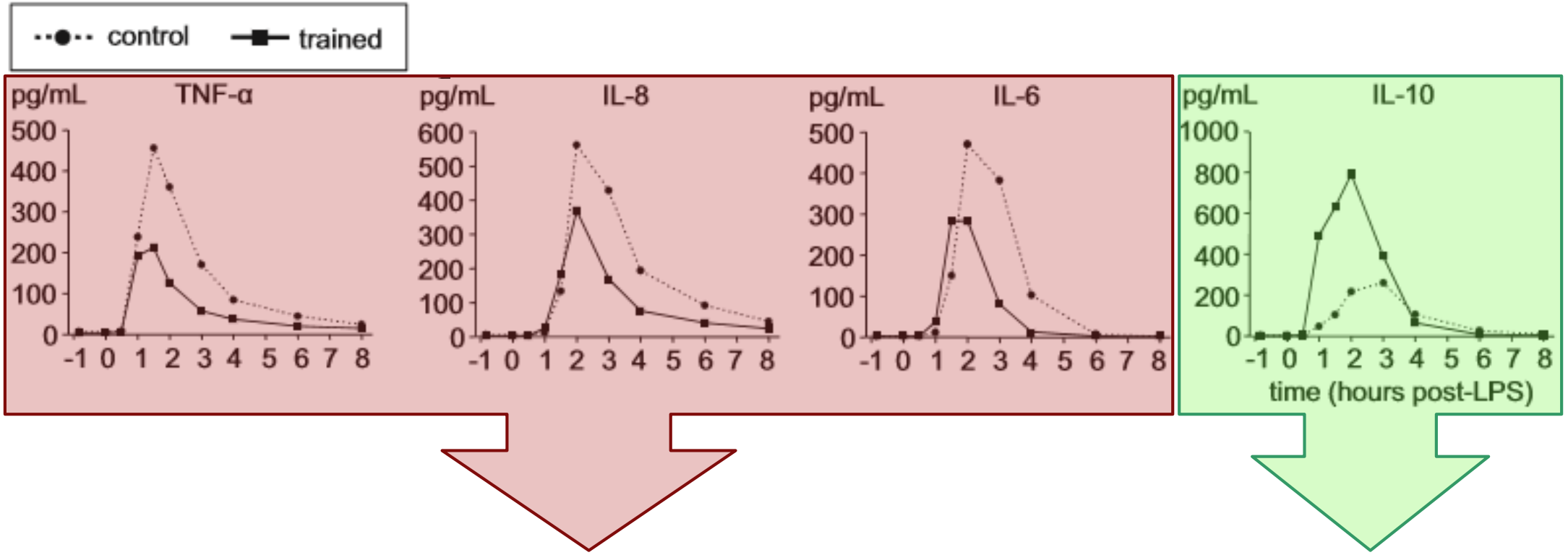


- Adrenaline = Epinephrine



Kox et al., PNAS 2014
https://en.wikipedia.org/

Innate Immune Response



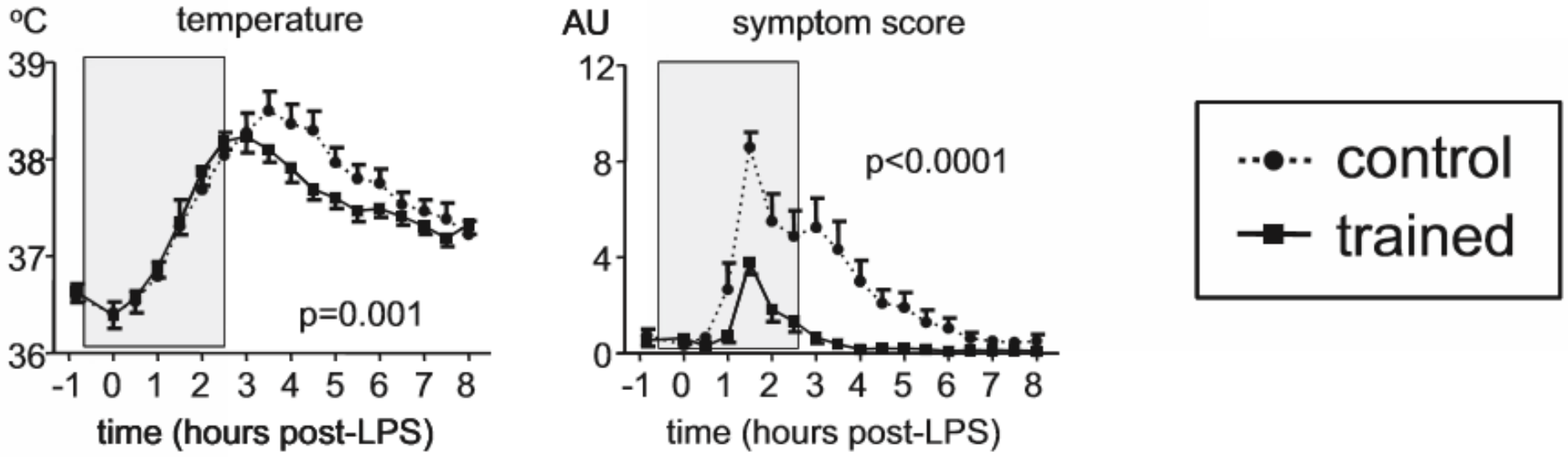
Proinflammatory cytokines
are significantly attenuated

Anti-inflammatory cytokine
IL-10 is markedly increased

Kox et al., PNAS 2014

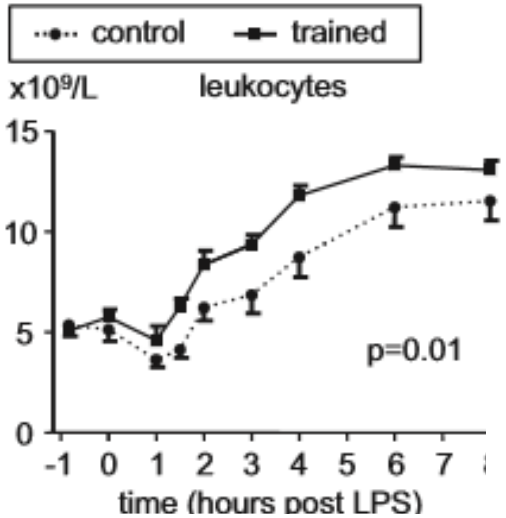
Proinflammatory Cytokines

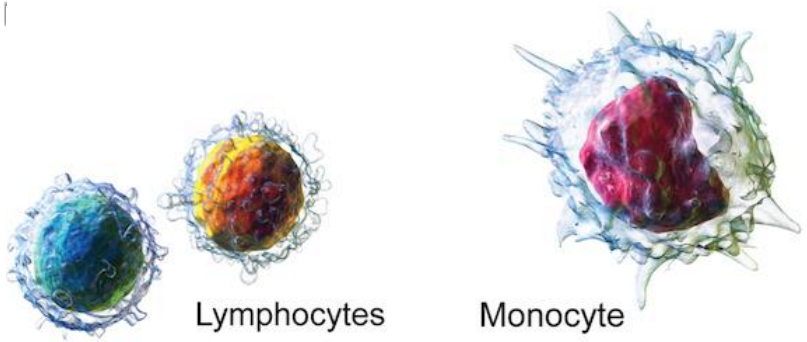
- trigger pathological pain (Zhang, 2007)
- cause fever, inflammation, tissue destruction (Dinarello, 2000)



Kox et al., PNAS 2014

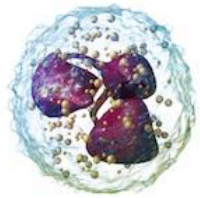
Leukocytes





Lymphocytes
20-25%

Monocyte
3-8%



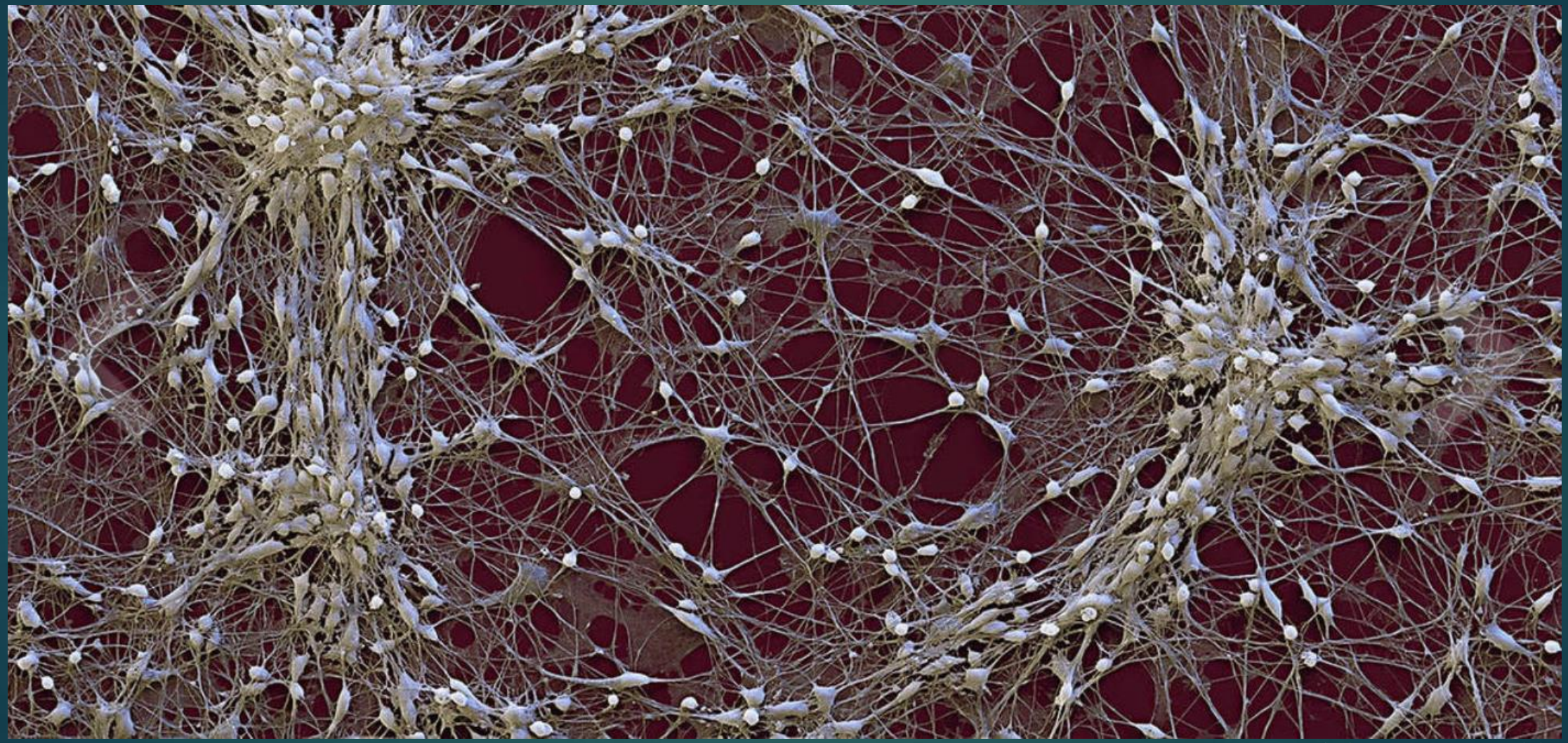
Neutrophil
60-70%

Digest bacteria and damaged tissue

B-lymphocytes produce antibodies
T-lymphocytes are involved in cell-mediated immunity

Kox et al., PNAS 2014

Connecing the dots…



http://www.eyeofscience.de/en/medicine