

SPORTSTAF 29/09/2010

Hoogtetraining

Johan Roeykens

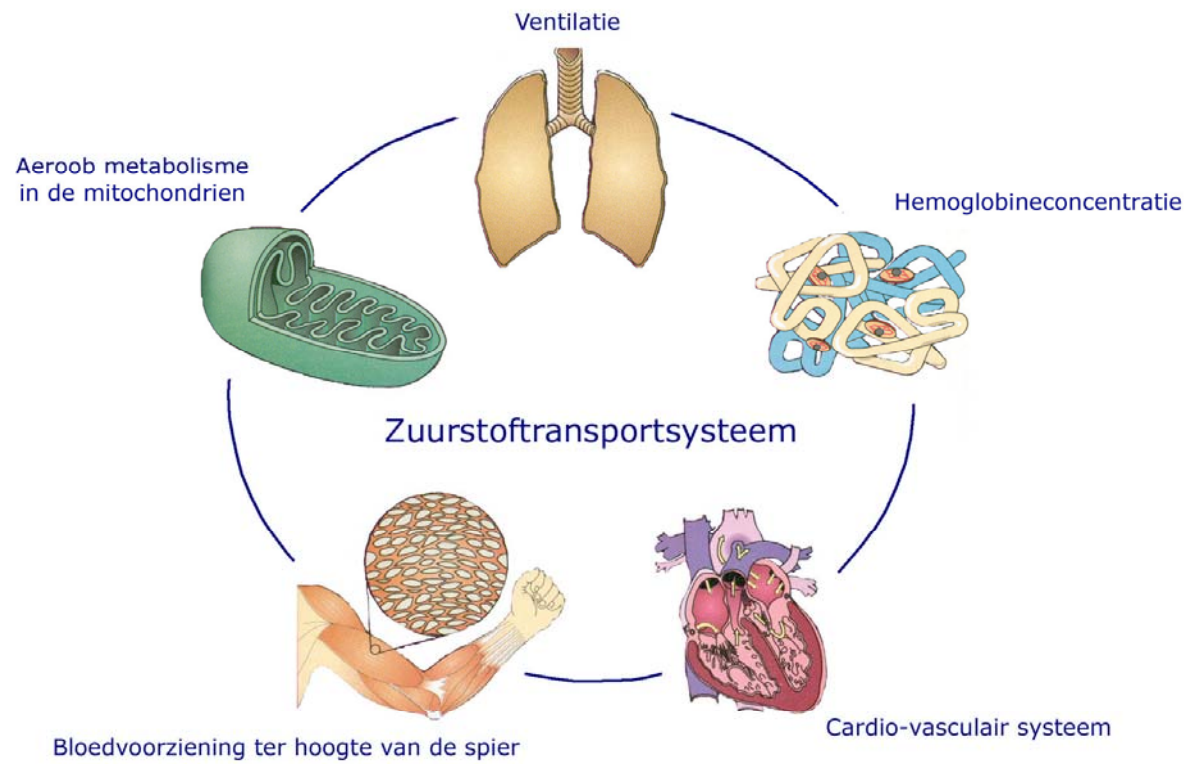


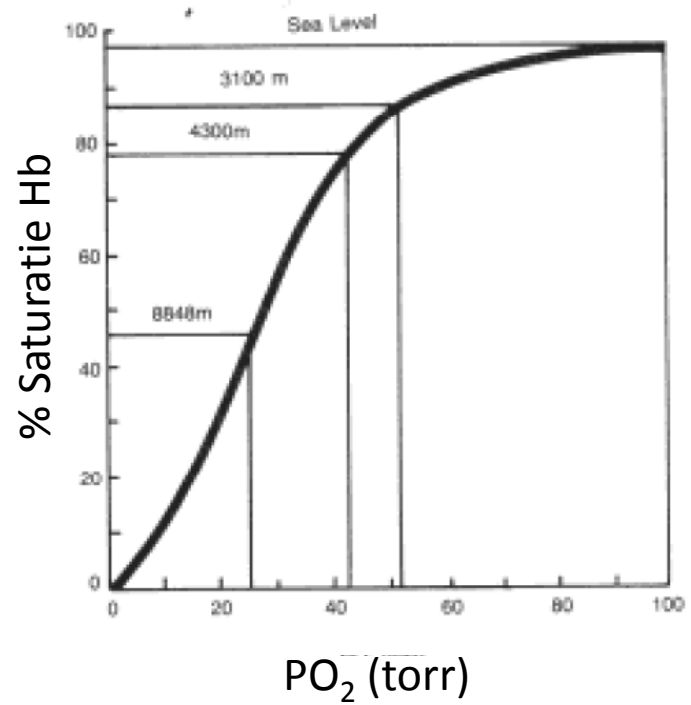
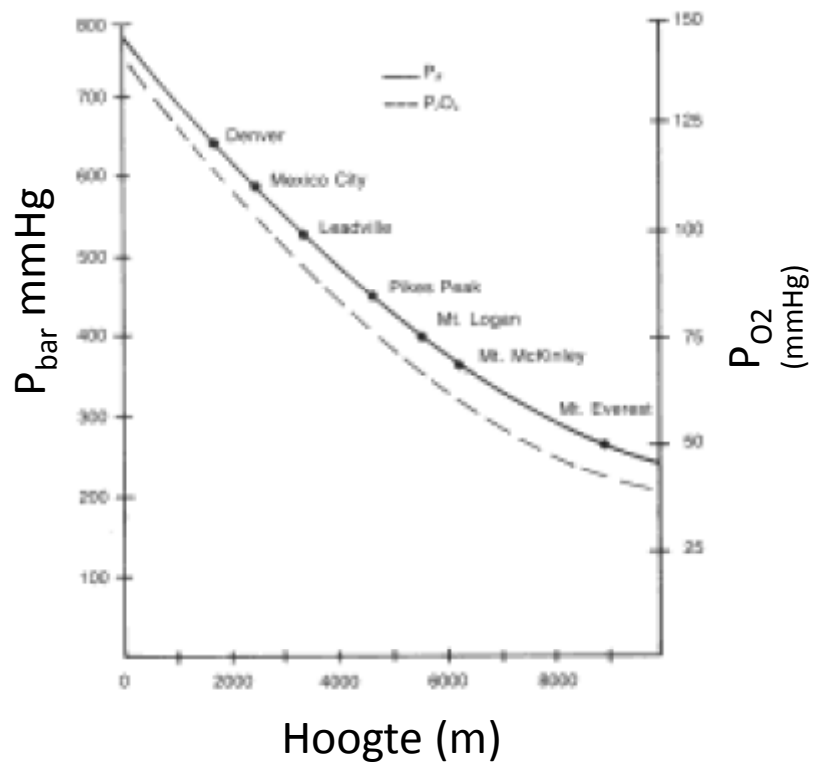
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Is Hypoxia Training Good for Muscles and Exercise Performance?

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Acute blootstelling

- $VO_2\text{max}$: ↓ vanaf 300 – 800 m
 - 0.9% / 100m boven 1100m (Wehrlin et al., EJAP 2006)
 - $M > V$
 - Sporters > Sedentairen
 -

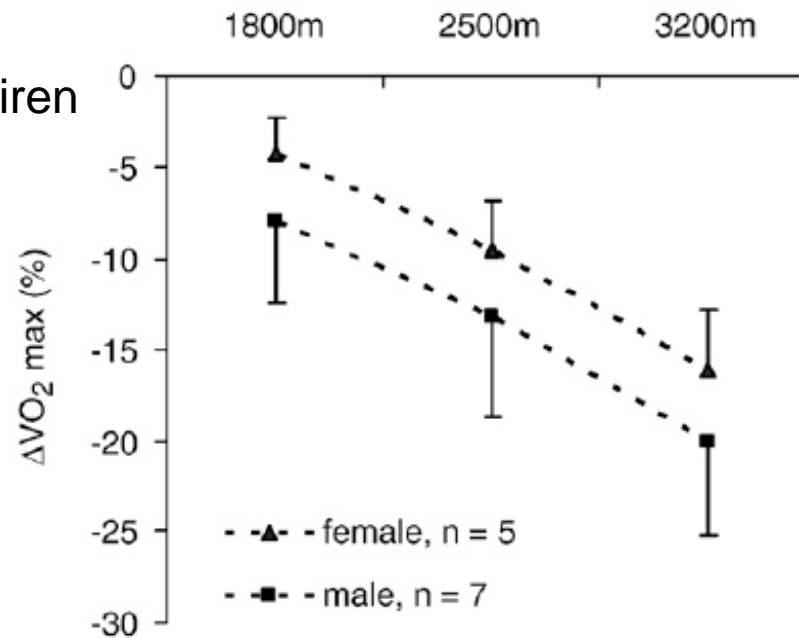
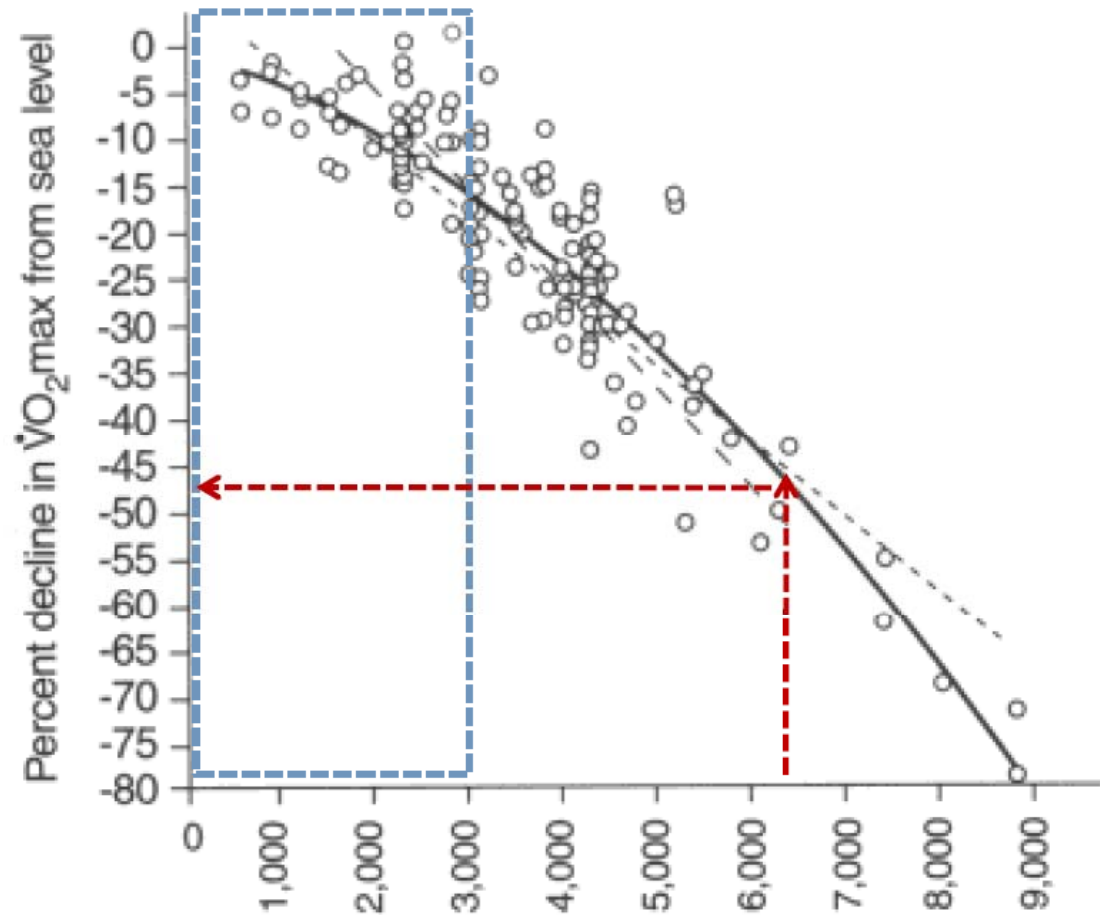


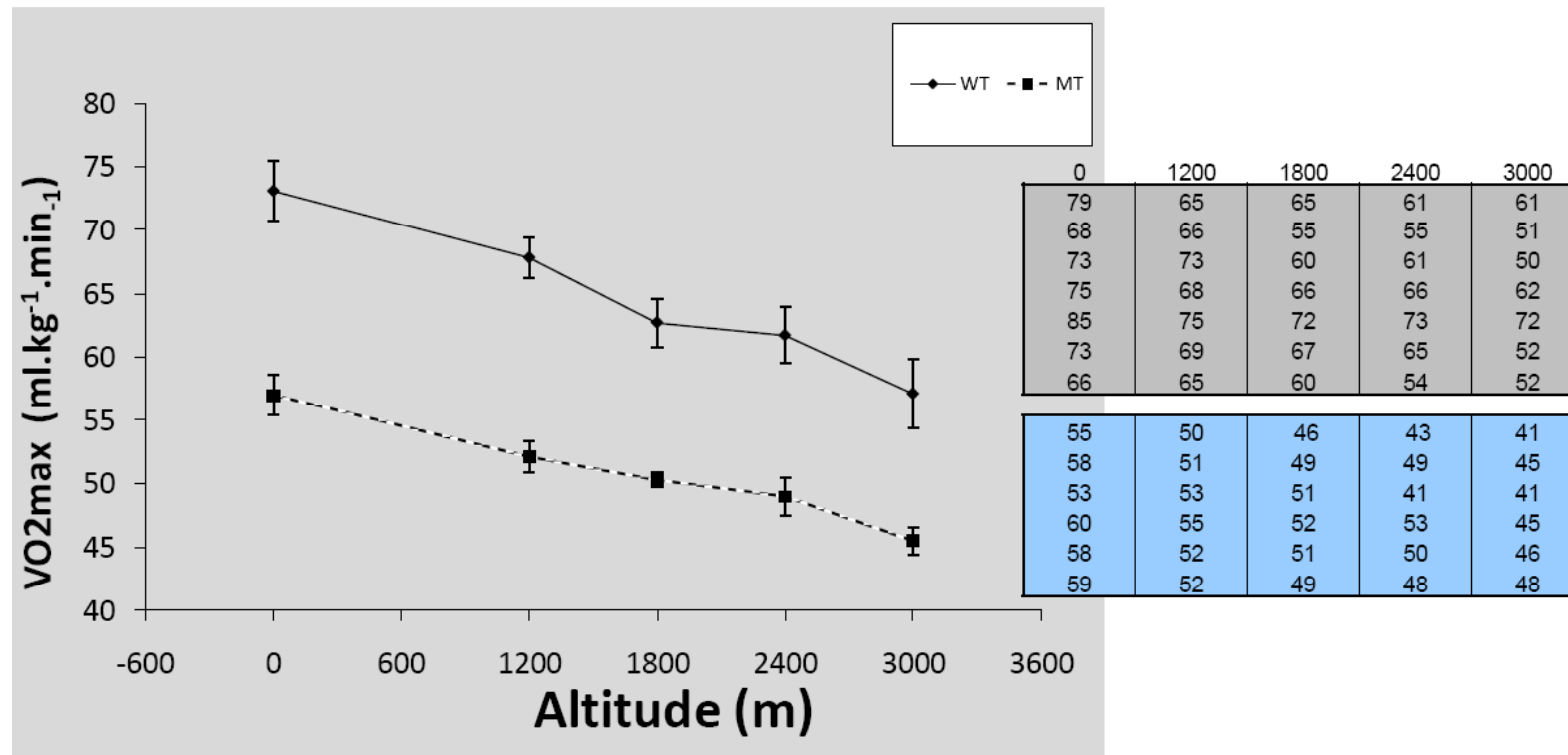
Fig 1. Sensitivity to hypoxia in elite cross country skiers. $\Delta VO_2\text{max}$ (%) = percentage difference between $VO_2\text{max}$ measured near sea level (500 m) and different simulated altitudes (1800 m, 2500 m, 3200 m).

VO₂max in hypoxia



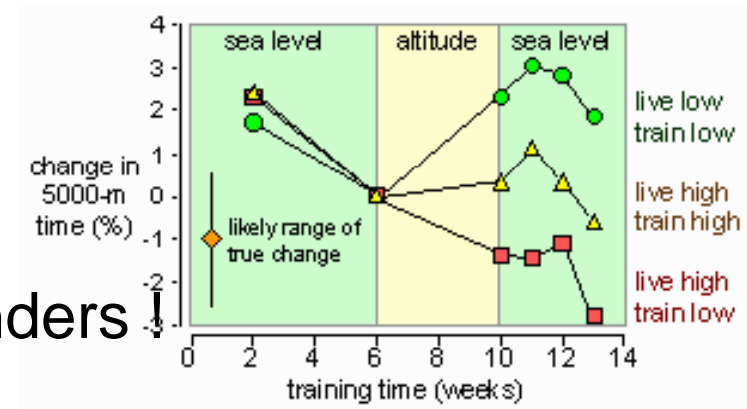
Bron: Hespel, P.

- Individuele respons op hoogte verschilt



- 1968: OS Mexico (2300m)
 - Voorbereiding op hoogte door acclimatisatie
 - n weken: Hb \uparrow maar prestatie op zeeniveau? OF \downarrow
 - Meer overtuiging dan hard bewijs
- 1997: Live high – train low concept

(Levine & Stray-Gundersen, JAP, 1997)



– Responders vs non responders

- Doel LHTL:

vooral O₂-transport aanpassingen
(hematologisch, spierniveau, ...),
zonder lagere trainingsintensiteit (detraining).

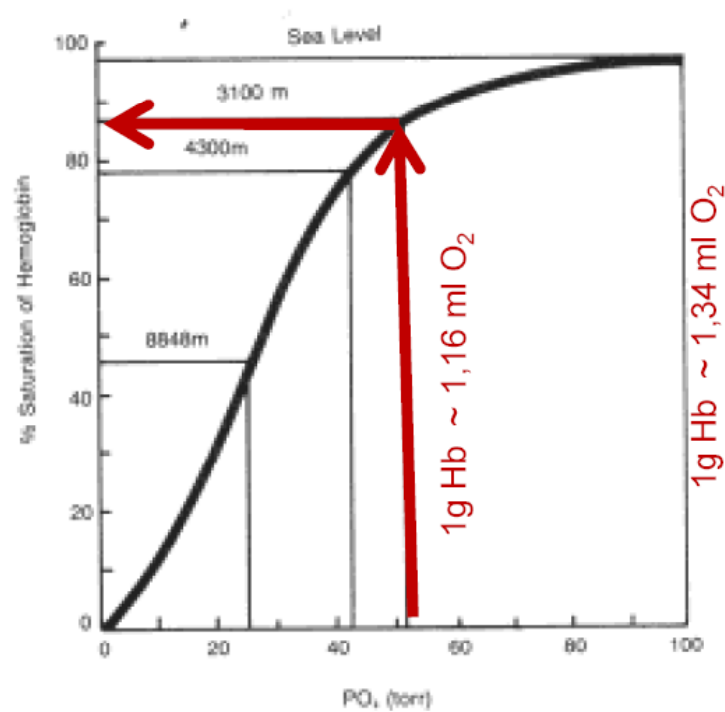
? Anaërobe sporten ?



Hypobare hypoxie

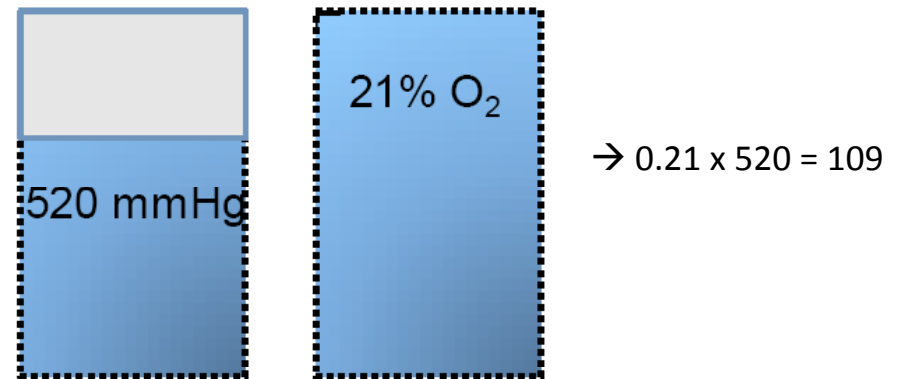
Normobare hypoxie



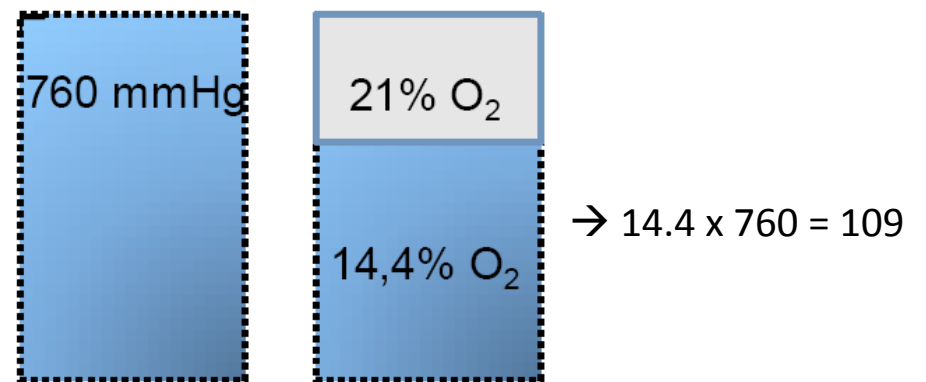


P_iO₂ : 109 mmHg

Hypobaric Hypoxia



Normobaric Hypoxia



- **Live low – train high** concept (laatste 10j):

Counteren van effecten van permanent of lang verblijf >5000m (LHTH)

→ negatief effect op skeletspieren en bijkomende (medische) complicaties

- vb: Himalaya expedities :

(-10 tot 15% spiervolume + 20 tot 25% verlies spiervezel diameter. Geen verandering in spiervezeltype. Daling oxydatieve capaciteit (mitochondrion), toename van glycolitische capaciteit.)

→ Recent (2007 en 2010): Cauldwell Extreme Everest expedition



Patron HRH The Duke of Edinburgh, KG, KT



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Welcome

Caudwell Xtreme Everest is a research project coordinated by the UCL Centre for Altitude, Space and Extreme environment medicine (CASE) - doctors and scientists studying human systems stretched to breaking point in extreme environments to increase our understanding of critically ill patients.

The group placed a research team on the summit of Mount Everest in May 2007 and made the first ever measurement of the level of oxygen in human blood at 8400m, on the balcony of Everest. This was the centrepiece of an extensive and continuing programme of research into hypoxia (low oxygen levels) and human performance at extreme altitude aimed at improving the care of the critically ill and other patients where hypoxia is a fundamental problem.



Xtreme Alps



HUMAN PHYSIOLOGY AT EXTREME ALTITUDE

[Xtreme Alps Website>](#)

Latest Blogs



 **Kay Mitchell**

 23rd Dec 2009

 1 message

Getting ready for the

Exploring Human Physiology at Extreme Altitude

<http://www.xtreme-everest.co.uk/> (cfr. BBC-reportages)

- Chronische blootstelling aan hypoxie:

Veranderingen op spierniveau:

→ daling in spierproteïne synthese?

→ daling van de belastbaarheid (intensiteit)?

Oplossing: Intermittente blootstelling ??

- **Effect Live Low – Train High op prestaties op zeeniveau:**

Review Vogt & Hoppeler:

9 studies op getrainden

12 studies op nt-getrainden

! Geen dubbelblind onderzoek mogelijk !

- Verschillende protocollen, expositieduur en hoogte → zie tabel

- geen effect op hematologische parameters

- geen consistent effect op LaMax

- geen effect op Pmax GXT, Pmean Time-Trial, Time Time-Trial

Besluit: GEEN functioneel voordeel LLTH, maar ...

Table 1
The “live low–train high” training protocols

	Intermittent intensity protocol	Intermittent hypoxia protocol	Threshold training I protocol	Threshold training II protocol	Low-intensity hypoxia training protocol
Method	Change between high and low intensity in hypoxia	Change between 5-min periods of training in hypoxia and 5-min rest periods in normoxia	Constant load at “respiratory compensation point” threshold	Constant load at “respiratory compensation point” threshold hypoxia training	Low to moderate intensity–high-volume hypoxia training
Duration	3-6 wk	3-6 wk	3-6 wk	3-6 wk	1-2 wk
No. of sessions	2-3/wk	2-3/wk	2/wk	3-5/wk	6-7/wk
Duration per session	30-40 min	60 min	Increasing weekly exposure duration wk 1, 2: 2 × 10 min, 5 min wk 3, 4: 2 × 15 min, 5 min wk 5, 6: 2 × 20 min, 5 min	30 min	90-120 min
Intensity	2 min, 90%-95% HR _{max} ; 3 min, 75%-80% HR _{max} (in the change over the entire session)	90%-95% HR _{max}	85%-90% HR _{max}	85%-90% HR _{max}	75%-80% HR _{max}
Altitude	2500-3000 m, natural or artificial hypoxia	3000-5000 m, artificial hypoxia	2500-3000 m, natural or hypoxia	3000-3500 m, natural or artificial hypoxia	2000-3000 m, natural or artificial hypoxia
Supplementary training	Low intensity–high volume (70%-75% HR _{max}) endurance training in normoxia	Low intensity–high volume (70%-75% HR _{max}) endurance training in normoxia	Low intensity–high volume (70%-75% HR _{max}) endurance training in normoxia	None	None (for endurance training)
Target group	Athletes	Athletes	Athletes	Untrained subjects	Athletes

- Methodologische verschillen
 - hoogtestimulus: 2300 tot 5700 m
 - duur interventie: 10 d tot 8 weken
 - Intensiteit: 50 tot 80% VO₂max
 - Intensiteit: relatief of absoluut !!

Besluit: te weinig evidentie voor uniform advies,
maar een aantal bevindingen dienen verder
onderzocht ...

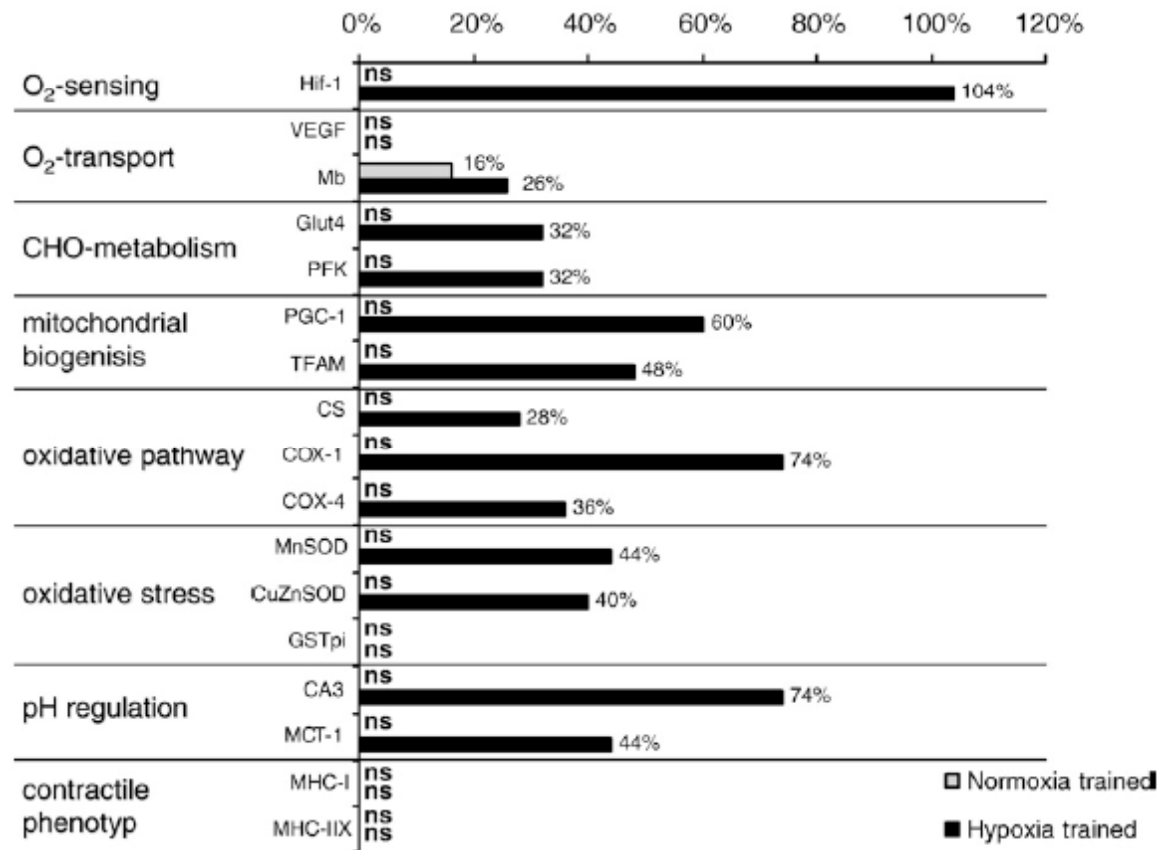
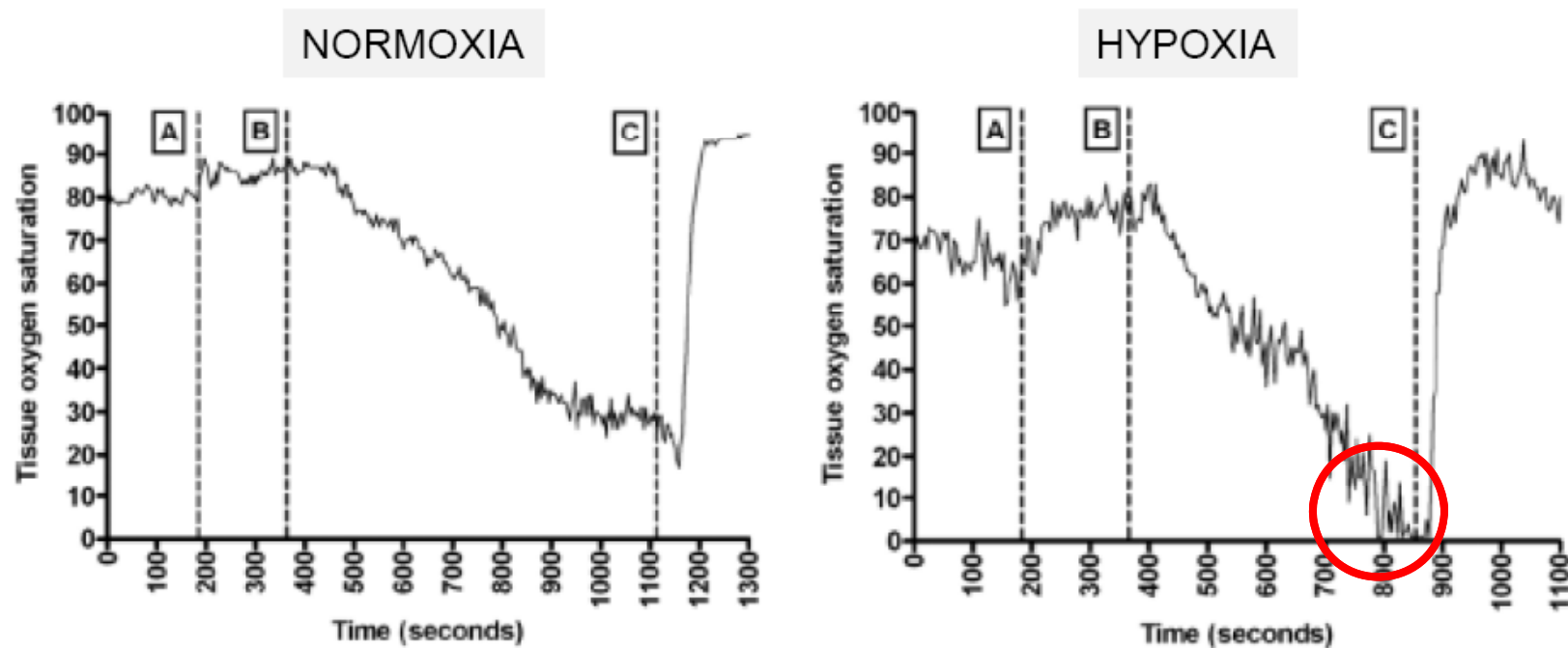


Fig 2. Change of the concentration of different mRNAs measured in musculus vastus lateralis of trained runners subjected to a 6-week training period with addition of either high-intensity hypoxic or normoxic training. ns indicates no significant difference between pretraining and posttraining measurements (data from Zoll et al (2006)³⁷).

- Zuurstofsaturatie in weefsel (NIRS)



- Effect LLTH op spierweefsel
 - meer metabole stress → vergrote spieradaptatie ⚡ risico op 'overreaching'

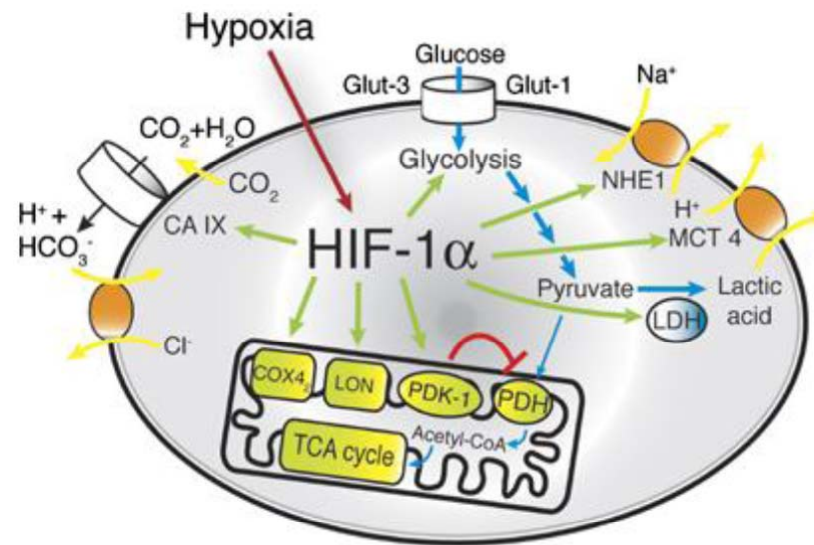
Oxydatieve capaciteit (# mitochondriën, CS-enzym, ...) → rol van INTENSITEIT

bv. 80% $Watt_{max}$ zeeniveau vs. 80% op hoogte

0 m: 400 $Watt_{max}$ → 320 Watt (intensieve training)

4000 m: 266 $Watt_{max}$ (-30%) → 213 Watt

- Glycolytische capaciteit
Effect op HIF-1 factor



- Capillair bed (Vascular Endothelial Growth Factor)

- Algemeen advies Vogt en Hoppeler

Geen hard bewijs ... atleten doen het.

Voorwaarden & aanbevelingen (Vogt en Hoppeler) :

- Gezond en goed getraind
- Check-up (bloedanalyse, ...)
- Sportvoeding (CHO !)
- Vermindering van intensieve normobare training
- Peak: 7-10 dagen na laatste training in hypoxie
- 3-4 weken effect

Vorzichtigheid geboden bij gebruik:

- PCO_2 (onvoldoende ventilatie)



Aanbevelingen P. Hespel (2)

- Optimale hoogte LHTH & LHTL
2200 – 2500 m stimulering erythropoïese
3000 m stimulering spieradaptaties

→ gevolg: elke trainingslokatie < 2000m ...

Aanbevelingen P. Hespel (1)

- Optimale duur LHTH & LHTL

± 4 weken voor RBC (ev. Combinatie
hoogtestage + normobare hypoxie)

± 2-3 weken voor spieradaptaties

Min 12u/dag ,

Aanbevelingen P. Hespel (3)

- LLTH (hypoxietraining)
 - Pre-competitiefase
 - 2 tot 3x/wk – 3 tot 6 weken
 - 3000 m of hoger
 - INTENSIEVE training (AD of hoger)
 - 30 tot 60 min (blokken van 10 tot 20 min)
 - afwisselende blokken Hyp / Norm

Bron: P. Hespel, Hoogte- en hypoxietraining in wielrennen. Wat is de evidentie? (29/6/2010 – Leuven)