HOW TO APPLY DIFFERENT ALTITUDE TRAINING METHODS IN PRACTICE?

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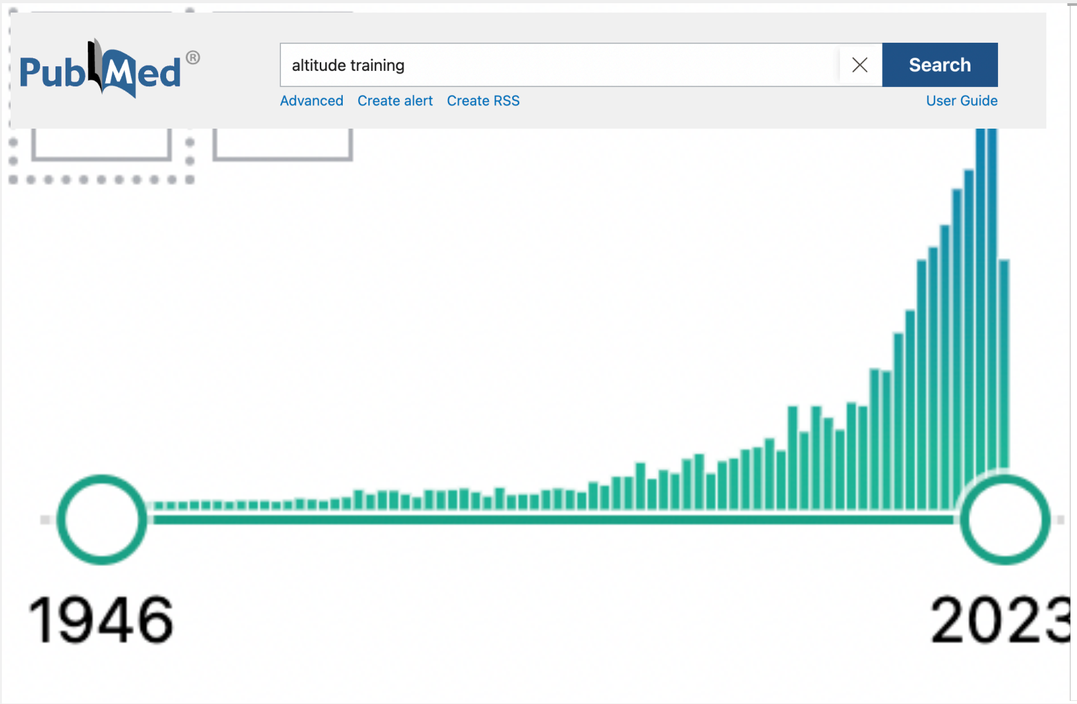
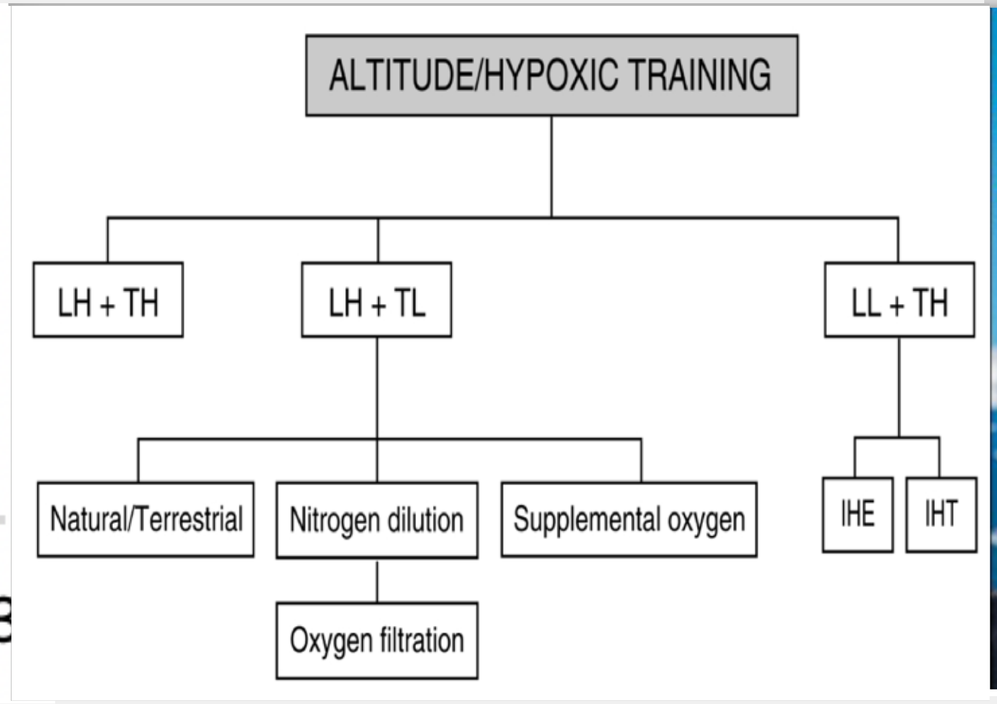
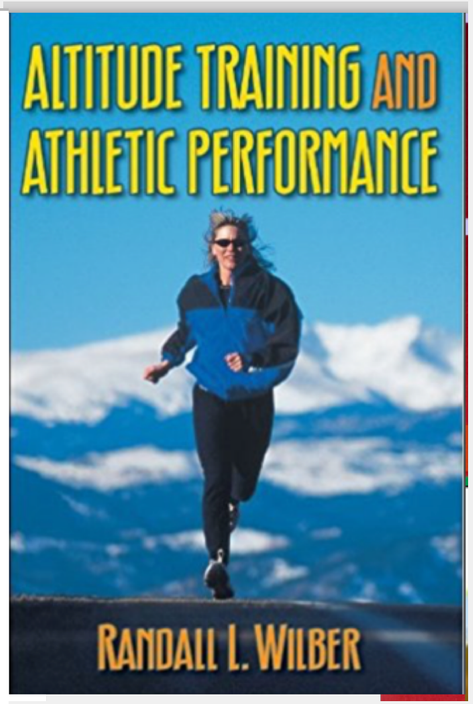
Zaragoza University

PANORAMA OF THE DIFFERENT ALTITUDE TRAINING METHODS USED IN THE EARLY 2000s



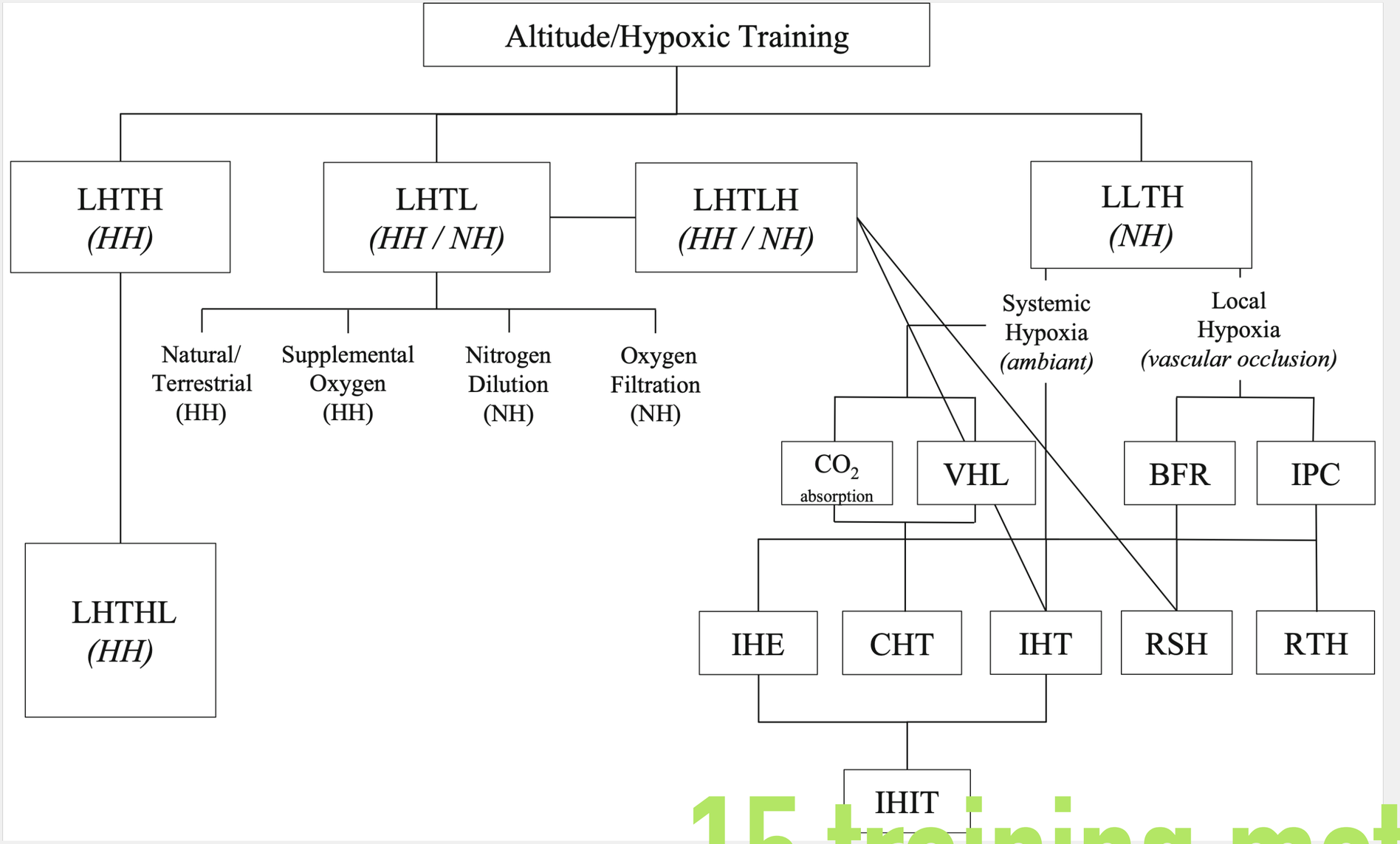




5 training methods

Source: Wilber, 2007.

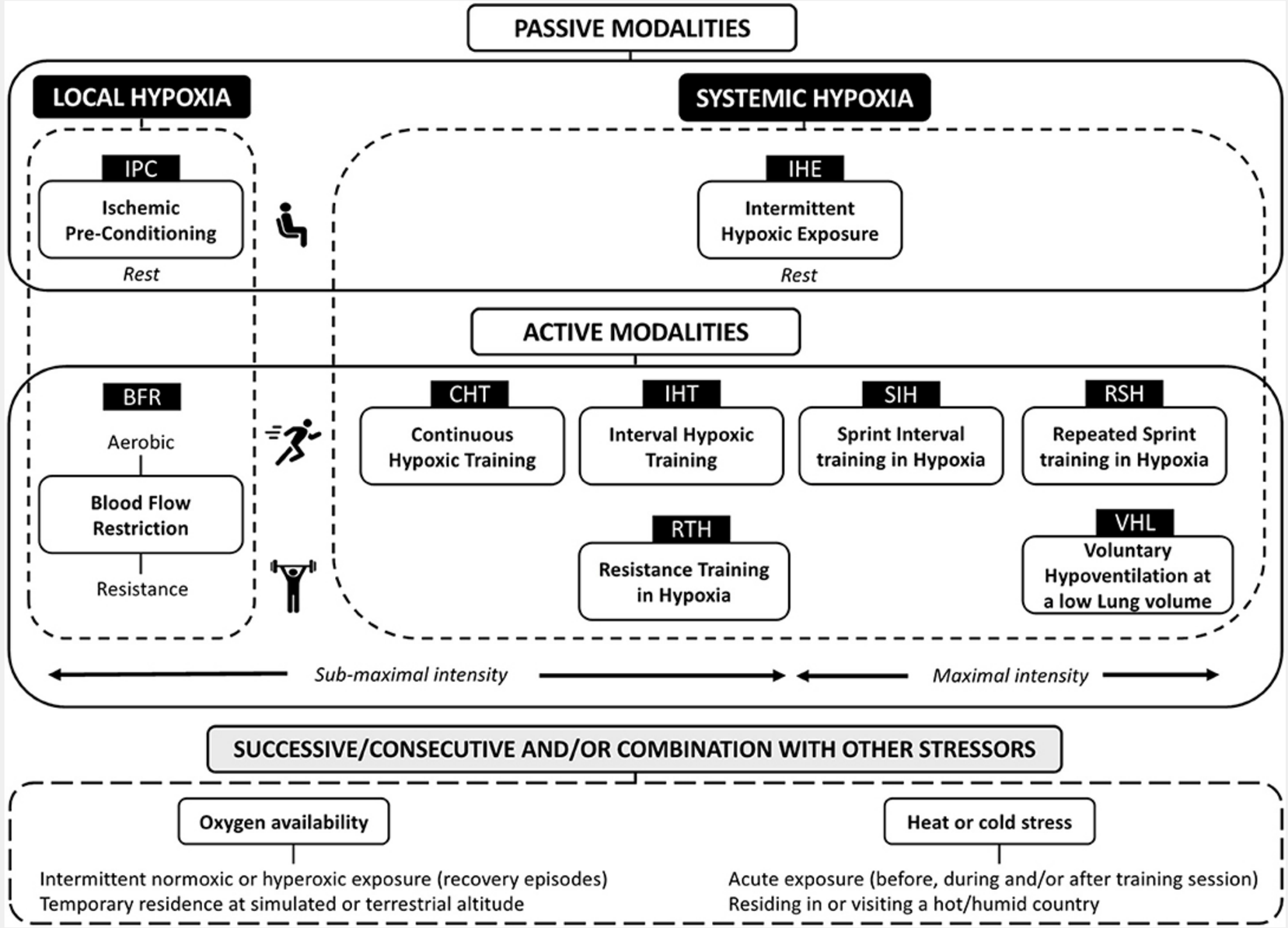
CURRENT METHODS IN ALTITUDE TRAINING



15 training methods

Source: Girard O, 2017

LLTH ALTITUDE TRAINING METHODS



Source: Girard O, 2020.

HOW TO APPLY AND COMBINE DIFFERENT ALTITUDE TRAINING METHODS?

– 05


LHTL
RSH
CHT
IPC

THE CHOICE OF ALTITUDE METHOD DEPENDS ON YOUR GOAL

07

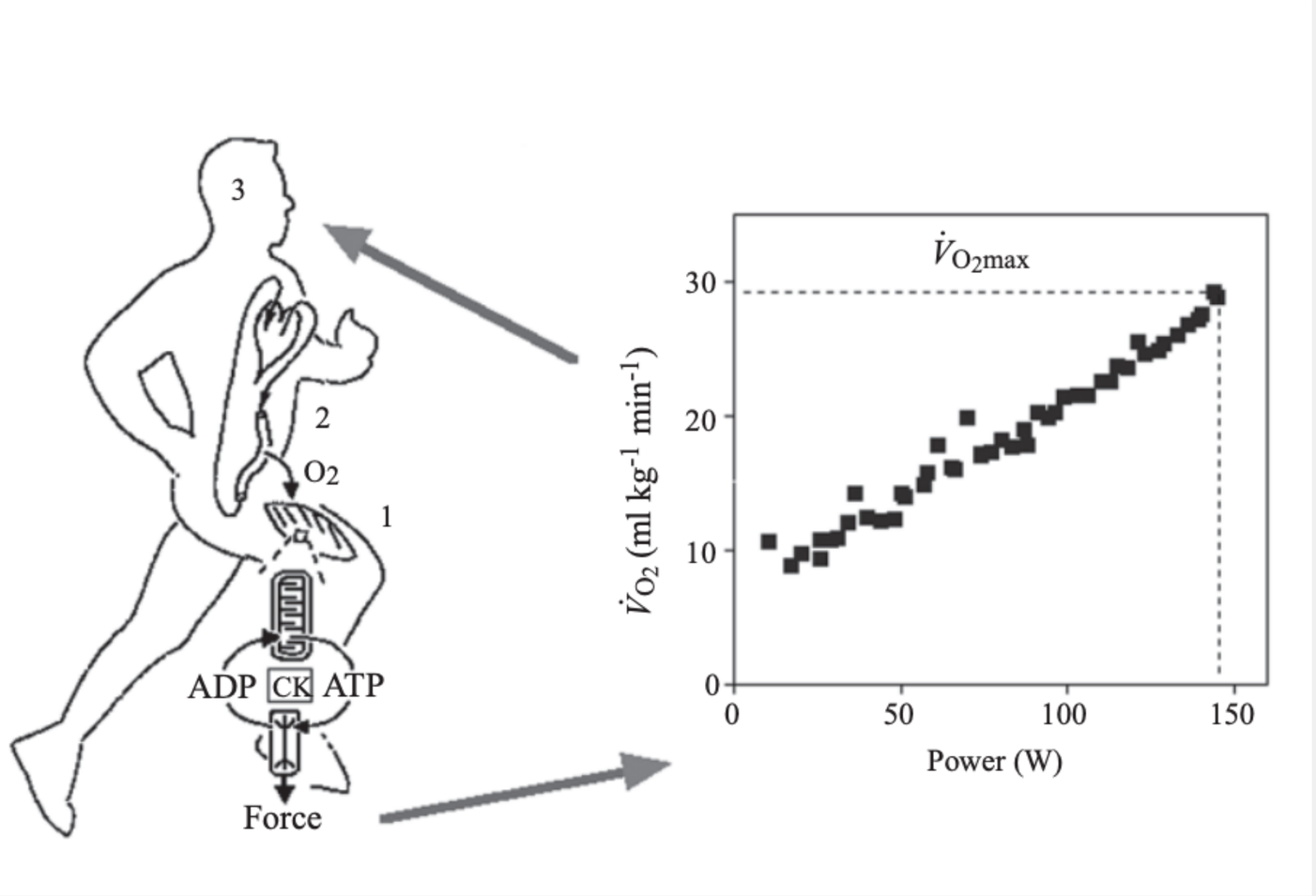
What system you would like to target and what goal you wold like to achieve?

08

IMPROVE AEROBIC PERFORMANCE

FACTORS LIMITING AEROBIC PERFORMANCE

- VO2max
- Cardiac output
- O2 delivery
  [tHb-mass]
  PO2
- O2 extraction
- Mitochondria



Lindstedt SL, Conley KE. Human aerobic performance: too much ado about limits to V(O(2)). J Exp Biol. 2001 Sep;204(Pt 18):3195-9. Review

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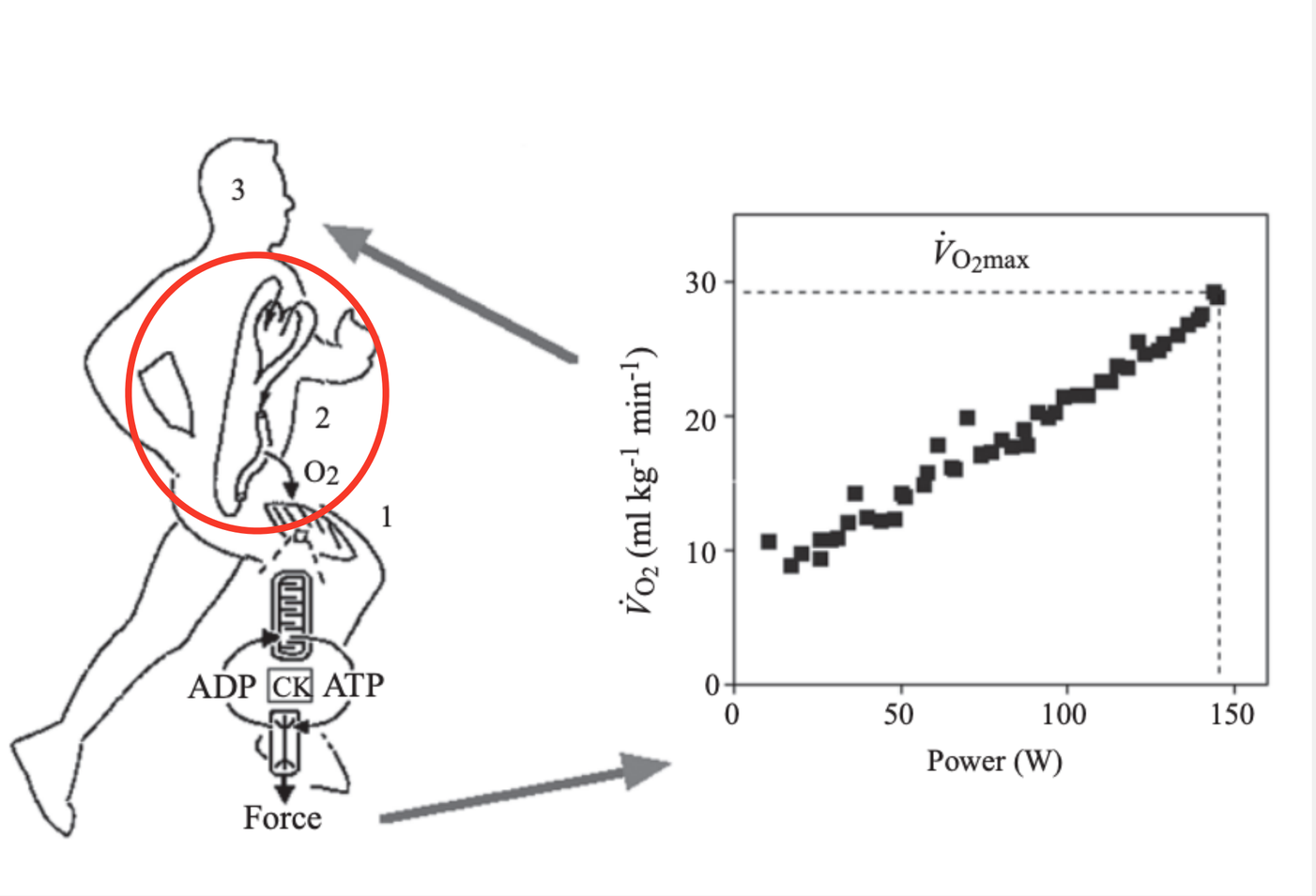

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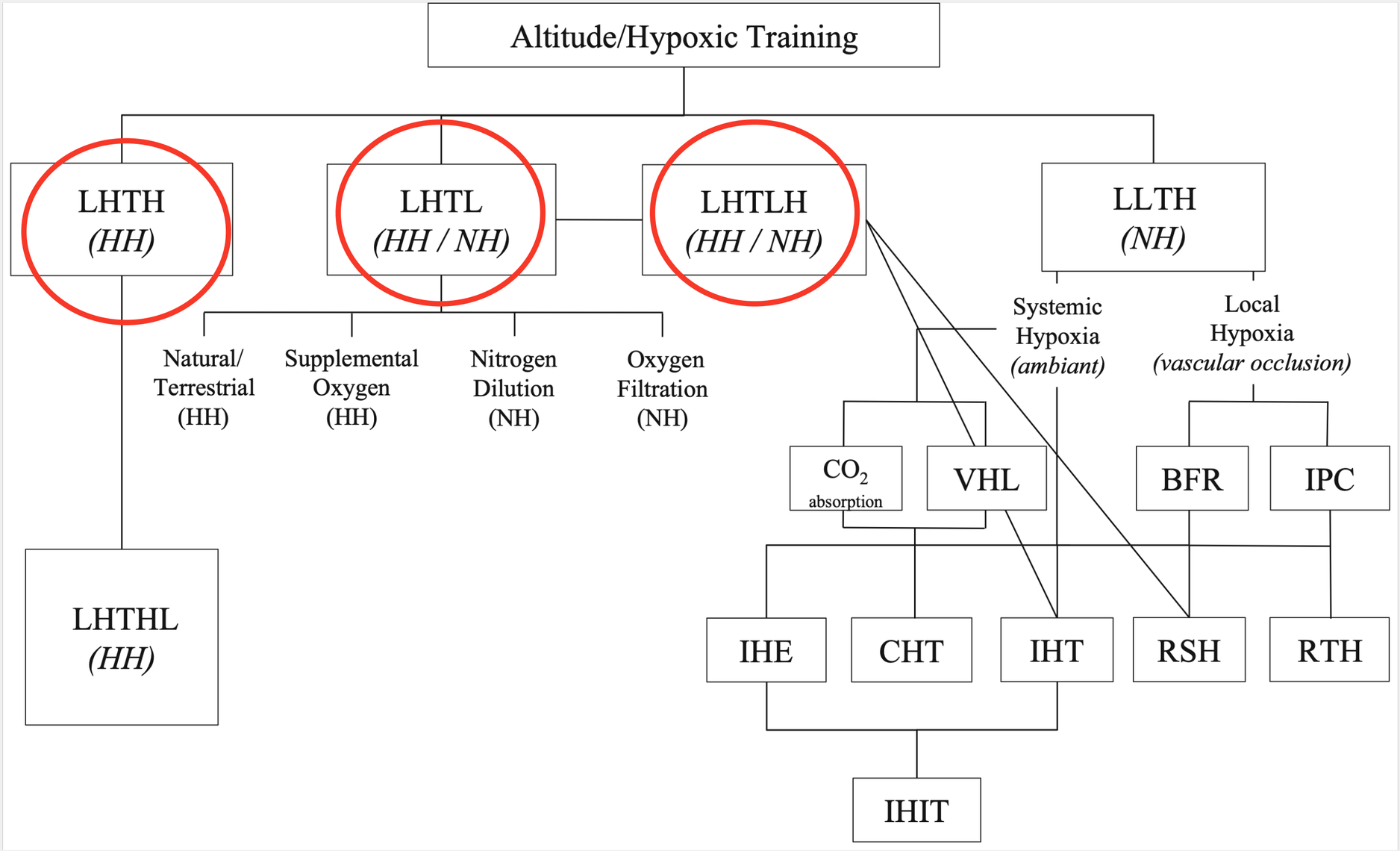
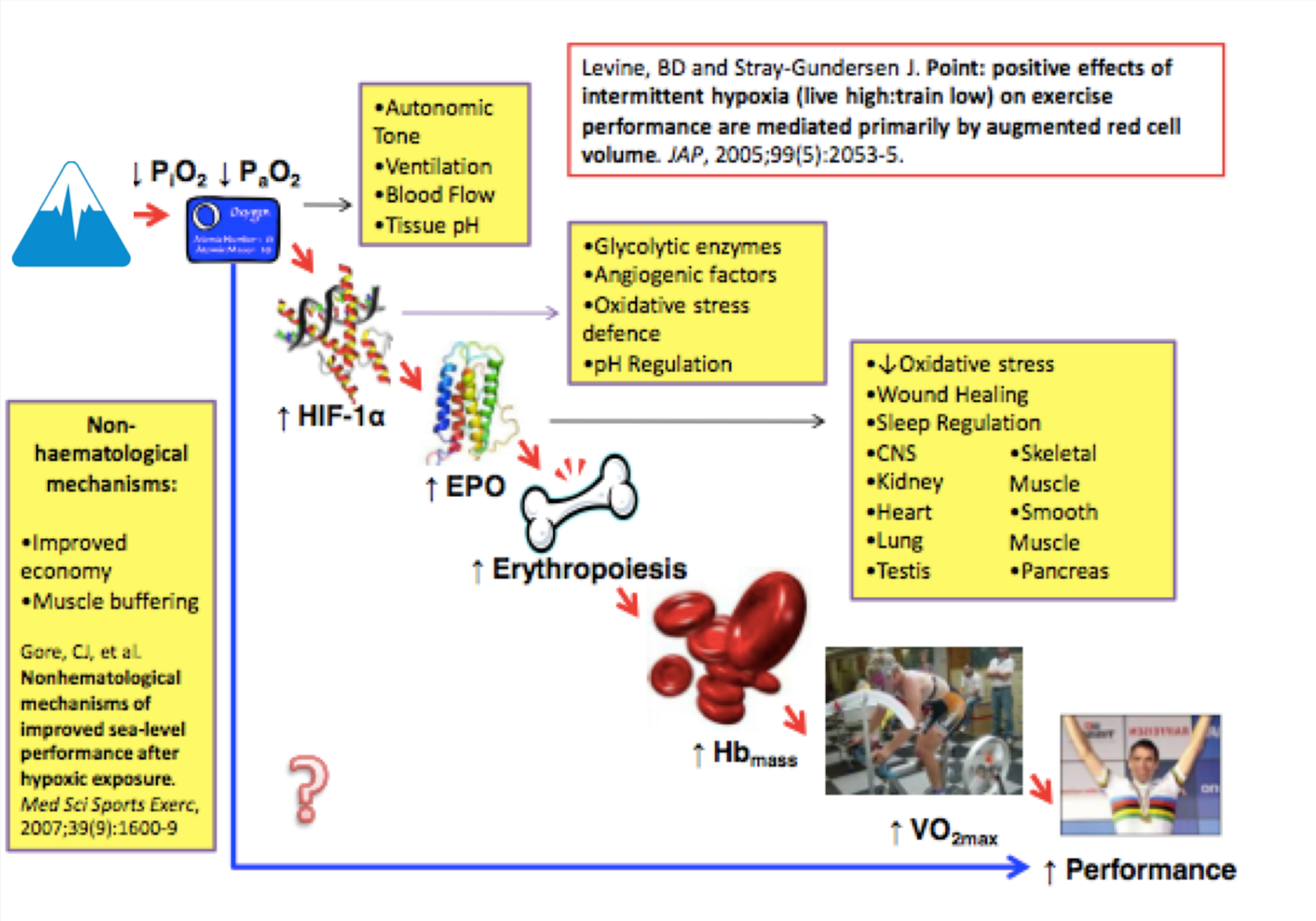


Source: Girard O, 2017

ALTITUDE TRAINING FOR PEAK PERFORMANCE

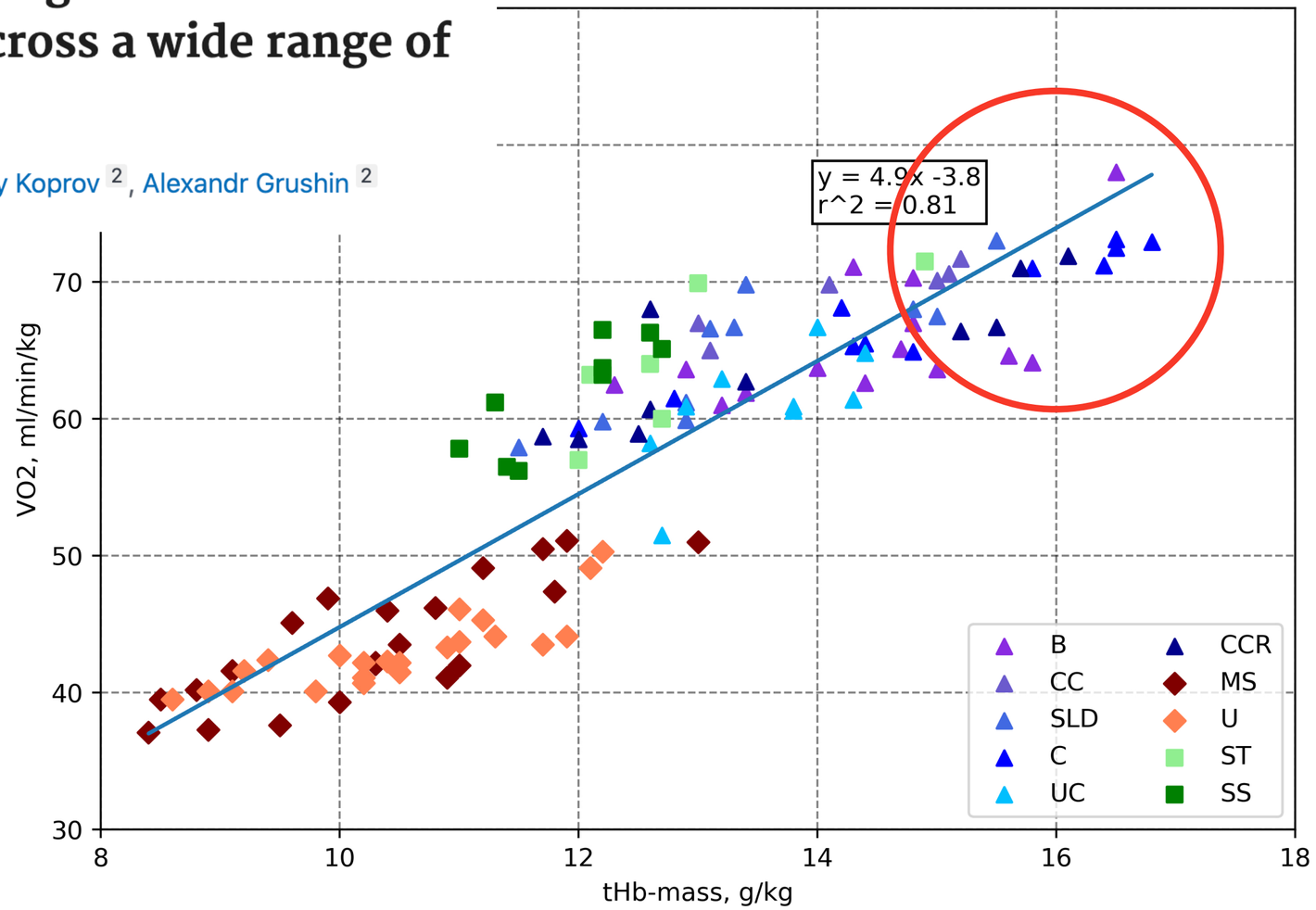


Garvican L. PhD Tesis

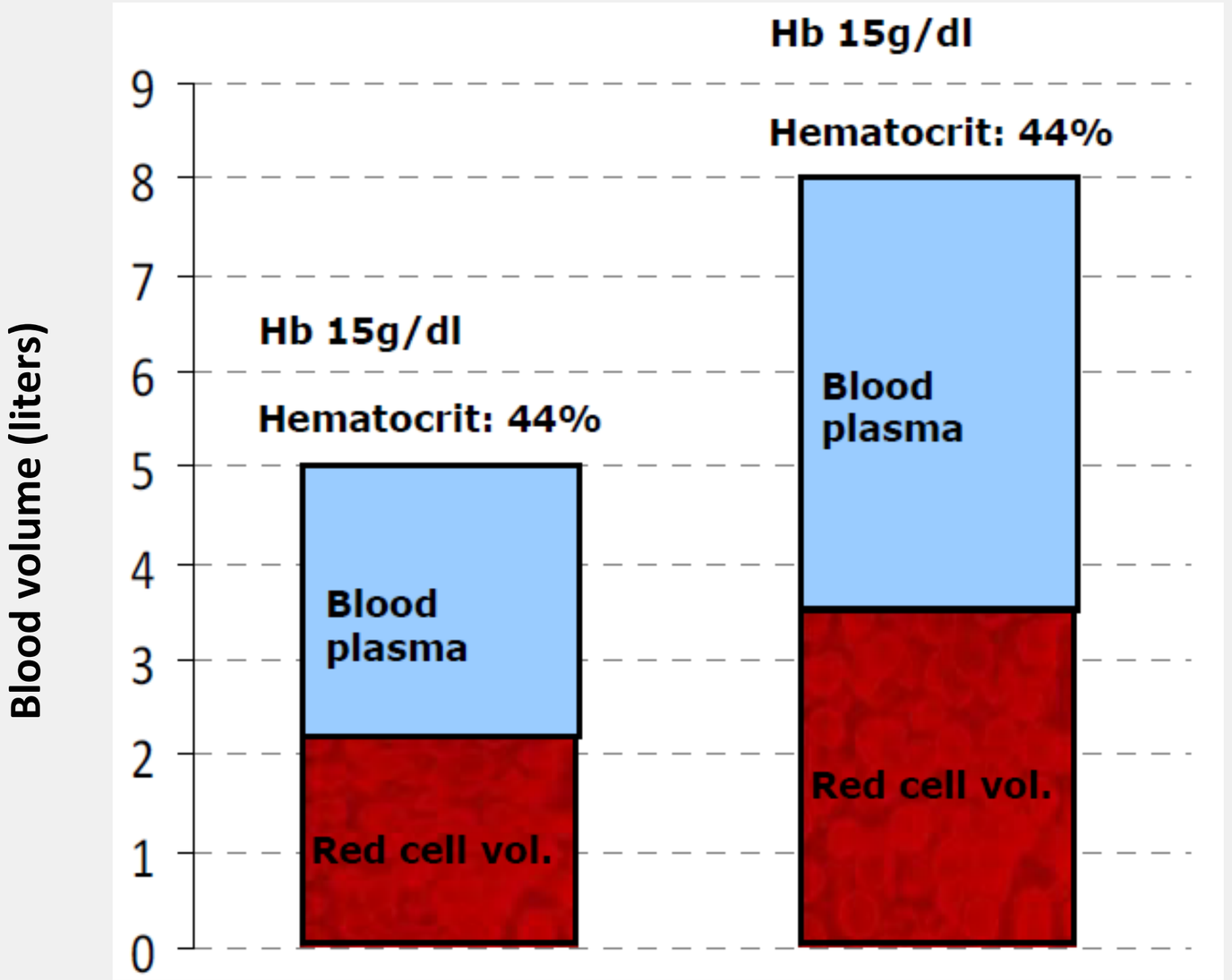
STRONG RELATIONSHIP BETWEEN VO2max AND THB-MASS

Comprehensive overview of hemoglobin mass and blood volume in elite athletes across a wide range of different sporting disciplines

Irina Zelenkova [1], Sergey Zotkin [2], Pavel Korneev [2], Sergey Koprov [2], Alexandr Grushin [2]



WE DON’T KNOW HOW THE ABSOLUTE VALUES ARE



IMPORTANCE OF THB-MASS MEASUREMENT

Individual reaction to the hypoxic exposure

Determination of individual changes in absolute values of tHb-mass.

Relationship between tHb-mass and VO2max

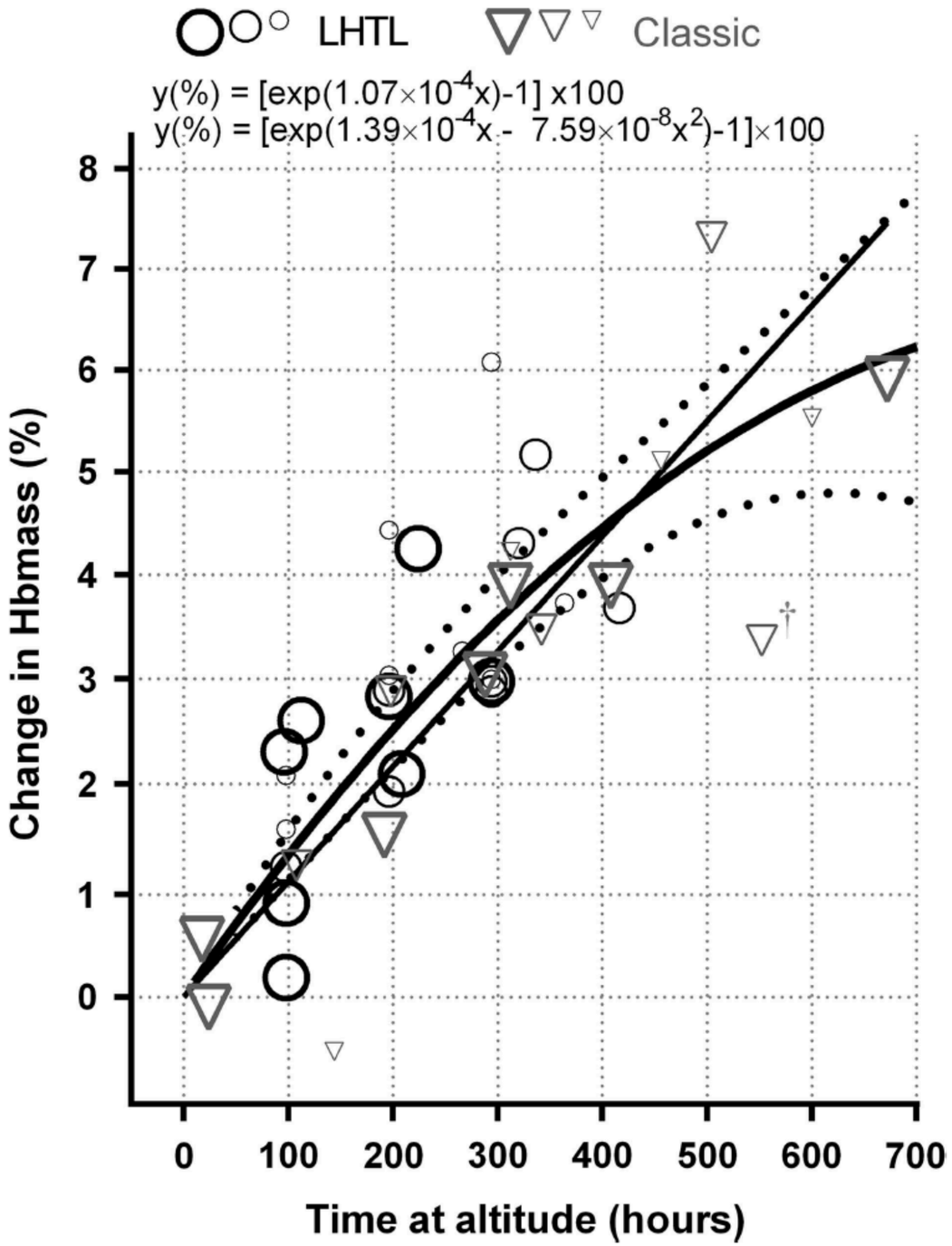
Increase in tHb-mass 1g - increase in VO2max 4 ml/min/kg
(Schmidt & Prommer Exerc Sport Scie Rev, 2010)

Current performance level determination

Classification of endurance athlete level: novice, regional, elite

Kilometer hours: km·h = (m/1,000) × h

During-altitude Hb-mass was estimated to increase by ~1.1%/100 h for LHTL and classic altitude.



Gore CJ et al. *Br J Sports Med*. 2013;47 Suppl 1(Suppl 1):i31-i39.

Athlete A

kmh
880,6
%

Time
in hypoxia
468
hours

tHb-mass
increase
48
g

Athlete B

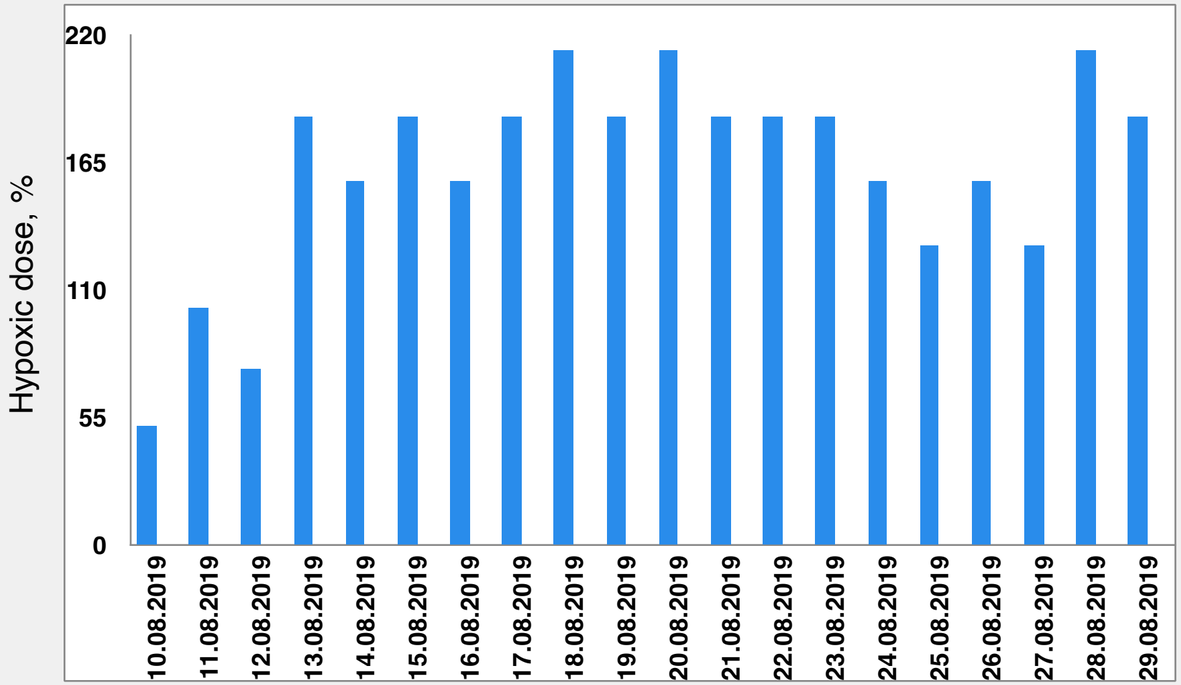
kmh
880,6
%

Time in
hypoxia
468
hours

tHb-mass
increase
6
g

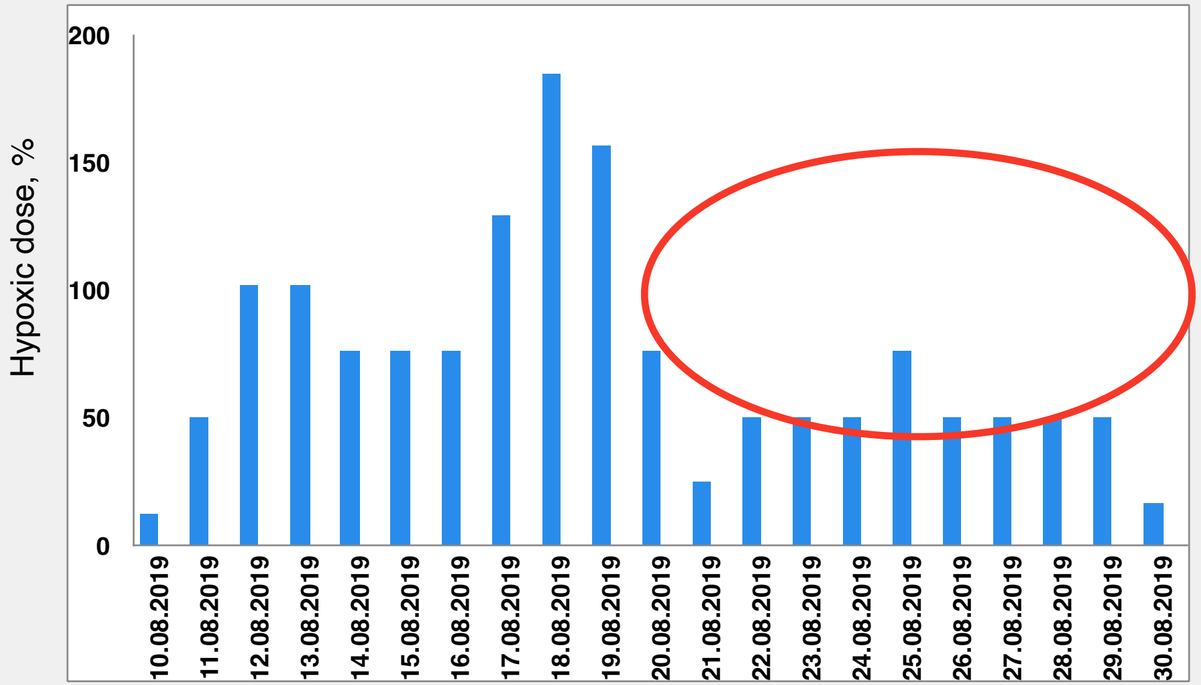
Athlete A

kmh	%h	Time in hypoxia	tHb-mass increase
880,6 %	3230 %	468 hours	48 g



Athlete B

kmh	%h	Time in hypoxia	tHb-mass increase
880,6 %	1507 %	468 hours	6 g



Hypoxic dose - is a powerful tool for the individualisation of the altitude training

Perspectives

J Appl Physiol 121: 352–355, 2016;
doi:10.1152/japplphysiol.00579.2015.

VIEWPOINT

Time for a new metric for hypoxic dose?

Laura A. Garvican-Lewis,[1,2] Ken Sharpe,[3] and Christopher J. Gore[1,2]

[1]University of Canberra Research Institute for Sport and Exercise, Canberra, Australia; [2]Physiology, Australian Institute of Sport, Canberra, Australia; and [3]School of Mathematics and Statistics, The University of Melbourne, Australia

Saturation hours: %·h = (98/s - 1) × t × 100%

Where s is the saturation value (in %) and h is the time (in hours) sustained at this level of saturation.

Dose-response modelling of total haemoglobin mass to hypoxic dose in elite speed skaters

Mikhail Vinogradov, Irina Zelenkova

doi: https://doi.org/10.1101/2020.06.18.159269

Saturation hours: %·h = (95/s - 1) × t × 100%

Where s is the saturation value (in %) and h the time (in hours) sustained at this level of the saturation.

the saturation

ADDITIONAL TOOLS FOR THE ALTITUDE TRAINING

INDIVIDUALISATION

IF THE HYPOXIC DOSE IS TOO LOW THE COMBINATION OF NORMOBARIC AND HYPOBARIC HYPOXIA CAN BE USED

ADDITIONAL EXTERNAL STIMULUS CAN BE ADDED (HEAT) OR HYPEROXIA

Takeno et al., 2001; Brinkmann et al., 2018

HYPOXIC TRAINING IS NOT A ONE SIZE FITS ALL APPROACH

ALTITUDE TRAINING SHOULD BE INDIVIDUALISED FOR THE ATHLETES SPECIFIC NEEDS

FACTORS LIMITING AEROBIC PERFORMANCE

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  [tHb-mass]
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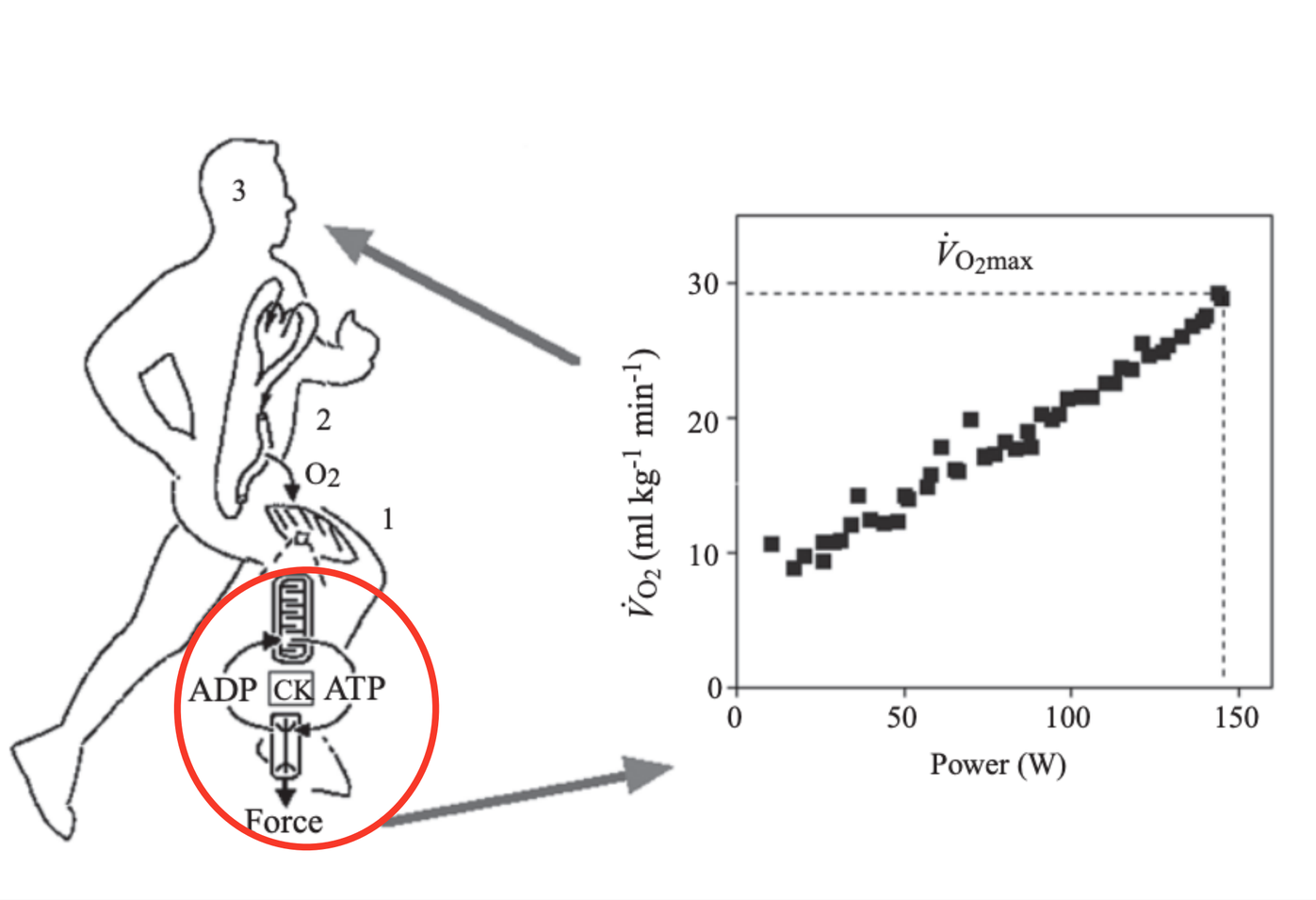

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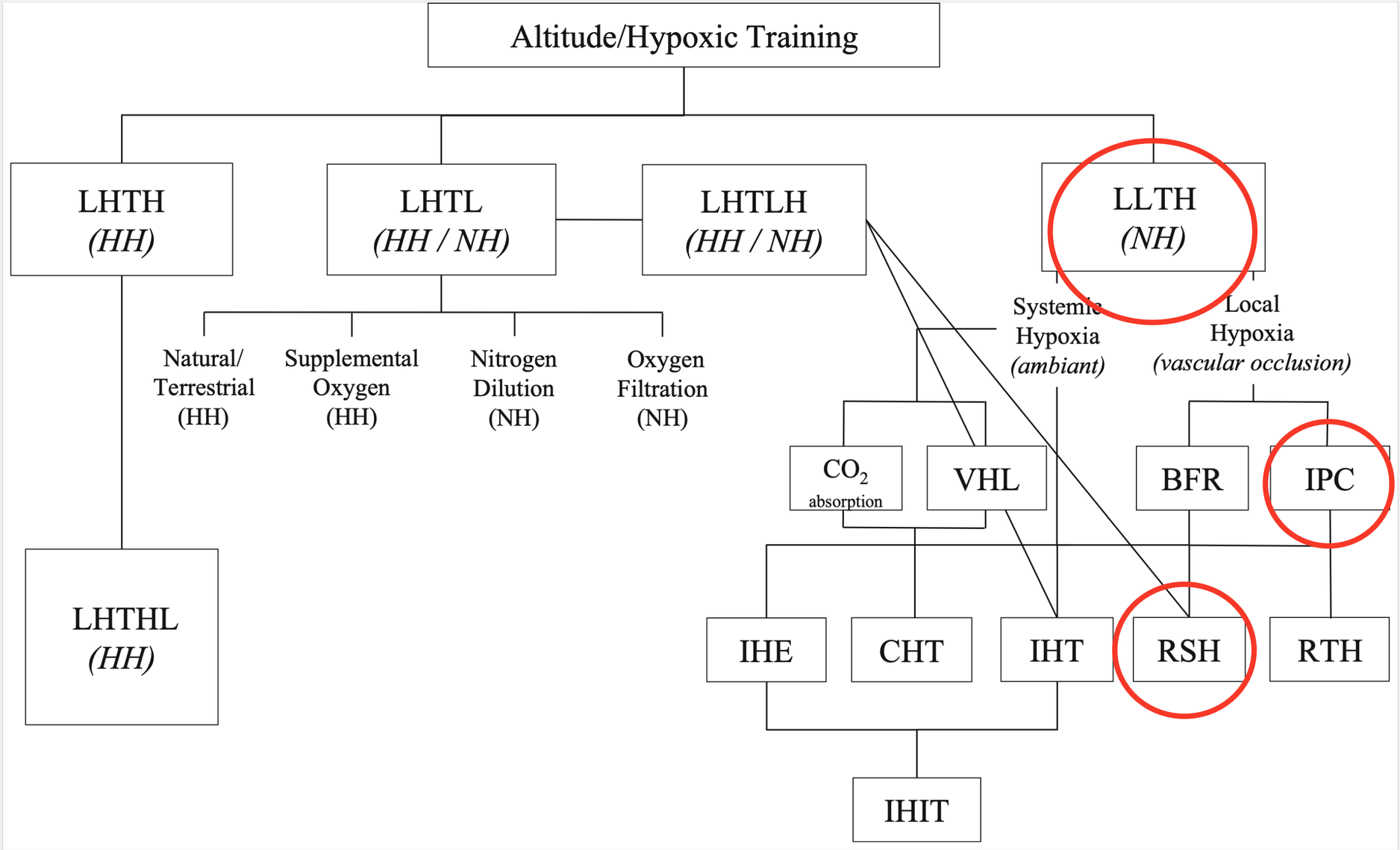
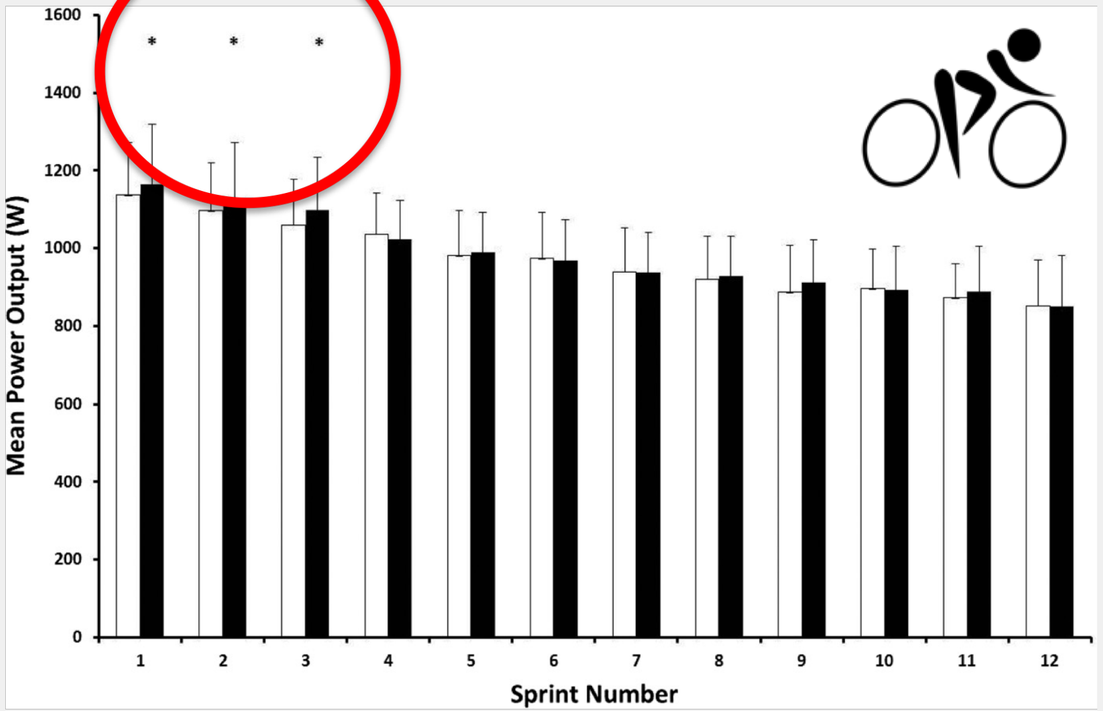


Source: Girard O, 2017

The Effect of Ischemic Preconditioning on Repeated Sprint Cycling Performance



Twelve 6-s sprints after four 5-min periods of bilateral limb occlusion at 220 mm

- **Improvement of muscle fibre activation**
- **Improvement of oxygen extraction**
- **eNos-derived nitric oxide production**

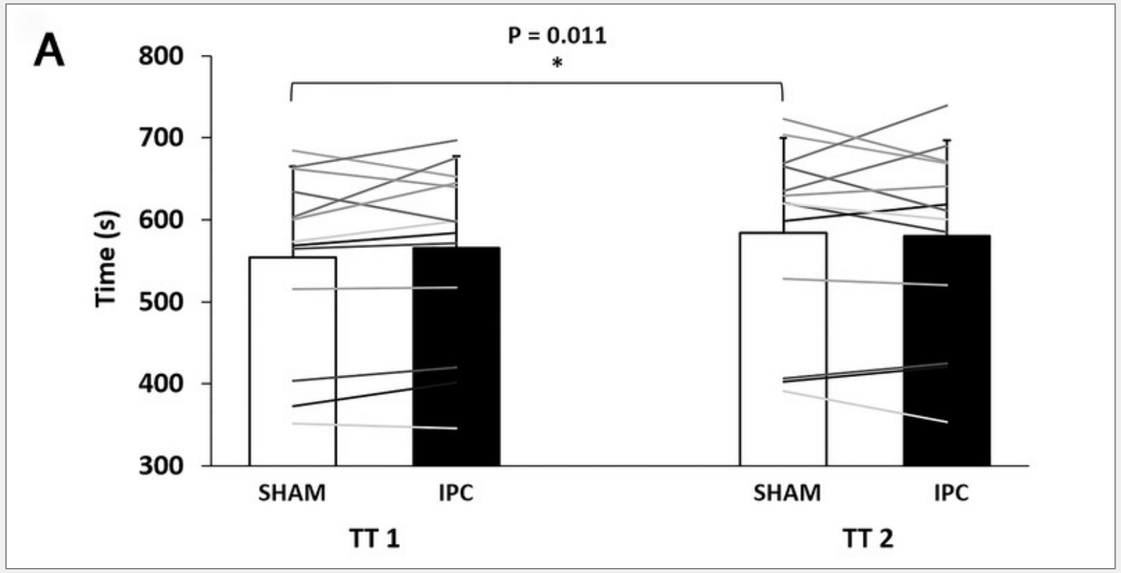
Patterson D et al 2015

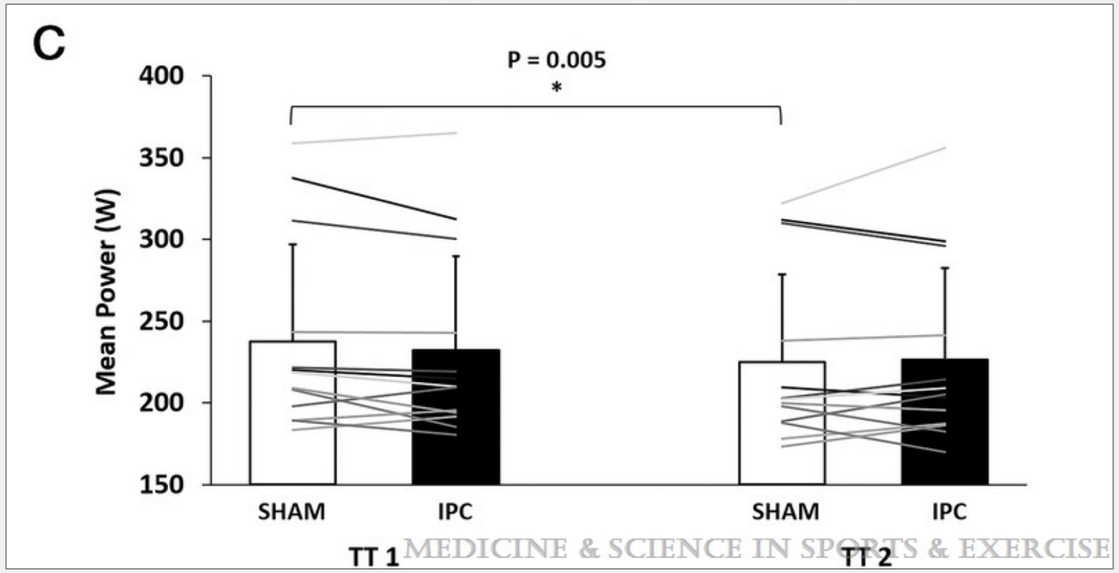
Ischemic Preconditioning Maintains Performance on Two 5-km Time Trials in Hypoxia

DA MOTA, GUSTAVO R.[1,2]; WILLIS, SARAH J.[2]; SOBRAL, NELSON DOS SANTOS[2]; BORRANI, FABIO[2]; BILLAUT, FRANÇOIS[3]; MILLET, GRÉGOIRE P.[2]

Ergogenic mechanism: increased blood volume and greater oxygen extraction during the TT in IPC

IPC helps to maintain the performance of a second TT similar to the first one





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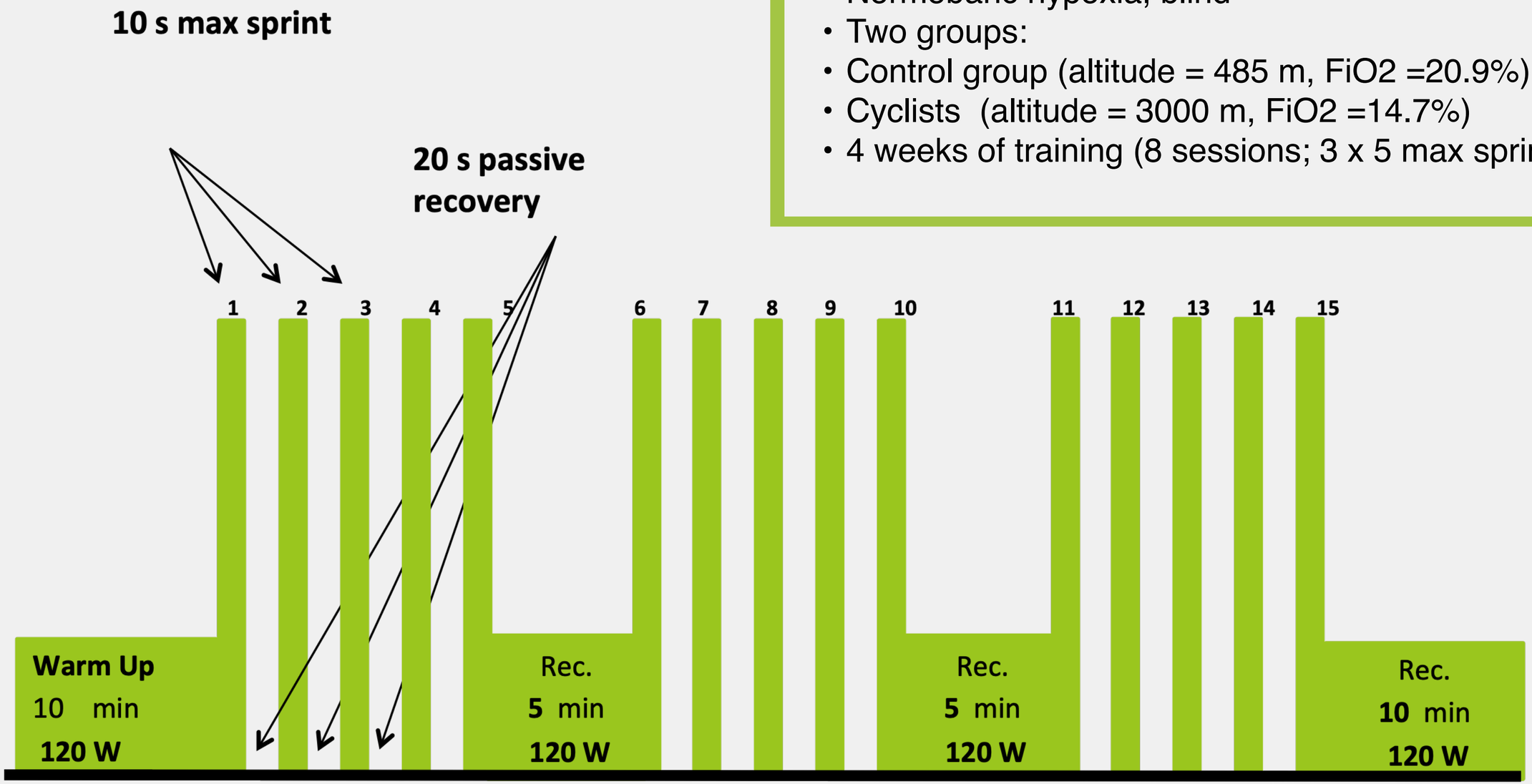
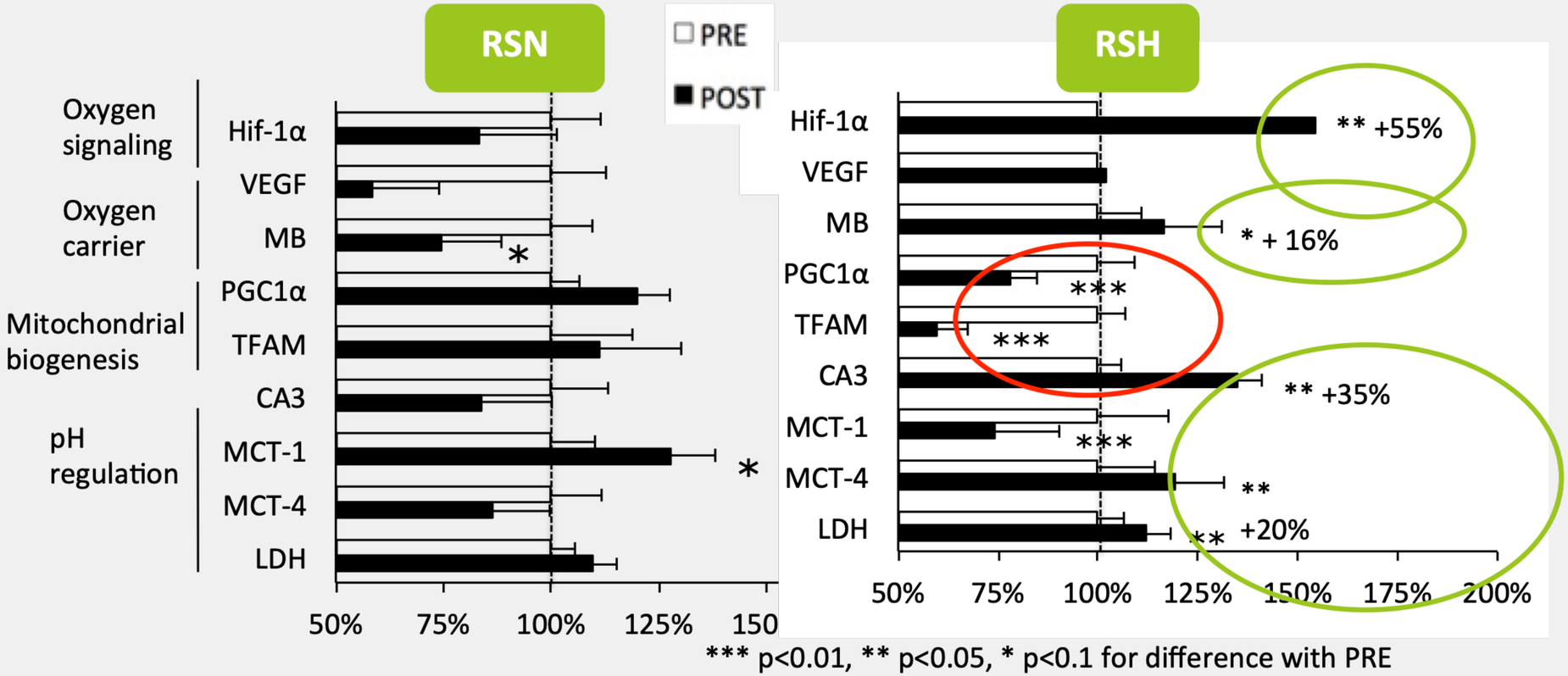
REPEATED SPRINTS IN HYPOXIA (RSH)

- Normobaric hypoxia, blind
- Two groups:
- Control group (altitude = 485 m, FiO2 =20.9%)
- Cyclists (altitude = 3000 m, FiO2 =14.7%)
- 4 weeks of training (8 sessions; 3 x 5 max sprints



Faiss et al 2013

MOLECULAR ADAPTATIONS



oxygen signaling

oxygen carrying

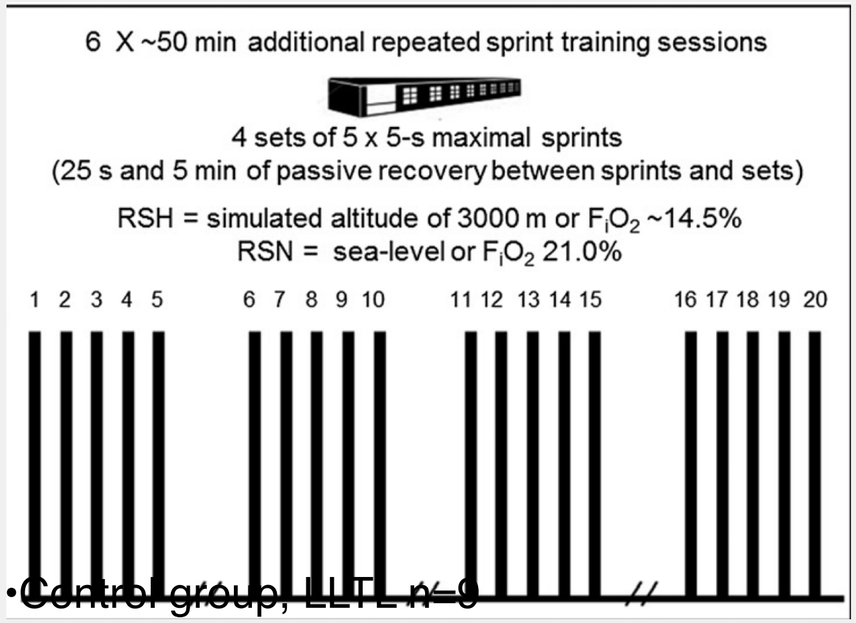
shift to anaerobic glycolytic activity

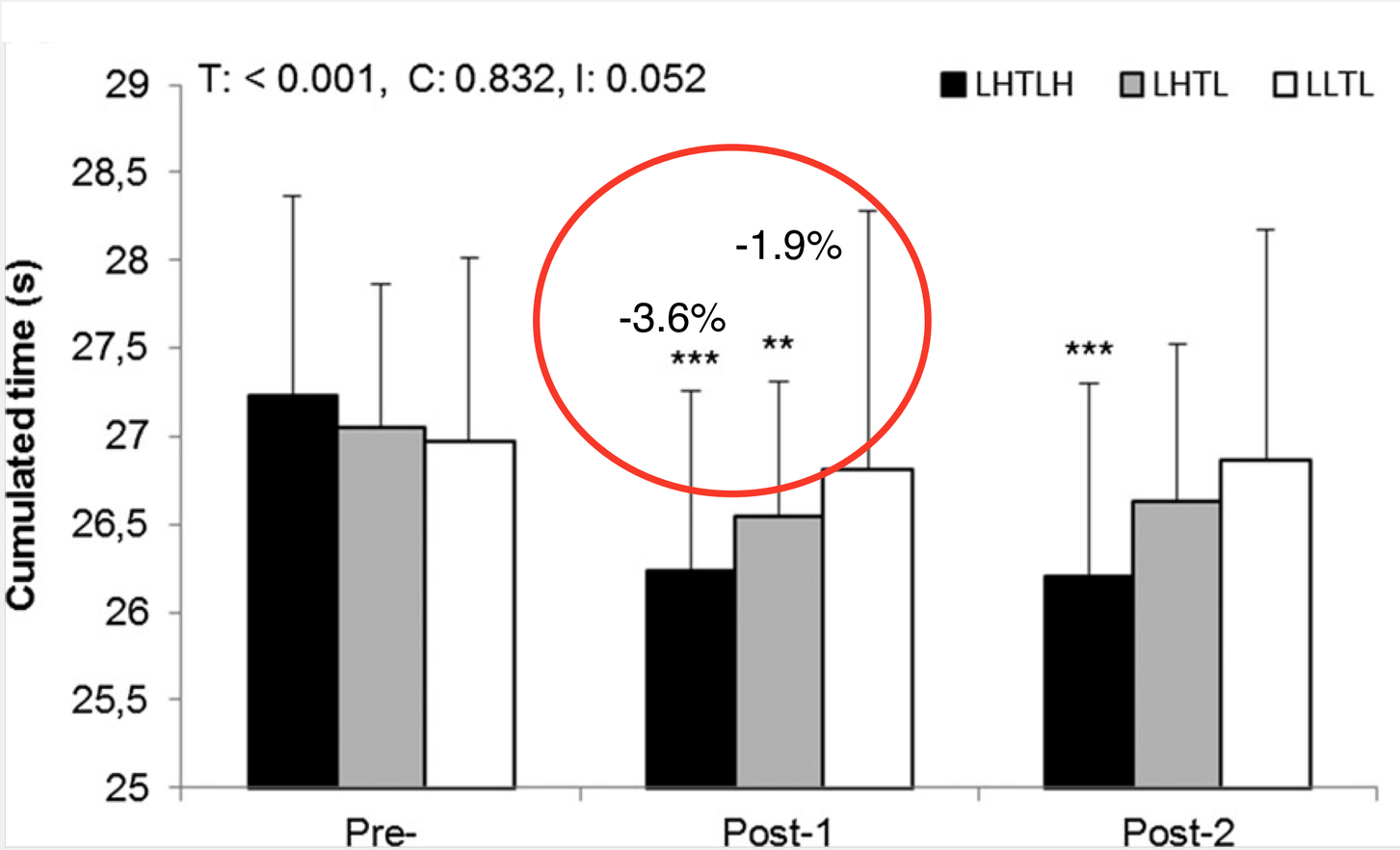
pH regulation

- **Fast-twitch fibers are better utilized**
- **Increase blood flow perfusion**
- **Improvement of anaerobic glycolytic activity**

Faiss et al 2013

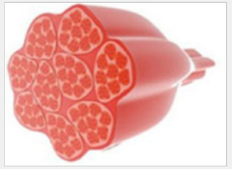
COMBINATION OF LHTL AND RSH





- ~~Control group, LLTL n=9~~
- Group LHTL + RSN n=12
- Group LHTL + RSH n=12
- ≥ 14 days, altitude 2500 – 3000 m (F_iO

,5 +



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LHTL RSH

Brocherie et al 2015

TAKE HOME COACHING TIPS

Altitude training needs to be **tailored to each athlete's needs**

The altitude training method should be **connected with the coaching goals**

Advances in technology allow **increased access to hypoxic training**

Irina Zelenkova.
Supporting those who dream big

THANK YOU FOR YOUR ATTENTION

Feel free to contact me

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INSTAGRAM

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