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High Altitude Racing and Events

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Outline

- High Altitude Environment + Effects
- Benefits of High Altitude Training
- How to Train at High Altitude
  - Protocols
  - Training plan + Pacing
- Returning to Sea Level
- Race Day Tips
- Supplements to Altitude Training

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What is Considered High Altitude?

High Altitude is above 5,000ft

Environmental stress increases exponentially as elevation increases

Examples: The Leadville 100, BWR Cedar City, The Mount Evans Hill Climb

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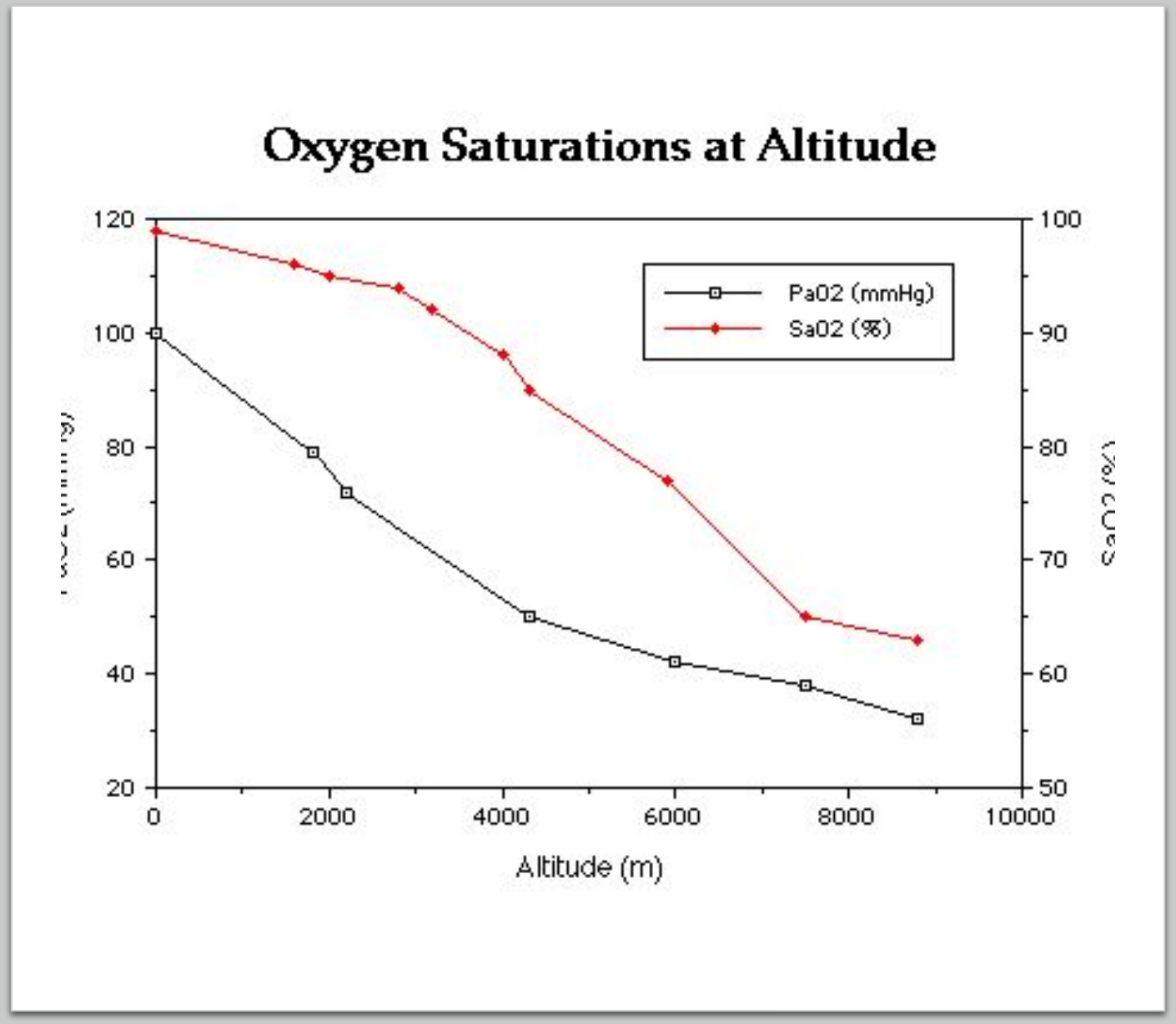
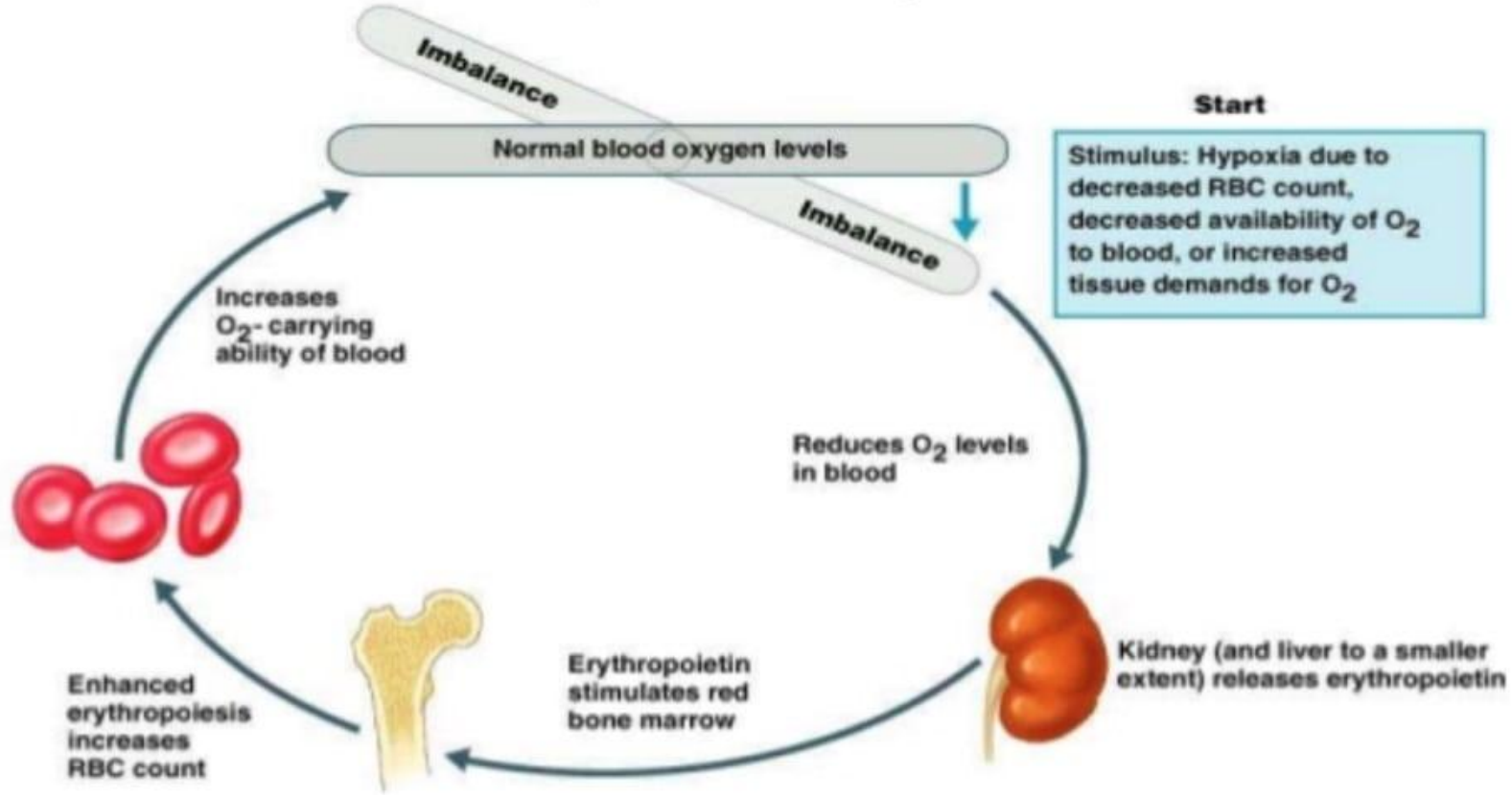
O2 Saturation Drop Off

•At 5,280 ft above sea level only about 85% of O2 is available to the working muscles compared to at sea level



- Hematologic Effects:
  - Increase red cell production/Hb



southafricaadventures.com/acute-mountain-sickness-ams/

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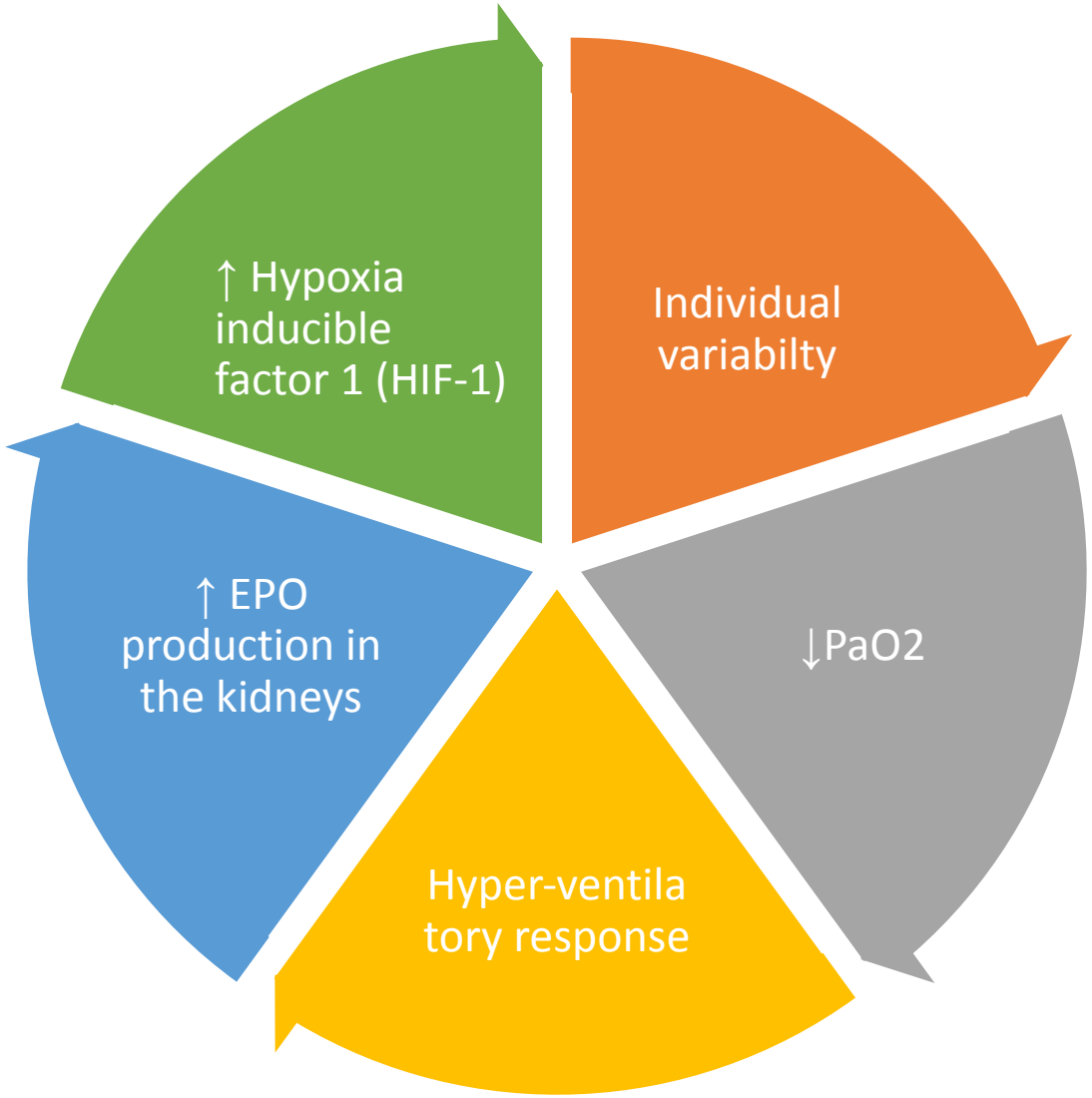
Physiological Effects of Altitude



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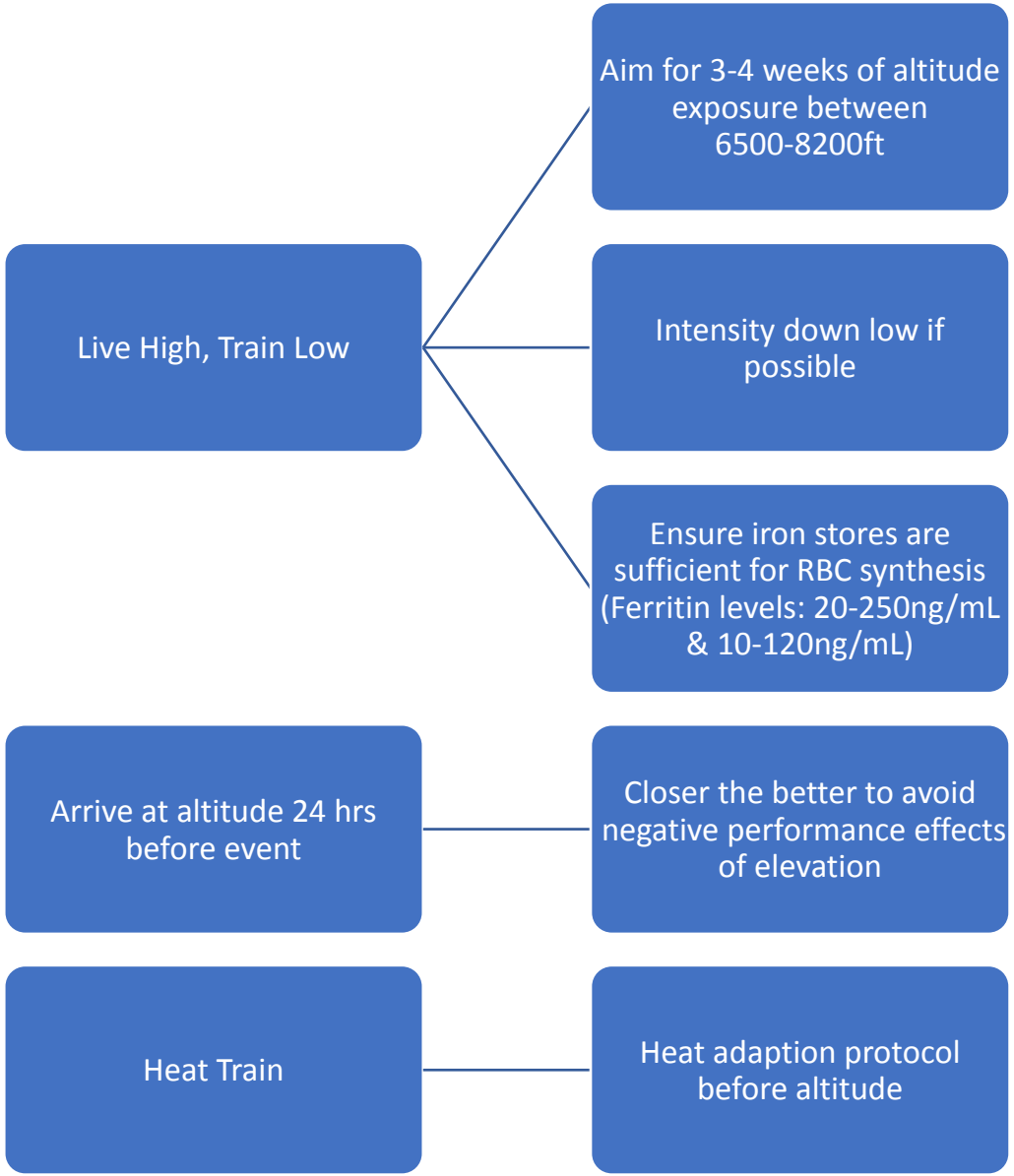
Altitude Adaptation Leads to Increased Performance

- On average 4% ↑ in Red Blood Cells
- 9% ↑ in Hemoglobin
- 4% ↑ in VO2max
- 8% ↑ in blood plasma volume
- ↑ muscle buffering capacity
- ↑ in economy of movement

Training Protocols for High Altitude Events



Practical Training Recommendations for Altitude

- Training volume and intensity should be reduced in the first 3-5 days at altitude
- Volume should be gradually increased, possibly never matching sea level volume
- Adjustments to intensity should be ongoing: when performing intervals either reduce the workload relative to sea level and increase the rest interval OR keep workload the same relative to sea level but reduce the duration of the effort/keep rest interval the same

What to Expect When Training

Heart rate elevated with a lower maximal HR	Maximal O2 consumption decreases	Hydration status effected: greater respiratory/urinary loss	Carbohydrate metabolism increased: carbohydrate utilization increases and muscle glycogen decreases
Decrease in iron ferritin	Increase in blood lactate and decrease in lactate buffering capacity	Immunosuppression occurs	Oxidative stress increases
Higher UV radiation	Sleep quality decreases	Potential decrease in muscle mass	Acute Mountain Sickness

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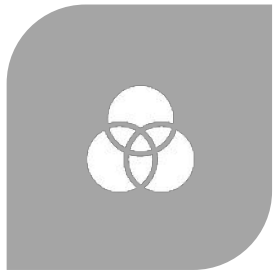
Setting Expectations and Pacing

- Significant drop off in aerobic power (FTP) as elevation increases
- Pacing strategy from sea level training needs to be adjusted accordingly to the elevation
- Recovery from maximal efforts is significantly longer

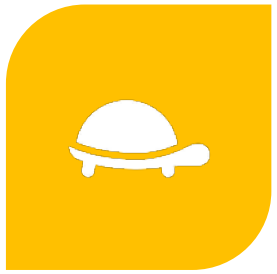
ELEVATION (feet above seal level)	AVAILABLE AEROBIC POWER		
	Bassett et al.[1]		Peronnett et al.[2]
	Acclimatized	*non-acclimatized*	
0	99.90%	100.00%	99.90%
1000	99.20%	98.60%	98.90%
2000	98.30%	97.00%	97.80%
3000	97.20%	95.20%	96.80%
4000	95.90%	93.20%	95.60%
5000	94.40%	91.10%	94.40%
6000	92.70%	88.90%	93.10%
7000	90.70%	86.50%	91.60%
8000	88.60%	84.20%	89.90%
9000	86.30%	84.20%	88.10%
10000	83.70%	79.30%	86.00%
11000	80.90%	77.00%	83.70%
12000	78.00%	74.70%	81.10%
13000	74.80%	72.50%	78.20%
14000	71.40%	70.40%	75.00%

Expectations When Returning to Sea Level

0-3 DAYS UPON RETURN = INCREASE IN PERFORMANCE



4-10 DAYS = UNSTABLE, SAME



11-14 DAYS = SLOWER, SAME

15-28 DAYS = FASTER

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Race/Event Day Tips

01

Adjust pacing, HR and power might be harder to use, base efforts off of RPE

02

Increase fluid and carbohydrate intake relative to sea level

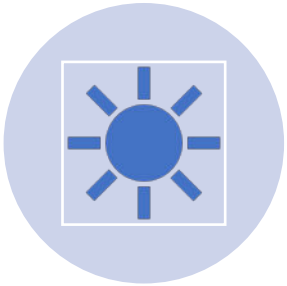
03

Focus on the breathe, keep respiration in check and avoid hyperventilation

Timing Arrival without Acclimatization

- For most athletes, the logistics of altitude acclimatization aren't feasible
- Two possible short term arrival strategies include:
  - 1. Arrive with as much time as logistically possible before the event as even one extra day acclimatizing may improve performance
  - 2. "Fly in, fly out" strategy – arriving as close to the event start as possible to mitigate acute negative effects of altitude exposure, such as sleep dis-ruptions, the small reduction in plasma volume, and the compensatory reduction in plasma bicarbonate

Heat Training to Mitigate Effects of Altitude



Similar crossover of adaptations can be seen after a period of heat acclimation

Potential for increased blood plasma volume as well as RBC synthesis

Implementing a heat training protocol may improve performance at altitude

Heat training post altitude camp has the potential to prolong effects from altitude exposure

Simulated altitude concludes mixed results

Nitrogen apartments have been used to reduce O2 concentration to 15.3% and 84.7% N

Commericially available altitude tents have been used when terrestrial altitude isn't logical.

Studies conclude mixed results

Other methods include LL/TH aka intermittent hypoxic training (IHT) and supplemental O2 usage

Take away

- If logistics allow, acclimatize to altitude 3-4 weeks prior to event
- If time doesn't allow prior acclimatization
  - Fly in / fly out strategy
  - Heat training protocol
- Best performance practices at sea level and altitude include:
  - Quality training
  - Adequate nutrition and hydration
  - Focusing on sleep and recovery off the bike
- Everyone responds differently

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QUESTIONS???

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