HIGH ALTITUDE PHYSIOLOGY

HIGH ALTITUDE ENVIRONMENT

- Hypobaric → **hypoxia** (↓ PO_2)
- Cold + wind chill → hypothermia
- Low humidity → dehydration
- Solar radiation → melanoma?
- ADAPTATION v ACCLIMATISATION

ADAPTATIONS

Physiology of native highlanders

- Sea Level
- 0m
- AP 760mmHg
- PO_2 150mmHg

- Morococha, Peru
- 4500m
- AP 440mmHg
- PO_2 93mmHg

- OXYGEN CASCADE

ADAPTATIONS
Preservation of oxygen gradients

1. Hyperventilation
2. Greater pulmonary diffusion capacity
3. Greater capacity for oxygen transport
4. More efficient offloading of oxygen at tissues
5. Enhanced diffusion at tissues
6. More myoglobin

ACCLIMATISATION

1. **Hyperventilation**

$\downarrow PO_2 \rightarrow \uparrow VE$

$\uparrow VE \rightarrow \downarrow PCO_2$

$\downarrow PCO_2 \rightarrow \downarrow VE$

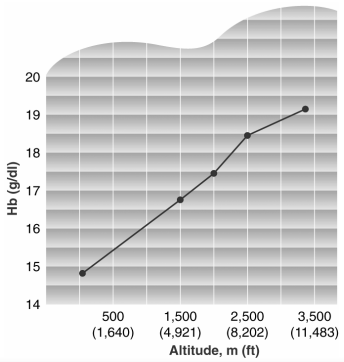
Respiratory Alkalosis

ACCLIMATISATION

2. **Oxygen transport**
   - $\uparrow$ Erythropoietin
   - $\uparrow$ Haemoglobin concentration
   - Polycythaemia

3. **Bohr Shift**
   - $\uparrow$ 2,3DPG $\rightarrow$ enhanced O_2 offloading

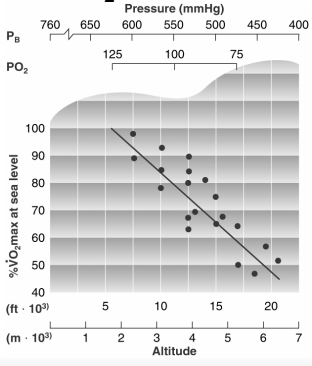
Hb CONCENTRATIONS AND ALTITUDE



ACCLIMATISATION

4. **Cardiovascular responses**
   - HR ↑ due to
     ↑ catecholamines
   - SV ↓ due to
     ↓ plasma volume
   - Q initial ↑ then ↓ to 90% of SL value
   - Pulmonary hypertension due to
     ↑ pulmonary vascular resistance

CHANGES IN $\dot{V}O_2$MAX WITH ALTITUDE



EXERCISE at ALTITUDE

Griffiths Pugh (1953)

	VO_2max (L/min)
SL	3.60-3.91
6100m	1.40-2.21
8230m	0.33

Habeler & Messner 1978

"I am nothing more than a single, narrow, gasping lung"

Exercise at altitude

1968 Mexico Olympics

2300m 580mmHg P_aO_2 80mmHg

Jokl & Jokl (1968)

- Melbourne Olympics 1956
- Pan Am Games Mexico 1955

INTERACTION

- Altitude x length of event

Exercise at Altitude

↑ VO_2

↑ HR ↑ VE ↑ $(a\text{-}v)O_2$diff

OBLA

↑ relative exercise intensity

BUT ↓ VO_2max > ↓ performance

↓ air resistance & ↓ gravity

Griffiths Pugh 1967

	3 mile times (13:46 in UK)	1 mile times (4:22 in UK)	VO_2max
Mexico Week 1	8.5% slower	3.6% slower	↓ 14.6%
Mexico Week 4	5.7% slower	1.5% slower	↓ 9.5%

ALTITUDE TRAINING

- Need to acclimatise before competition at altitude in aerobic events
- What about training at altitude for competition at sea level?

ALTITUDE TRAINING

Adams (1975)
- No sig. improvements in VO_2max or 2 mile times

Mizuno et al (1990)
- SL performance not sig. improved after alt.

Klausen et al (1966)
- ↑ VO_2max attributed to ↑ trg.

Ingjer & Myhre (1992)
- ↓ BLA

ALTITUDE TRAINING

- Effectiveness for SL performance not supported by experimental evidence
  - Can't maintain training intensity → ↓ muscle mass, ↓ max HR & SV
- BUT
  - *individuals* may benefit
  - Optimal height, duration etc
  - Holiday effect
  - Live high, train low

Seminar Question

Describe and explain the effect of going to high altitude on endurance performance in man. In addition, comment on the effectiveness of training at high altitude.