

**Altitude / Hypoxic Training:  
The Canadian Model**

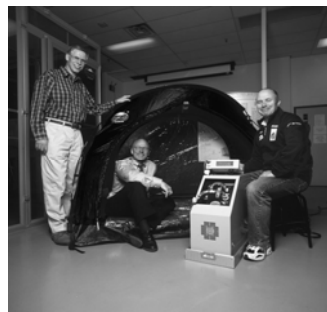
**David J. Smith**

Human Performance Laboratory  
Faculty of Kinesiology, University of Calgary  
and  
Canadian Sport Centre – Calgary, Alberta, Canada

USOC International Altitude Training Symposium  
Colorado Springs, Colorado, October, 2009



**Sport Science Colleagues  
Jon Kolb Stephen Norris**

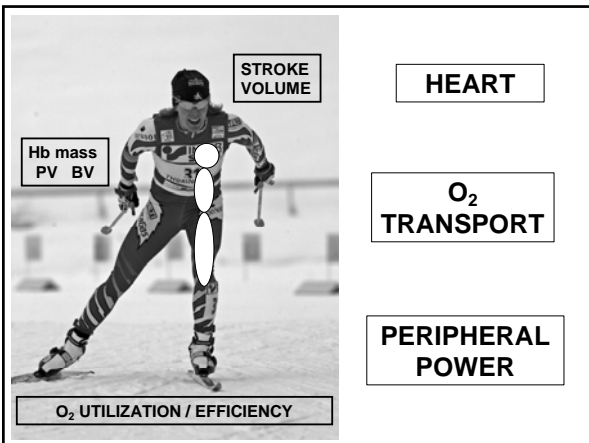


**(Swimming) Performance  
Excellence – Goldsmith, 2003**

- **The ability to maintain:**
  - **TECHNICAL** excellence,
  - at **SPEED**,
  - under **PRESSURE** and
  - when **FATIGUED**

**The Goal of Training**

- is to increase the ability to sustain the highest speed or power output for a given distance or time.  
Hawley, 2002
- Improve capacity and tolerance for work
- Provide individualized training that accounts for athlete characteristics and response



**Altitude / Hypoxia**

- **Not a 'toy', 'fad', or 'magic bullet'**
- **Long term plan**
  - Athlete exposure
    - age, training status, activities, health
  - Successive exposures
    - per year / over years
- **Short term plan**
  - Training & / or competition objectives

Norris, 2001

# Altitude / Hypoxia: The Canadian Model

## Altitude / Hypoxic Strategies



**Natural Altitude**

- Live High / Train High
- Live High, Train Low
- Live Low / Train High



**Oxygen Filtration**

- Simulated Altitude  
– Train Low

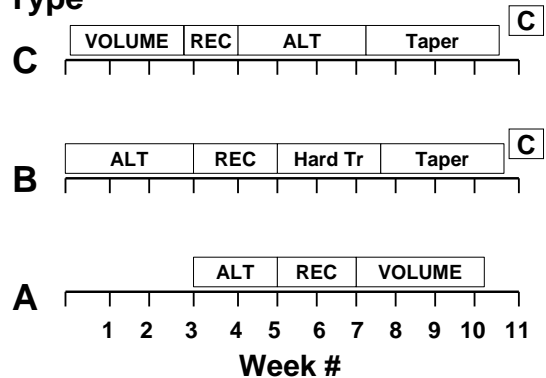
## Live High, Train High / Low Locations

- Mammoth Lakes (USA) 2377 m
- Sierra Nevada (Spain) 2320 m
- Los Alamos (USA) 2194 m
- Park City Utah (USA) 2200 m
- Flagstaff (USA) 2134 m
- Lake Louise (CAN) 2100 m
- Font Romeu (FRA) 1859 m

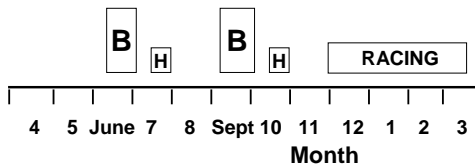
## 1) Live High / Train High Aims of Altitude Training

TYPE	AIM	DURATION
A	Improve general fitness - especially aerobic capacity	10 -14 days
B	To prepare for high intensity training following altitude	14 - 21 days
C	Improve competitive performance	17 - 21 days

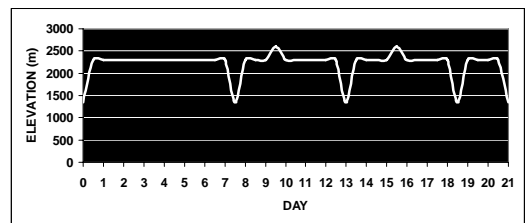
## Type



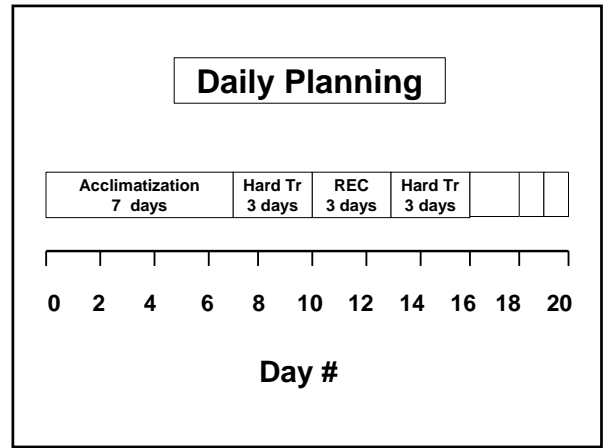
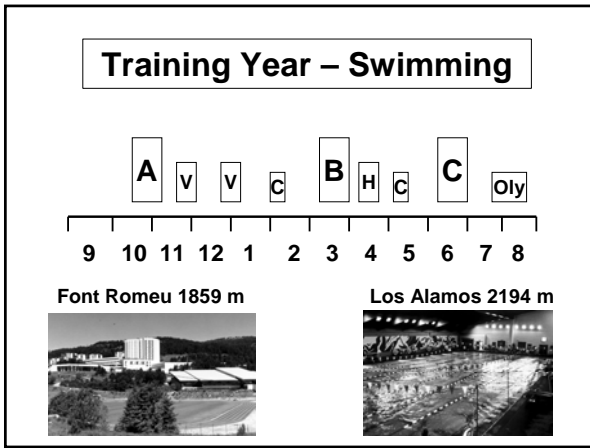
## Training Year – Winter Sports



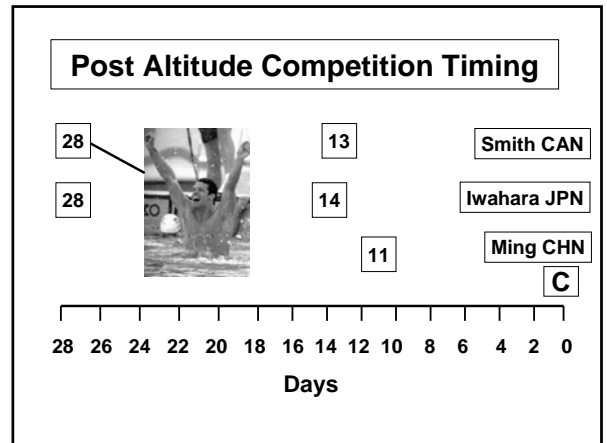
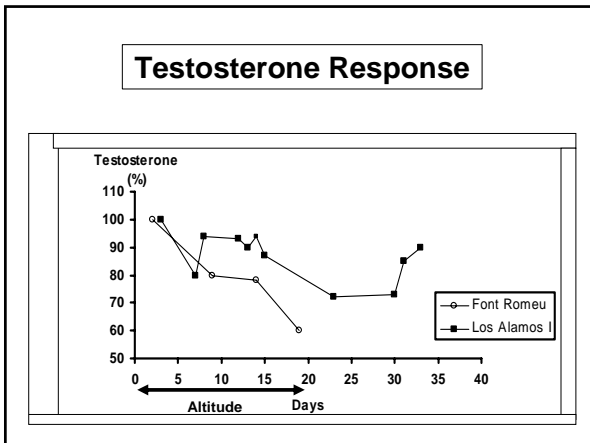
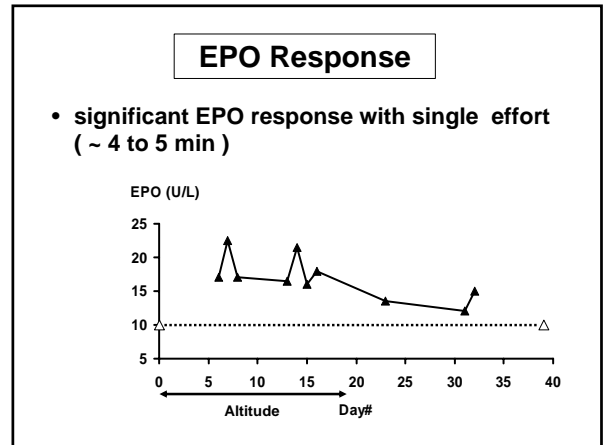
## Live High / Train Lower Type B



# Altitude / Hypoxia: The Canadian Model



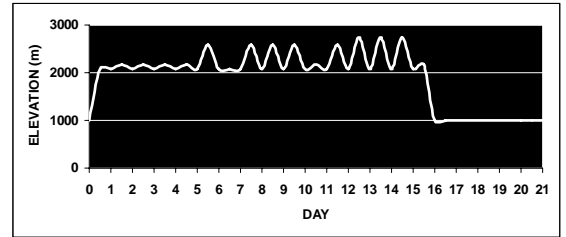
- ### Training at Altitude
- to induce central and peripheral adaptations
  - Use hypoxia as an additional training stimulus
  - Work on speed
  - Use intensity training up to 70 sec



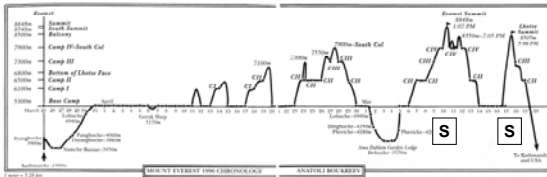
## 2) YoYo Altitude Training

- Live High / Train Higher
- Live Low / Train High

### YoYo Model Live High / Train Higher

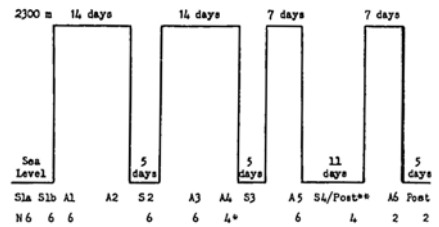


### Everest Preparation, 1996 A. Boukreev, "The Climb"

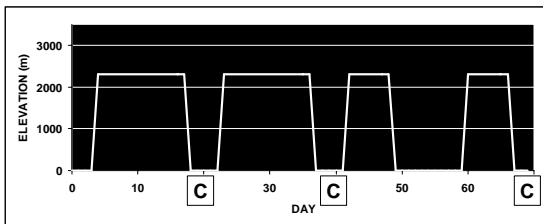


← Base Camp 11 days → YoYo Training 21 days → Summit Assault Day 7 and 14

### Daniels and Oldridge, 1970 Med Sci Sport and Exerc.

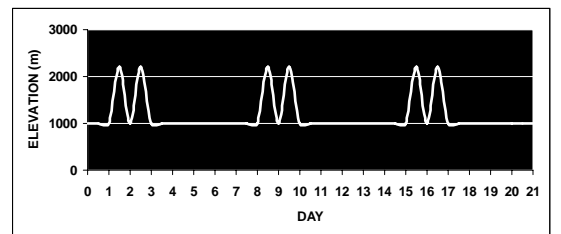


### Daniels and Oldridge, 1970 Med Sci Sport and Exerc.



Addition of various exposures of several hours each up to 3300 m

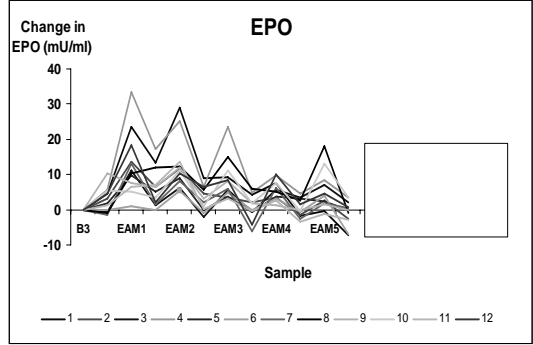
### Live Low / Train High (Cal Zaryski, 2002)



**3) Simulated Altitude**



**5 x 12 hr @ 4000 m (Kolb et al., 2004)**



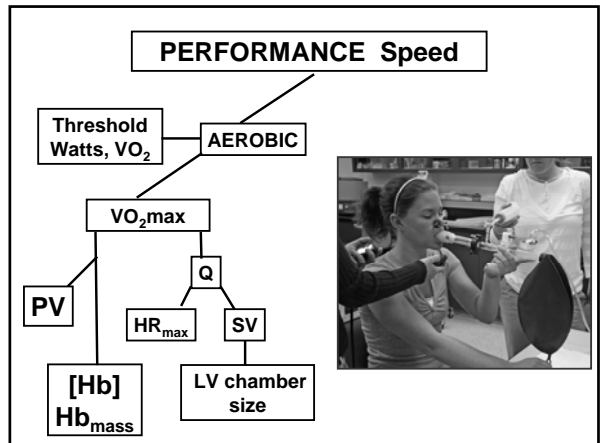
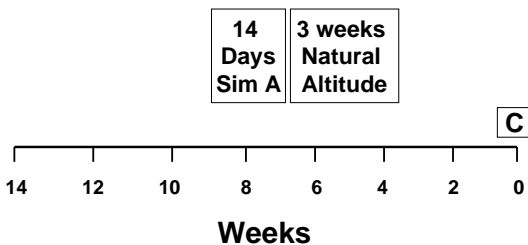
**Altitude Chamber – Women’s Ice Hockey Team Preparation, 2002**



**Altitude Chamber – Women’s Ice Hockey Team Preparation**



**Simulated Altitude - Timing**



# Altitude / Hypoxia: The Canadian Model

## SV Hb mass BV

### Stroke Volume

- Male
  - Elite > 200 ml
  - Mean = 179 ml

### - Female

- Elite > 134 ml
- Mean = 116 ml

### Hb mass

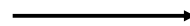
- Male > 14.0 g/kg
- Female > 12.0 g/kg

### Blood Volume

- Male > 105 ml/kg
- Female > 95 ml/kg

## Continuum of Malleable Adaptation (Norris, 2001)

Acute



Chronic

Substrate  
Utilization shifts

PV restoration  
Total Hb inc.

Ventilation  
Acid-Base  
Plasma Volume  
Heart Rate

Muscle Buffering  
inc. vasodilation

Cardiac Remodeling ?

Muscle Efficiency ?

## Key Points

- Successive exposures over years
- Develop Blood Volume
- Build the “Engine” – Heart size
- Build Hb<sub>mass</sub> – Oxygen carrying capacity
- Improve “Economy of Effort”
- Smart Training - Loads and Sequence

## Acknowledgements

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