Exercise & sport physiology

- Exercise is a sever normal stress
- Metabolism increases to 2000 percent during a marathon race

Metabolic systems during exercise

- **ATP is the primary source of energy**
- **Mechanism responsible for formation of new ATP**

1. Creatine phosphate (CP + ATP → phosphagen system → 8-10 sec maximal muscle contraction
2. The glucose – lactic acid system → 1.3 – 1.6 min of maximal exercise activity- rapid
3. The aerobic system

Prolonged muscle activity as long as nutrients are available

Oxygen – dept (excess post- exercise oxygen consumption EPOC)

- To replenish all stored O_2 & reconstitute phosphagen & lactic acid system
- Factors keeping high post-exercise O_2 consumption

  1 - increased body temp

  2- ↑ catecholamines & thyroid hormones

Stored O_2

- FRC
- Body fluids
- Hemoglobin
- Muscle myoglobin

Steady state " second wind"

Rate of production of lactic acid equals rate of its oxidation during prolonged exercise

Function of lactic acid

- Determine O_2 dept
- Stimulates respiration & circulation
- Fuel for the heart
- Converted to liver glycogen
- VD in muscle& shift of O_2 dissociation curve to right

Fuel of exercise

1. Carbohydrates

- (glycogen & blood glucose).
- the best for short activity
- glycogen store ⟶100 min of activity
- blood glucose reserve is limited

2. Fat

(Adipose tissue is the main energy reserve)

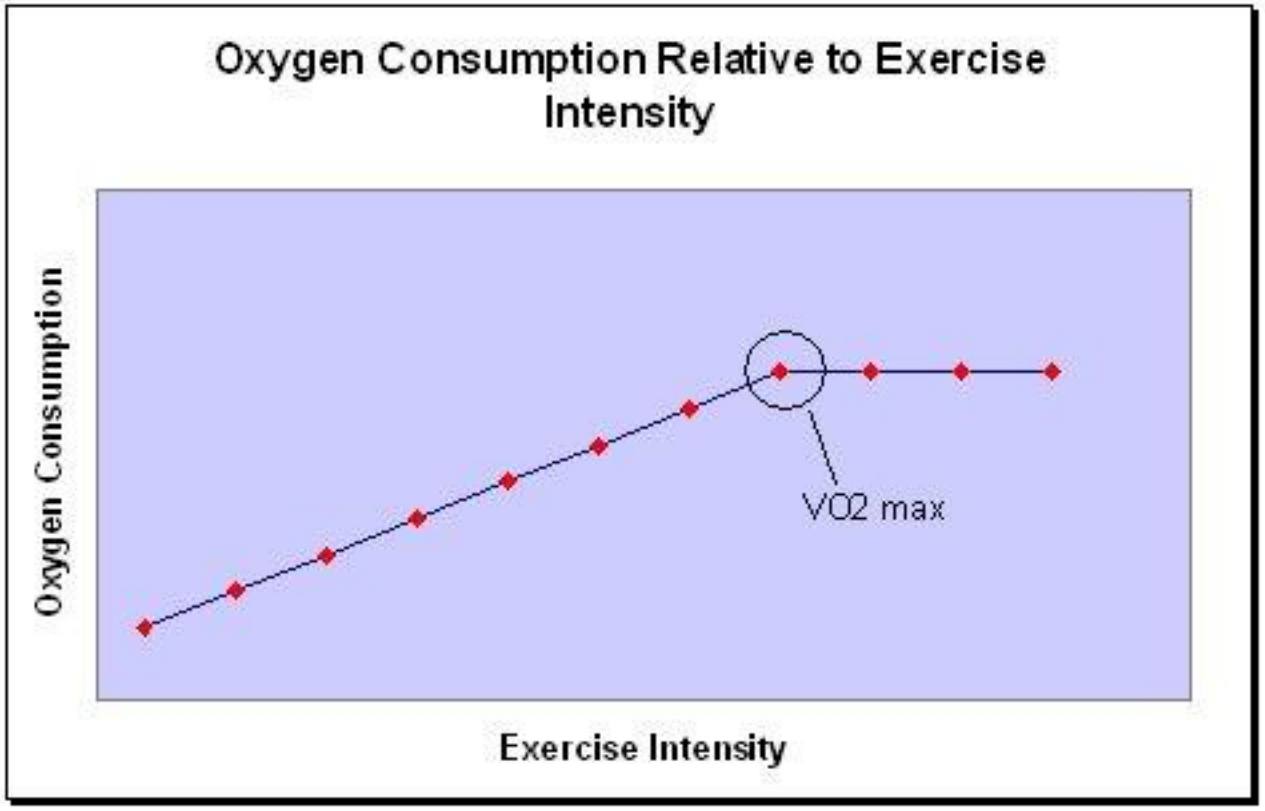
the relative use of CHO & fats during exercise depends on

- Intensity & duration of exercise
- Blood levels of glucose & FA
- State of training

Physiological response during exercise

Metabolic response

- Increased metabolism $\longrightarrow$ O_2 uptake increases until maximum (VO_2 max) & increased CO_2
- Anaerobic threshold is the point where anaerobic metabolism supplement aerobic system


Oxygen Consumption Relative to Exercise Intensity
Oxygen Consumption
VO2 max
Exercise Intensity

Respiratory response

- Increased tidal volume up to plateau & ↑respiratory rate ⟶ ↑ ventilation
- Increased O_2 diffusion capacity

Endocrinal response

↑ growth H, thyroxin & aldosterone

Cardiovascular response

Increased muscle blood flow due to

- Intramuscular VD
- ↑ ABP
- ↑ CO

Increased CO due to

- increased stroke volume to 110-160 ml/beat
- increased heart rate up to 220 – age (maximal heart rate)

Cardiac response

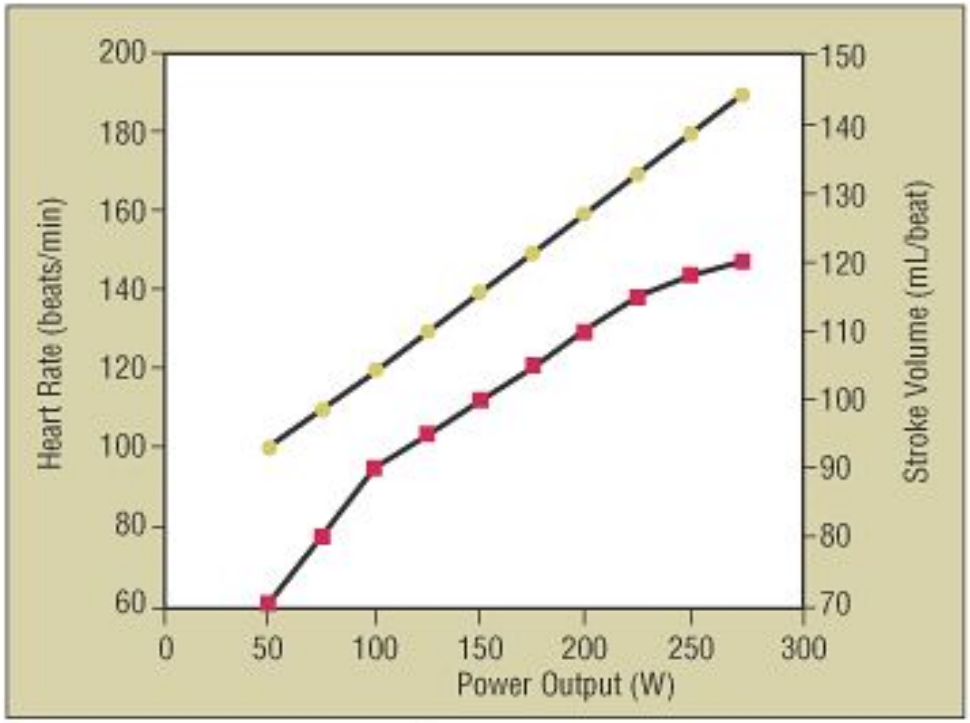
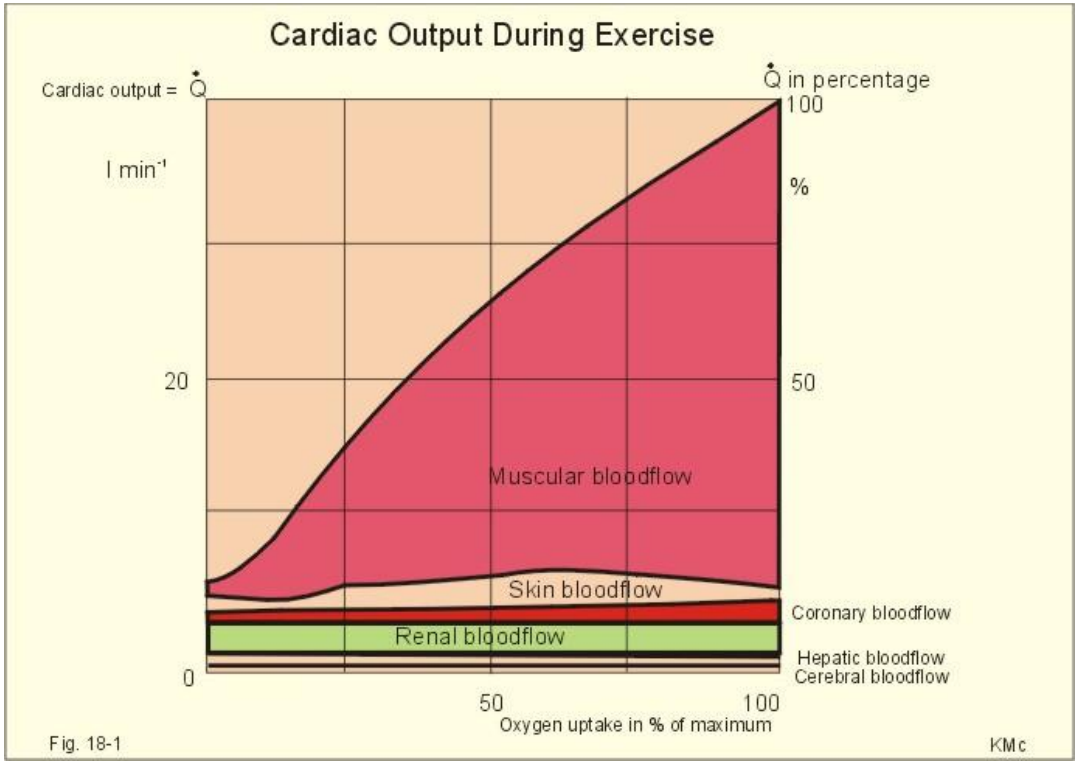


FIGURE 3. Changes in heart rate and stroke volume with increasing power output up to exhaustion. The represented exercise was performed on a cycle ergometer.

Redistribution of CO during exercise



Arterial –venous oxygen content difference

It is widened due to

- increased CO_2 & high O_2 extraction in the muscles
- shift of O_2 dissociation curve to the right
- Increased O_2 diffusion due to increased muscle capillary blood volume

Body heat in Exercise

- 20-25 % of energy is used in useful work and the remainder is converted to heat
- Heat loss must be ↑ to keep body temperature constant (sweating)
- Normal rise in body temp stimulate respiration , circulation & oxidative removal of lactic acid

Physical fitness

Physiological adaptations to training

Regulatory: (rapid)

- A shift to parasympathetic activity
- Redistribution of blood flow
- Initiating sweating at a lower core temp.
- Increased sensitivity to insulin allowing an improved glucose tolerance at lower insulin levels.

Structural (slow)

- Increased muscle mass, cardiac & bone tissue with parallel increase in capillary blood supply

Physiological adaptation to regular physical training

1- metabolic & cellular adaptation

- Increased VO_2 max
- increased anaerobic power
- increased aerobic power
- increasing fat utilization & sparing glycogen for anaerobic activity
- hypertrophy of the muscle fibers with increased myofibrils, mitochondria , ATP , CP & glycogen

VO2 max & LT with training

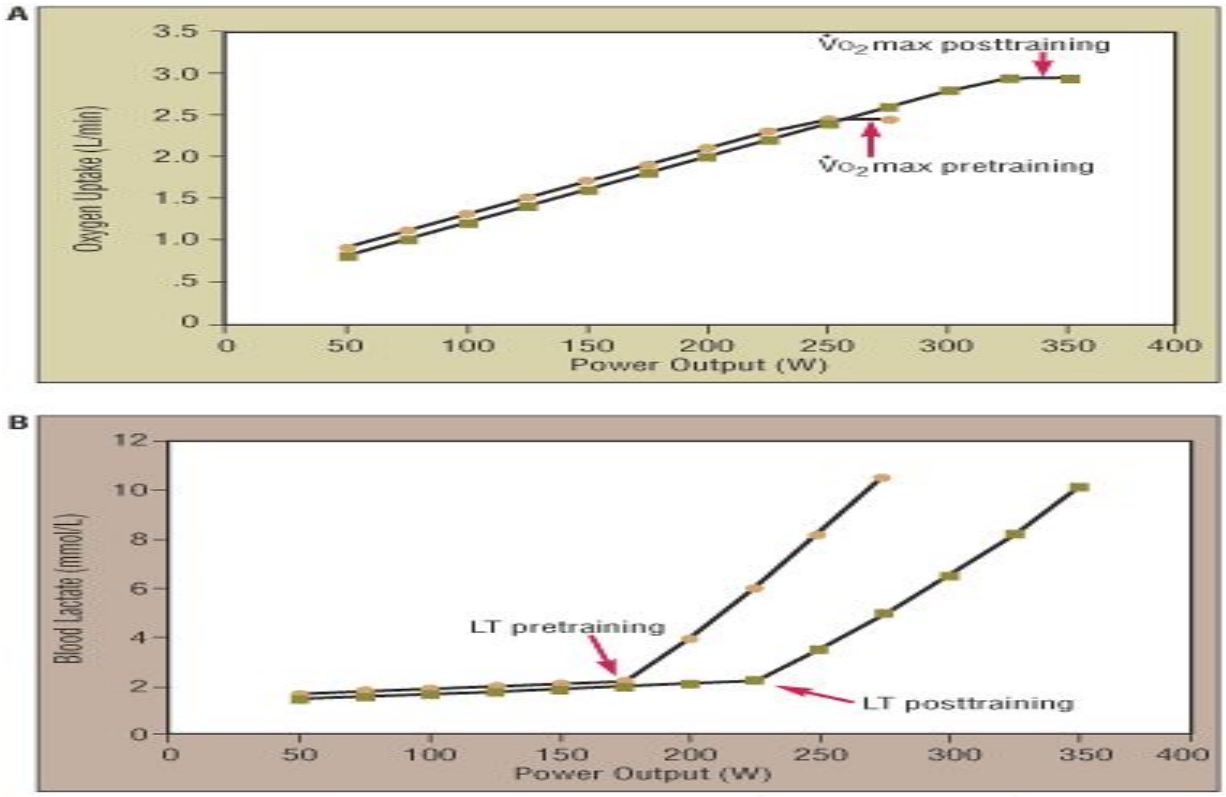


FIGURE 2. Changes in $\dot{V}O_2$submax and $\dot{V}O_2$max (A) and lactate threshold (B) after 6 months of aerobic training. In this example, the subject cycles for 2 minutes at each power output to achieve steady-state $\dot{V}O_2$ values. $\dot{V}O_2$ plateaus ($\dot{V}O_2$max) as the subject reaches exhaustion. More power is produced before LT is reached in well-trained athletes.

LT = lactate threshhold

2- Respiratory adaptation

Increase mechanical efficiency

Decrease ventilatory drive in moderate exercise

Reduction of sensitivity of chemoreceptors & lactate production

3- Cardiac adaptation

- Cardiac hypertrophy → Large SV & reduced HR
- Increased myocardial perfusion

4- Body composition adaptation

- Muscle hypertrophy
- Adipose tissues
  - Reduced adipose cells
  - Increased sensitivity to B-receptors more free FA
  - Decreased LDL, triglycerides & cholesterol

Effect of drugs

Caffeine:

- small amounts increase exercise performance

Male sex hormones

- Increase muscle bulk & strength
- cause liver damage & cancer, decrease testicular functions in males.
- cause hirsutism and menstrual disturbances in females

Amphetamine & cocaine

- as psychic stimulants.
- addictive
- Interaction with catecholamines released during exercise might cause sudden death