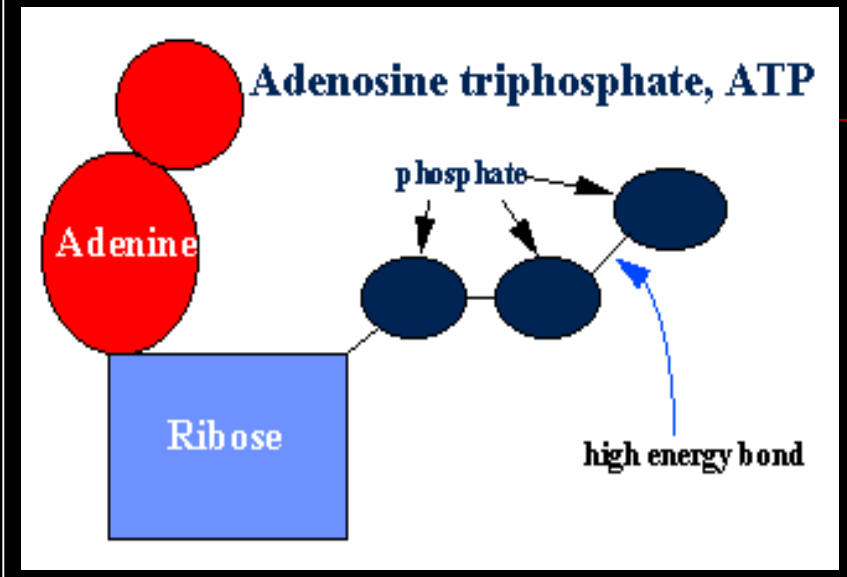
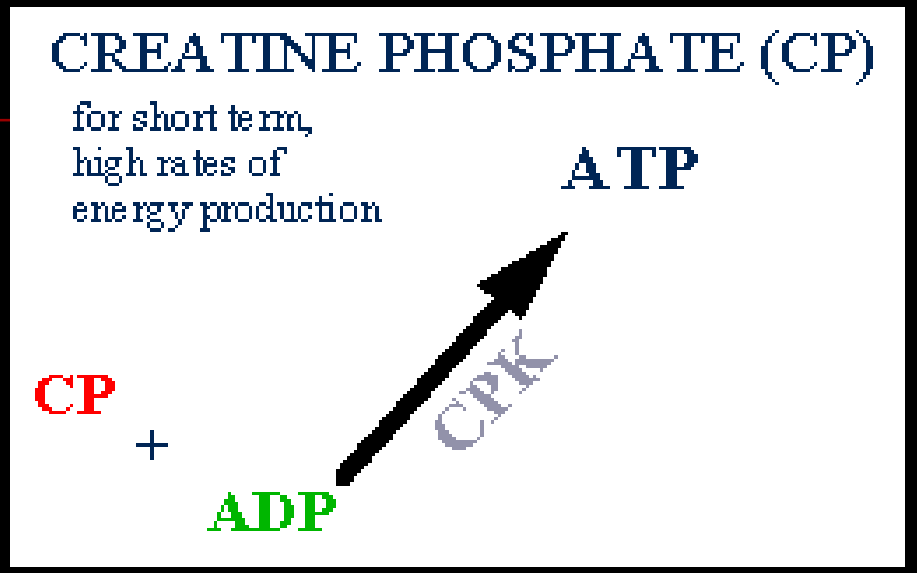
Working metabolism

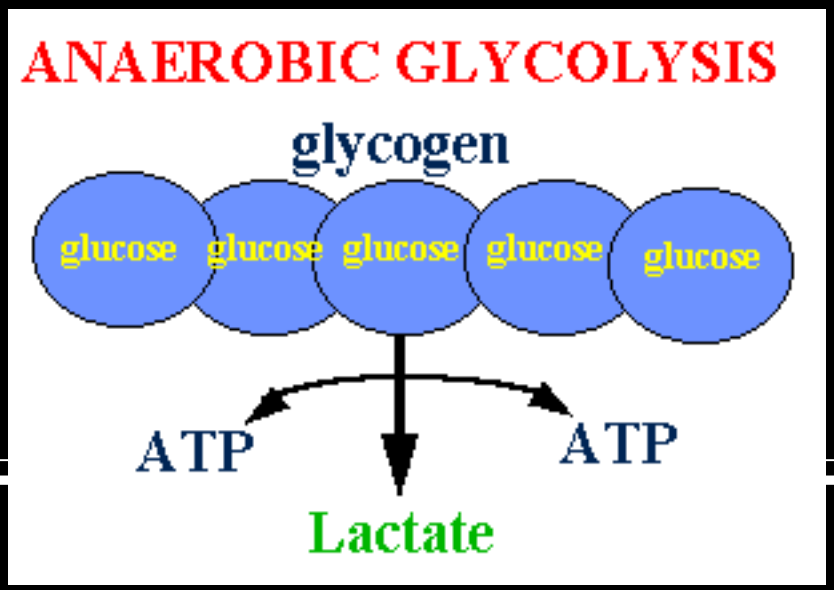
Definition

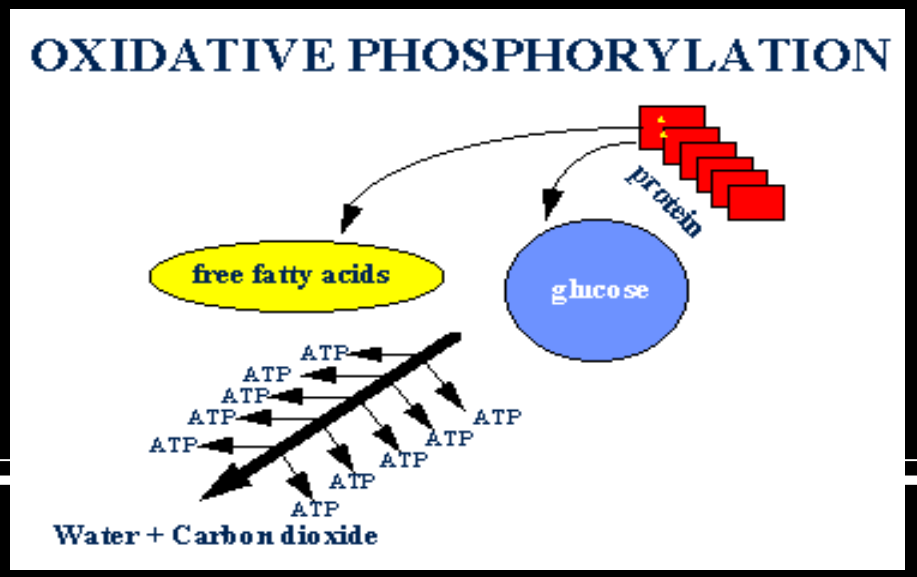
- Energy expenditure during muscle work
  - Contribution to whole metabolism

Energy sources

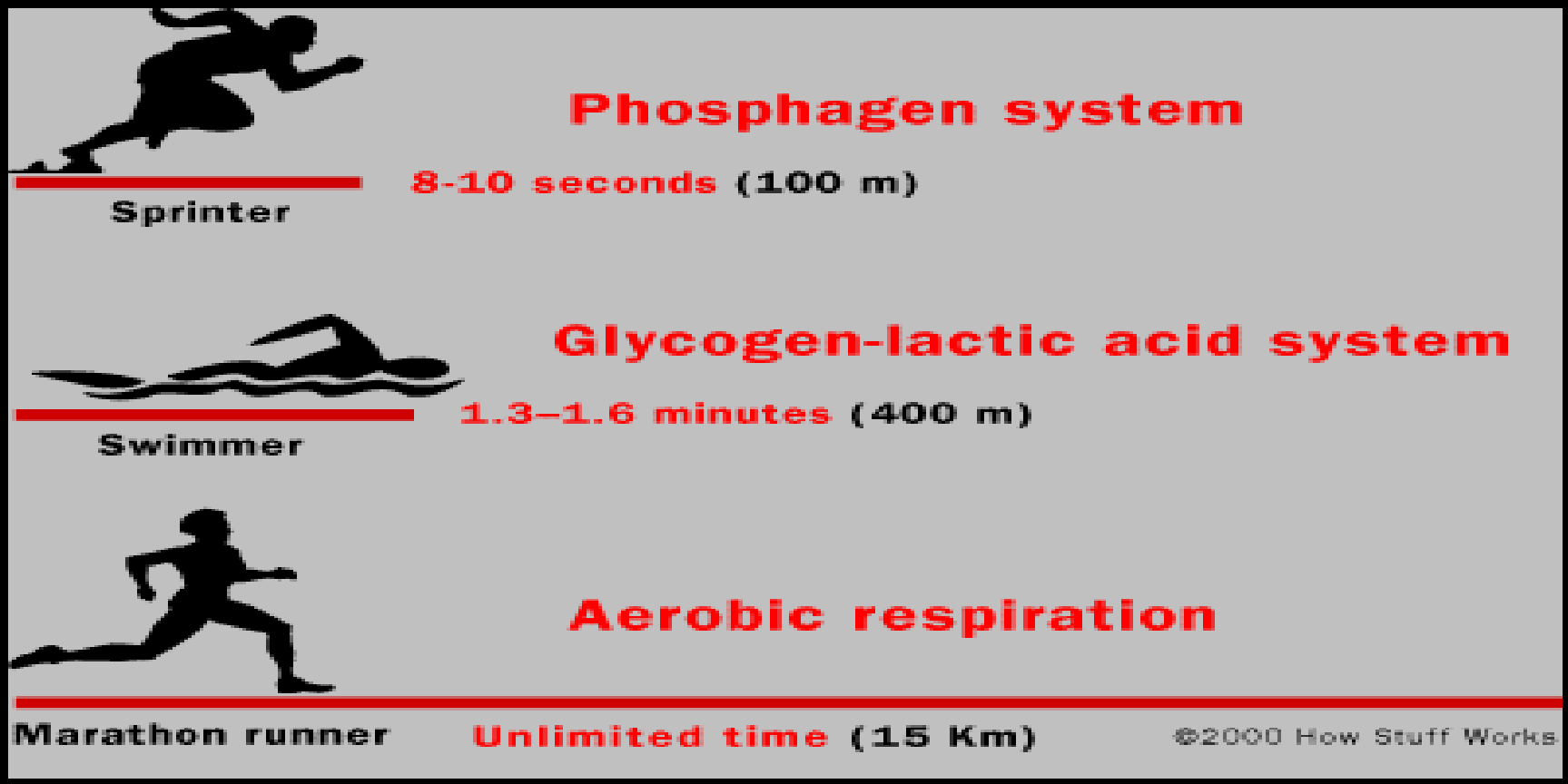








Energy sources



Aerobic load

- Aerobic means with „oxygen“
  - oxygen delivery = organism needs
  - waste products are CO2 and water
- Subgroups:
  - short aerobic– 2 – 8 min (lactat/aerobic)
  - mezzo aerobic – 8 – 30 min (mainly aerobic)
  - longterm aerobic - 30 min and more (aerobic)
- Aerobic endurance is built up by continual and interval running
  - continual running enhances the maximal oxygen usage (VO2max)
  - interval running enhances the effect of heart as a pump
- **Aerobic treshold**
  - point where organism starts to take energy from anaerobic sources
  - approx. in 65% of maximal heart frequency

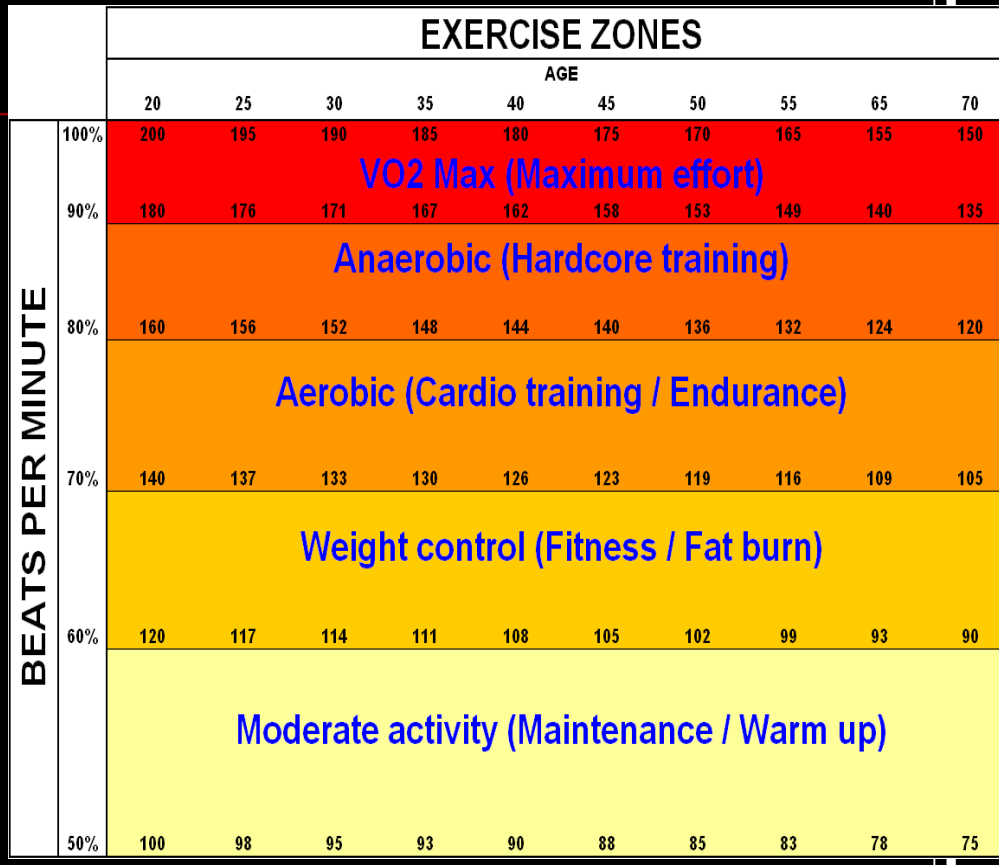
Anaerobic load

- Anaerobic means without „oxygen“
  - organism depends upon energy reserves
  - waste products are accumulating, and oxygen debt is created
  - other similar activity is not possible until debt is „paid“
  - lactate and alactate anaerobic load
- Subgroups
  - short anaerobic – less then 25s (mainly alactate)
  - mezzo anaerobic - 25s - 60s (mainly lactate)
  - longterm anaerobic - 60s – 120s (lactate +aerobic)
- Anaerobic endurance is built up by repeating excercise with high load
- **Anaerobic threshold**
  - point where lactate starts to accumulate in muscles
  - between 85-90% of maximal heart frequency (approx. about 40 bpm higher than aerobic threshold

Effect to heart

- Athlets
  - bradycardia – heart rate in rest under 50 bpm
  - ECG – ventricle hypertrophy, early repolarization
  - heart enlargment of X-rays
  - elevated cardial enzymes

- **Exercise zones of heart frequency**
  - **resting zone - 60% - 70%**
  - **aerobic zone - 70% - 80%**
  - **anaerobic zone - 80% - 90%**
  - **critical zone 90% - 100%**



Physical load

- Vessel dilatation in muscles – increase in blood flow and oxygen delivery
- During excessive activity and slower oxygen supply, anaerobic glycolysis starts
- **Lactate acid (lactate)**
  - **80 % lactate returns back to the liver**

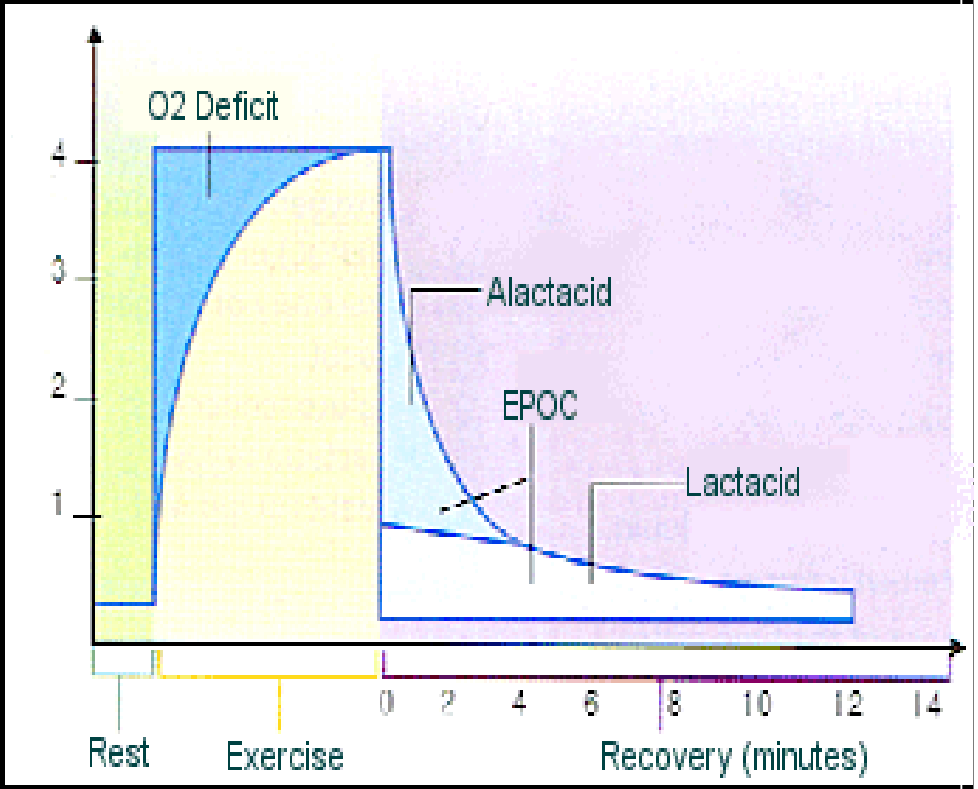
After physical load

- When oxygen delivery is sufficient (after activity finishes):
  - Lactate – turns to CO_2 and water
  - replenishment of ATP, phosphocreatine, glycogen
  - oxygen returns to hemoglobine, myoglobine and body fluids
- Additional oxygen that needs to be delivered to organism after physical activity is called the **oxygen debt** (A.V. Hill 1886-1977).
  - Excess Post-exercise Oxygen Consumption (EPOC)
- Replenishment of muscle and liver glycogen
  - carbohydrate diet
  - Several hours and days

Oxygen debt

Two main components of oxygen debt payback:

- alactate oxygen debt (fast component)
  - portion of oxygen needed for synthesis of muscle ATP and PC
- lactate oxygen debt (slow component)
  - portion of oxygen needed for lactate removal from muscle cells and blood



VO2 max

- Parameter of stamina/endurance
  - maximal amount of oxygen that is organism able to consump/deliver during the load
  - ml/min/kg VO2 max
  - built up: work between 65 and 85% of max. HR, at least for 20 min, 3-5 a week
  - Average amount of VO2 max
    - men 3.0 l/min
    - women 2.0 l/min
    - athletes 6.0 l/min

External determinants of VO2

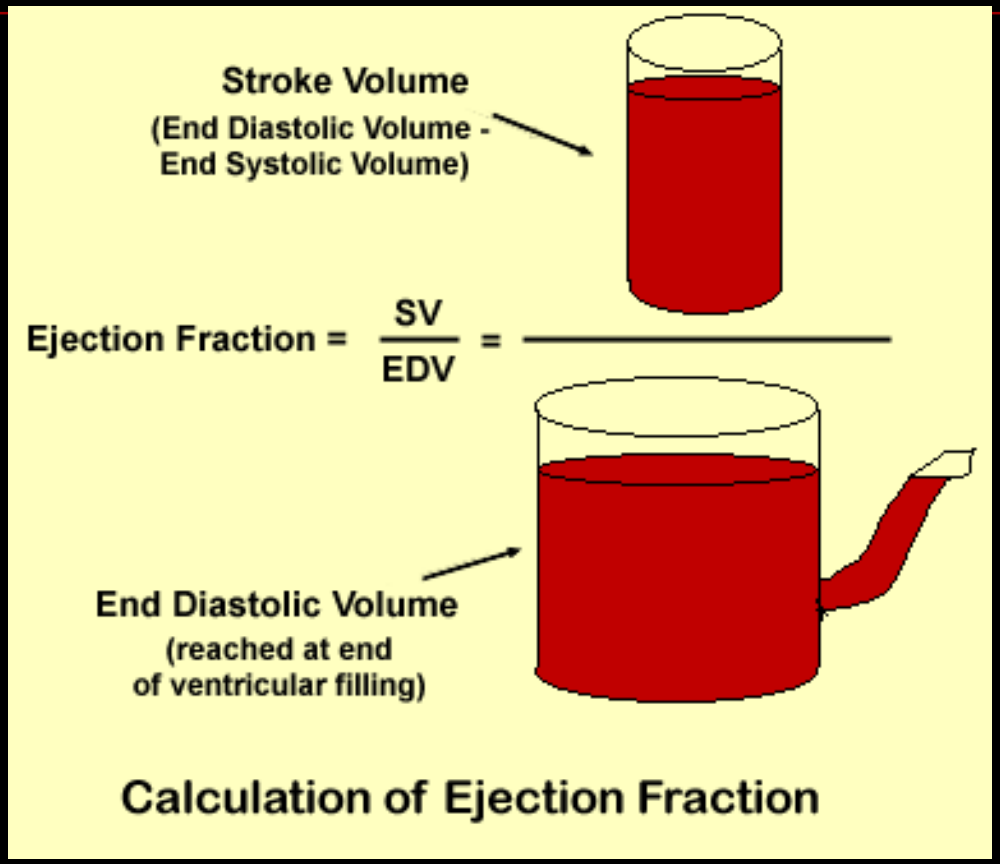
- **Factors**
  - Altitude – lowering pO2 means decrease in VO2max about 7% in altitude of 5000m
- **Age:**
  - maximal VO2max is around 20yrs
  - decrease about 30% between the age of 30-65 yrs.
- **Gender:**
  - Women have about 20% lower VO2max
  - Different composition, smaller heart with lower heart stroke, lower levels of Hb

Vo2 max	Sport
>75 ml/kg/min	Endurance Runners and Cyclists
65 ml/kg/min	Squash
60-65 ml/kg/min	Football (male)
55 ml/kg/min	Rugby
50 ml/kg/min	Volleyball (female)
50 ml/kg/min	Baseball (male)

Internal determinants of VO2

- Cardiac output (the amount of blood pumped out during 1 minute)
- Transport capacity (amount of Hb)
- Amount of muscles

Cardiac output



HRmax= 220 - Age

EF = 65%

Hormonal changes during physical activity

- catecholamins
- ADH
  - antidiuretic hormone
- ACTH, STH, TRH
  - adrenocorticotropic, somatotropic, thyreotropic hormone
- glucocorticoids, mineralocorticoids
- glucagon – insulin
- testosterone