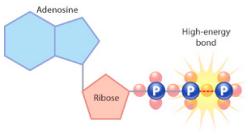
Skeletal Muscle Physiology
Part 2 – Metabolism & Exercise

Where do Muscles Get Their Energy?

- ATP - adenosine triphosphate
  - muscles only store 4-6 seconds worth
- ATP ⟶ ADP + P
- 3 pathways turn ADP back into ATP
  - direct phosphorylation by creatine phosphate (CP)
  - anaerobic respiration
  - aerobic respiration



Creatine Phosphate

- CP - unique high-energy molecule stored in muscles
- can directly transfer energy and a phosphate to ADP
- 14-16 seconds of stored ATP and CP
  - used in surges of activity lasting only a few seconds
  - weightlifting, diving, sprinting
- CP reserves restored during inactivity or rest

CP + ADP ⟶ creatine + ATP

Anaerobic Respiration

- glycolysis - glucose breakdown
  glucose ⟶ pyruvic acid + 2 ATP
- can occur with or without oxygen
  - oxygen present - pyruvic acid enters mitochondria for aerobic respiration
  - oxygen absent - pyruvic acid converted into **lactic acid**
- together, stored ATP & CP, and glycolysis can support muscle activity for about a minute
  - used during on-and-off or burst-like activities
  - tennis, soccer, swimming

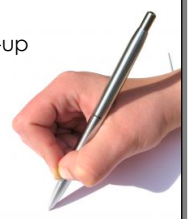
Aerobic Respiration

- occurs in mitochondria
- requires oxygen and glucose
- glucose comes from...
  - muscle glycogen
  - bloodborne glucose
  - pyruvic acid (glycolysis)
  - fatty acids (after about 30 minutes)
- used during endurance activities (jogging)

glucose + oxygen ⟶ carbon dioxide + water + lots of ATP

Muscle Fatigue

- physiological inability to contract even though muscle may still be receiving stimuli
- possible causes
  - problem in E-C coupling
  - neuromuscular junction
  - ionic imbalances (potassium)
  - pH increase due to lactic acid build-up
- ex. writer's cramp



Metabolism and Exercise

Oxygen Deficit

- for a muscle to return to its resting state, it must...
  - replenish oxygen, ATP, and CP reserves
  - convert lactic acid back to pyruvic acid
  - replace glycogen
- during anaerobic respiration, there is not enough oxygen to accomplish all this so it is deferred until oxygen is present
- oxygen deficit - extra oxygen the body must take in to restore muscles to their resting states

Types of Muscle Fibers

- classified by their speed of contraction and major pathways for forming ATP
- slow oxidative (SO) fibers (red in color)
  - contraction - slow
  - ATP production - aerobic
  - used in endurance activities
- fast oxidative (FO) fibers (red to pink)
  - contraction - fast
  - ATP production - aerobic/anaerobic
  - sprinting, walking
- fast glycolytic (FG) fibers (white)
  - contraction - fast
  - ATP production - anaerobic
  - used in short-term intense or powerful movements

Muscles & Excercise

- endurance exercises
  - increase stamina (resistance to fatigue)
  - more efficient muscle metabolism
  - swimming, jogging, biking, fast walking
- resistance exercises
  - increase strength
  - increases size of individual muscle fibers
  - weight lifting