NAME:

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Energy Production in Skeletal Muscle

ATP is the energy for cross bridge formation, sarcomere sliding, and even muscle relaxation. Muscle fibers need a continual supply of ATP, but the amount of ATP stored in muscles is rapidly depleted during exercise and needs to be continually replenished through three methods. *More detail on each system will be presented in Chapter 12.*

1. **ATP/CP.** As intensive exercise begins, small amount of ATP stored in muscles is rapidly depleted. CP (creatine phosphate) is a molecule found inside the muscle cells that is used to make ATP directly. Creatine phosphate stores produce ATP for about 20 seconds, and then other methods must be used.

2. **Anaerobic Glycolysis/Lactic Acid System** This ATP production system breaks down glucose (from carbohydrates) without the use of oxygen and produces 'lactic acid' as a by-product. ATP production during this system is limited and only produces about 5% of what the aerobic systems is capable of producing. The anaerobic glycolysis system is most efficient for intense exercise bouts 30 seconds to 1 ½ in minutes in duration.

3. **Aerobic System.** During low to moderate intensity exercise, most of the ATP is supplied by the aerobic system. This system requires oxygen and can use carbohydrates, fats and proteins (if necessary) to supply the raw materials for ATP production. Aerobic systems are capable of producing high levels of ATP.

Effect of Exercise on Skeletal Muscle

Muscles have the ability to adapt and get bigger and stronger depending on the type and amount of stress placed upon them.

Endurance Training Muscles subject to long term endurance or aerobic training can show the following adaptations:

- Increased number of capillaries, especially in slow twitch fibers (increased blood flow and oxygen delivery)
- More efficient ATP production through aerobic methods
- Increased muscle endurance capacity (take longer to fatigue)
- Increases strength of the skeletal system (bone density increases)

Resistance Training Muscles challenged with regular resistance training (weight training is an example), can undergo the following adaptations:

- Increased size (hypertrophy) of individual muscle fibers
- Increased strength
- Increased connective tissue between muscle cells, ligaments, and tendons (makes the entire muscle stronger)
- Increased bone health and density

Muscle Naming and Action Terminology

Muscles can be named by many different methods.

- **Action**-flexors, extensors, adductors
- **Shape**-deltoid, rhomboid
- **Direction of muscle fibers**-external obliques, rectus abdominus (straight)
- **Size**-gluteus maximus, medius, minimus,
- **Location**-temporalis (located on the temporal bone of the skull)
- **Number of origins**-bicep (two sites of origin), tricep (three sites of origin) quadriceps (four sites of origin)
- **Location of origin and insertion-** sternocleidomastoid (origin on sternum, and clavicle, and insertion on the mastoid process of the temporal bone of the skull).

Muscle Dynamics

How do all of the muscle fibers interact to produce force and cause movement of the body?

All-or-none-principle. The amount of force produced by an individual muscle fiber is determined by the number of cross-bridges formed within each sarcomere. Any time an individual muscle fiber contracts, it **contracts fully or not at all.** The only way to alter the force produced within a complete muscle is to:

- Vary the number of fibers recruited (stimulated to contract)
- Increase the rate of stimulation of muscle fibers