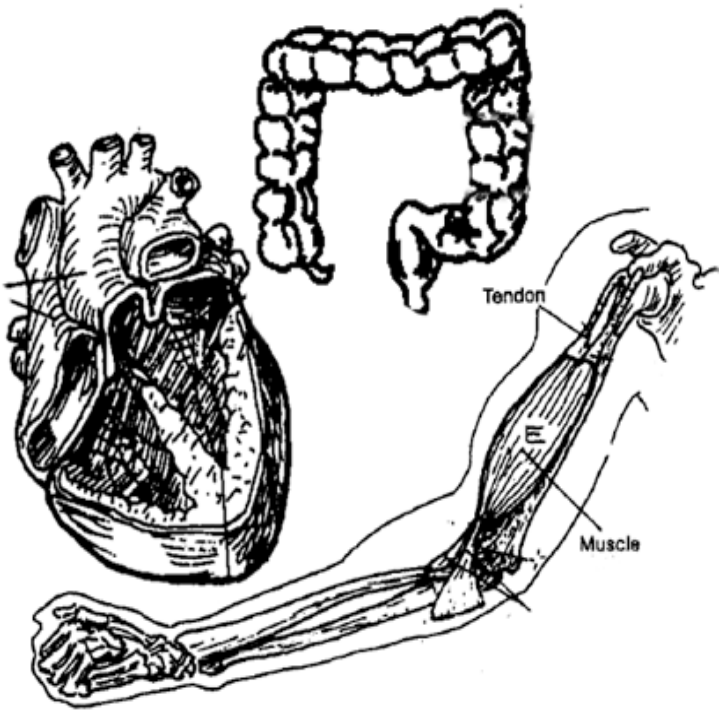
Movement

Muscle is one of the four basic tissue types that make up the human body. Muscle tissue are able to **contract** in response to stimulation from nerves or hormones.



There are three kinds of muscle tissues:

- **Skeletal -** move bones at joints has short, rapid contractions
- **Cardiac -** found only in the heart has short, rapid rhythmic contractions
- **Smooth -** found in the lining of organs has slow, rhythmic contractions

Muscles always pull ... they never push

Skeletal muscle cells are **long, striated, and multi-nucleated**. Muscle cells contain large quantities of mitochondria within their cytoplasm. Due to their high rates of cellular respiration muscles are highly vascularized and contain many capillaries. **Skeletal muscles attach to bones** or other muscles using tendons. Skeletal muscle contractions are rapid but brief shortenings and can generate great amounts of force. Contractions of Skeletal Muscle is usually under voluntary control, but the brain involuntarily maintains the body's muscle tone.

Cardiac muscle cells make up the **heart muscle**. They are specialized **branched**, striated cells with one or two centrally located nuclei. Their structure is similar to skeletal muscle, but its contractions are rhythmic, strong, and well regulated by a special set of impulse-conducting muscle cells called the SA Node instead of nerves.

Smooth muscle cells are long, tapered cells with centrally placed nuclei. These cells are smooth (**non-striated**). Smooth muscle cells are **found in the walls of organs** with cavities and serve to move the contents along the length of those cavities by slow, sustained, often powerful rhythmic contractions (peristalsis). Smooth muscle cells wrapped around tubular organs act as sphincters regulating the flow of the passing materials such as delaying the flow of urine. Generally speaking smooth muscle is not usually under voluntary control.

Sources of Energy in Muscle Fibers

Aerobic Respiration: When muscles are put under a sudden stress (such as lifting a bag containing several freshly severed zombie heads from the ground) they quickly use up their stored supply of ATP. To produce more ATP the cells activate their mitochondria which begin using Oxygen and Glucose from the blood. If the weight of the zombie head bag is light enough the lungs will be able to supply enough oxygen to the blood and the heart will be able to pump fast enough to keep up with the supply demands of the cells.

However if you are unexpectedly attacked by several dozen more of the undead the bursts of intense energy needed by your cells to swing your battle axe will exceed the supply of Oxygen in your blood. Even with your cardiovascular system working at full capacity it still may not be unable to suck in enough oxygen from the air to keep up with the needs of your muscle cells. At this point you have only one choice if you want to keep harvesting zombie heads... to switch over to your emergency backup metabolism...what biologists call Anaerobic respiration.

Anaerobic respiration: When the body is unable to supply enough oxygen to the mitochondria they switch over to Lactic Acid Fermentation. This energy pathway produces far few fewer ATP but allows the muscle to continue contracting.

2 Kinds of Skeletal Muscle Fiber

Slow Twitch: Red muscle, does areobic respiration, slower movements

Fast Twitch: white muscle, does anerobic respiration, very fast movements

How Skeletal Muscle Contract

Muscles are made up of bundles of cells called **fibers**

Muscle Fibers are made of special cells that contain hundreds of **myofibrils**

Myofibrils are striated (meaning banded or striped) because they are made up of two types of **protein filaments**.

Actin filaments are thin while **Myosin** filaments are thick

Each contracting unit is called a sarcomere and is made up of repeating bands of thin actin and thick myosin proteins. When the muscles contract the thin myosin fibers are pulled towards each other by the thick myosin fibers.