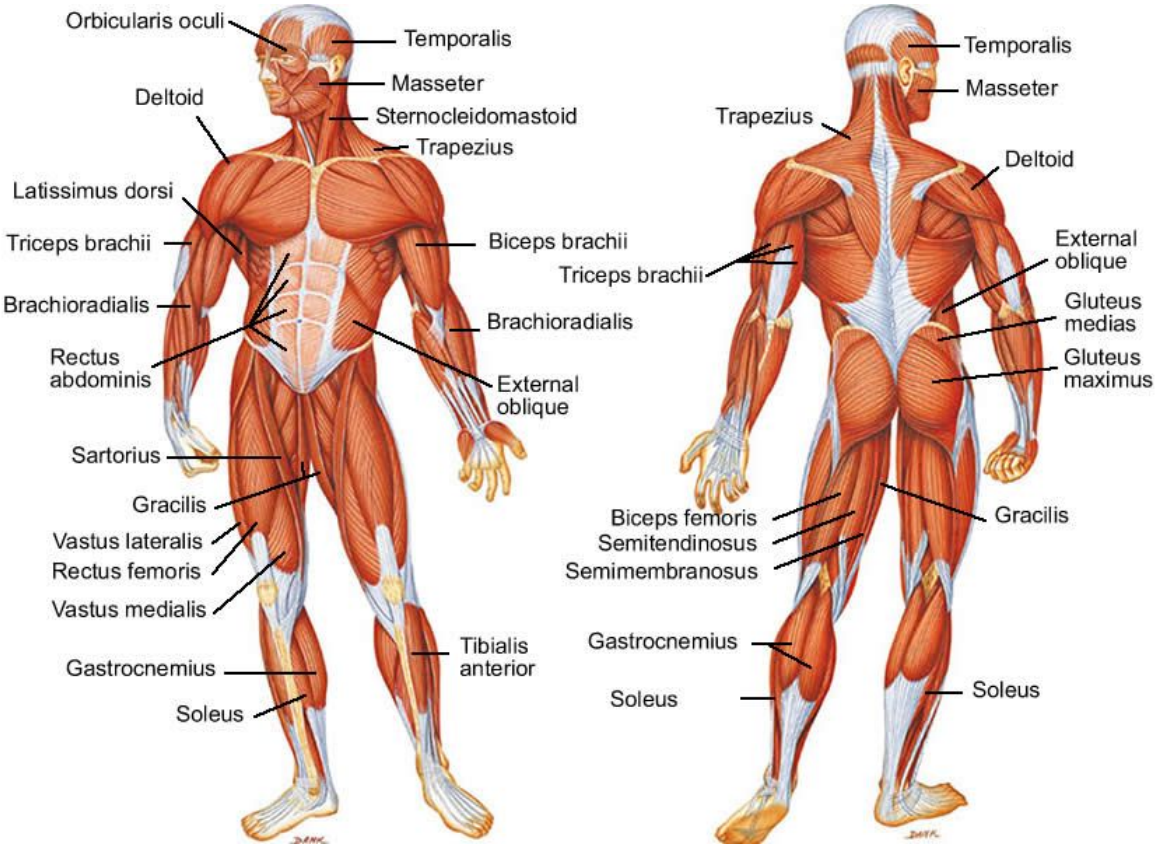
Muscle Brochure By Richard Panduro

Enter the Types of Muscles in the human body and their functions



Muscles

There are three distinct types of muscles: skeletal muscles, cardiac or heart muscles, and smooth (non-striated) muscles. Muscles provide strength, balance, posture, movement and heat for the body to keep warm.

Upon stimulation by an action potential, skeletal muscles perform a coordinated contraction by shortening each sarcomere. The best proposed model for understanding contraction is the sliding filament model of muscle contraction. Actin and myosin fibers overlap in a contractile motion towards each other. Myosin filaments have club-shaped heads that project toward the actin filaments.

Larger structures along the myosin filament called myosin heads are used to provide attachment points on binding sites for the actin filaments. The myosin heads move in a coordinated style, they swivel toward the center of the sarcomere, detach and then reattach to the nearest active site of the actin filament. This is called a ratchet type drive system. This process consumes large amounts of adenosine triphosphate (ATP).

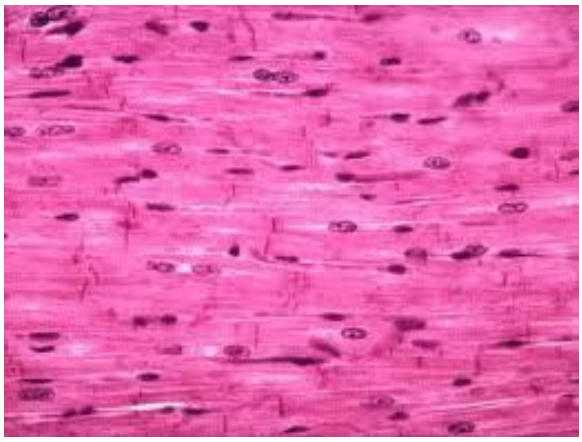
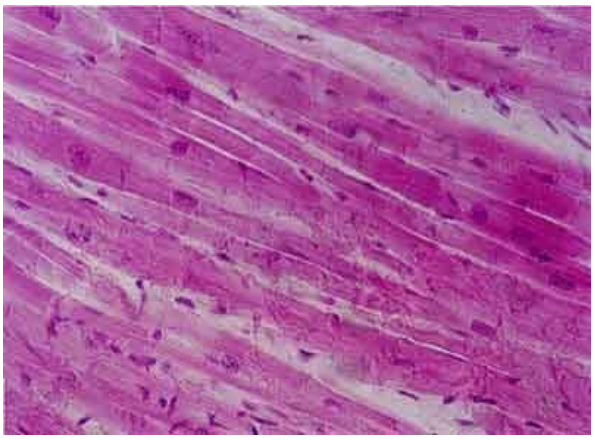
Energy for this comes from ATP, the energy source of the cell. ATP binds to the cross bridges between myosin heads and actin filaments. The release of energy powers the swiveling of the myosin head. Muscles store little ATP and so must continuously recycle the discharged adenosine diphosphate molecule (ADP) into ATP rapidly. Muscle tissue also contains a stored supply of a fast acting recharge chemical, creatine phosphate which can assist initially producing the rapid regeneration of ADP into ATP.

Calcium ions are required for each cycle of the sarcomere. Calcium is released from the sarcoplasmic reticulum into the sarcomere when a muscle is stimulated to contract. This calcium uncovers the actin binding sites. When the muscle no longer needs to contract, the calcium ions are pumped from the sarcomere and back into storage in the sarcoplasmic reticulum.

Aerobic and anaerobic muscle activity

At rest, the body produces the majority of its ATP aerobically in the mitochondria without producing lactic acid or other fatiguing byproducts. During exercise, the method of ATP production varies depending on the fitness of the individual as well as the duration, and intensity of exercise. At lower activity levels, when exercise continues for a long duration (several minutes or longer), energy is produced aerobically by combining oxygen with carbohydrates and fats stored in the body. Activity that is higher in intensity, with possible duration decreasing as intensity increases, ATP production can switch to anaerobic pathways, such as the use of the creatine phosphate and the phosphagen system or anaerobic glycolysis. Aerobic ATP production is biochemically much slower and can only be used for long-duration, low intensity exercise, but produces no fatiguing waste products that can not be removed immediately from sarcomere and body and results in a much greater number of ATP molecules per fat or carbohydrate molecule.

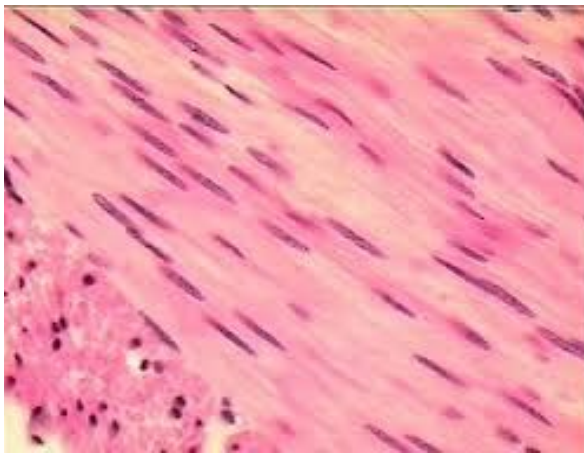
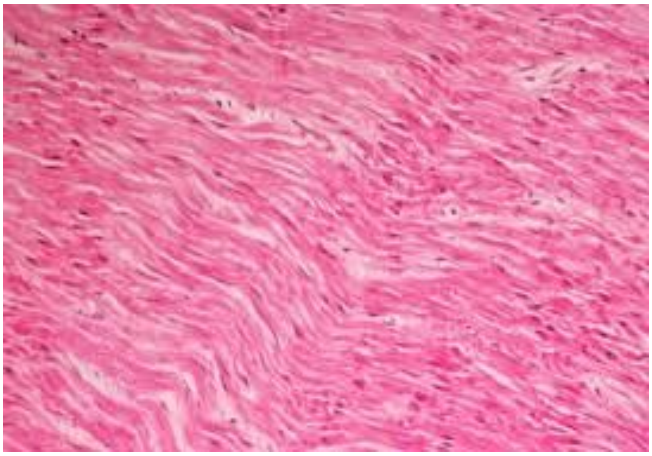
Aerobic training allows the oxygen delivery system to be more efficient, allowing aerobic metabolism to begin quicker. Anaerobic ATP production produces ATP much faster and allows near-maximal intensity exercise, but also produces significant amounts of lactic acid which render high intensity exercise unsustainable for greater than several minutes.The phosphagen system is also anaerobic, allows for the highest levels of exercise intensity, but intramuscular stores of phosphocreatine are very limited and can only provide energy for exercises lasting up to ten seconds. Recovery is very quick, with full creatine stores regenerated within five minutes.

Cardiac muscle (heart muscle) is involuntary, striated muscle that is found in the walls and histological foundation of the heart, specifically the myocardium. Cardiac muscle is one of three major types of muscle, the others being skeletal and smooth muscle. These three types of muscle all form in the process of myogenesis. The cells that constitute cardiac muscle, called cardiomyocytes or myocardiocytes, predominantly contain only one nucleus, although populations with two to four nuclei do exist. The myocardium is the muscle tissue of the heart, and forms a thick middle layer between the outer epicardium layer and the inner endocardial layer.

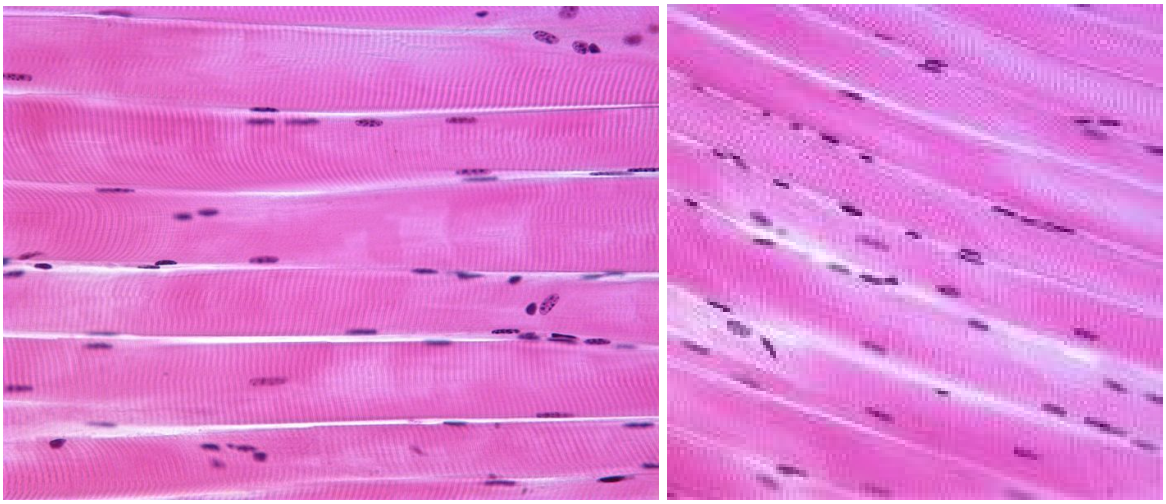
Coordinated contractions of cardiac muscle cells in the heart propel blood out of the atria and ventricles to the blood vessels of the left/body/systemic and right/lungs/pulmonary circulatory systems. This complex mechanism illustrates systole of the heart.

Cardiac muscle cells, unlike most other tissues in the body, rely on an available blood and electrical supply to deliver oxygen and nutrients and remove waste products such as carbon dioxide. The coronary arteries help fulfill this function.

Visceral muscle is an involuntary non-striated muscle. It is divided into two subgroups; the single-unit (unitary) and multiunit smooth muscle. Within single-unit cells, the whole bundle or sheet contracts as a syncytium (i.e. a multinucleate mass of cytoplasm that is not separated into cells). Multiunit smooth muscle tissues innervate individual cells; as such, they allow for fine control and gradual responses, much like motor unit recruitment in skeletal muscle.

Smooth muscle is found within the walls of blood vessels (such smooth muscle specifically being termed vascular smooth muscle) such as in the tunica media layer of large (aorta) and small arteries, arterioles and veins. Smooth muscle is also found in lymphatic vessels, the urinary bladder, uterus (termed uterine smooth muscle), male and female reproductive tracts, gastrointestinal tract,respiratory tract, arrector pili of skin, the ciliary muscle, and iris of the eye. The structure and function is basically the same in smooth muscle cells in different organs, but the inducing stimuli differ substantially, in order to perform individual effects in the body at individual times. In addition, the glomeruli of the kidneys contain smooth muscle-like cells called mesangial cells.



Skeletal muscle is one of three major muscle types, the others being cardiac muscle and smooth muscle. It is a form of striated muscle tissue which is under the voluntary control of the somatic nervous system. Most skeletal muscles are attached to bones by bundles of collagen fibers known as tendons.

A skeletal muscle refers to multiple bundles of cells called muscle fibers (fascicles). The fibres and muscles are surrounded by connective tissue layers called fasciae. Muscle fibres, or muscle cells, are formed from the fusion of developmental myoblasts in a process known as myogenesis. Muscle fibres are cylindrical, and have more than one nucleus.

Muscle fibers are in turn composed of myofibrils. The myofibrils are composed of actin and myosin filaments, repeated in units called sarcomeres, which are the basic functional units of the

muscle fiber. The sarcomere is responsible for the striated appearance of skeletal muscle, and forms the basic machinery necessary for muscle contraction.

Control of muscle contraction

Neuromuscular junctions are the focal point where a motor neuron attaches to a muscle. Acetylcholine, (a neurotransmitter used in skeletal muscle contraction) is released from the axon terminal of the nerve cell when an action potential reaches the microscopic junction, called a synapse. A group of chemical messengers cross the synapse and stimulate the formation of electrical changes, which are produced in the muscle cell when the acetylcholine binds to receptors on its surface. Calcium is released from its storage area in the cell's sarcoplasmic reticulum. An impulse from a nerve cell causes calcium release and brings about a single, short muscle contraction called a muscle twitch. If there is a problem at the neuromuscular junction, a very prolonged contraction may occur, tetanus. Also, a loss of function at the junction can produce paralysis.

Skeletal muscles are organized into hundreds of motor units, each of which involves a motor neuron, attached by a series of thin finger-like structures called axon terminals. These attach to and control discrete bundles of muscle fibers. A coordinated and fine tuned response to a specific circumstance will involve controlling the precise number of motor units used. While individual muscle units contract as a unit, the entire muscle can contract on a predetermined basis due to the structure of the motor unit. Motor unit coordination, balance, and control frequently come under the direction of the cerebellum of the brain. This allows for complex muscular coordination with little conscious effort, such as when one drives a car without thinking about the process.

References:

1. Taylor, Tim. "Muscular System." *InnerBody*. Anatomy and Physiology Instructors, n.d. Web. 10 May 2016. <http://www.innerbody.com/image/musfov.html>.

2. "Muscle." *Wikipedia*. Wikimedia Foundation, n.d. Web. 10 May 2016. <https://en.wikipedia.org/wiki/Muscle>.

3. "Muscular System." *Wikipedia*. Wikimedia Foundation, n.d. Web. 10 May 2016. <https://en.wikipedia.org/wiki/Muscular_system>.