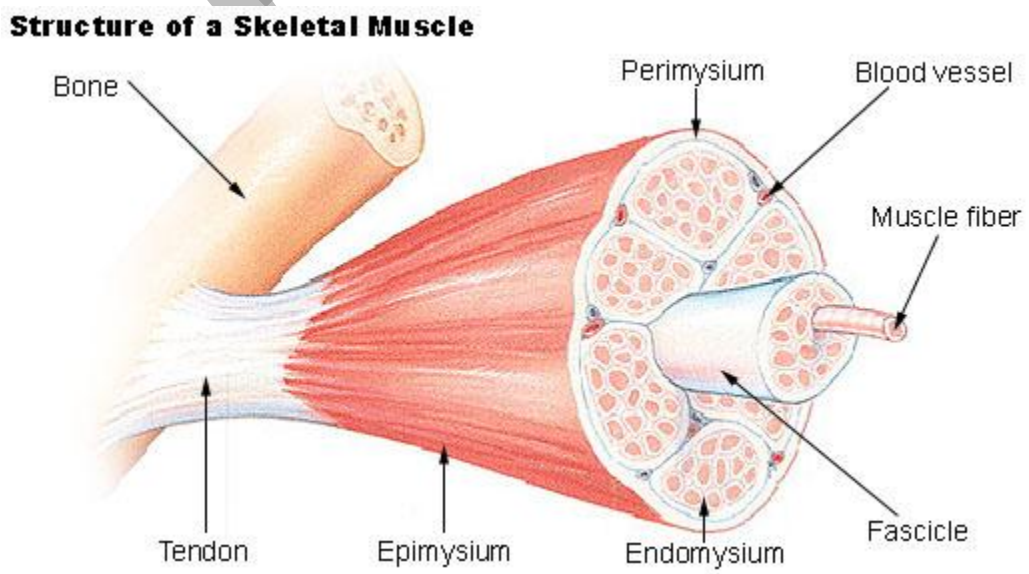
Baida Almusawy **Human Physiology/ The Muscular System**

The **muscular system** is the biological system of humans that produces movement. The muscular system, in vertebrates, is controlled through the nervous system, although some muscles, like cardiac muscle, can be completely autonomous. **Muscle** is contractile tissue and is derived from the mesodermal layer of embryonic germ cells. Its function is to produce force and cause motion, either locomotion or movement within internal organs. Much of muscle contraction occurs without conscious thought and is necessary for survival, like the contraction of the heart or peristalsis, which pushes food through the digestive system. Voluntary muscle contraction is used to move the body and can be finely controlled, such as movements of the finger or gross movements that of the biceps and triceps. The bend double forearm process, which constrict the biceps (biceps) and flattens the triceps muscle (triceps) at the same time, When the muscle contracts fall short in length but increasingly thicker in the center and that is happening in the muscle fibers and thus appear in the entire muscle. Therefore it swells biceps at arm bend.



Muscle is composed of muscle cells (sometimes known as "muscle fibers"). Within the cells are myofibrils; myofibrils contain sarcomeres which are composed of actin and myosin. Individual muscle cells are lined with endomysium. Muscle cells are bound together by perimysium into bundles called fascicles. These bundles are then grouped together to form muscle, and is lined by epimysium. Muscle spindles are distributed throughout the muscles, and provide sensory feedback information to the central nervous system. Skeletal muscle, which involves muscles from the skeletal tissue, is arranged in discrete groups. An example is the biceps brachii. It is connected by tendons to processes of the skeleton. In contrast, smooth muscle occurs at various scales in almost every organ, from the skin (in which it controls erection of body hair) to the blood vessels and digestive tract (in which it controls the caliber of a lumen and peristalsis, respectively). There are approximately 640 skeletal muscles in the human body (see list of muscles of the human body). Contrary to popular belief, the number of muscle fibers cannot be increased through exercise; instead the muscle cells simply get bigger. It is however believed that myofibrils have a limited capacity for growth through hypertrophy and will split if subject to increased demand.

In skeletal muscle, contraction is stimulated at each cell by nervous impulses that releases acetylcholine at the neuromuscular junction, creating action potentials along the cell membrane. All skeletal muscle and many smooth muscle contractions are stimulated by the binding of the neurotransmitter acetylcholine. Muscular activity accounts for most of the body's energy consumption. Muscles store energy for their own use in the form of glycogen, which represents about 1% of their mass. Glycogen can be rapidly converted to glucose when more energy is necessary.

Types

There are three types of muscle:

• **Smooth muscle or "involuntary muscle"** consists of spindle shaped muscle cells found within the walls of organs and structures such as the esophagus, stomach, intestines, bronchi, uterus, ureters, bladder, and blood vessels. Smooth muscle cells contain only one nucleus and no striations.

• **Cardiac muscle** is also an "involuntary muscle" but it is striated in structure and appearance. Like smooth muscle, cardiac muscle cells contain only one nucleus. Cardiac muscle is found only within the heart.

• **Skeletal muscle or "voluntary muscle"** is anchored by tendons to the bone and is used to effect skeletal movement such as locomotion. Skeletal muscle cells are multinucleated with the nuclei peripherally located.

Type	Fiber Appearance	Location	Control
Skeletal	Striated	Attached to skeleton	Voluntary
Smooth	Spindle-shaped	Wall of hollow organs (e.g., intestine, urinary bladder, uterus, and blood vessels)	Involuntary
Cardiac	Striated and branched	Heart	Involuntary

Muscular System Working With Other Body Systems

• 1. Homeostasis

• 2. Protection

• 3. Calcium Metabolism

• 4. Maintaining Body Temperature

Myofibrils

Myofibrils are composed of 2 types of myofilaments: thick and thin. In skeletal muscle, these myofilaments are arranged in a very regular, precise pattern: thick myofilaments are typically surrounded by 6 thin myofilaments. In a side view, thin myofilaments can be seen above and below each thick myofilament.

Thick myofilaments are composed of a protein called MYOSIN. Each MYOSIN molecule has a tail which forms the core of the thick myofilament plus a head that projects out from the core of the filament. These MYOSIN heads are also commonly referred to as CROSS-BRIDGES.

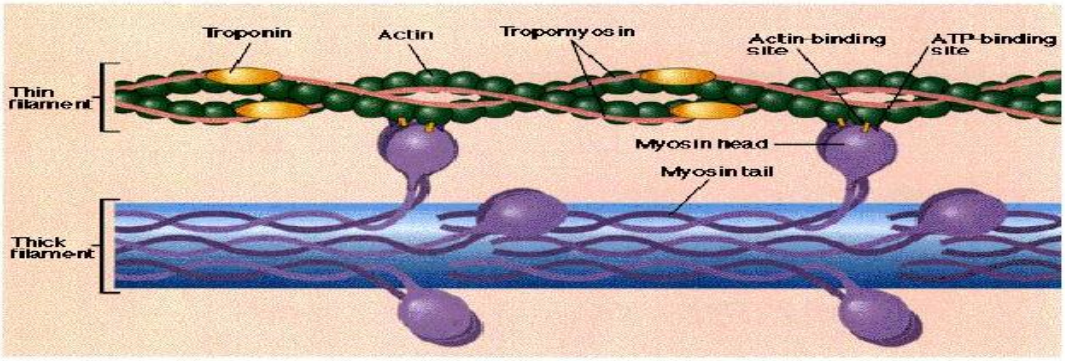
The MYOSIN HEAD has several important characteristics:

- it has ATP-binding sites into which fit molecules of ATP. ATP represents potential energy.
- it has ACTIN-binding sites into which fit molecules of ACTIN. Actin is part of the thin myofilament and will be discussed in more detail shortly.
- it has a "hinge"at the point where it leaves the core of the thick myofilament. This allows the head to swivel back and forth, and the "swivelling" is, as will be described shortly, what actually causes muscle contraction.

Thin myofilaments are composed of 3 types of protein: actin, troponin, and tropomyosin.

` The actin molecules (or G-actin as above) are spherical and form long chains. Each thin myofilament contains two such chains that coil around each other. Tropomyosin molecules are lone, thin molecules that wrap

around the chain of actin. At the end of each tropomyosin is an troponin



molecule. The tropomyosin and troponin molecules are connected to each other. Each of these 3 proteins plays a key role in muscle contraction

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1- **ACTIN :-** when actin combines with myosin head the ATP associated with the head breaks down into ADP. This reaction released energy that causes the myosin head to swivel.

2- TROPOMYOSIN: - In a relaxed muscle, the myosin heads of the thick myofilament lie against tropomyosin molecules of the thin myofilament. As long as the myosin heads remain in contact with tropomyosin nothing happens (i.e., a muscle remains relaxed).

3- TROPONIN: - Troponin molecules have binding sites for calcium ions. When a calcium ion fills this site it causes a change in the shape and position of troponin. And, when troponin shifts, it pulls the tropomyosin to which it is attached. When tropomyosin is moved, the myosin heads that was touching the tropomyosin now comes in contact with an underlying Actin molecule.

Skeletal Muscle Contractions

1. Nerve impulse reaches myoneural junction
2. Acetylcholine is released from motor neuron
3. Ach binds with receptors in the muscle membrane to allow sodium to enter
4. Sodium influx will generate an action potential in the sarcolemma
5. Action potential travels down T tubule
6. Sarcoplasmic reticulum releases calcium
7. Calcium binds with troponin to move the troponin, tropomyosin complex
8. Binding sites in the actin filament are exposed
9. Myosin head attach to binding sites and create a power stroke
10. ATP detaches myosin heads and energizes them for another contraction
11. When action potentials cease the muscle stop contracting

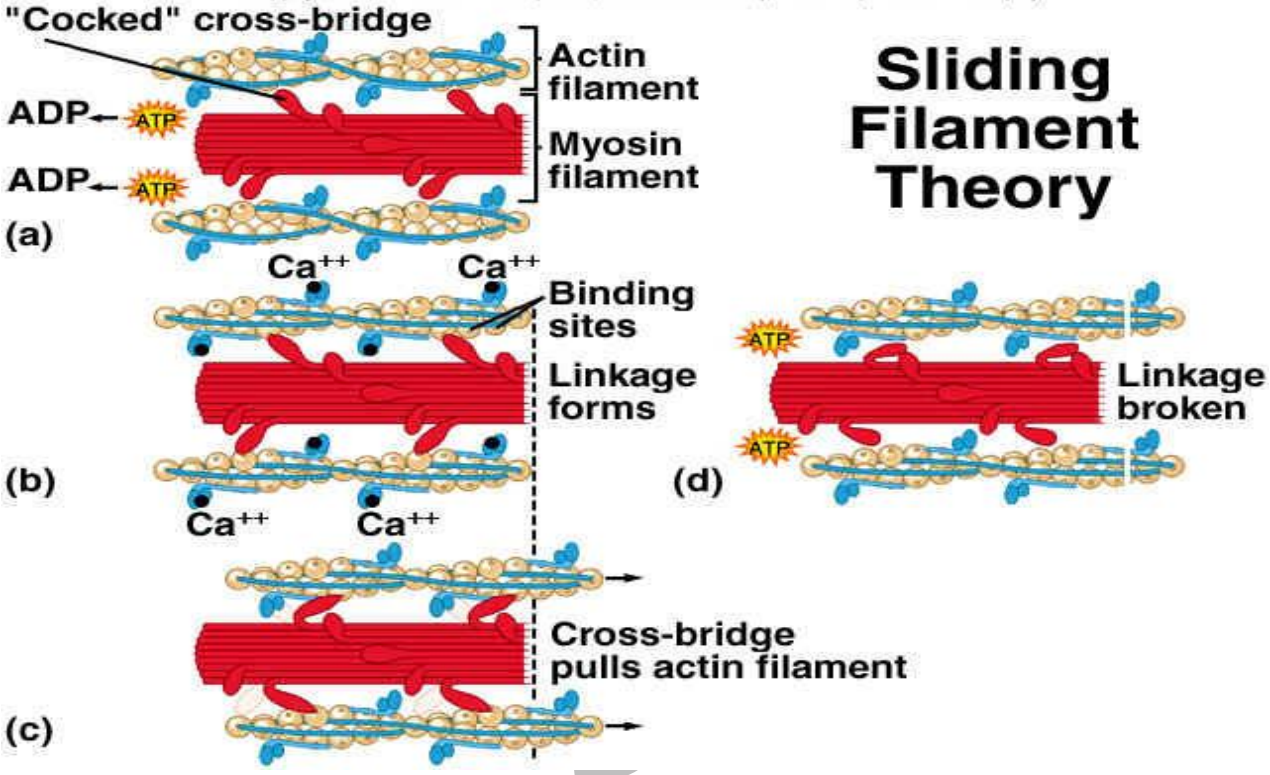
Types of Contractions:

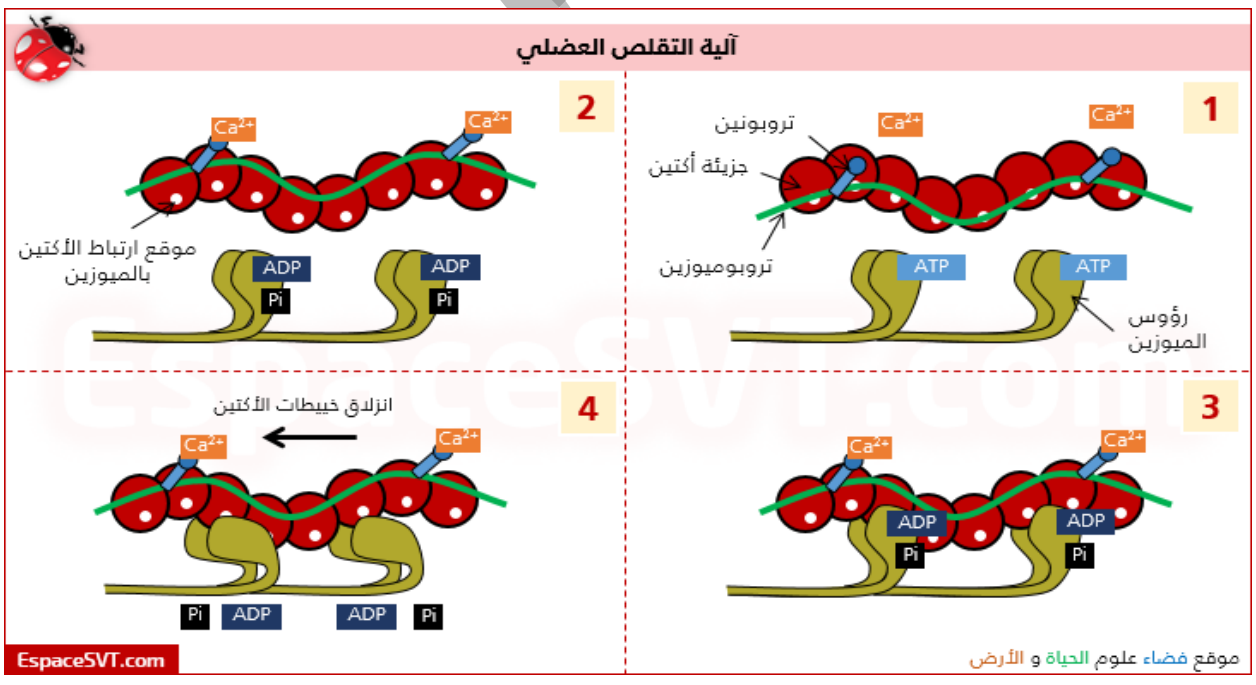
• **Isometric contraction--**muscle does not shorten during contraction and does not require the sliding of myofibrils but muscles are stiff.

• **Isotonic contraction** is used to move or work. More energy is used by the muscle and contraction lasts longer than isometric contraction.

Sliding Filament theory

When a muscle contracts, the actin is pulled along myosin toward the center of the sarcomere until the actin and myosin filaments are completely overlapped. The H zone becomes smaller and smaller due to the increasing overlap of actin and myosin filaments, and the muscle shortens. Thus when the muscle is fully contracted, the H zone is no longer visible (as in the bottom diagram, left). Note that the actin and myosin filaments themselves do not change length.





Muscle tension .

Increased muscle tension in the cold air and this leads to the appearance of small bumps in the skin causing the skin to **name** swan skin. The whole human body just covered with very light hair to the point that we do not feel it. And grow from these follicles minute capillaries under the skin. This and connects to the wall of the follicle muscles to contract very accurate when the skin is exposed to cold or frost stand in the skin hair. This is a way of ways to keep the body heat, and at the same time pay follicles under the skin to the outside so that you can see it in the form of small bumps.

Involuntary Muscle Movement

Spasms (Cramps)

When Smooth and skeletal muscles go through multiple spasms it is referred either as seizure or convulsion. Strenuous activities can cause painful spasms that are long, this is referred to as cramps.

Steroids

Anabolic steroids, which are synthetic versions of the primary male sex hormone testosterone, can be injected, taken orally, or used transdermally. These drugs are Controlled Substances that can be prescribed to treat conditions such as body wasting in patients with AIDS, and other diseases that occur when the body produces abnormally low amounts of testosterone. However, the doses prescribed to treat these medical conditions are 10 to 100 times lower than the doses that are used for performance enhancement. Anabolic steroids can lead to premature heart attacks, strokes, liver tumors, kidney failure and serious psychiatric problems. In addition, because steroids are often injected, users risk contracting or transmitting HIV or hepatitis. Some athletes abuse anabolic steroids to enhance performance. Abuse of anabolic steroids can lead to serious health problems, some of which are irreversible.

Major side effects can include liver tumors and cancer, jaundice, high blood pressure, kidney tumors, severe acne, and trembling. In males, side effects may include shrinking of the testicles and breast development. In females, side effects may include growth of facial hair, menstrual changes, and deepened voice. In teenagers growth may be halted prematurely and permanently.

ATP in the Human Body

Muscles cells, like all cells, use ATP as an energy source. The total quantity of ATP in the human body at any one time is about 0.1 Mole. The energy used by human cells requires the hydrolysis of 200 to 300 moles of ATP daily.

This means that each ATP molecule is recycled 2000 to 3000 times during a single day. ATP cannot be stored, hence its consumption must closely follow its synthesis. On a per-hour basis, 1 kilogram of ATP is created, processed and then recycled in the body. Looking at it another way, a single cell uses about 10 million ATP molecules per second to meet its metabolic needs, and recycles all of its ATP molecules about every 20-30 seconds.