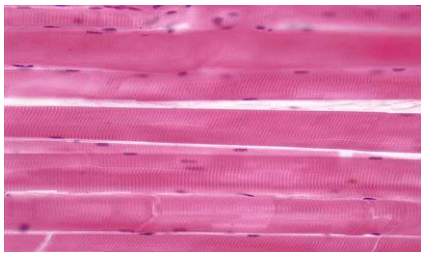
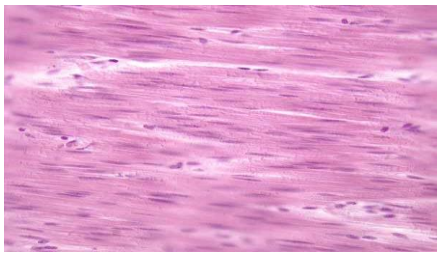
الكلية	العلوم
القسم	علوم حياة
المادة باللغة الانجليزية	Histology
المادة باللغة العربية	علم الانسجة
المرحلة الدراسية	الثالثة
اسم التدريسي	د.هند يونس خلف عبدالله
عنوان المحاضرة باللغة الانجليزية	Muscle Tissue
عنوان المحاضرة باللغة العربية	النسيج العضلي
رقم المحاضرة	4
المصادر والمراجع	
	Junquera Basic Histology Text and Atlas.Copyright © 2013 by McGraw-Hill Education

Muscle tissue

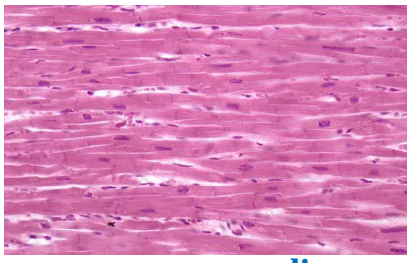
All muscles are composed of elongated cells called fibers,Derived from the **mesoderm**, it is classified into three types



Skeletal



smooth

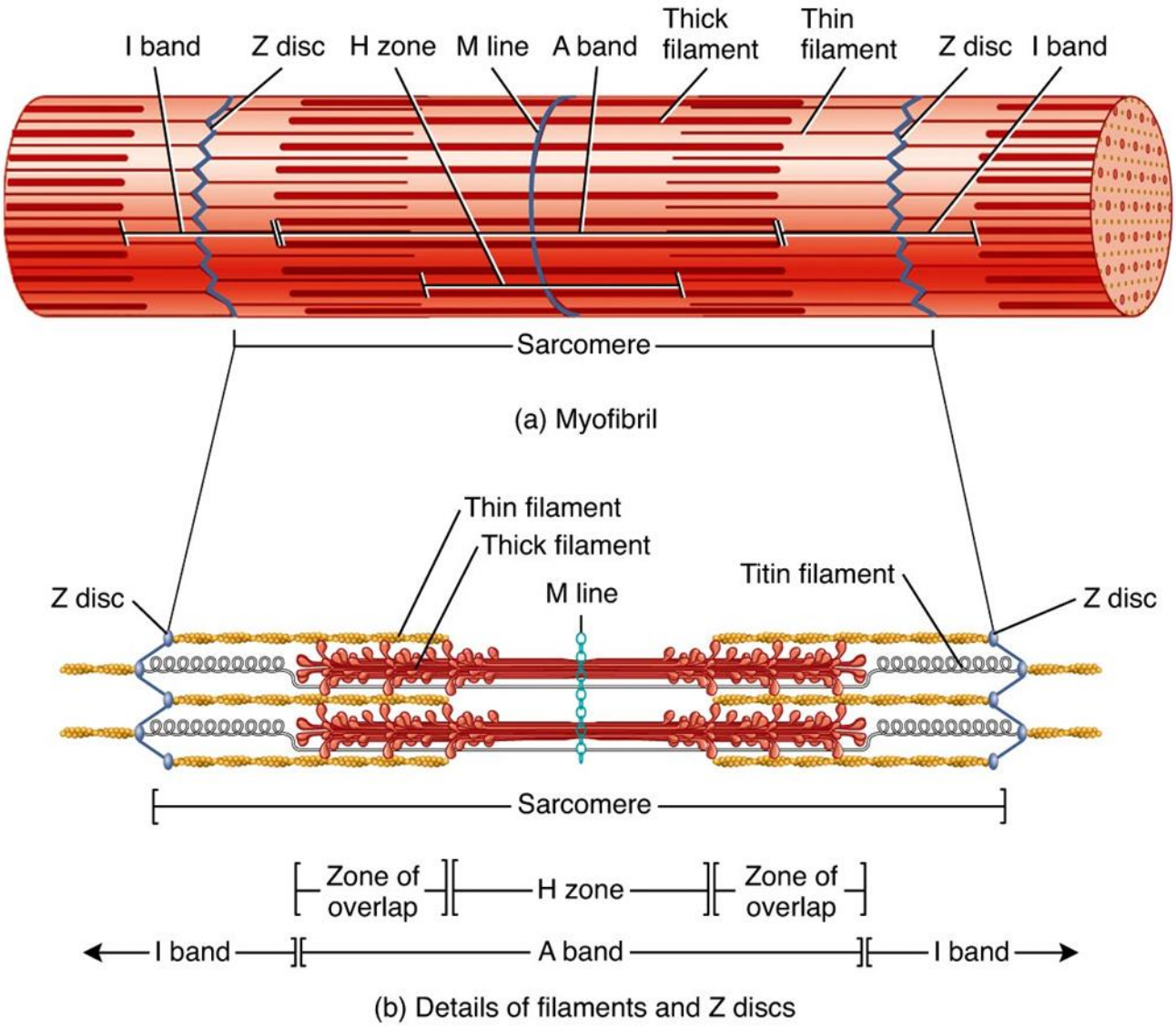


cardiac

skeletal muscle: Voluntary striated muscle ,formed from huge, multinucleate muscle fibers, which develop by fusion of many individual embryonic cells called myoblasts. individual cells, the term "muscle cell" is commonly used to refer to one multinucleate fiber. The unique contractile cytoplasm of muscle fibers is called **sarcoplasm** .The contractile machinery is concentrated into myofibrils (myo = muscle), long narrow structures (1-2 µm in diameter) which extend the length of the fiber and form the bulk of the sarcoplasm. Mitochondria (once called **sarcosomes**) and **sarcoplasmic reticulum** (a highly specialized form of endoplasmic reticulum) surround each myofibril. The plasma membrane of muscle fibers is sometimes called the **sarcolemma**. the entire muscle fiber appears uniformly striated.

The length of a skeletal muscle fiber varies by location. In the anterior thigh, a muscle fiber may be a meter long. In contrast, muscle fibers making up the stapedius, a small muscle of the inner ear, are only a few millimeters in length. Myofibrils are rod shaped subunits of muscle cells. The actin and myosin filaments making up the myofibrils are organized into sarcomeres.

The sarcomere is broken up into three bands. The A band is in the middle and corresponds to the myosin filaments together with the thin filaments overlapping on both ends. There are two I bands on either side of the A band and represent the area in which only actin filaments are present.



Sarcomere Structure

A sarcomere is the functional unit of skeletal muscle

- **Sarcomere exists from Z-line to Z-line**
- **A-Band is dark middle band**
- **I-Band – ends of A-Band, thin filaments only**
- **Z-line is in the middle if the I-Band**

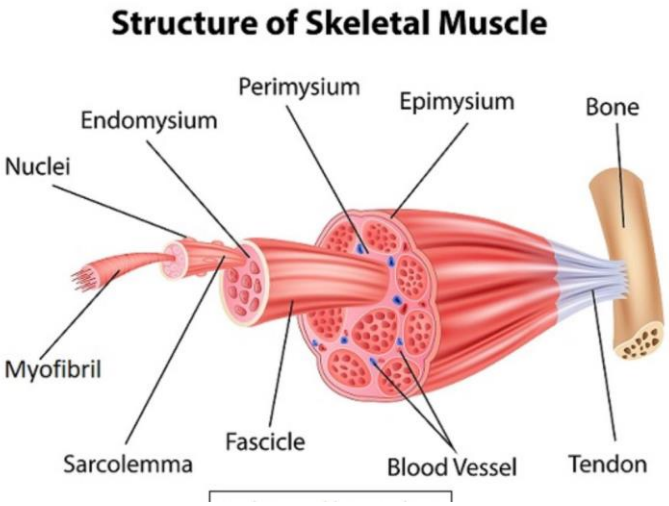
The center of the sarcomere lacks actin filaments and is referred to as the H zone. An M line runs down the middle of the H zone perpendicular to the filaments. Thick myosin filaments are found between the actin filaments.

Structure

Skeletal muscle tissue is made up of a collection of muscle fibers wrapped in connective tissue sheaths. There are three types of connective tissue sheaths named for their location. **Endomysium** surrounds individual muscle fibers. It is made up of a delicate layer of reticular fibers and permits only small-diameter nerve fibers and capillaries, thus acting as a site of metabolic exchange.

Perimysium is a slightly thicker layer of connective tissue consisting mainly of type I and III collagen and surrounds a group of fibers. This fiber group is referred to as a fascicle or bundle. Fascicles are the functional units of skeletal muscle tissue. The perimysium contains slightly larger blood vessels and nerve fibers.

Epimysium surrounds the entire collection of fascicles making up an individual muscle. This dense connective tissue made up of mainly type I collagen contains the neurovascular supply to the muscle.



Function of skeletal muscle

- muscles are excitable or "irritable"(they have the ability to respond to a stimulus)
- muscles are also:**Contractible** (they can shorten in length)

  Extensible (they can extend or stretch)

Elastic (they can return to their original shape)

Accessory proteins

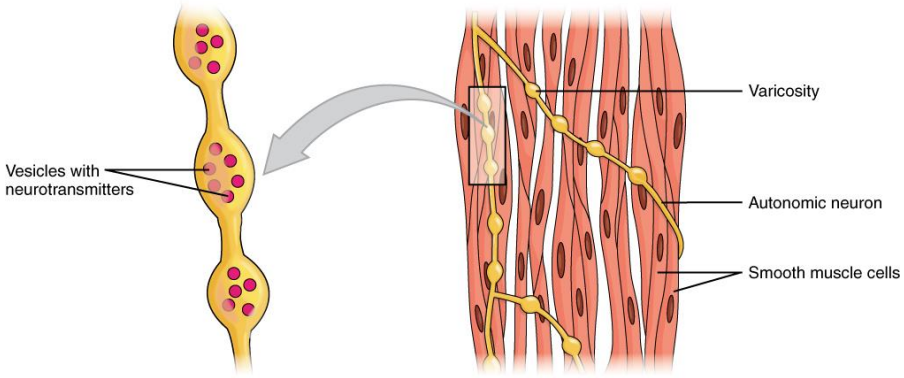
The thick and thin filaments in the myofibrils are supported by accessory proteins. These proteins maintain the speed and alignment of filaments during the contraction cycle. Some of them are described below.

- Titin is a large, elastic protein the anchors thick filaments to Z lines to prevent excessive stretching of the myofibril
- Tropomodulin acts like an actin cap. It attaches to the free end of an actin filament to maintain its length.
- α-Actinin is a short, rod-shaped protein that arranges thin filaments into parallel bundles and anchors them to the Z line
- Desmin is an intermediate filament that forms a lattice surrounding the sarcomere near the Z lines to attach them to each other and the plasma membrane.
- Nebulin is a thin, elongated protein running parallel to thin filaments.
- Dystrophin is thought to link actin filaments to the external lamina of the muscle cell
- Myomesin anchors thick filaments to the M line.

Smooth muscles

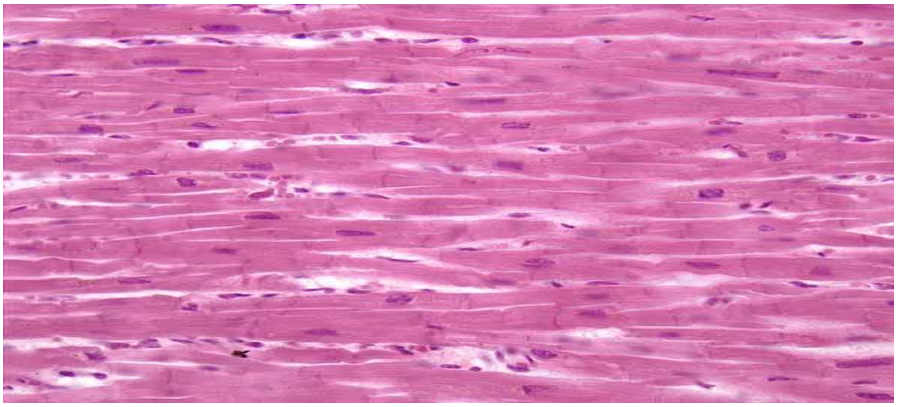
Smooth muscles have a wide distribution in the body and predominantly line the visceral hollow organs and blood vessels. In digestive tract organs, the uterus, ureters, and other hollow organs, In the dermis of the skin, smooth muscles are associated with hair follicles. Under a light microscope, smooth muscle appears as elongated individual fibers with fusiform shapes of slender fascicle bundles. Individual muscle fibers are also shorter than the skeletal muscles and exhibit a single central nucleus. Individual smooth muscle fibers contain contractile actin and myosin filaments; actin and myosin course obliquely throughout the cell in the form of a lattice network that crisscrosses

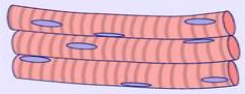
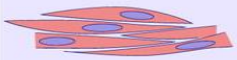
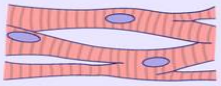
the sarcoplasm. As a result of the irregular distribution of contractile elements, these muscle fibers appear smooth, or nonstriated. In smooth muscle, the contraction is not controlled voluntarily by the nervous system, but by signals from the nerve impulses, hormones, and other chemicals released by specialized organs. Smooth muscle is specialized to contract persistently, unlike skeletal muscle which much contract and release quickly.



Cardiac muscles

Although the organization of the contractile proteins (actin and myosin) in cardiac myofibers and their arrangement in sarcomeres is essentially the same as in skeletal muscles, there are important differences. at the Z lines and are much larger than those in skeletal muscles. Furthermore, the sarcoplasmic reticulum is less developed. Also, the mitochondria are larger and more abundant in the cardiac cells indicating the increased metabolic demands on the cardiac muscle fibers for continuous function. Cardiac cells(cardiomyocyte) are joined end to end by specialized, interdigitating intercalated discs composed of fascia adherens, desmosomes, and gap junctions, gap junction allow a very rapid spread of stimuli throughout the entire cardiac muscle mass. Most cardiac muscle cells contain one nucleus, but some have two . Cardiomyocytes contain many mitochondria to produce large amounts of adenosine triphosphate (ATP) and myoglobin to store oxygen to meet the demands of muscle contraction, and has an extensive cardiac capillary network,which occupy 40% or more of the cytoplasmic volume,reflecting the need for continuous aerobic metabolism in heart muscle.
fatty acids ,transported to cardiac muscle cell by lipoproteins, are the major fuel of the heart , asmall amount of glycogen is present and can be brokendown to glucose and used for energy production during periods of stress.



	Main features	Histology
Skeletal muscle	• Fibers: striated, tubular and multi nucleated • Voluntary • Usually attached to skeleton	
Smooth muscle	• Fibers: non-striated, spindle-shaped, and uninucleated • Involuntary • Usually covering wall of internal organs	
Cardiac muscle	• Fibers: striated, branched and uninucleated • Involuntary • Only covering walls of the heart	

cardiac fibers have their own pacemaker cells like the sinoatrial (SA) node that spontaneously depolarizes. These depolarizations occur at a consistent pace, but the pacemaker cells can also receive input from the autonomic nervous system to decrease or increase the heart rate depending on the requirements of the body.

The pacemaker cells are connected to other cardiac muscle cells, allowing them to pass along signals. This results in a wave of contractions of your cardiac muscle, which creates heartbeat

Cardiac Action Potential

The cardiac action potential is a transient voltage change (membrane potential) across the membranes of the heart. This is brought on by the flow of charged ions (or atoms) through ion channel proteins from inside to outside cells. Along with significant differences, cardiac muscle shares several characteristics with neurons and skeletal muscle. When at rest, a specific cardiac cell has a negative membrane potential, similar to a neuron. Voltage-gated ion channels open in response to stimulation above a threshold, allowing a stream of cations to enter the cell. An action potential begins when the threshold is reached. This results in the entry of positively charged ions into the cell, called depolarisation. There are five major phases of cardiac action potential ,phase 0, phase 1, phase 2 , phase 3 and phase 4.

Phase 0

When the rapid Na^+ channels open, leading to a rapid inflow of Na^+ ions (I_{Na}) into the heart cell and the onset of the rapid depolarisation phase. The phase 0 slope, or V_{max}, represents the highest cell depolarisation rate.

Phase 1

This is the phase of rapid repolarisation. The rapid Na^+ channels are deactivated during phase 1 of the cardiac action potential. The flow of Cl^- and K^+ ions causes the short net outward movement, generating the mild downward deviation of the action potential.

It has been proposed that the transport of Cl^- cell membranes during phase I results from a shift in membrane potential caused by K^+ efflux and not from their involvement in the initial repolarisation ("notch").

Phase 2

This is the longest phase, also called the "plateau" phase. This "plateau" phase is maintained by a balance between the outward movement of K^+ ions through the delayed rectifier potassium channels, IKs, and the inward movement of Ca^{2+} ions (I_{Ca}) via L-type calcium channels.

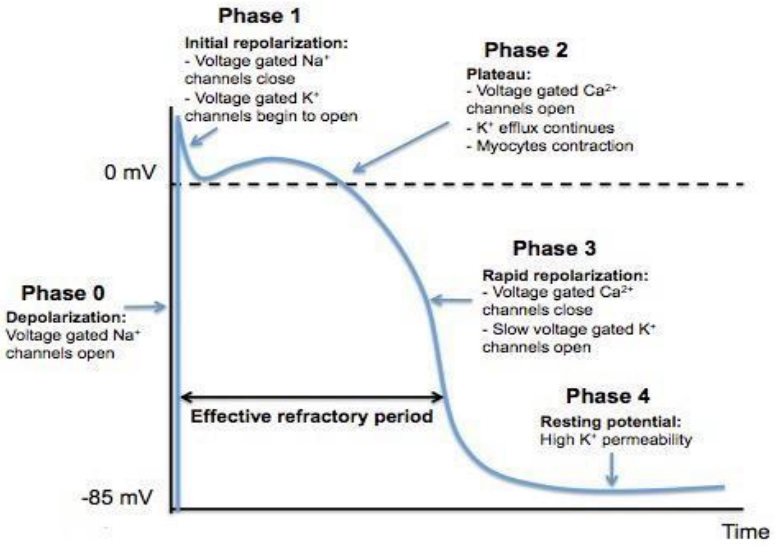
Phase 3

Ca^{2+} channels close during phase 3 of the action potential, whereas slow delayed rectifier (IKs) K^+ channels remain open. More types of K^+ channels can open due to the net outward current that results from the negative change in the membrane potential. The cell repolarises due to this net outward, positive current, which is equivalent to the positive charge loss from the cell.

The cardiac units of the sinoatrial node provide the pacemaker potential that synchronises the heart. The cardiac action potential is essential for controlling the heart's contraction. Human diseases, particularly arrhythmias, can result from abnormalities in the cardiac action potential, whether due to a hereditary mutation or injury.

Phase 4

This is the resting membrane potential. The cell remains in this state until it receives an external electrical stimulus, usually from an adjacent cell. This indicates that both the calcium and sodium voltage-gated channels are closed. Specific heart cells can spontaneously depolarise, generating an action potential without the involvement of adjacent cells. It is often referred to as "**automaticity**".


Phase 1
Initial repolarization:
- Voltage gated Na+ channels close
- Voltage gated K+ channels begin to open
Phase 2
Plateau:
- Voltage gated Ca2+ channels open
- K+ efflux continues
- Myocytes contraction
0 mV
Phase 3
Rapid repolarization:
- Voltage gated Ca2+ channels close
- Slow voltage gated K+ channels open
Phase 0
Depolarization:
Voltage gated Na+ channels open
Effective refractory period
Phase 4
Resting potential:
High K+ permeability
-85 mV
Time