Muscular tissues: is responsible for movement of the body and its parts for changes in the size and shape of internal organs. This tissue is characterized by aggregates of specialized, elongated cells arranged in parallel array that have the primary role of **contraction.**

General Concepts

Specializations, unique terms are used for certain structures in muscle cells.

1. Individual muscle cells are called **muscle fibers or myocytes**
2. The cytoplasm of muscle fibers is called **sarcoplasm.**
3. The muscle fiber plasma membrane is called the **sarcolemma.**
4. The smooth endoplasmic reticulum is called the **sarcoplasmic reticulum,** while mitochondria called **sarcosomes.**
5. **Myofilaments:** interaction is responsible for muscle cell contraction. It has two types' thin filaments **(actin**) and Thick filaments (**myosin**)

Certain forms of contractile cell function as single-cell contractile units:

1. **Myoepithelial cells** are an important component of certain secretory glands.
2. **Pericytes** are smooth muscle-like cells that surround blood vessels.
3. **Myofibroblasts** are cells that have a contractile role in addition to being able to secrete collagen. This type of cell found in normal tissues but becomes important in tissue damage during the process of healing and repair, leading to formation of a scar.

Classification of Muscle

➢ **Functional classification**: is based on the type of neural control divided in to two types:

- Voluntary
- Involuntary

➢ **Structural classification:** is based on the presence or absence of cross striations divided in to two types:

- Striated
- No striated (smooth)

➢ Combined **functional and structural classification** divided in to three types:

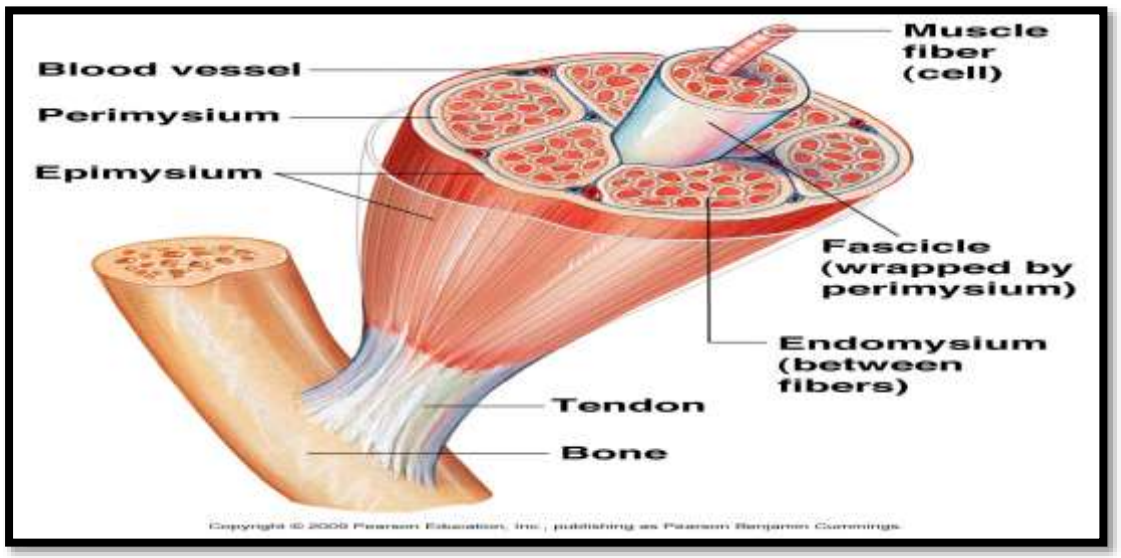
- Skeletal muscle
- Cardiac muscle

- Smooth (visceral) muscle.

Skeletal muscle tissues: contains bundles of very long, multinucleated cells with cross-striations. Their contraction is quick, forceful, and usually under voluntary control.

Organization of a Skeletal Muscle

1. **Epimysium** is the sheath of dense connective tissue that surrounds a collection of fascicles that constitutes the muscle. The major vascular and nerve supply of the muscle penetrates the epimysium.
2. **Perimysium** is a thicker connective tissue layer that surrounds a group of fibers to form a **bundle** or **fascicle**. Fascicles are functional units of muscle fibers that tend to work together to perform a specific function. Larger blood vessels and nerves travel in the perimysium.
3. **Endomysium** is the delicate layer of reticular fibers that immediately surrounds individual muscle fibers .Only small-diameter blood vessels and the finest neuronal.

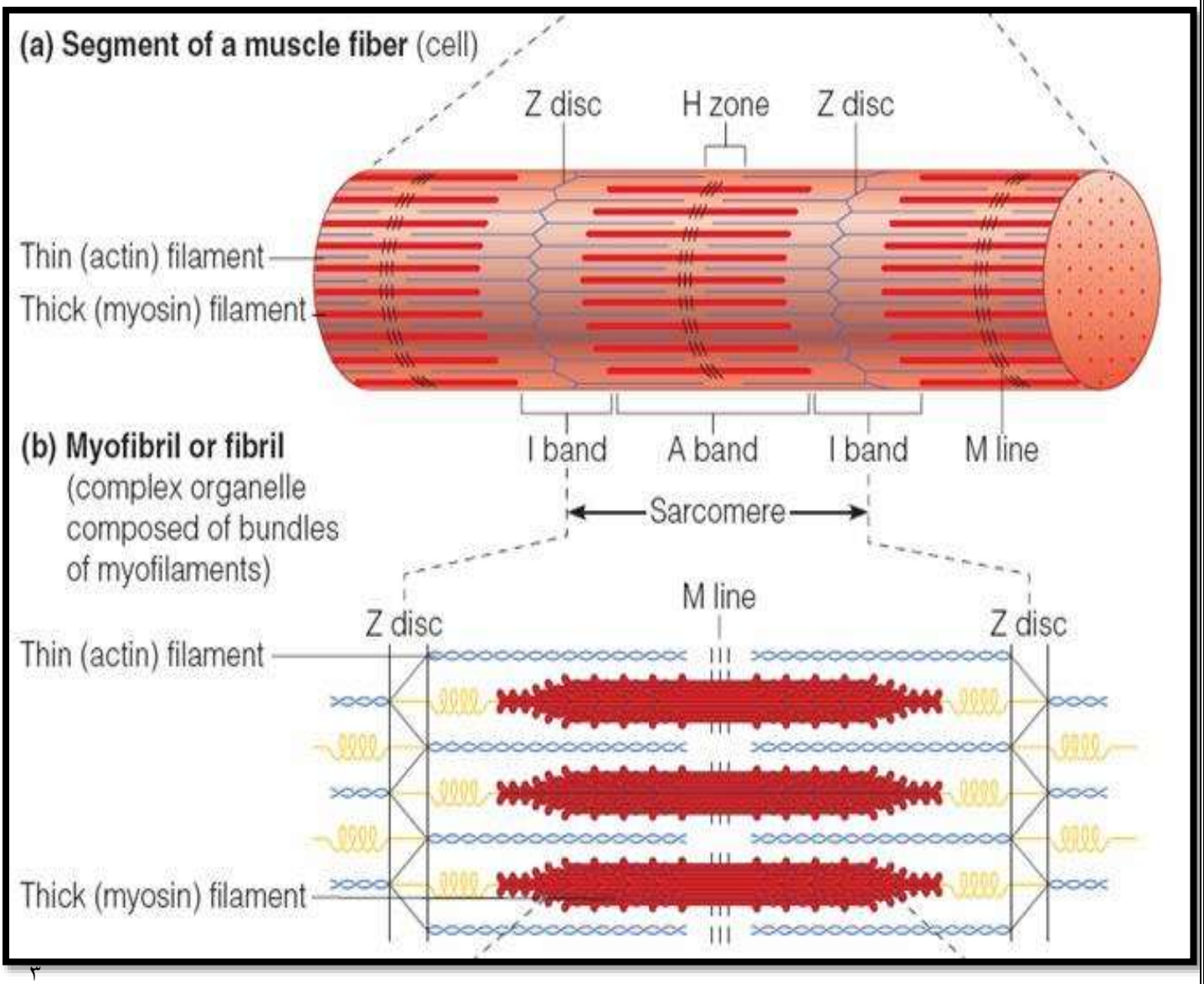


Myofibrils and Myofilaments (Actin and Myosin Filaments)

A **muscle fiber** is filled with longitudinally arrayed structural subunits called **myofibrils** Myofibrils consist of an end-to end repetitive arrangement of **sarcomeres.** The A and I banding pattern in sarcomeres is due mainly to the regular arrangement of thick and thin myofilaments, composed of myosin and F-actin, respectively, organized within each myofibril in a symmetric pattern containing thousands of each filament type.

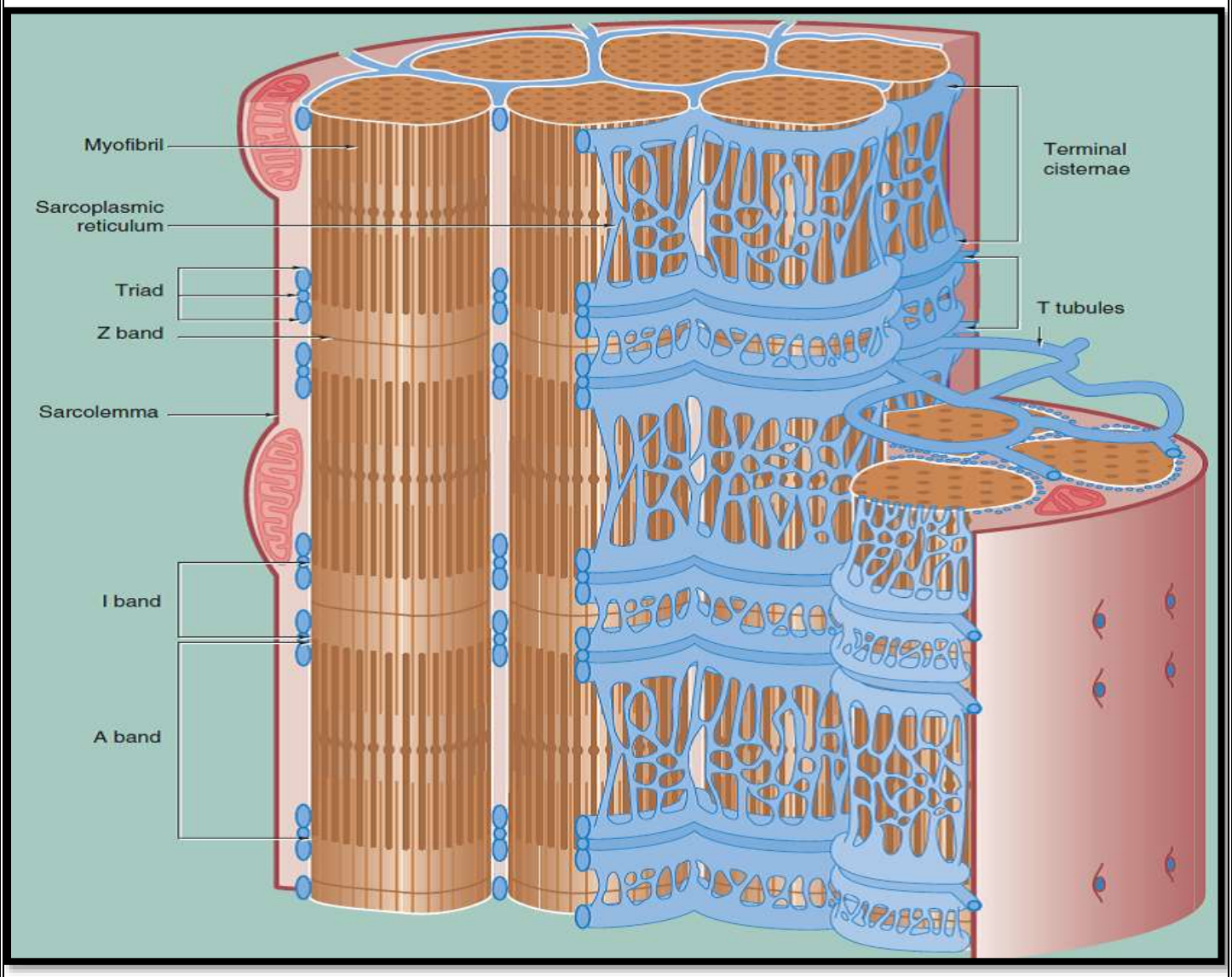
Organization within Muscle Fibers

Each muscle fiber contains several hundred to thousand *myofibrils*, each myofibril is composed of about several thousand of myofilaments (1500 adjacent *myosin filaments* and 3000 *actin filaments)*, responsible of muscle contraction. The myofibrils have alternate light and dark bands. The light bands contain only actin filaments and are called ***I bands***. The dark bands contain myosin filaments, as well as the ends of the actin filaments and are called ***A bands***. Each I band is bisected by a dark transverse line, the **Z line,** the smallest repetitive subunit of the contractile apparatus; the **sarcomere** extends from Z line to Z line. Close observation of the A band shows the presence of a lighter zone in its center, the **H band.** Bisecting the H band is the **M line,** a region at which lateral connections are made between adjacent thick filaments. The major protein of the M line is **creatine kinase** transport phosphate group to ADP and **myomesin** make inhibition of thick filament.



The conducting system for contractile in skeletal muscle (Sarcoplasmic Reticulum &Transverse Tubule System)

In skeletal muscle fibers the smooth ER, or (sarcoplasmic reticulum), is specialized for Ca^{2+} sequestration, and cause uniform contraction of all myofibrils, **the sarcolemma** is folded into a system of **transverse** or **T tubules** it is long fingerlike invaginations of the cell membrane penetrate deeply into **the sarcoplasm** and encircle every myofibril near the aligned A- and I-band boundaries of **sarcomeres**. Adjacent to each side of every T tubule are expanded **terminal cisterns** of the sarcoplasmic reticulum. The complex of a **T tubule** with two closely associated small **cisterns** of sarcoplasmic reticulum on each side is known as a **triad.** After depolarization of the sarcoplasmic reticulum membrane, calcium ions concentrated within these cisternae are released through Ca^{2+} channels in the membrane into cytoplasm surrounding the thick and thin filaments. Ca2+ binds troponin and allows bridging between actin and myosin molecules. When the membrane depolarization ends, the sarcoplasmic reticulum pumps Ca2+ back into the cisternae, ending contractile activity.



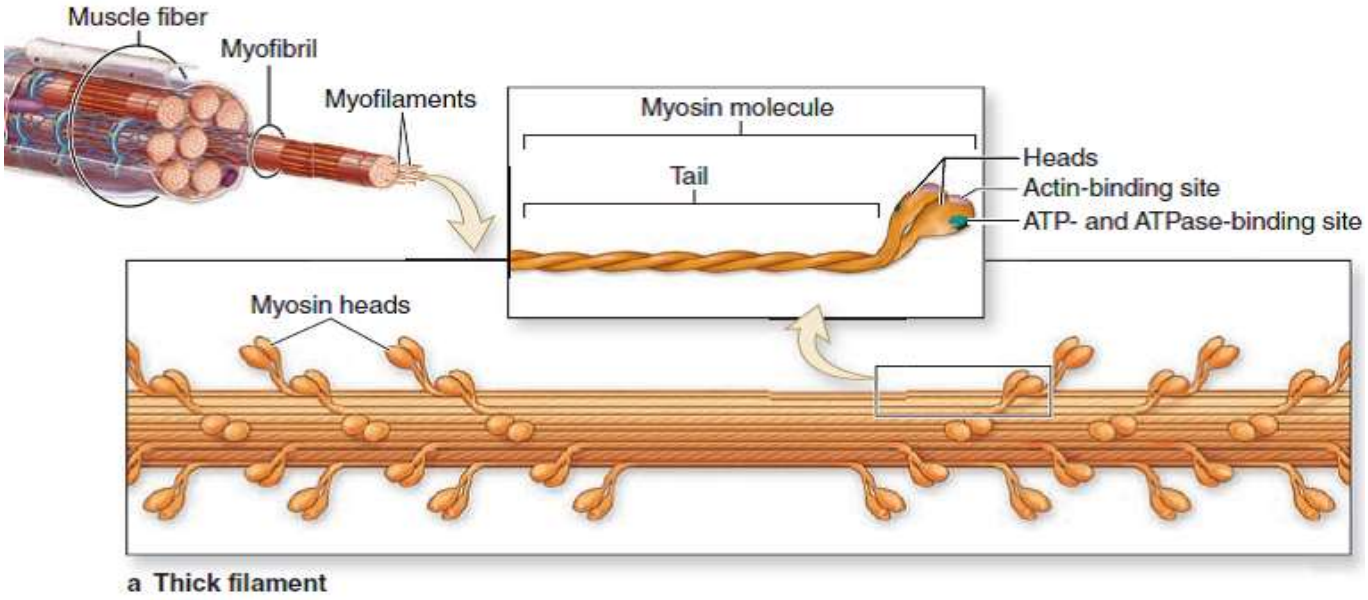
Myofilament interaction is responsible for muscle cell contraction: Two types of **myofilaments** are associated with cell contraction

1. **Thin filaments** are composed primarily of the protein **actin**. Each thin filament of fibrous actin (**F-actin**) is a polymer formed from globular actin molecules (**G-actin**).
2. **Thick filaments** are composed of the protein **myosin** consists of tail and head (contain binding site for actin and for ATP, ATPase). this myofilament consist of two types:

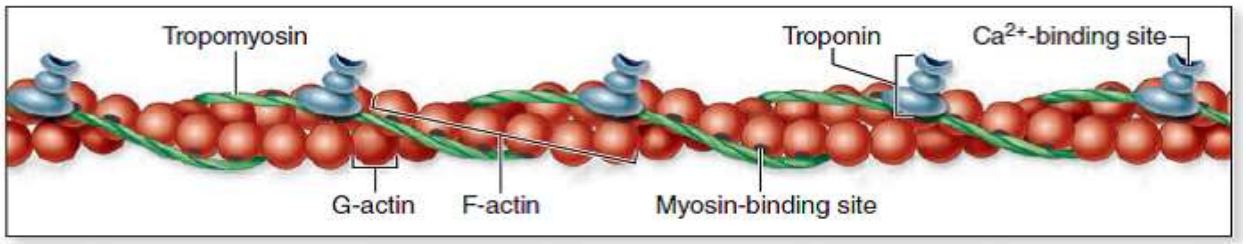
A. Tropomyosin is protein of double helix of two polypeptides.

B. Troponin complex consists of a three globular subunits.

- **Troponin-C (TnC)** It binds Ca^{2+}
- **Troponin-T (TnT)**, binds to tropomyosin
- **Troponin-I (TnI)**, thus inhibiting actin–myosin interaction



a Thick filament



b Thin filament

Smooth muscle tissues: is specialized for slow, steady contraction and is controlled by a variety of involuntary mechanisms (also called visceral muscle) are elongated, tapering, and nonstriated cells, form the walls of most hollow organs with the exception of the heart.

Structure of smooth muscle fibers

1. Smallest fiber type, length varies from 20 microns in blood vessels to 500 microns in the uterus
2. Unbranched spindle-shaped fibers are elongated with tapering ends.
3. Possess a single, centrally placed, oval nucleus, which can appear spiraled or "inch-worm"–shaped when the fiber is contracted.
4. Organelles are clustered at the poles of the nucleus.
5. No striated
6. External (basal) lamina is present along with reticular fibers.
7. Abundant gap junctions.
8. Capable of both hypertrophy and hyperplasia.

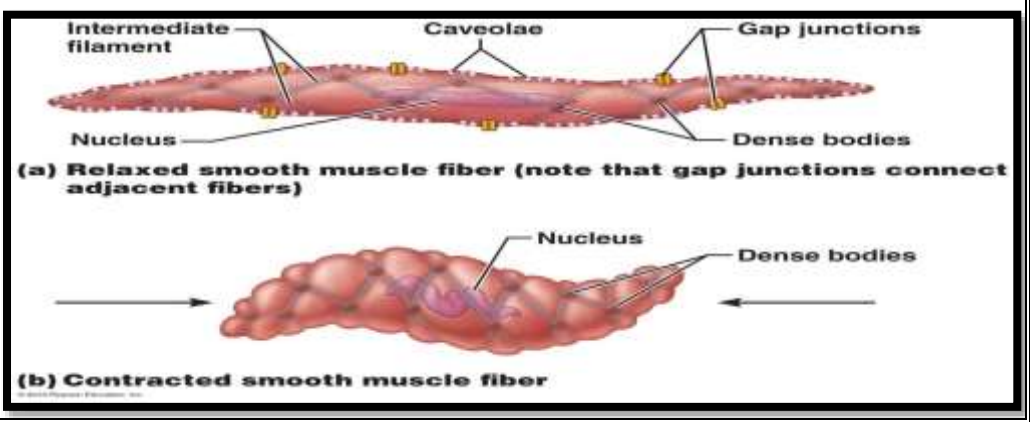
Organization of the contractile proteins

- Actin and myosin myofilaments are present, but they are not organized into myofibrils.
- Myofilaments overlap as in striated muscle and crisscross throughout the sarcoplasm, forming a reticulum.

Dense bodies

- Serve as insertion points for myofilaments to transmit the force of filament sliding
- Contain actinin myofilaments and, thus, resemble Z-lines of striated muscle
- Present in the cytoplasm and associated with the sarcolemma.

caveolae are small (50–100 nanometer) invaginations of the plasma membrane in many smooth muscle, also found in other cells types especially in endothelial cells and adipocytes. These structures are rich in proteins as well as lipids such as cholesterol and sphingolipids and have several functions in signal transduction like (T-tubules) in skeletal muscle. They are also believed to play a role in endocytosis.



A Cardiac Muscle tissue: occurs only in the myocardium of the heart and, in the roots of large vessels where they join the heart.

Structure of cardiac muscle fibers

1. Intermediate in size between skeletal and smooth muscle
2. Fibers are cylindrical, branch, and form interwoven bundles.
3. Usually one nucleus per fiber located in the center
4. Organelles are clustered at the poles of the nucleus.
5. Myofilament organization into myofibrils is identical to skeletal muscle. Cross-striations of bands are presented, but not as prominent as in skeletal muscle.
6. High vascularity and with large numbers of mitochondria reflect the high metabolic requirements of cardiac muscle fibers.
7. Fibers are capable of hypertrophy but not hyperplasia.

Intercalated discs

Junctional complexes those are unique to cardiac muscle fibers. Consist of specialized cell junctions of the sarcolemma at the ends of the fibers. Contain three types of junctions

- **zonula adherens** of epithelia; serve to attach cardiac muscle fibers and anchor actin filaments of the terminal sarcomeres at the ends of the cell. Acts as a hemi-Z-line.
- **Desmosomes**. Bind ends of fibers together
- **Gap junctions**. Provide ionic coupling between fibers