Tissue

"Muscle Tissue and Organization"

Objectives

1. Describe and identify the 3 major muscle groups (skeletal, cardiac and, smooth).
2. Describe the general anatomy of muscles.
3. Describe the ultra-structure of skeletal muscle and its role in muscle contraction.

Functions of Muscle

1. Movement: skeletal, cardiac, and smooth muscles
2. Stability: skeletal muscle
3. Communication: skeletal muscle
4. Control of body openings and passages: skeletal and smooth muscles
5. Heat production: skeletal muscles

Properties of Muscles

1. Excitability (responsiveness) respond to chemical, mechanical or electrical stimuli.
2. Conductivity initiate events that lead to contraction.
3. Contractility ability to shorten substantially
4. Extensibility able to stretch between contractions.
5. Elasticity ability to return to original length after stretching.

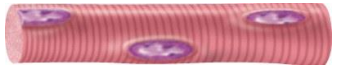
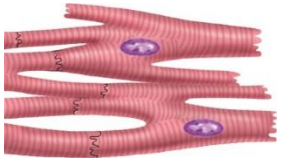
Three types of muscle tissues

1. Skeletal muscle

2. Cardiac muscle

3. Smooth muscle

Three Types of Muscular Tissue

	Location	Function	Appearance	Control
Skeletal 	skeleton	movement, heat, posture	striated, multi-nucleated (eccentric), fibers parallel	voluntary
Cardiac 	heart	pump blood continuously	striated, one central nucleus	involuntary
Visceral (smooth muscle) 	G.I. tract, uterus, eye, blood vessels	Peristalsis, blood pressure, pupil size, erects hairs	no striations, one central nucleus	involuntary

Muscular System

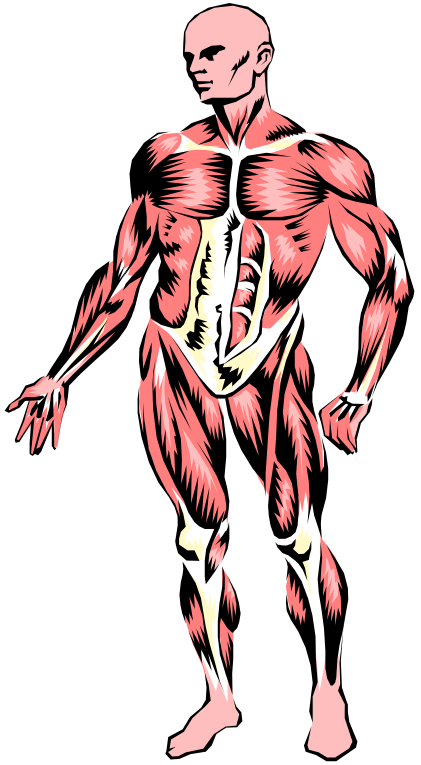
- **Skeletal muscle is the only organ of the muscular system**

- **Skeletal muscle is composed of skeletal muscle tissue and also contains nervous tissue, blood vessels and connective tissue**

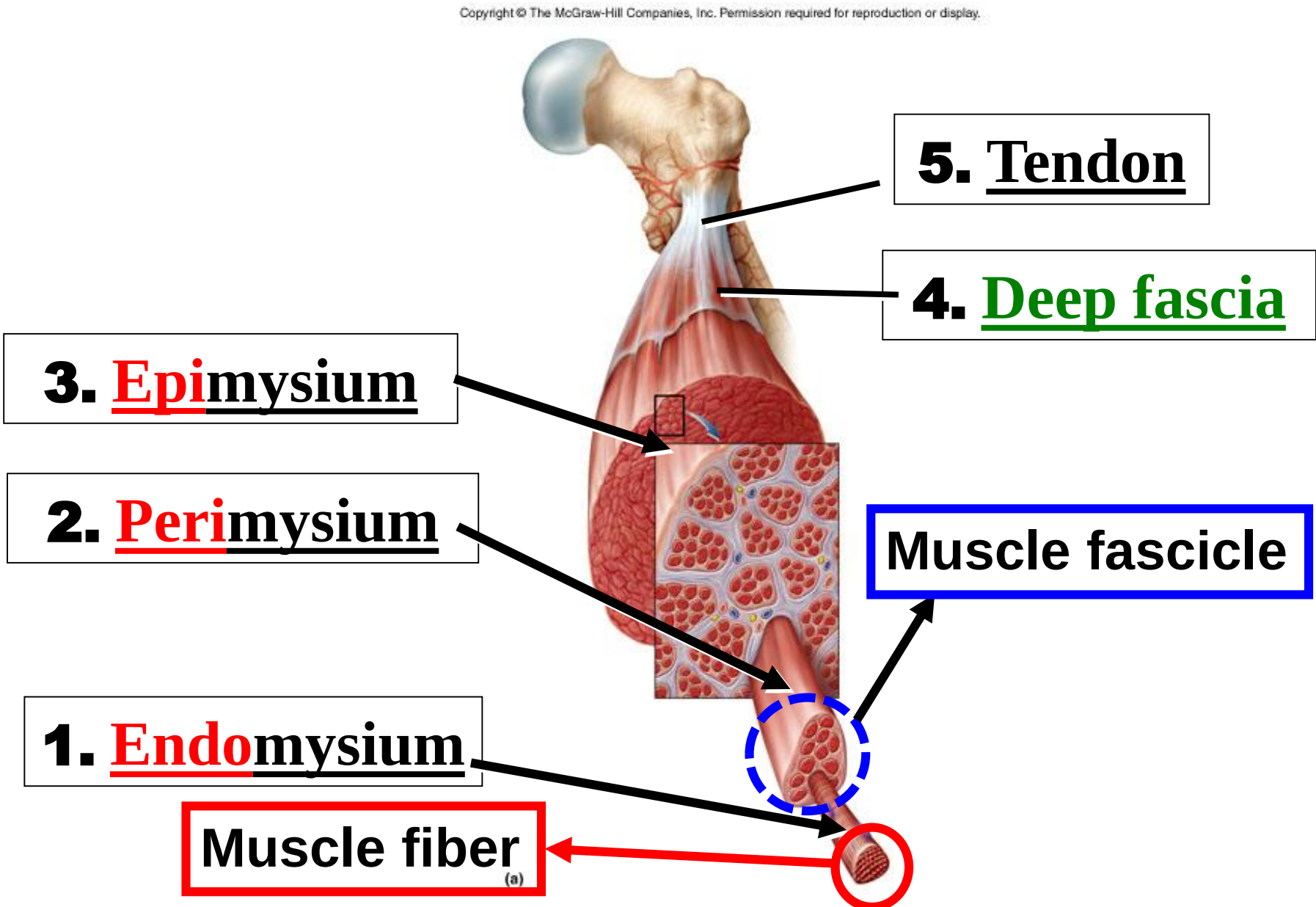
- **Half of the body's weight is muscle tissue**
  - **Skeletal muscle = 40% in males, 32% in females**
  - **Cardiac muscle = 10%**

Structure of Skeletal Muscles

- Skeletal muscles
  - The major components of the muscular system
- Composition
  - Connective tissue
  - Skeletal muscle tissue
  - Blood vessels
  - Nerves



Connective Tissues of a Muscle

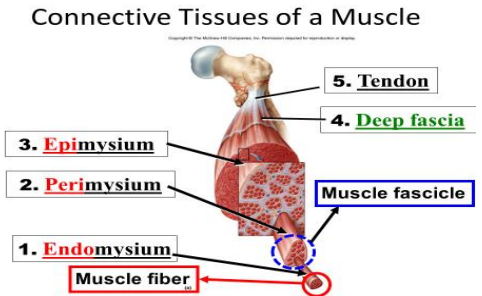


Connective Tissue Coverings

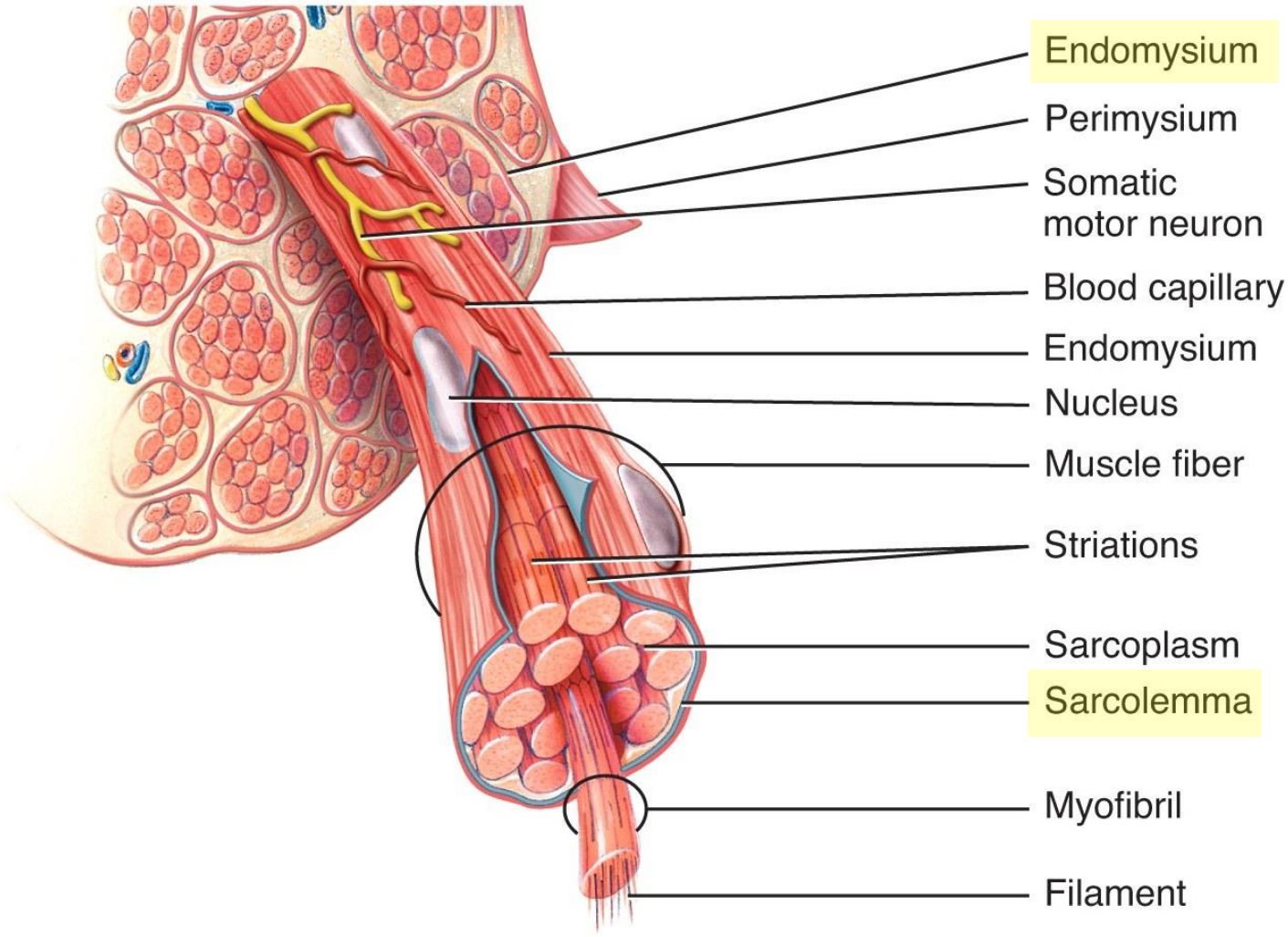
- ***Fascia***
  - Covers entire skeletal muscles
  - Separates them from each other
- ***Tendon***
  - A tough, cord-like structure made of fibrous connective tissue
  - Connects muscles to bones
- ***Aponeurosis***
  - A tough, sheet-like structure made of fibrous connective tissue
  - Attaches muscles to other muscles

Connective Tissue Coverings (cont.)

- ***Epimysium***
  - A thin covering that is just below the fascia of a muscle and surrounds the entire muscle
- ***Perimysium***
  - Connective tissue that divides a muscle into sections called ***fascicles***
- ***Endomysium***
  - Covering of connective tissue that surrounds individual muscle cells



Organization of Muscle Tissue

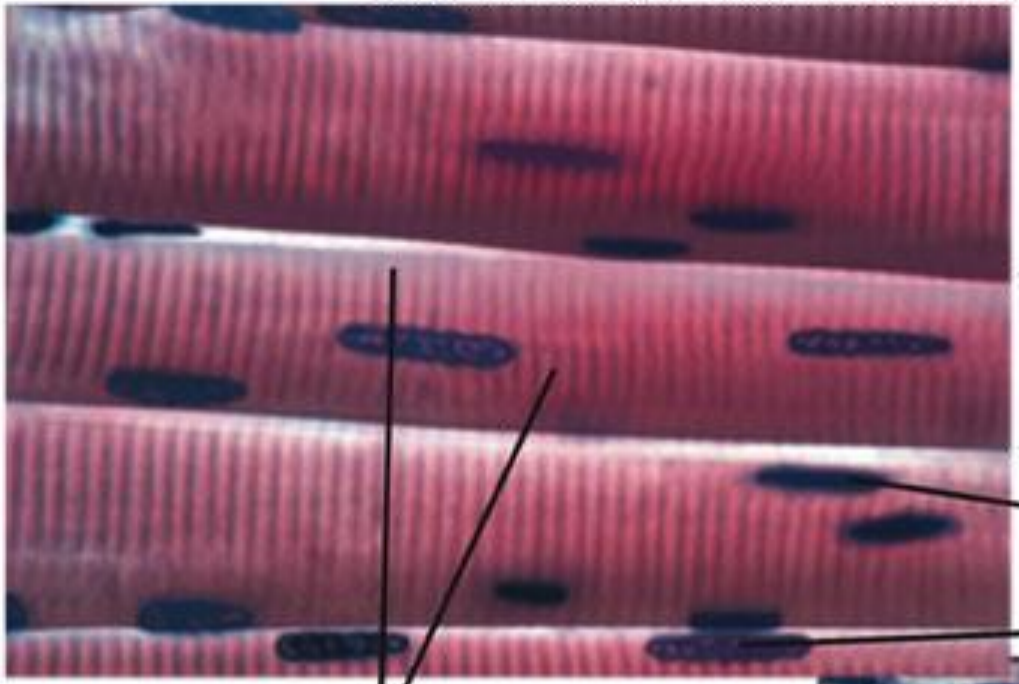


Organization of a muscle fiber

Characteristics of Skeletal Muscle Tissue

- **Long, thin contractile fibers that are Striated**
  - **Striations due to arrangement of thick and thin filaments**
- ***Under voluntary control***
- **Attached to the bones of the skeleton by tendons**
- **Allow for movement, facial expressions, breathing, swallowing, writing, talking and singing, posture, heat production, joint stability**

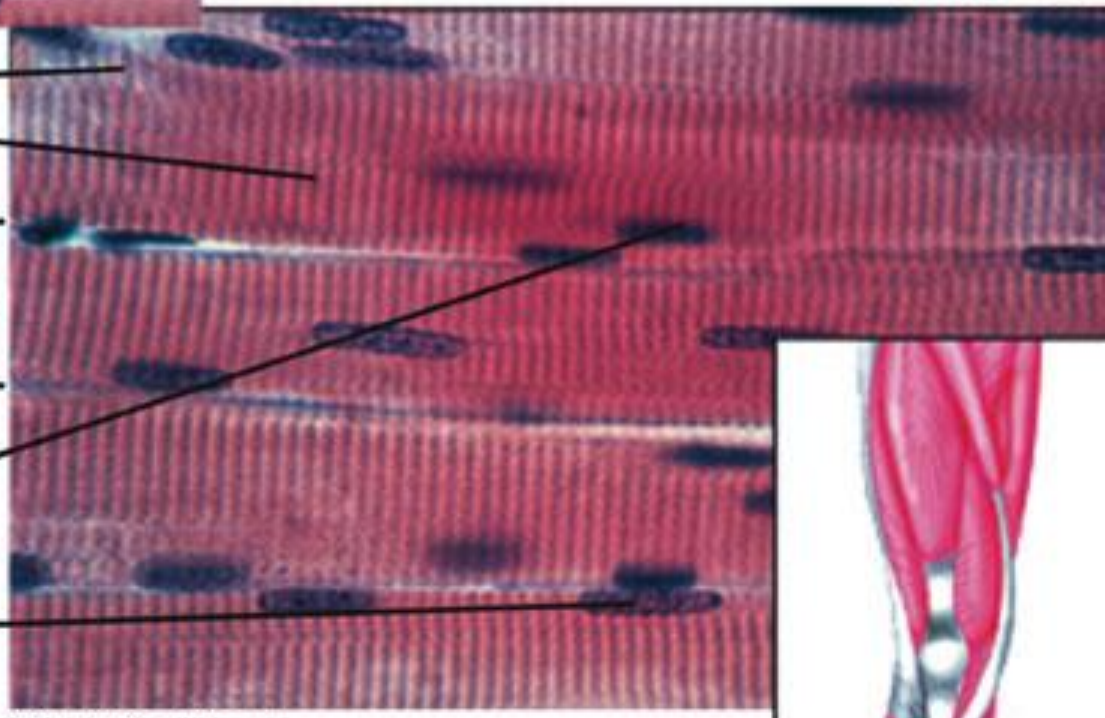
Skeletal Muscle Tissue



Muscle fiber

Nuclei

Striations

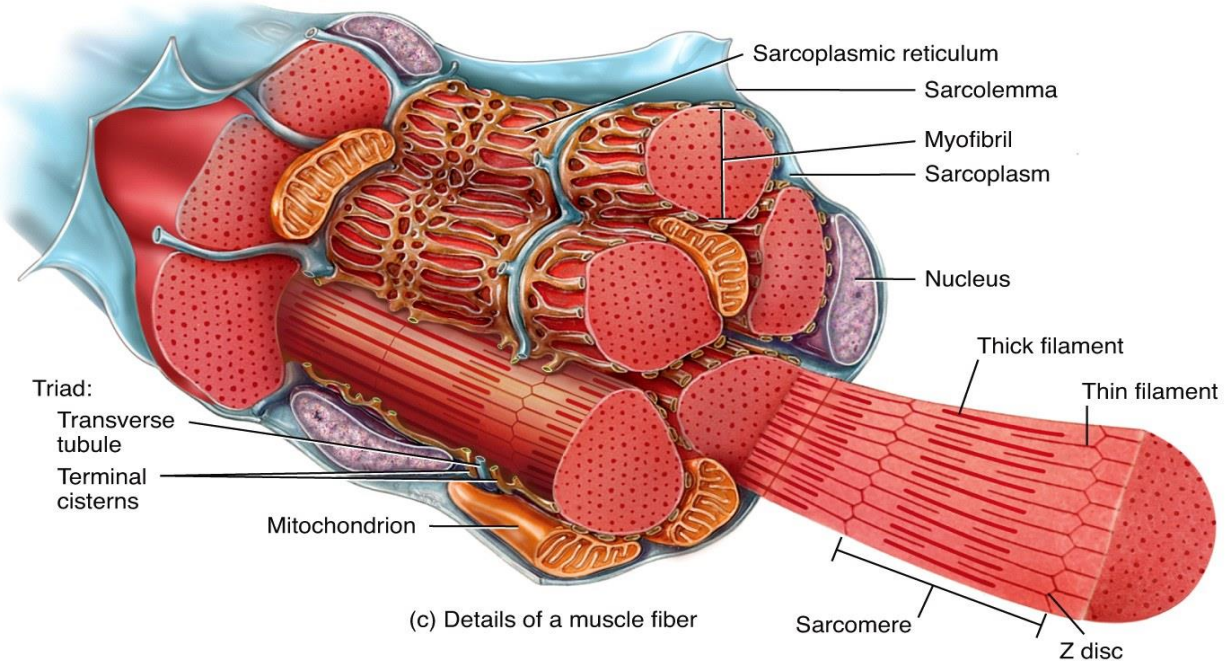


Muscle fiber

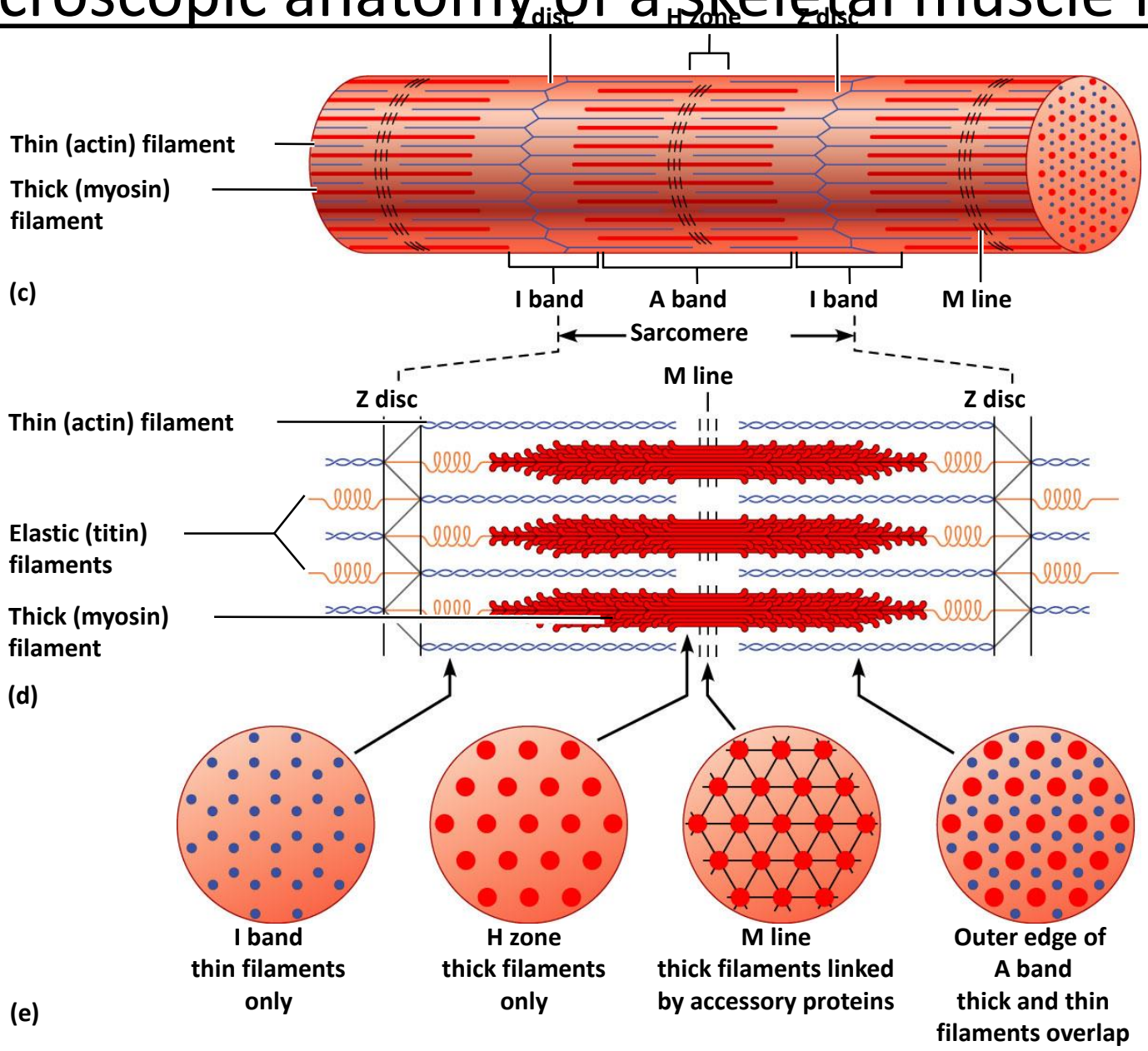
Nuclei

Skeletal Muscle Arrangement

- A single muscle cell is a muscle fiber
  - Fibers are made up of myofibrils
  - Myofibrils are made up of thick and thin filaments
- Sarcolemma – muscle cell membrane
- Sarcoplasm
- muscle cell cytoplasm



Microscopic anatomy of a skeletal muscle fiber

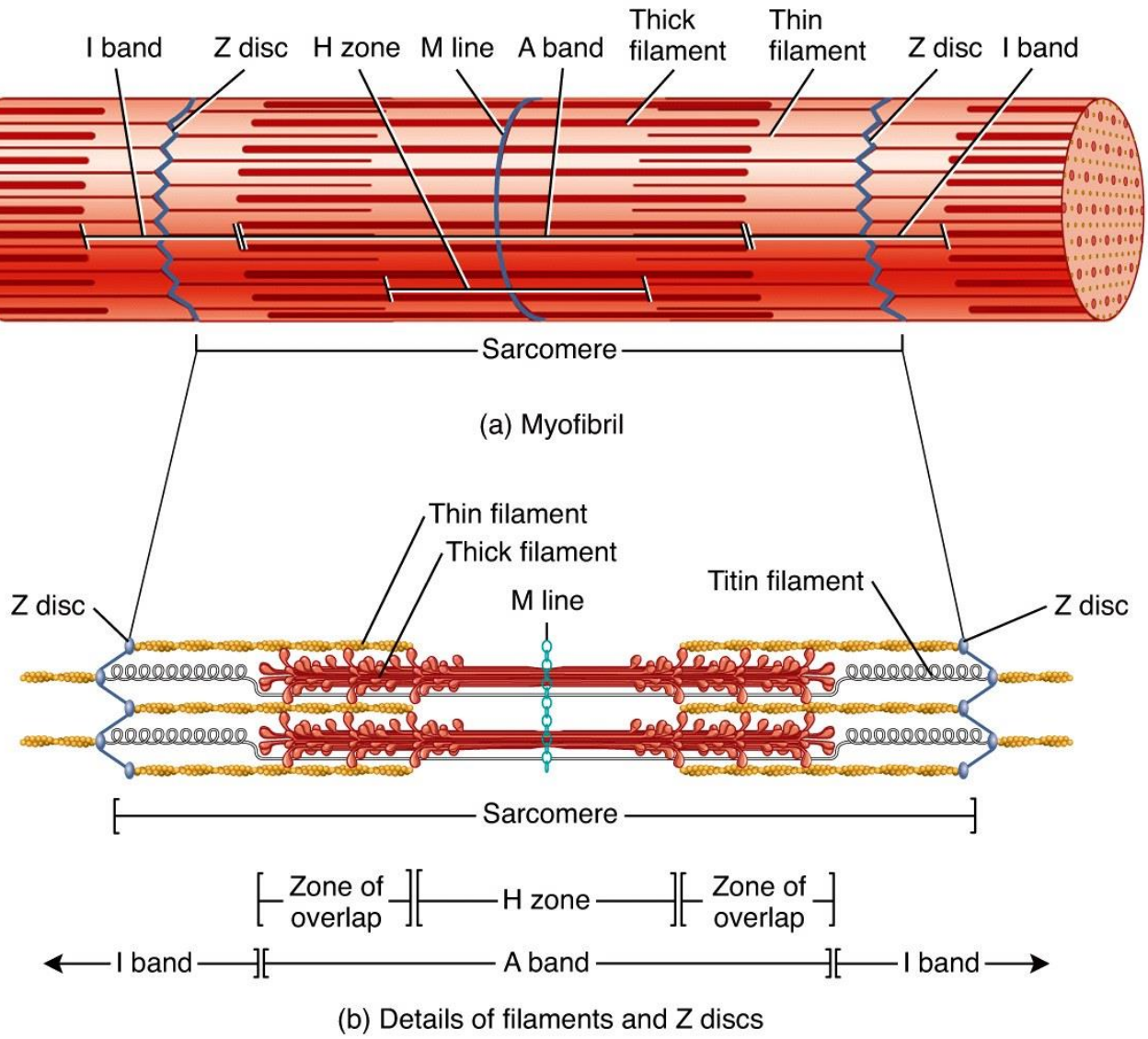


Skeletal Muscle Cells

- **Myofibrils are striated**
  - **Striations due to arrangement of thick and thin filaments**
    - **Seen as alternating areas of light and dark bands**

- **The length of each myofibril is divided into repeating units called sarcomeres**
  - **A sarcomere is the functional unit of skeletal muscle**

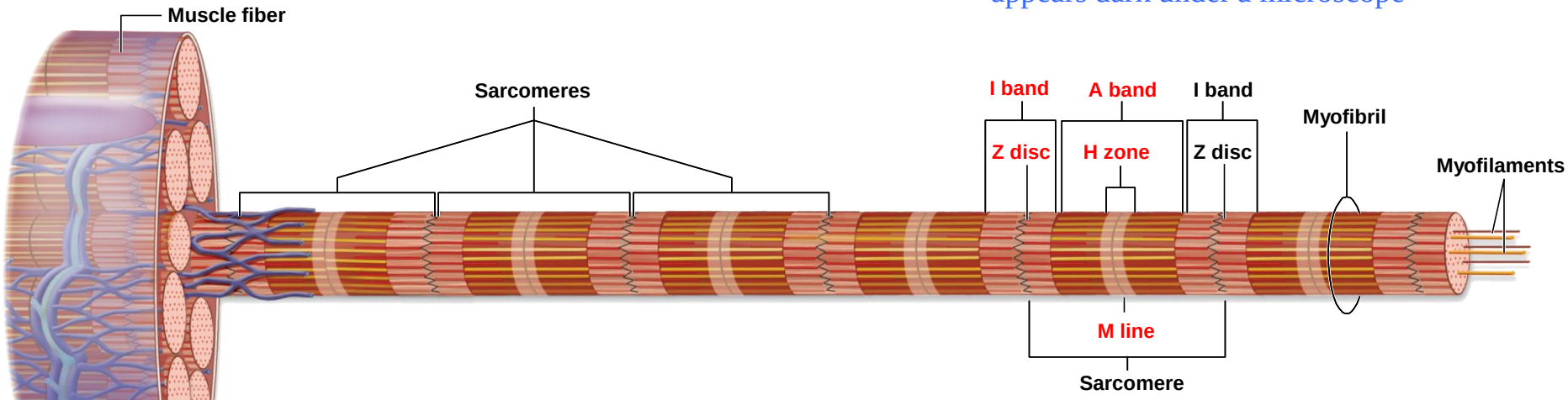
Sarcomere Arrangement



Organization of a Sarcomere

Myofibrils consist of repeating units called **sarcomeres**.
- number varies with length of myofibril.
- composed of overlapping thick and thin filaments
- delineated at both ends by Z discs

A band (DARK regions)
- central region of sarcomere
- contains entire thick filament
- contains partially overlapping thin filaments
- appears dark under a microscope



Z discs
- contains specialized proteins running perpendicular to myofilaments which anchor thin filaments

I bands (LIGHT regions)
- contains only thin filaments
- extend from both directions of Z disc
- appear light under a microscope
- disappear at maximal muscle contraction

(Figure 10.5 a)

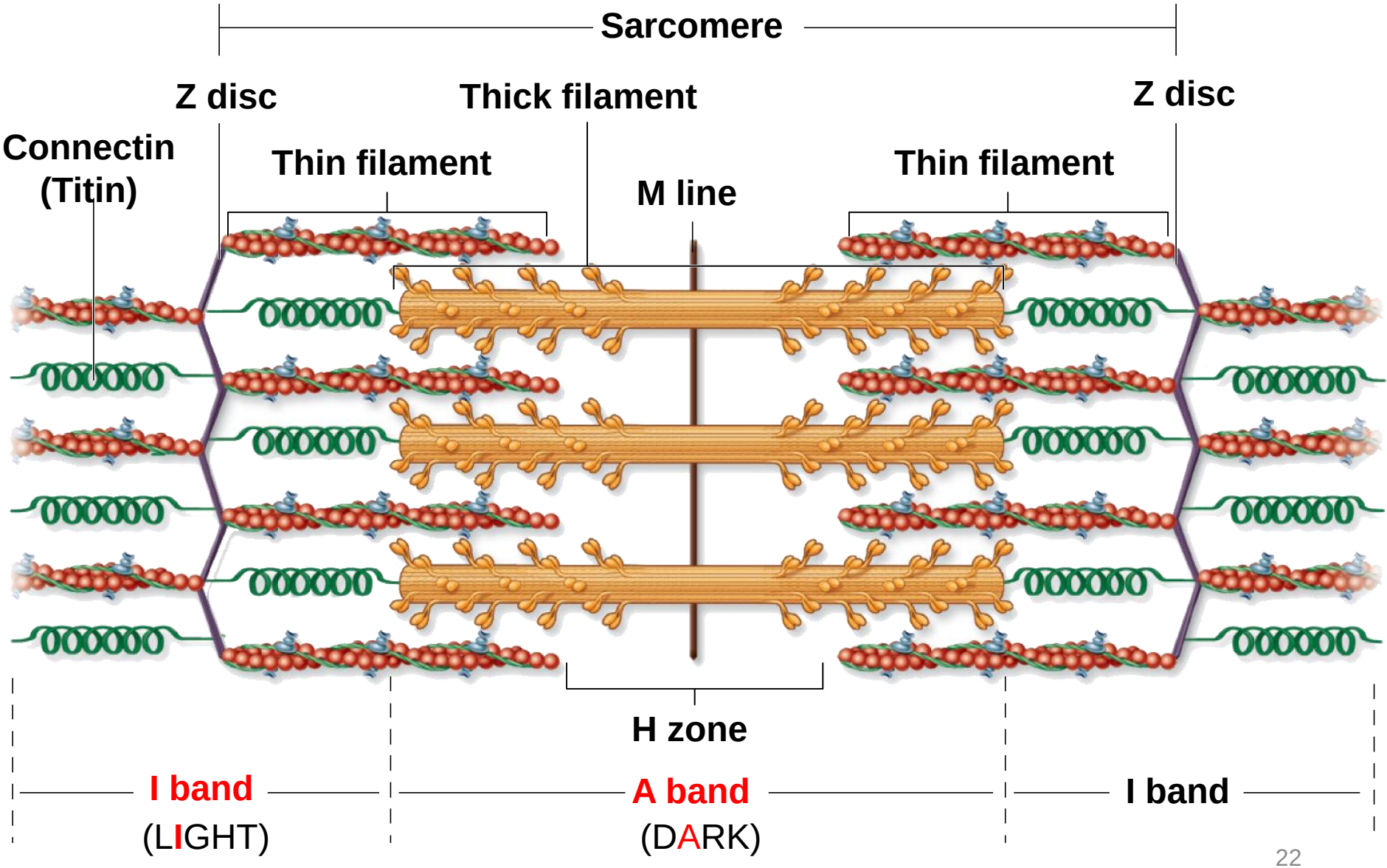
H zone
- central portion of A band
- only thick filaments present; no thin filaments
- disappears during maximal muscle contraction

M line
- protein meshwork structure at center of H zone
- attachment site for thick filaments

Sarcomere Structure

- Sarcomere exists from Z-line to Z-line
- A-Band is dark middle band
  - Overlapping think and thin filaments
- I-Band – ends of A-Band, thin filaments only
- Z-line is in the middle if the I-Band
- Myosin filaments are held to the Z-line by titin proteins

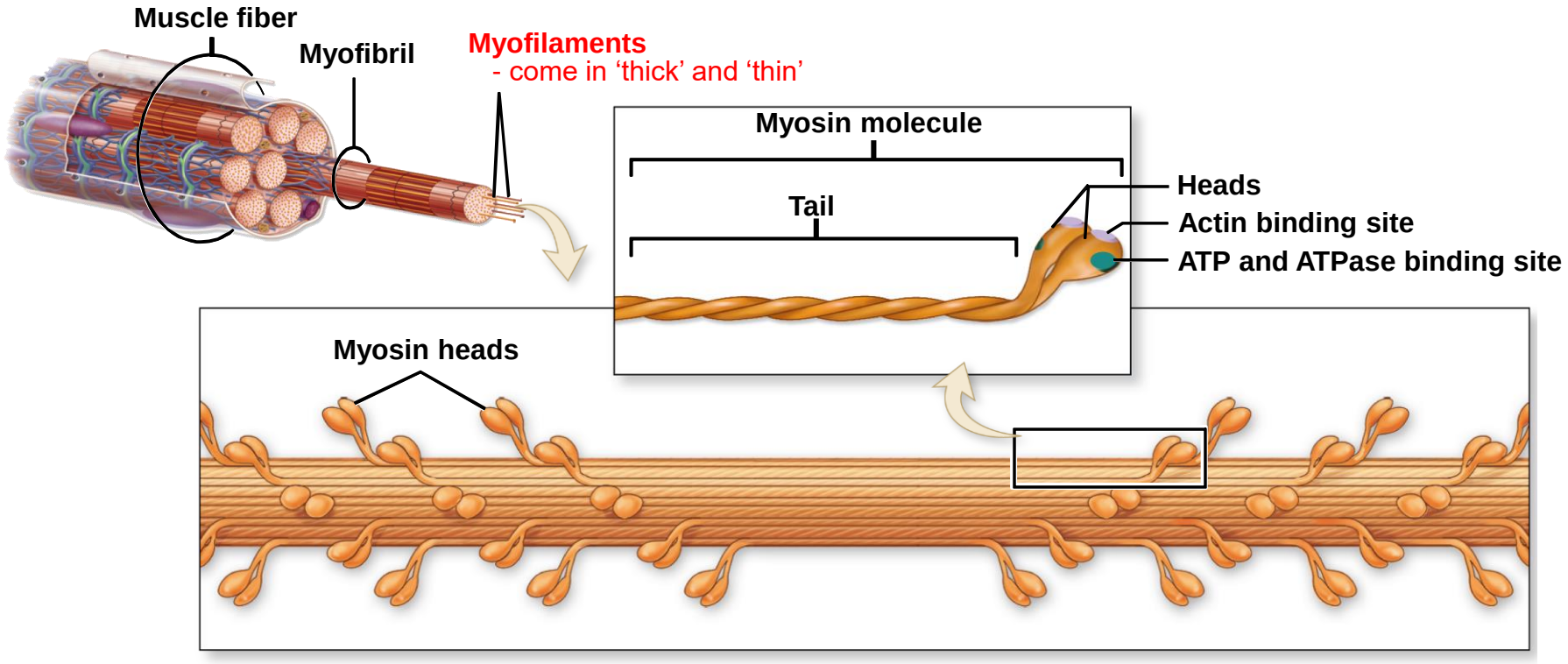
A Sarcomere: The Functional Unit of Skeletal Muscle Contraction



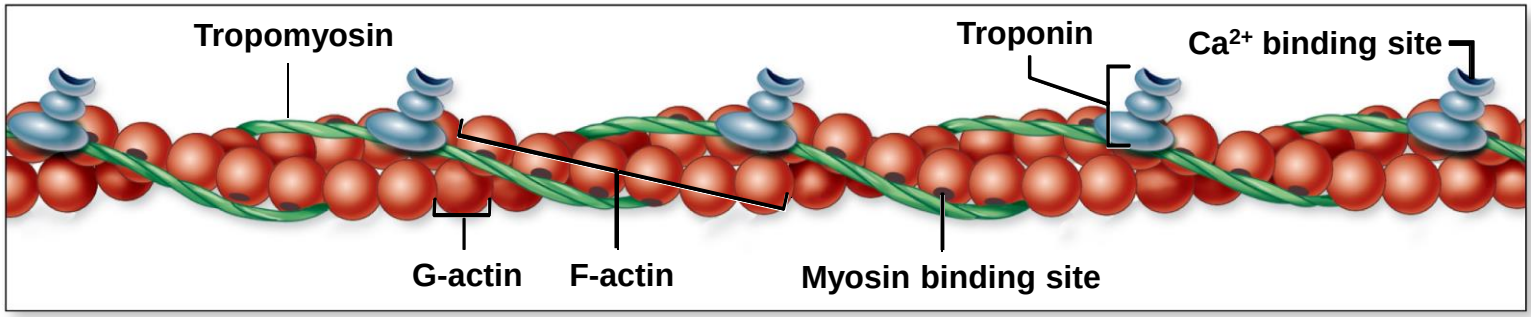
(Figure 10.5 b)

Molecular Structure of Thick and Thin Filaments

(Figure 10.4)



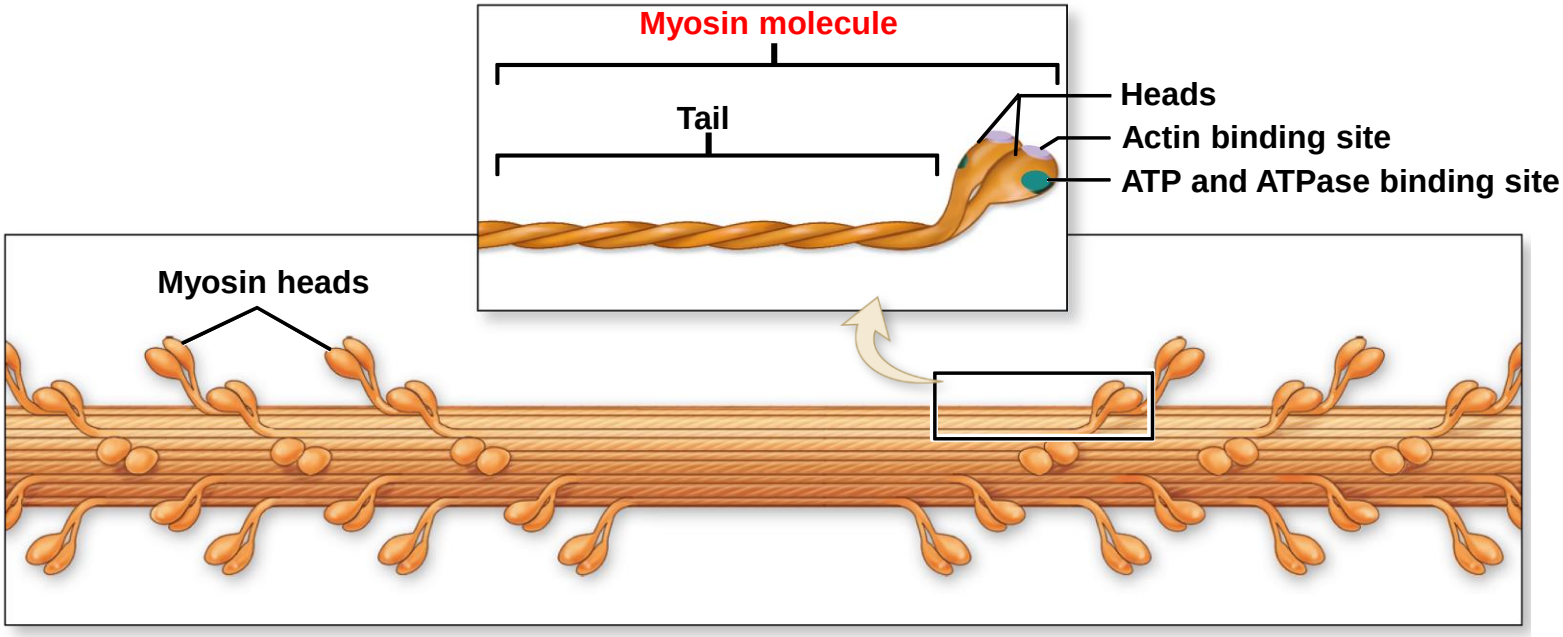
(a) Thick filament



(b) Thin filament

Molecular Structure of Thick and Thin Filaments

(Figure 10.4)



Thick filaments

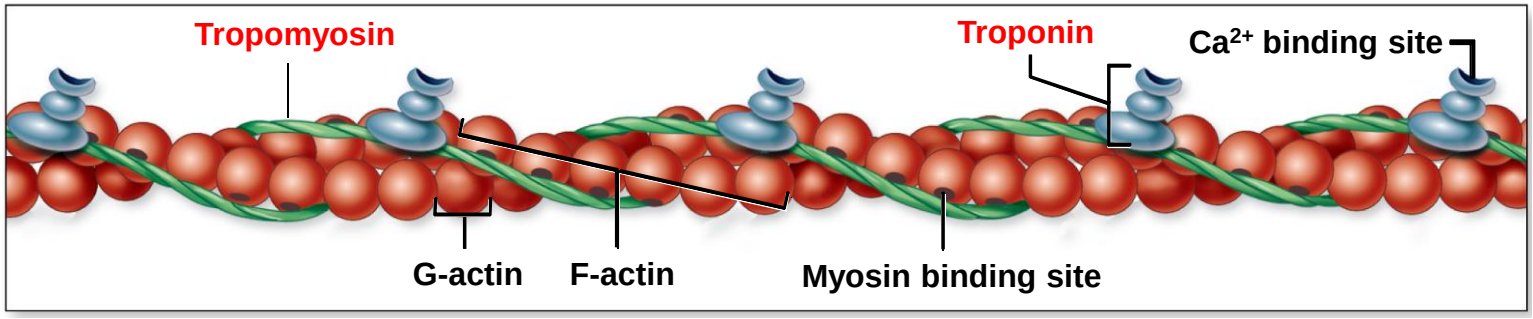
- assembled from bundles of protein molecules, **myosin**
- each myosin protein has two intertwined strands
- each strand has globular head and elongated tail
- tails pointing toward center of thick filaments
- heads pointing toward edges of thick filaments
- head with a binding site for actin (on thin filaments)
- head has site where ATP attaches and is split by ATPase

Molecular Structure of Thick and Thin Filaments

(Figure 10.4)

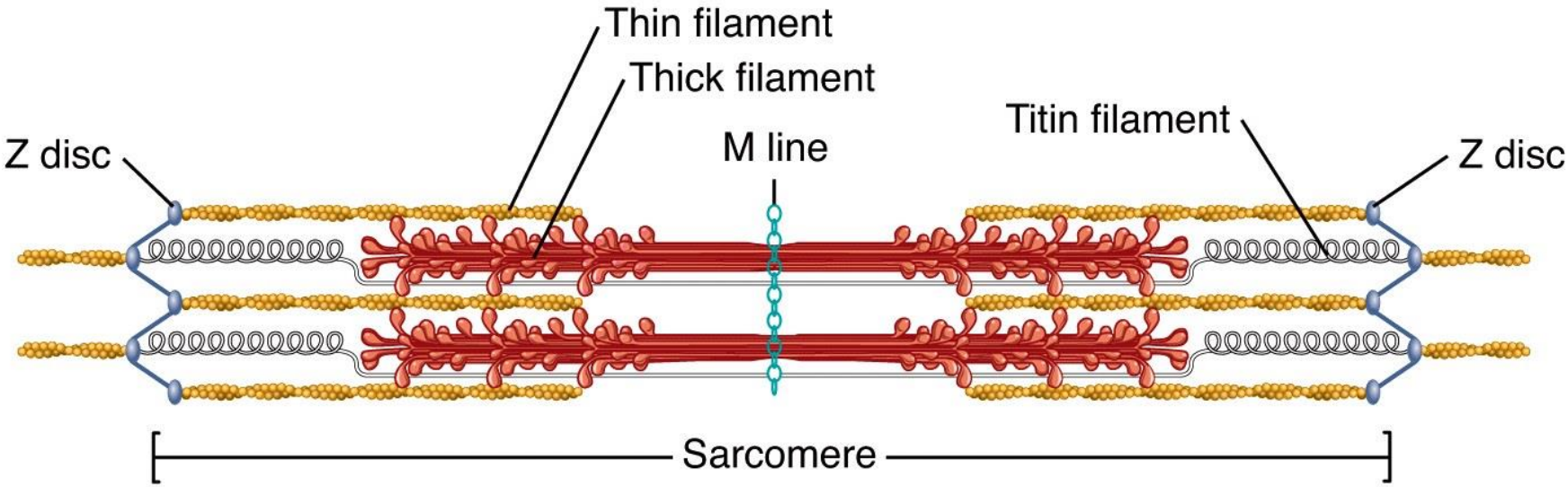
Tropomyosin
- twisted stringlike protein
- covers small bands of F-actin
- covers myosin binding sites in noncontracting muscle

Troponin
- globular protein attached to tropomyosin
- has binding site for Ca^{2+}
- together form troponin-tropomyosin complex



Thin filaments

- composed primarily of two strands of **actin**
- strands twisted around one another
- actin strands composed of spherical molecules, globular actin (G-actin)
- connect to form a fibrous strand, filamentous actin (F-actin)
- G-actin has **myosin binding site -** where myosin head attaches during contraction

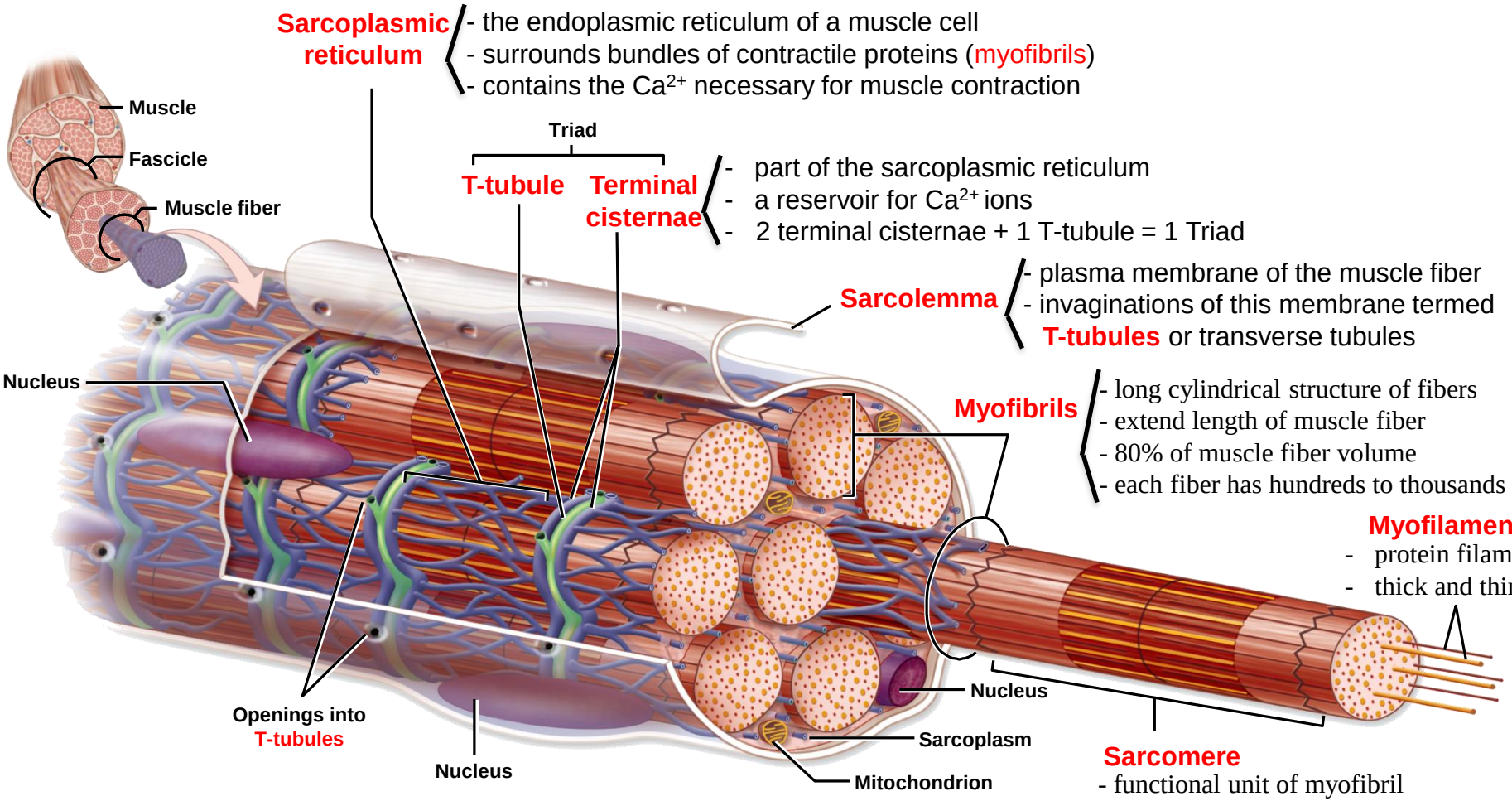

Thin filament
Thick filament
Titin filament
Z disc
M line
Z disc
Sarcomere

Specialized Organelles of Skeletal Muscle

- **Sarcoplasmic Reticulum (SR) – a type of ER**
  - **Surrounds each myofibril, running parallel to it**
  - **Stores calcium, when stimulated, calcium diffuses into sarcoplasm**

- **Transverse Tubules (TT)**
  - **Extends into sarcoplasm as invaginations continuous with sarcolemma**
    - **T tubules run between cisternae of SR**
  - **Filled with extracellular fluid**
  - **Cisternae of SR and TT form a triad near where thick and thin filaments overlap**

Inside a Skeletal Muscle Fiber



(a) Skeletal muscle fiber

(Figure 10.3 a)

Smooth muscle

- Characterized by:
  - Spindle shaped cells
  - Not striated
  - Uni-nucleate cells
  - Involuntary control
- Found in walls of hollow organs, blood vessels and glands

Cardiac Muscle

- Found only in heart
- Striated
- Each cell usually has one nucleus
- Has intercalated disks and gap junctions
- Autorhythmic cells
- Action potentials of longer duration and longer refractory period
- Ca^{2+} regulates contraction

Regeneration of Muscle Tissue

The three types of adult muscle have different potentials for regeneration after injury.

- **Cardiac muscle:** has almost no regenerative capacity beyond early childhood. Defects or damage (eg, infarcts) in heart muscle are generally replaced by the proliferation of connective tissue, forming myocardial scars.
- **Skeletal muscle**,:-they can undergo limited regeneration. The source of regenerating cells is the **satellite cells. T**hey are a sparse population of mononucleated spindle-shaped cells that lies within the basal lamina surrounding each mature muscle fiber.
  - The Satellite cells are inactive myoblasts that persist after muscle differentiation.
  - After injury or certain other stimuli, the normally quiescent satellite cells become activated, proliferating and fusing to form new skeletal muscle fibers.
  - satellite cells have been implicated in muscle hypertrophy, where they fuse with their parent fibers to increase muscle mass after extensive exercise.
- **The Smooth muscles:-** are capable of an active regenerative response. After injury, viable mononucleated smooth muscle cells and pericytes from blood vessels undergo mitosis and provide for the replacement of the damaged tissue.

Effects of Aging on Skeletal Muscle

- Reduced muscle mass
- Increased time for muscle to contract in response to nervous stimuli
- Reduced stamina
- Increased recovery time
- Loss of muscle fibers
- Decreased density of capillaries in muscle


Patience is a way to earn the companionship of Allah
AND BE PATIENT.
SURELY ALLAH IS WITH
THOSE WHO ARE PATIENT
(QURAN 8:46)
Only those who are patient shall receive their reward in full,
without reckoning. (39:10)


THANK YOU