Muscle Tissue

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Muscle Tissue Lecture Objectives

- Describe, compare, and contrast the histologic structure of the three types of muscle, as seen with the light and electron microscope.
- For skeletal muscle, know what the following terms mean: myofiber, myofibril, myofilament.
- Describe, compare, and contrast the structure and organization of the sarcomere in skeletal vs. cardiac muscle, including the banding pattern, transverse tubules, and sarcoplasmic reticulum.

Muscle Tissue Lecture Objectives

- Describe the unique structural features of smooth muscle which distinguish it from skeletal and cardiac muscle.
- Describe the connective tissue sheaths that surround skeletal muscle.
- Compare the ability of the three types of muscle to regenerate.

Muscle Tissue Lecture Outline

- Introduction
- Skeletal muscle
- Cardiac muscle
- Smooth muscle

Muscle Tissue Lecture Outline

- Introduction

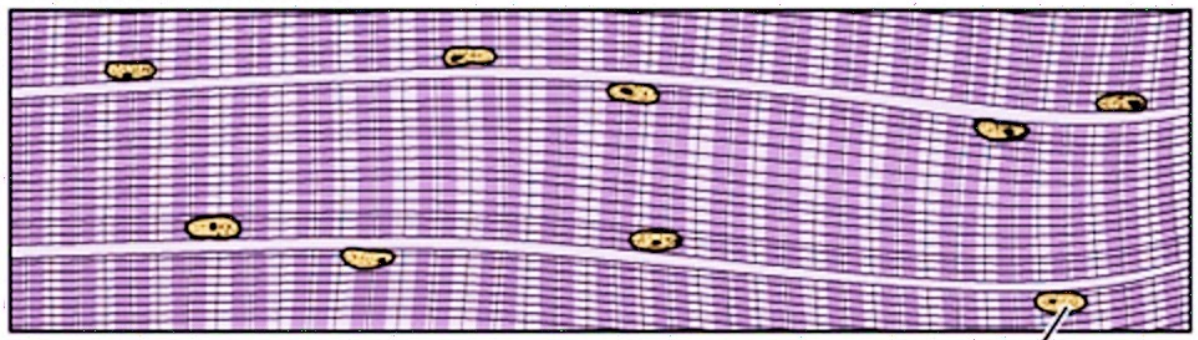
Fun facts about muscle terminology

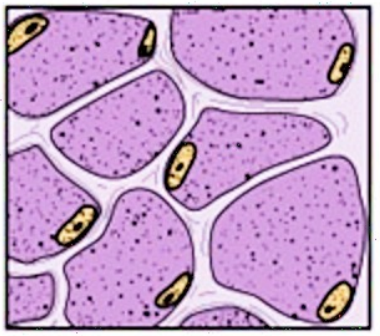
- "Sarco-" is from the Greek *sarx* (flesh)
- "Myo-" is from the Greek *mys* (muscle)
- Muscle cells are longer than they are wide, so they are also called "fibers"
- There are three types of muscle cells: smooth, skeletal and cardiac. Smooth muscle cells are non-striated; skeletal and cardiac muscle cells are striated.

Muscle types and activity

Skeletal muscle

Cross sections

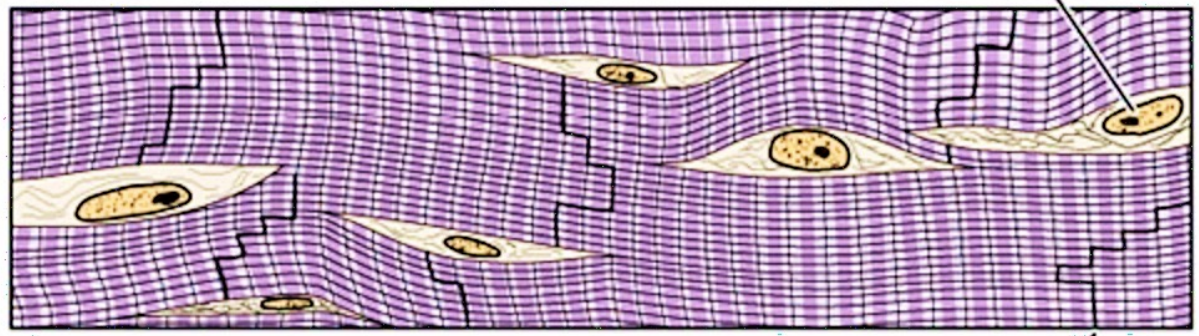


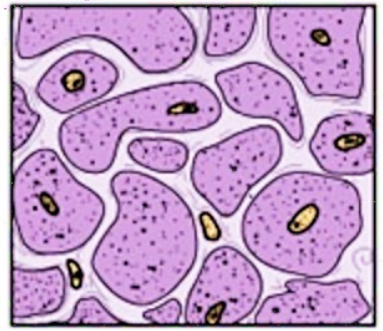


Strong, quick discontinuous voluntary contraction

Nuclei

Cardiac muscle

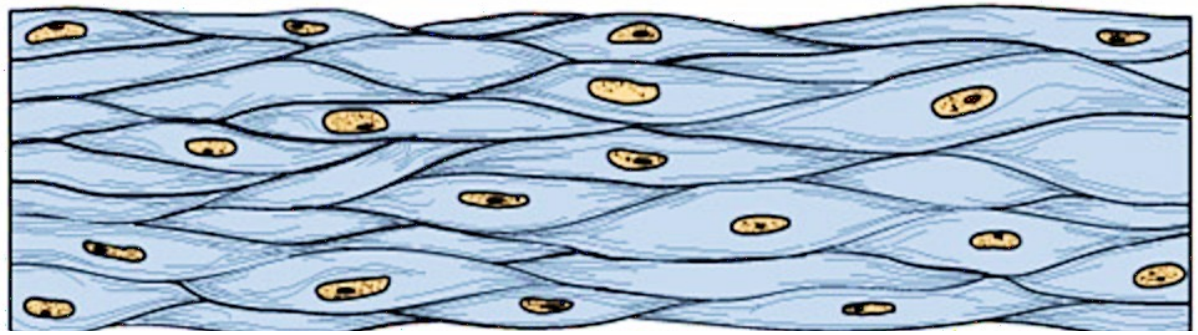


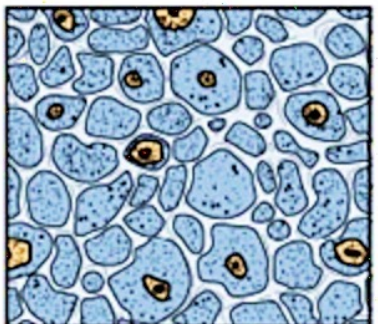


Strong, quick continuous involuntary contraction

Intercalated disks

Smooth muscle

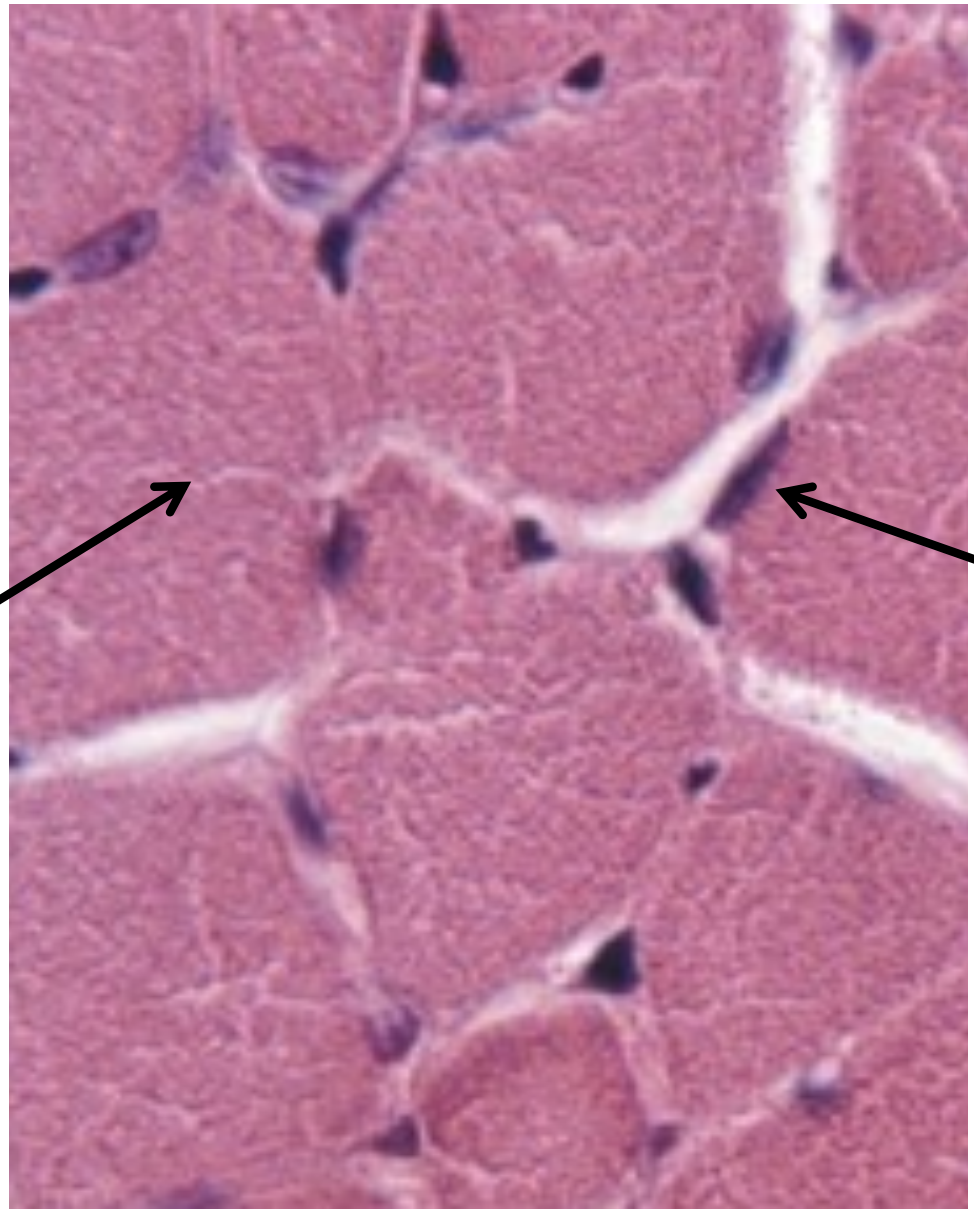




Weak, slow involuntary contraction

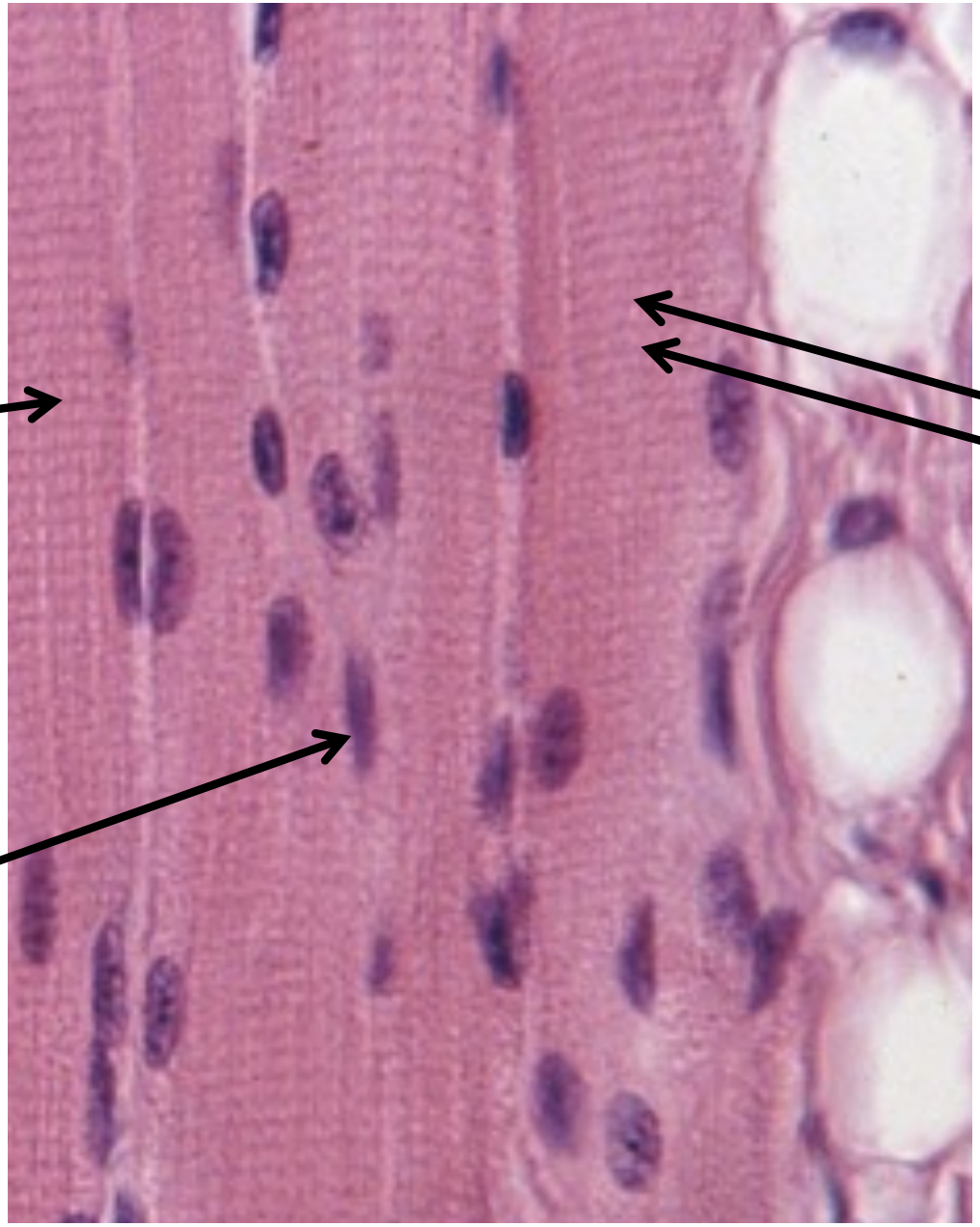
Muscle Tissue Lecture Outline

- Introduction
- Skeletal muscle



Skeletal muscle

Cells are long, unbranched tubes



Can just barely see striations

Peripheral, flattened nuclei

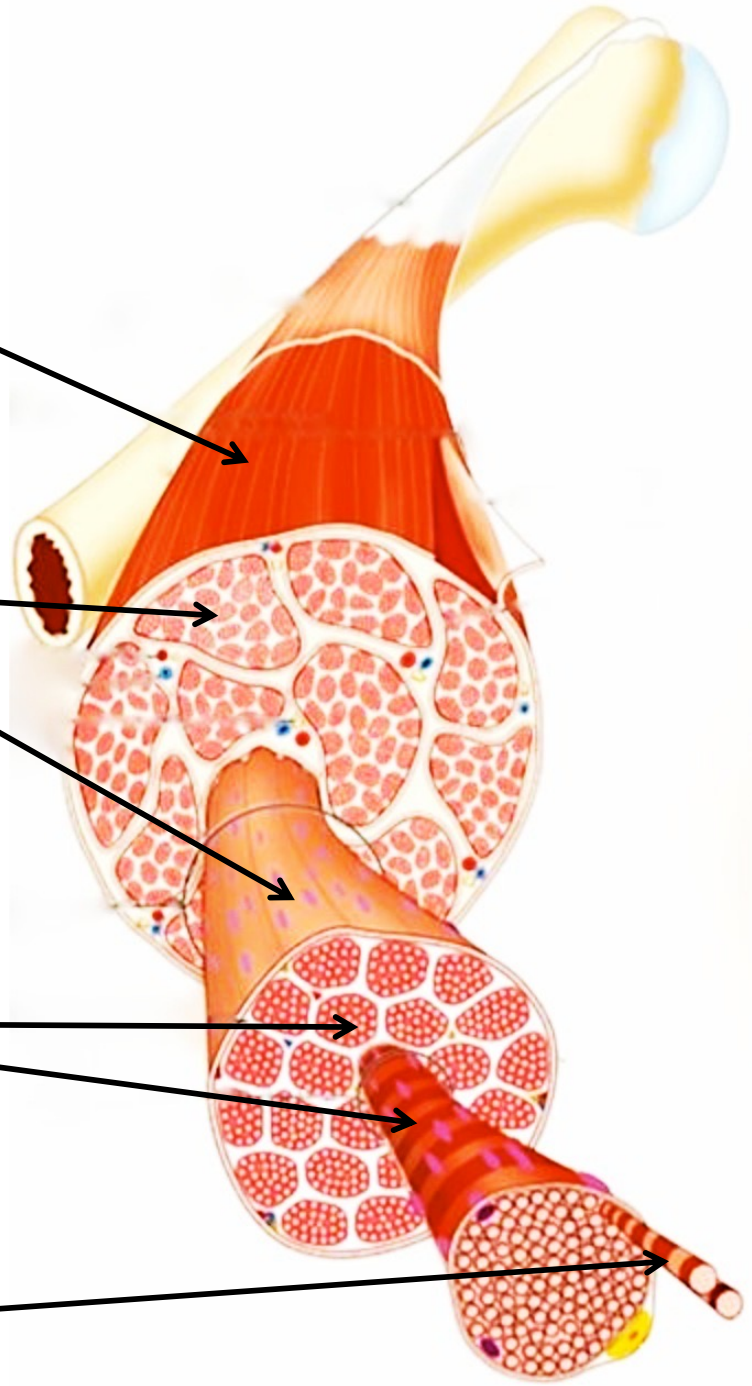
Skeletal muscle

What's in an actual skeletal muscle?

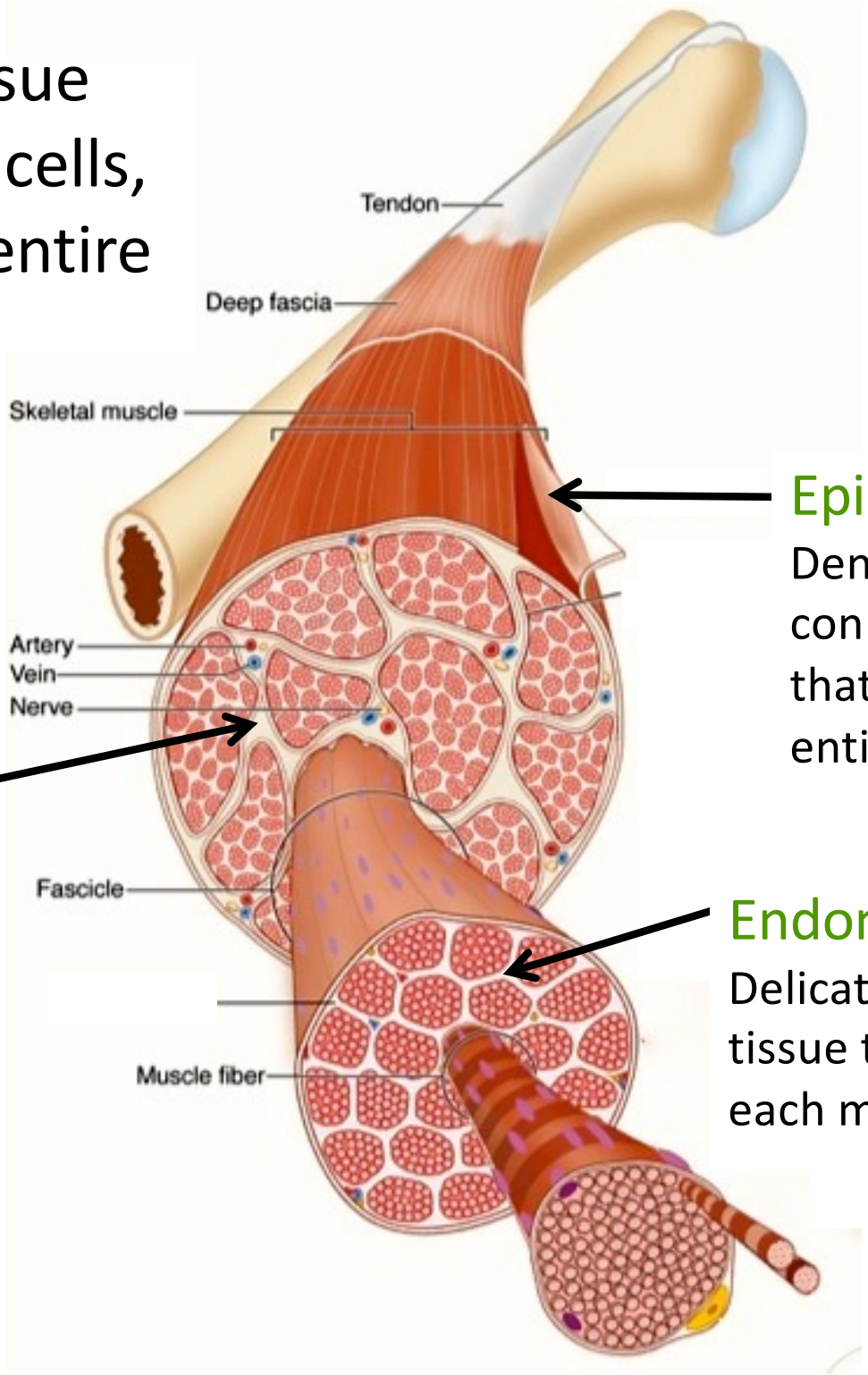
A bunch of fascicles.

Each fascicle is composed of a bunch of muscle cells (myofibers).

Each muscle cell contains a bunch of myofibrils.



Connective tissue surrounds the cells, fascicles, and entire muscle.



Epimysium

Dense layer of connective tissue that surrounds entire muscle

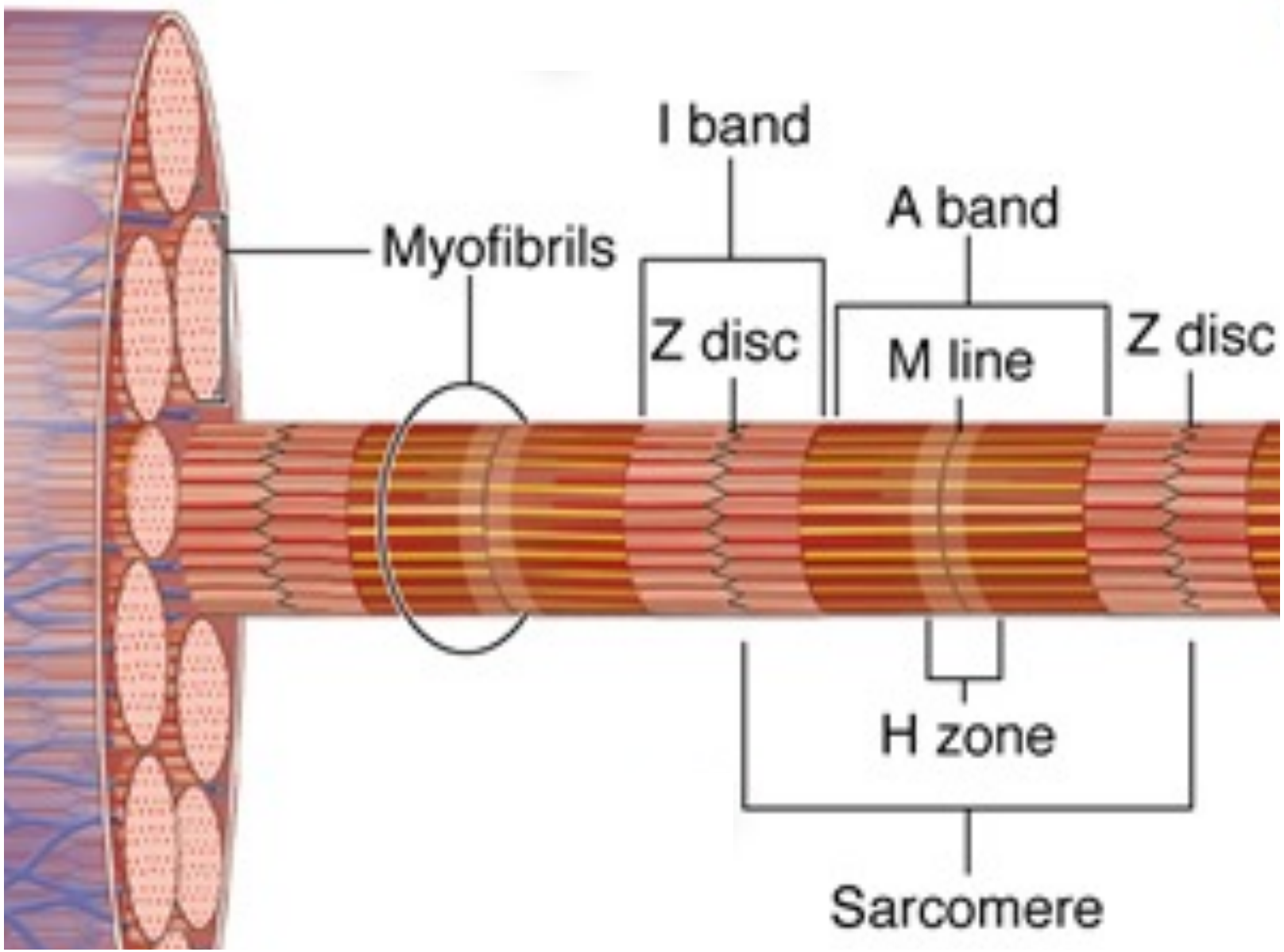
Perimysium

Connective tissue that surrounds each fascicle

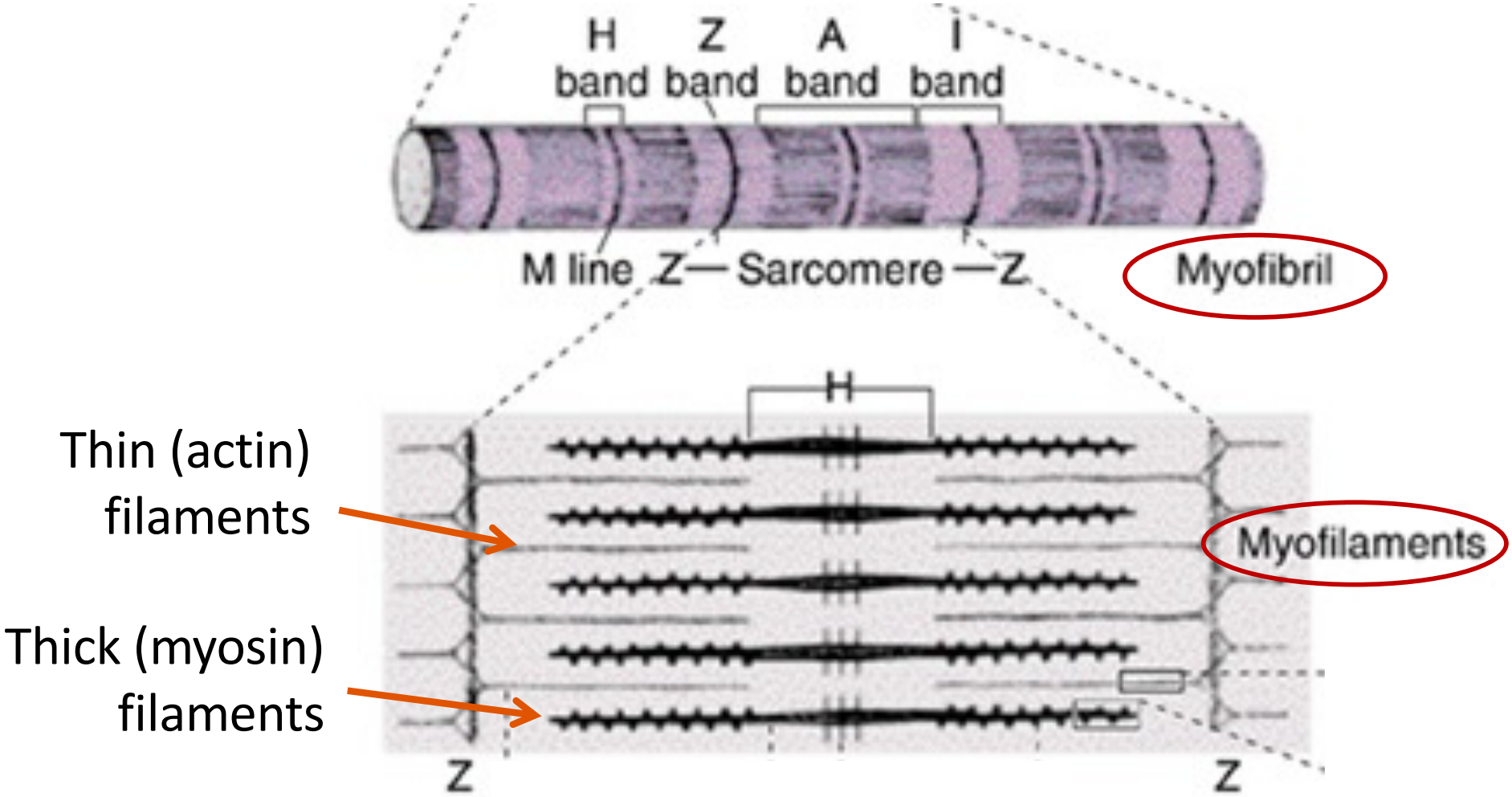
Endomysium

Delicate connective tissue that surrounds each muscle cell

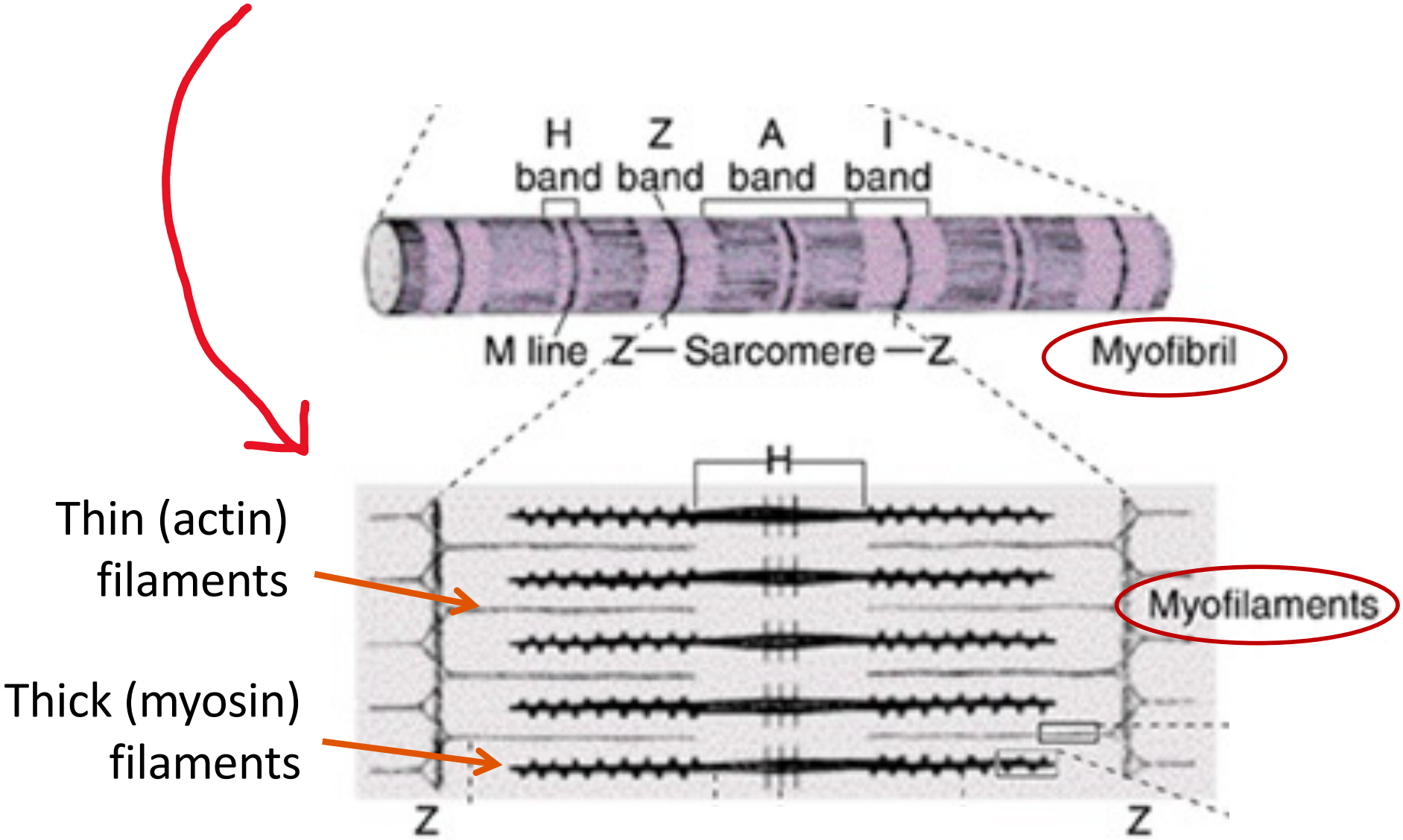
Myofibrils have stripes (striations)



Q. What is it that makes that super-specific repeating pattern of light and dark bands?



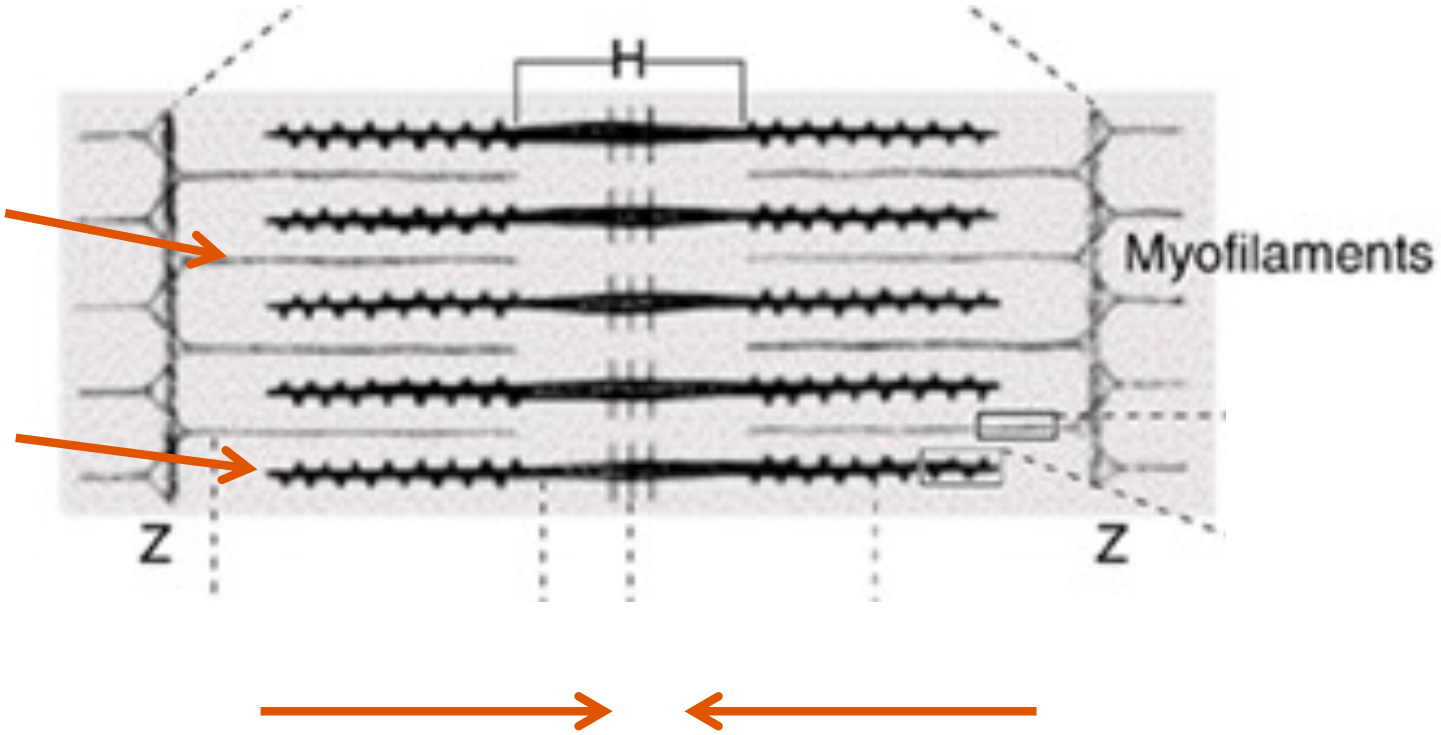
A. The arrangement of thick and thin myofilaments!



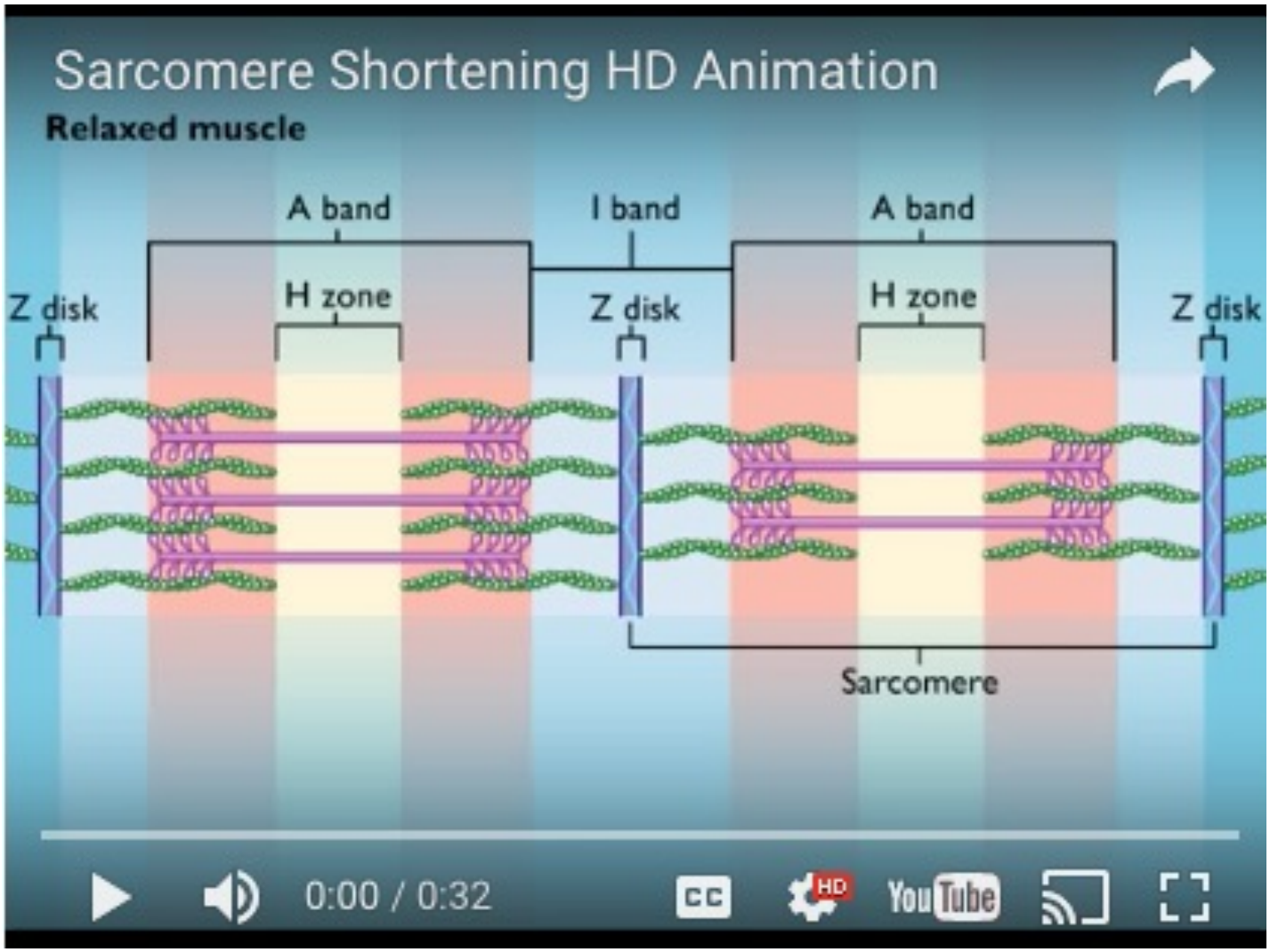
When muscles contract, sarcomeres shorten!

Thin (actin) filaments

Thick (myosin) filaments

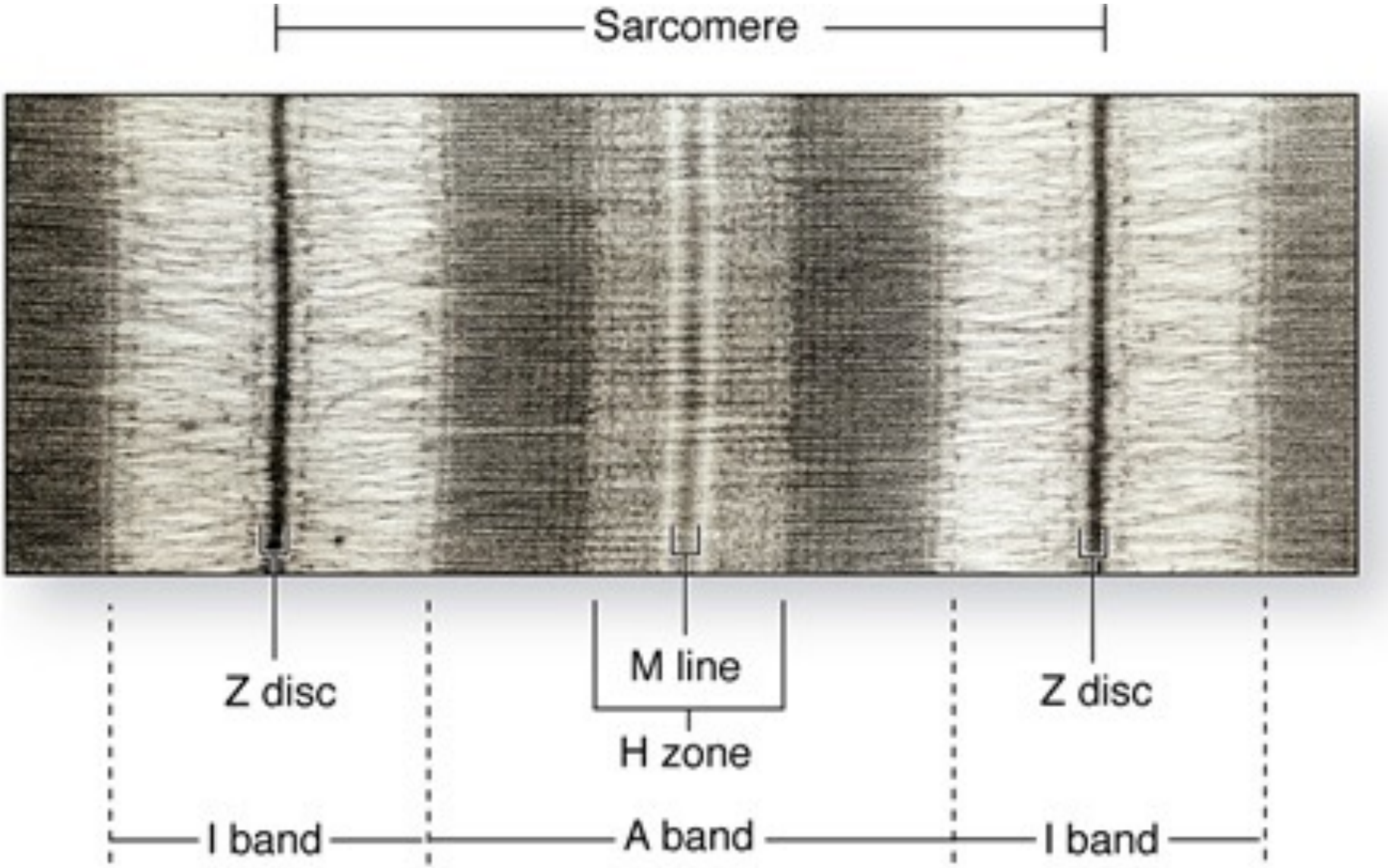


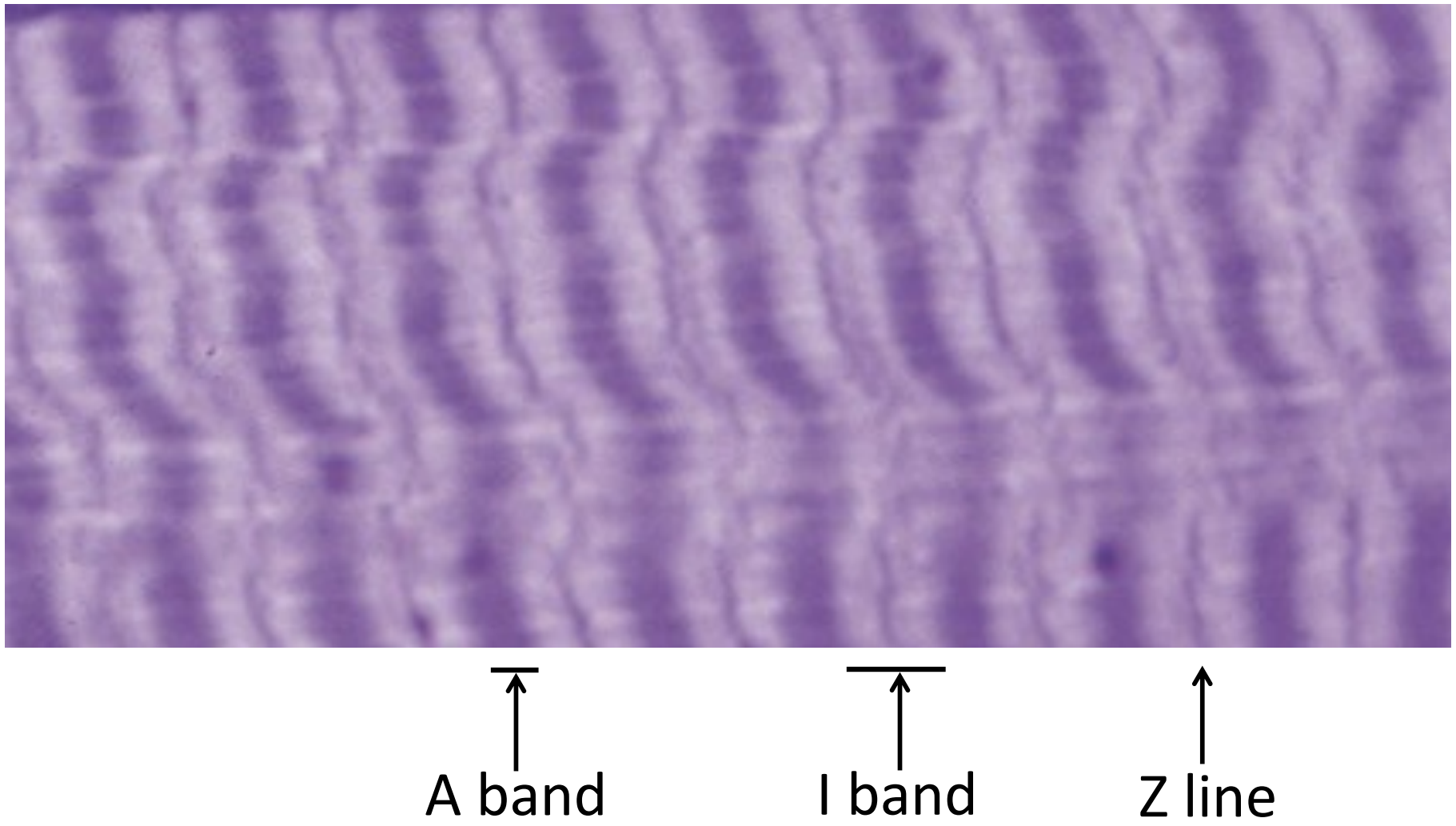
Actin filaments get pulled toward each other.
The distance between the Z lines shortens,
and the H band disappears.



Check out this video to see how the sarcomere shortens!
https://youtu.be/U2TSaz8-yNQ

Sarcomere and bands

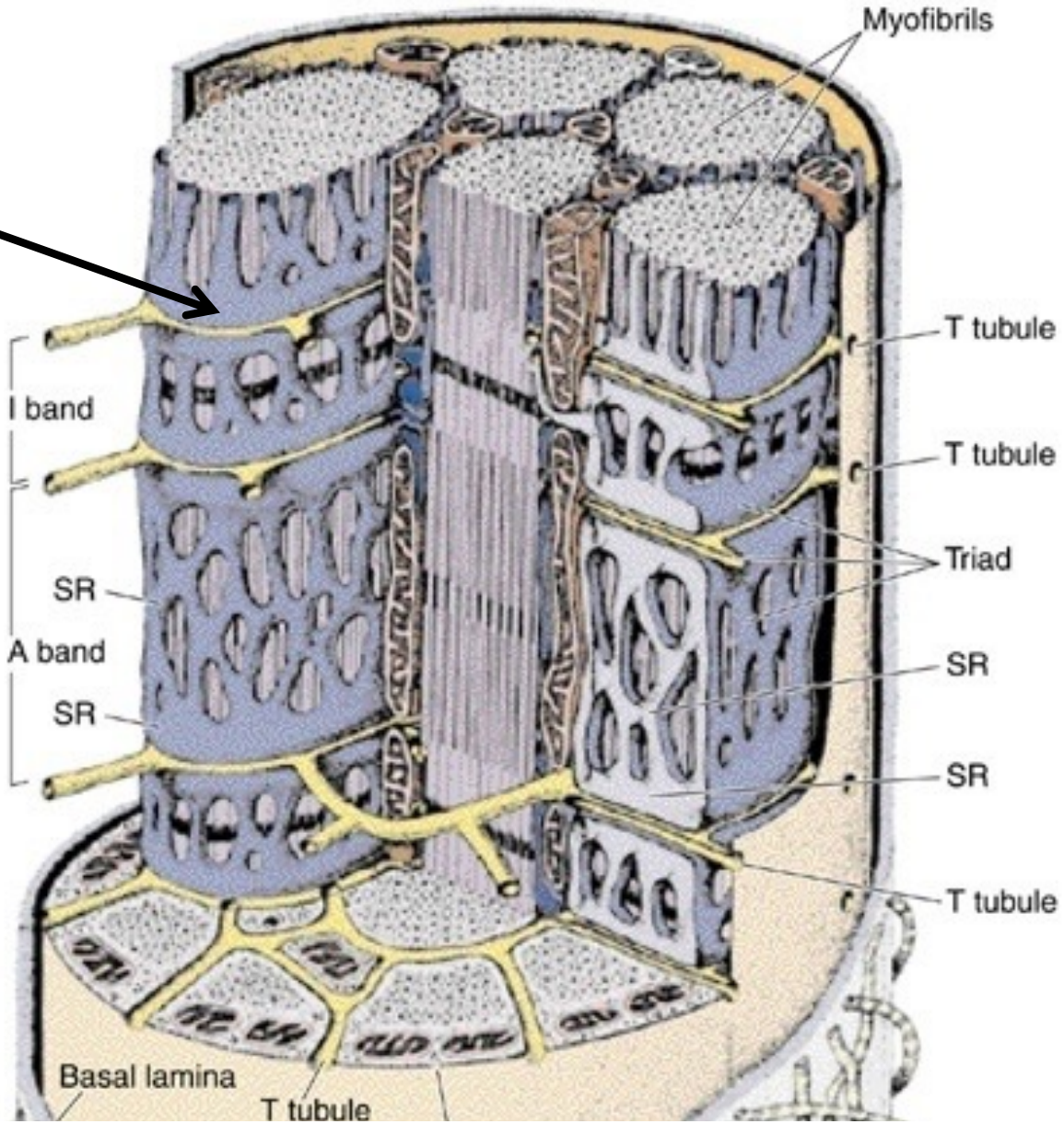




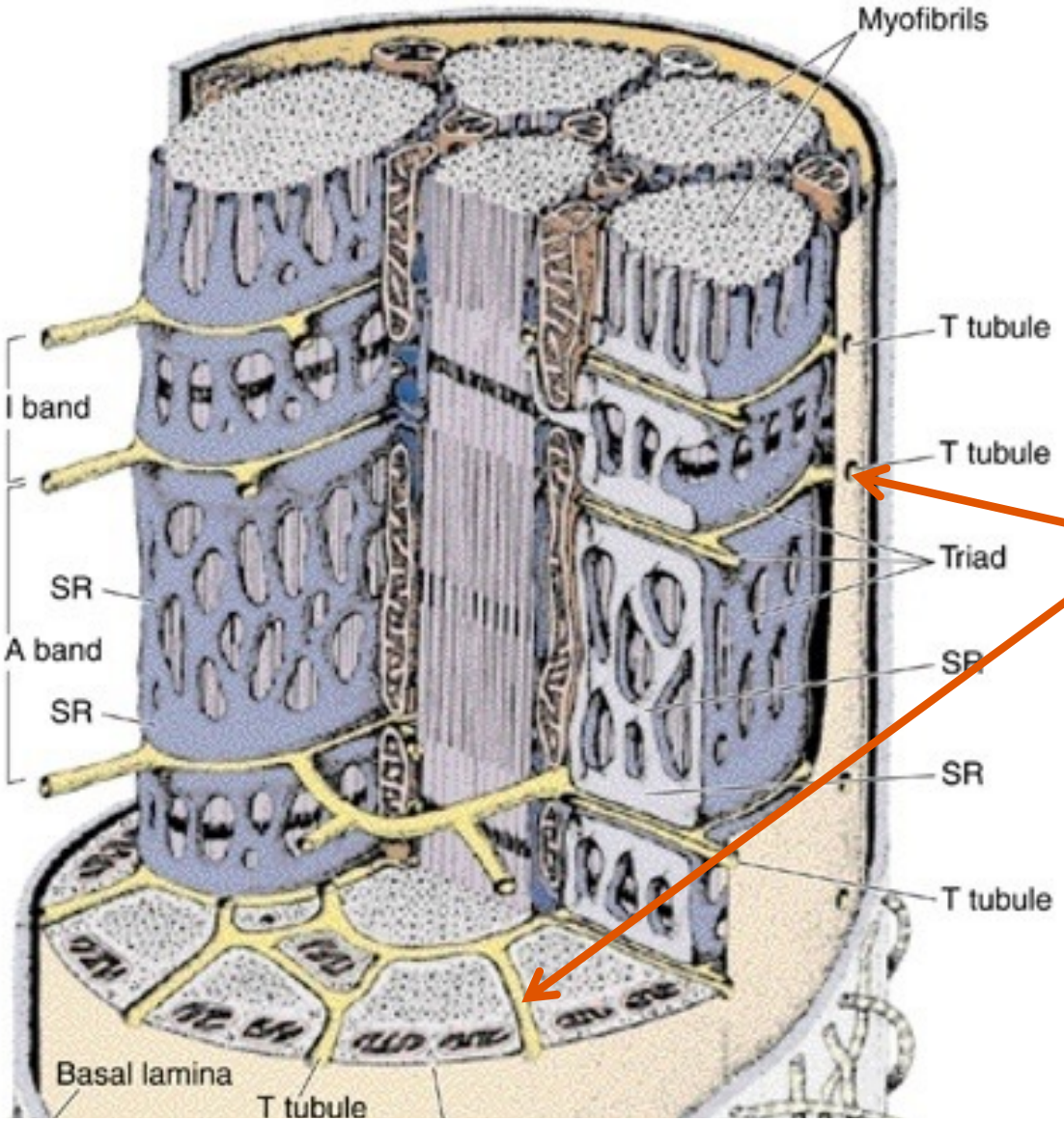
Skeletal muscle with A bands, I bands, Z lines

Sarcoplasmic reticulum

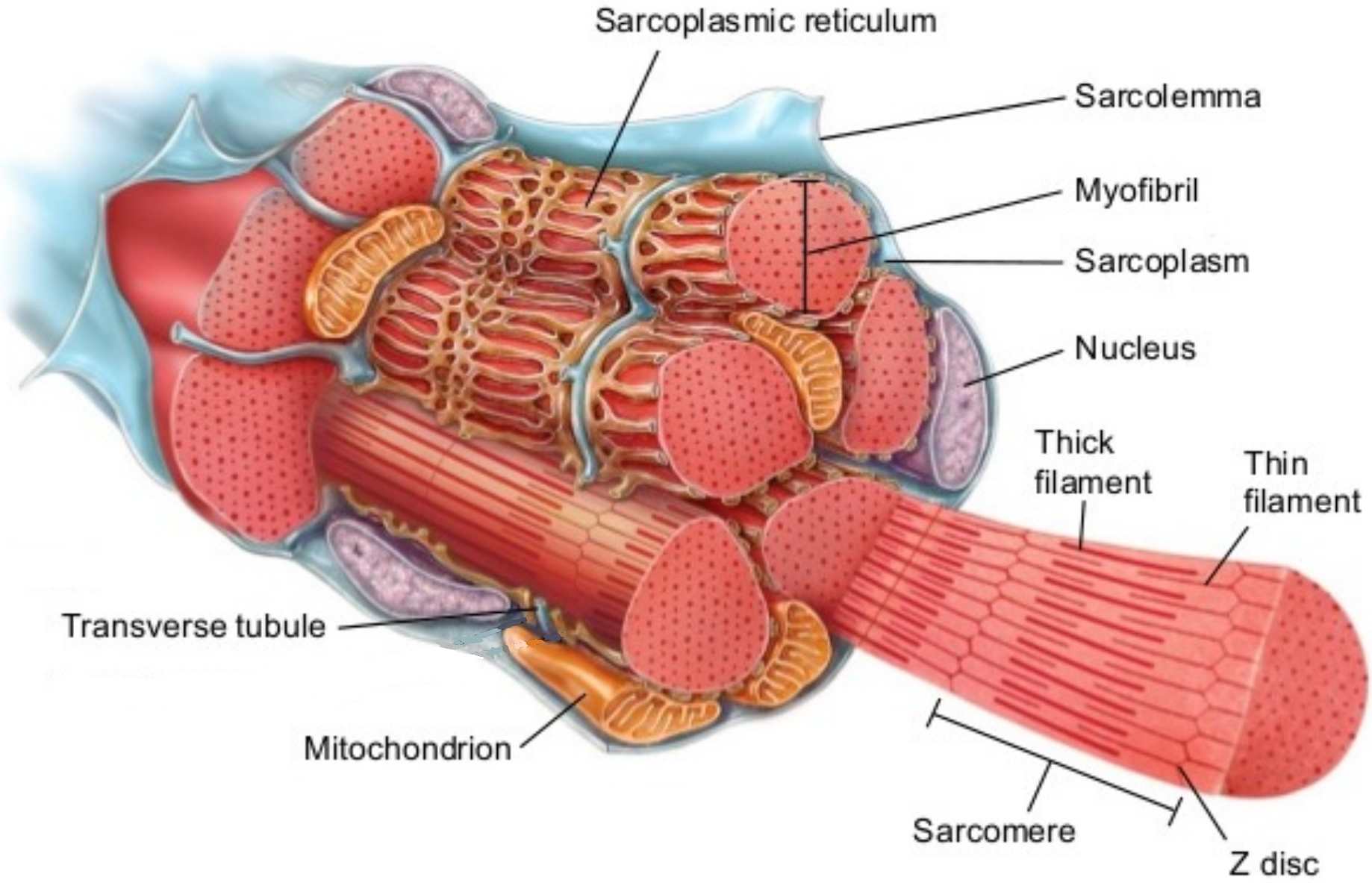
- Sarcoplasmic reticulum is the smooth endoplasmic reticulum in skeletal muscle.
- It is specialized to sequester & release calcium ions.
- It ensheathes or surrounds each myofibril.



Transverse (T) tubules



At each A-I band junction, a tubular invagination of the sarcolemma termed a transverse (T) tubule penetrates the muscle fiber and lies next to the surface of myofibrils.


Sarcoplasmic reticulum
Sarcolemma
Myofibril
Sarcoplasm
Nucleus
Thick filament
Thin filament
Transverse tubule
Mitochondrion
Sarcomere
Z disc

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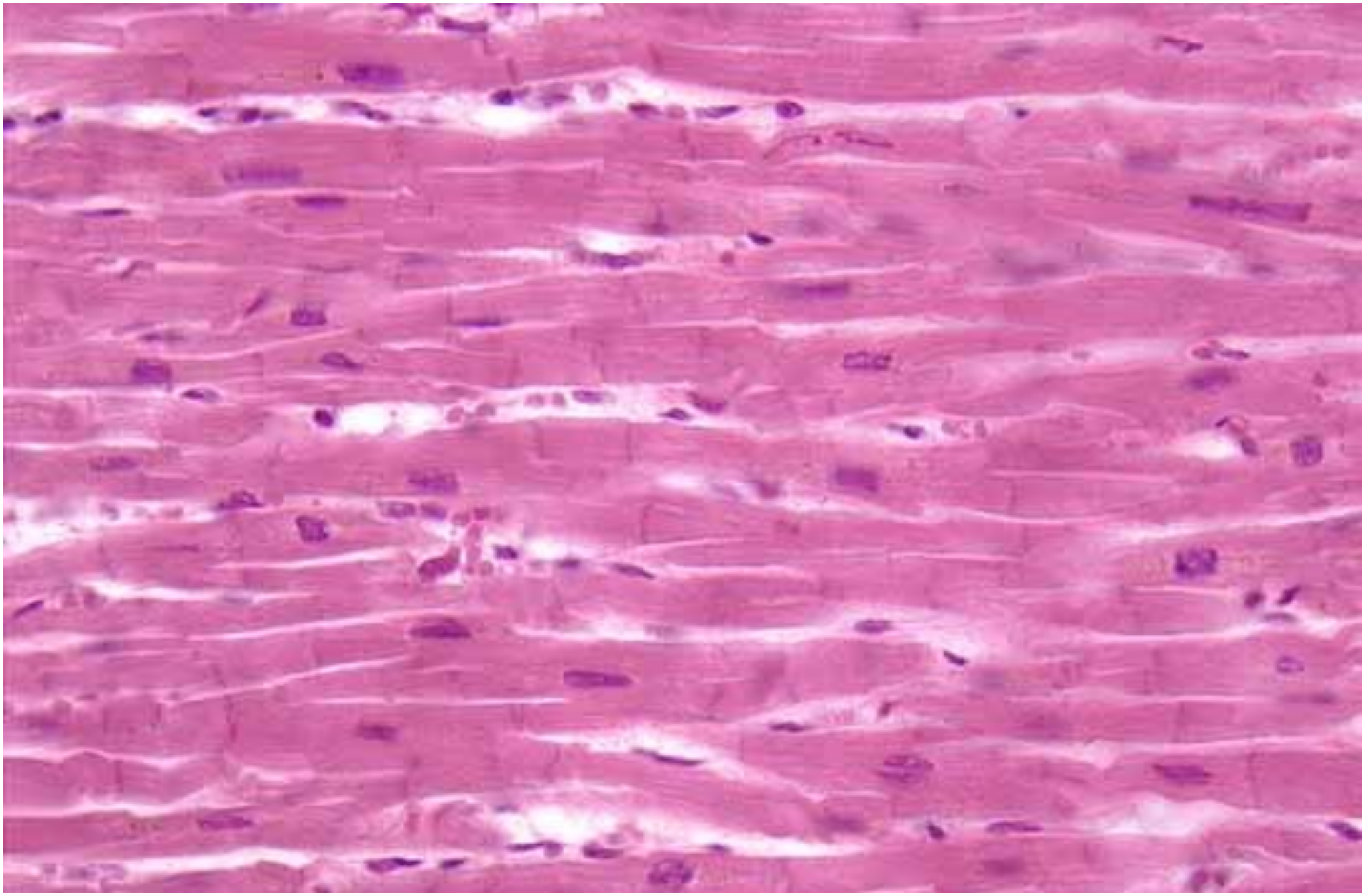
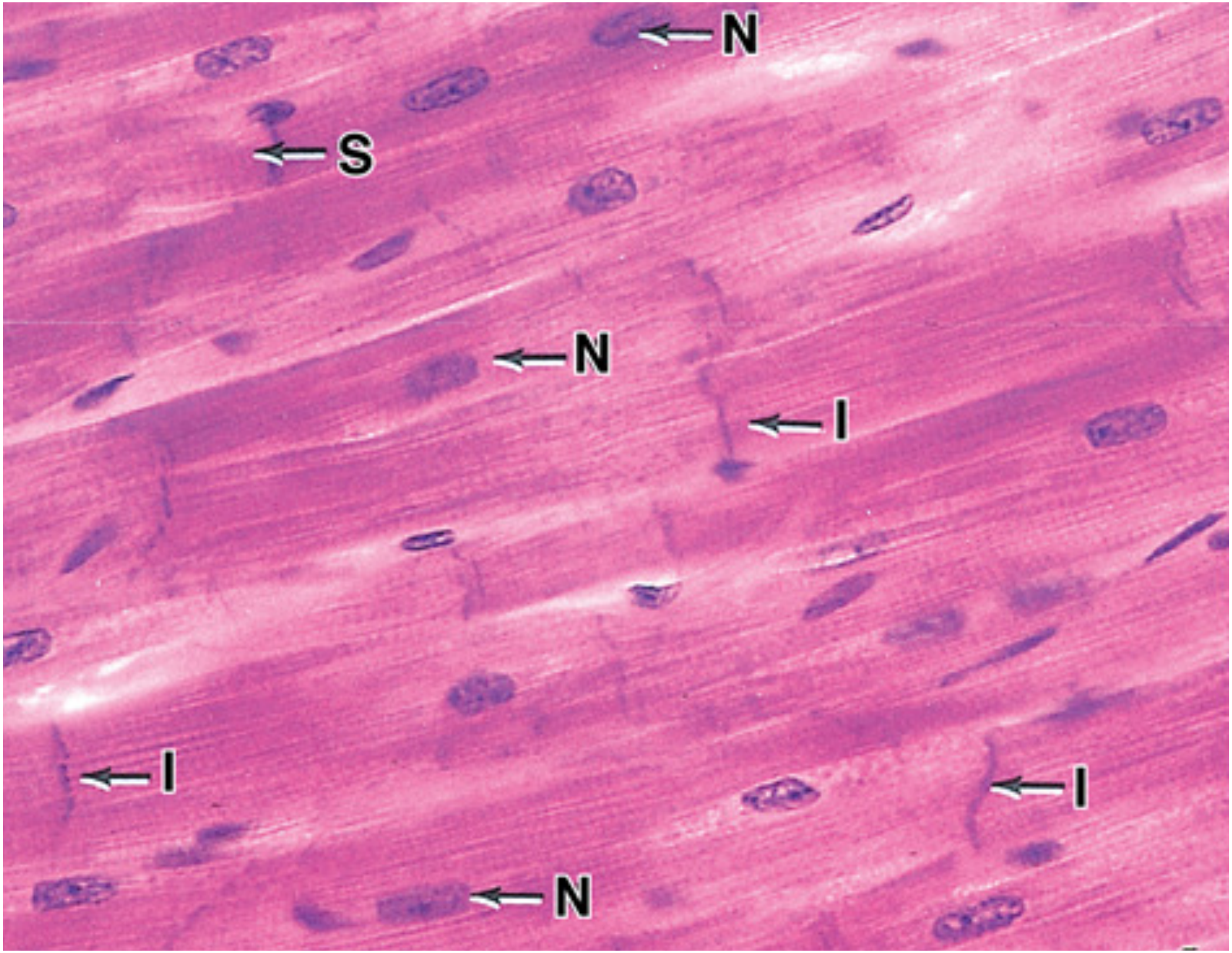


Cardiac muscle

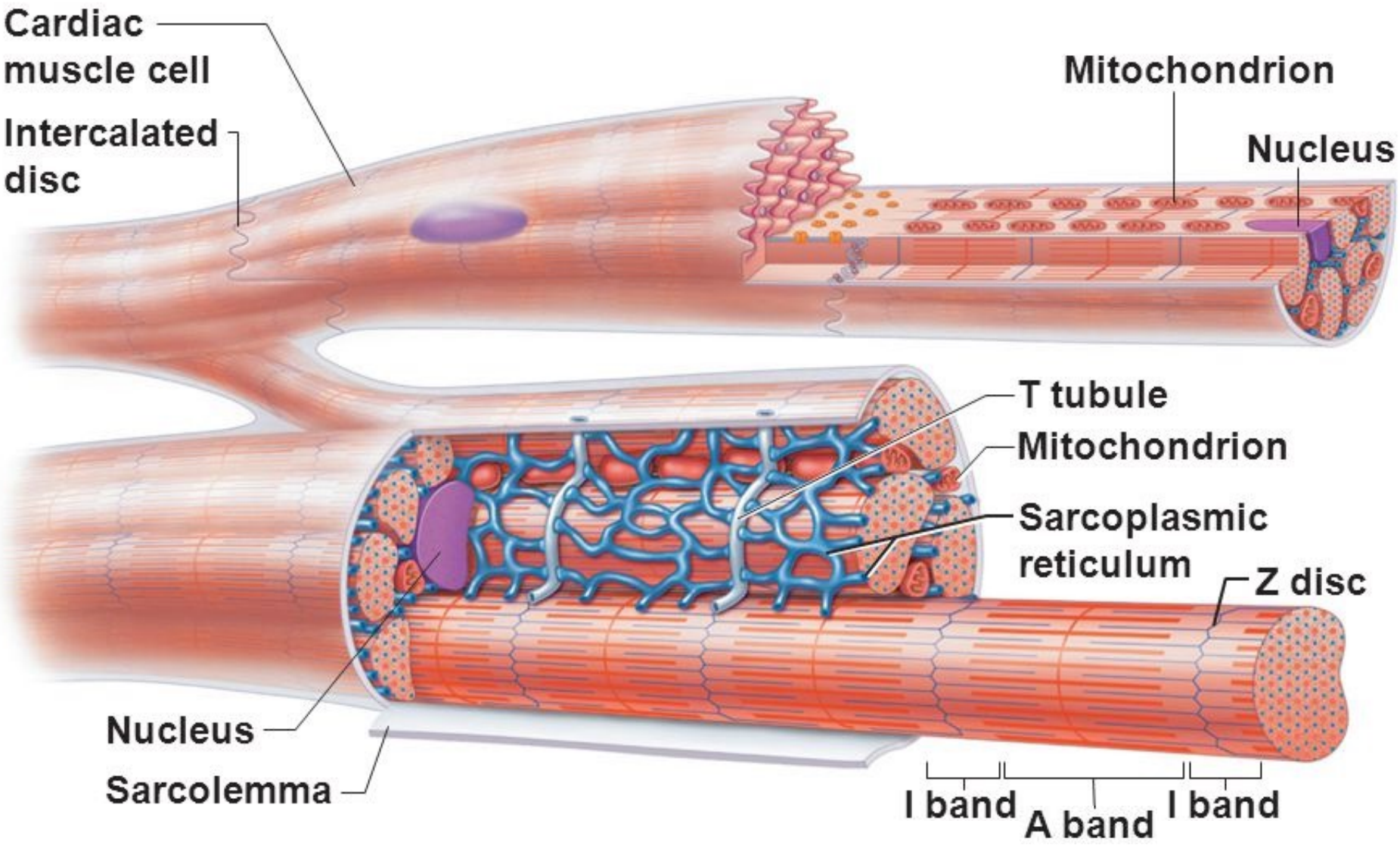


Cardiac muscle cells with nuclei (N), intercalated discs (I), and striations (S)

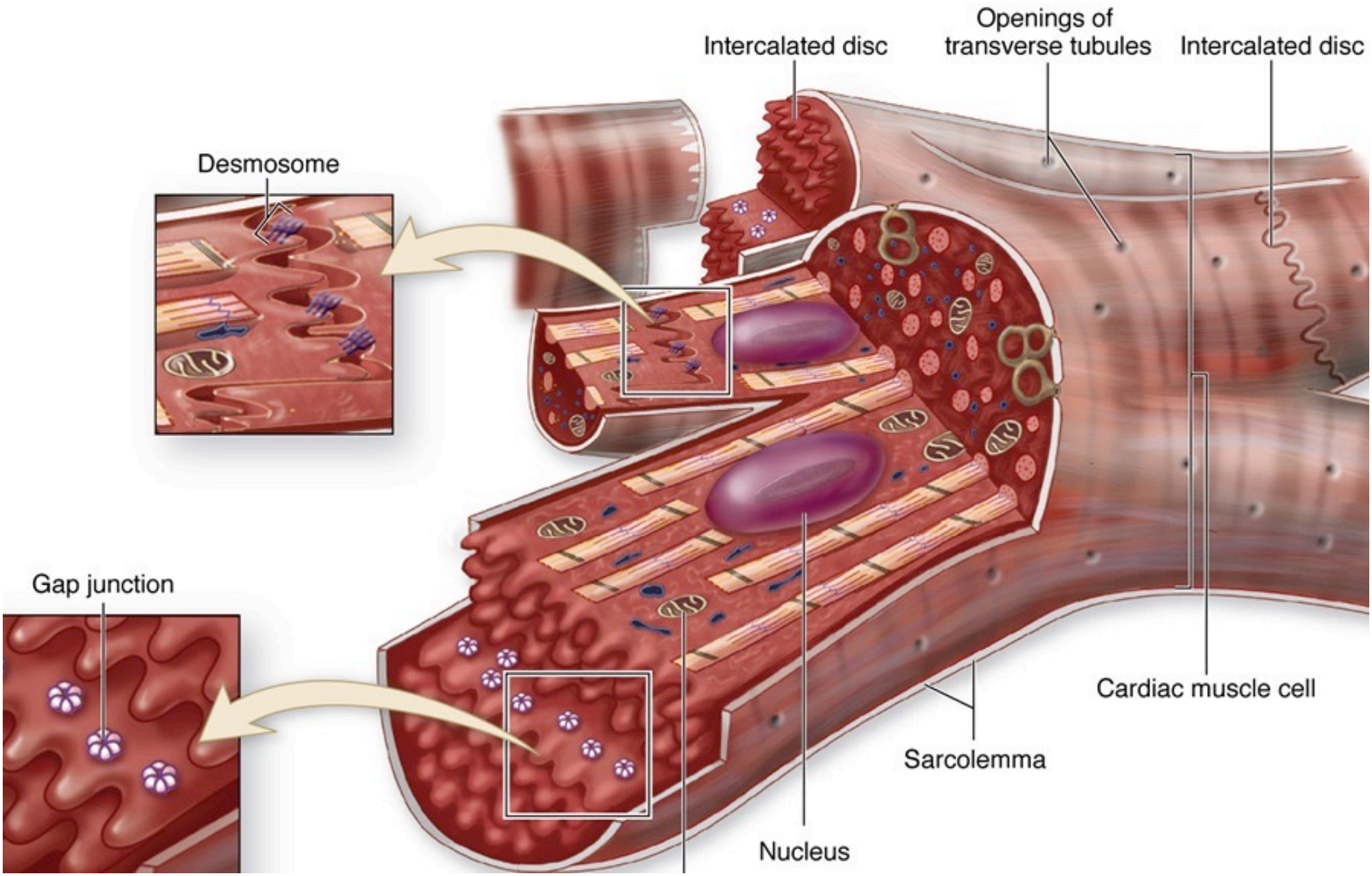
Structure of cardiac muscle cells

- Cardiac muscle cells are branched and striated.
- Intercalated disks glue adjacent cells together.
- Sarcoplasmic reticulum is kind of sparse.

Cardiac Muscle Cells



Close-up of intercalated discs



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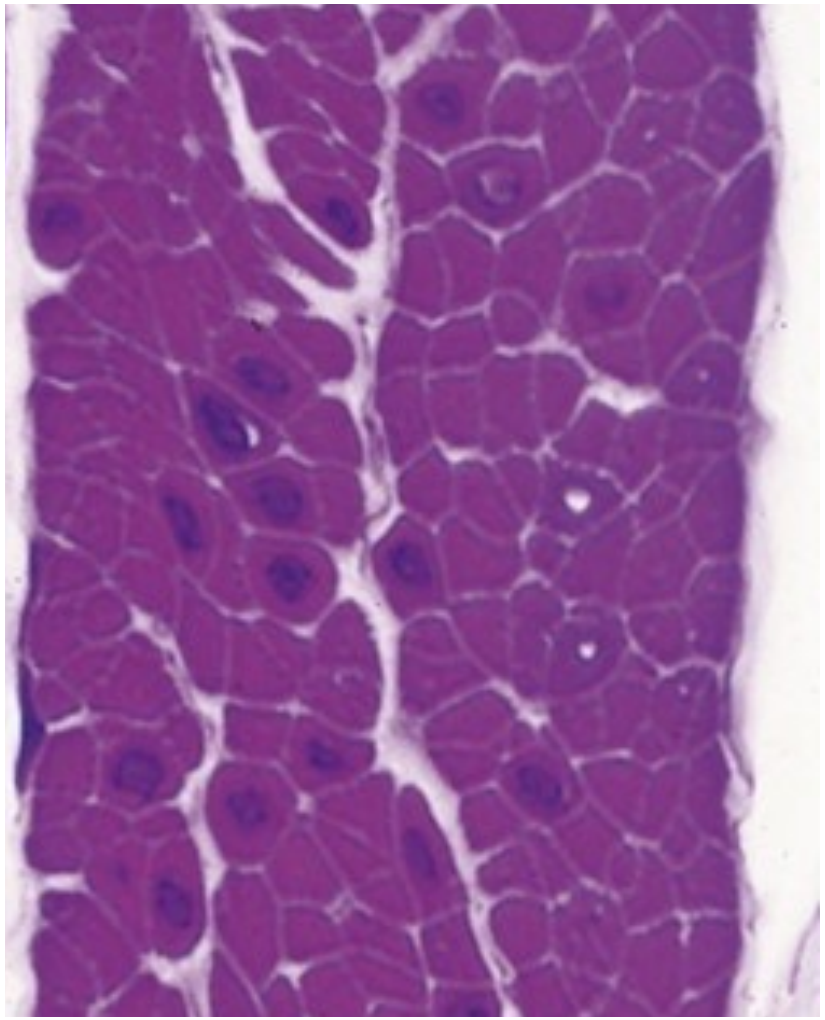
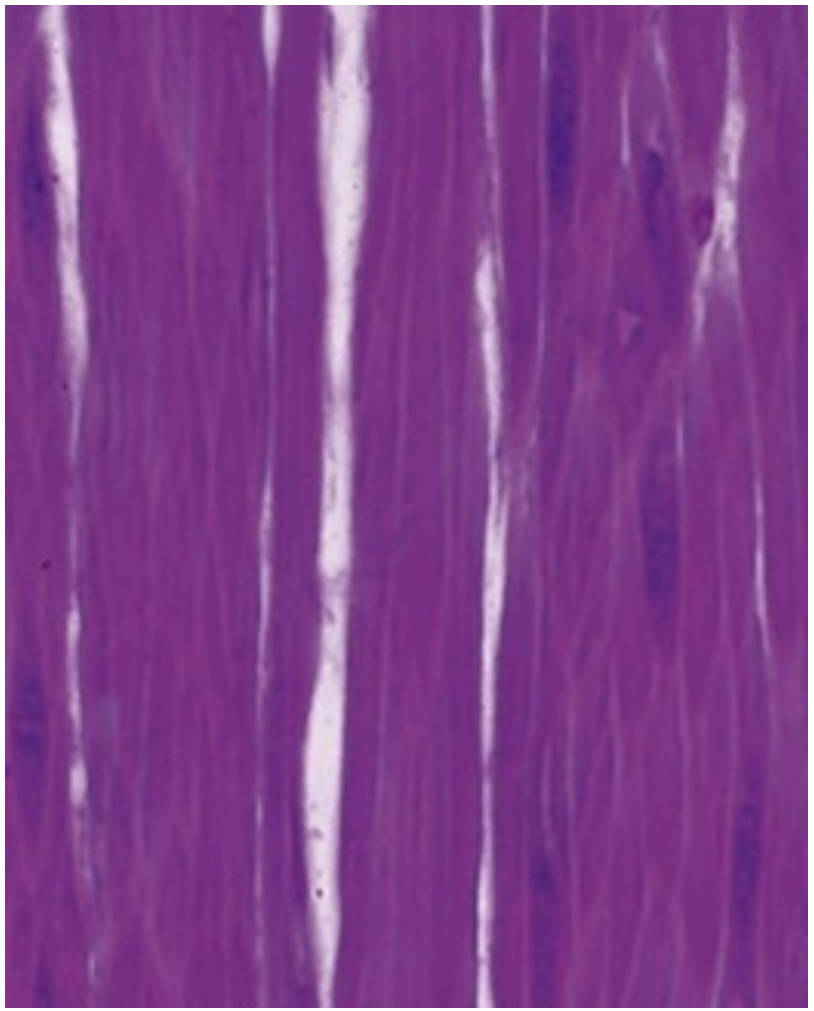


Transverse section



Longitudinal section

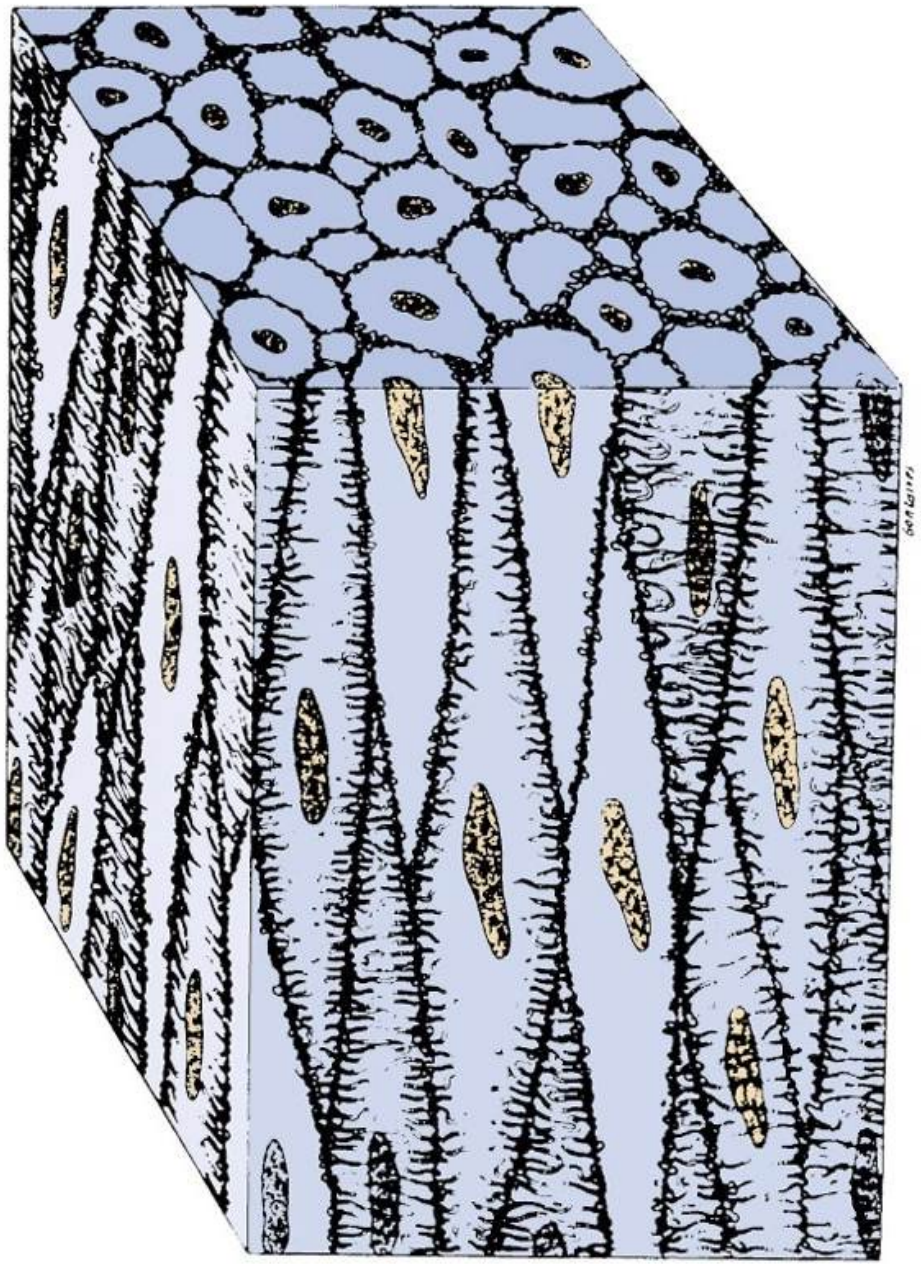
Smooth muscle

Where is smooth muscle in the body?

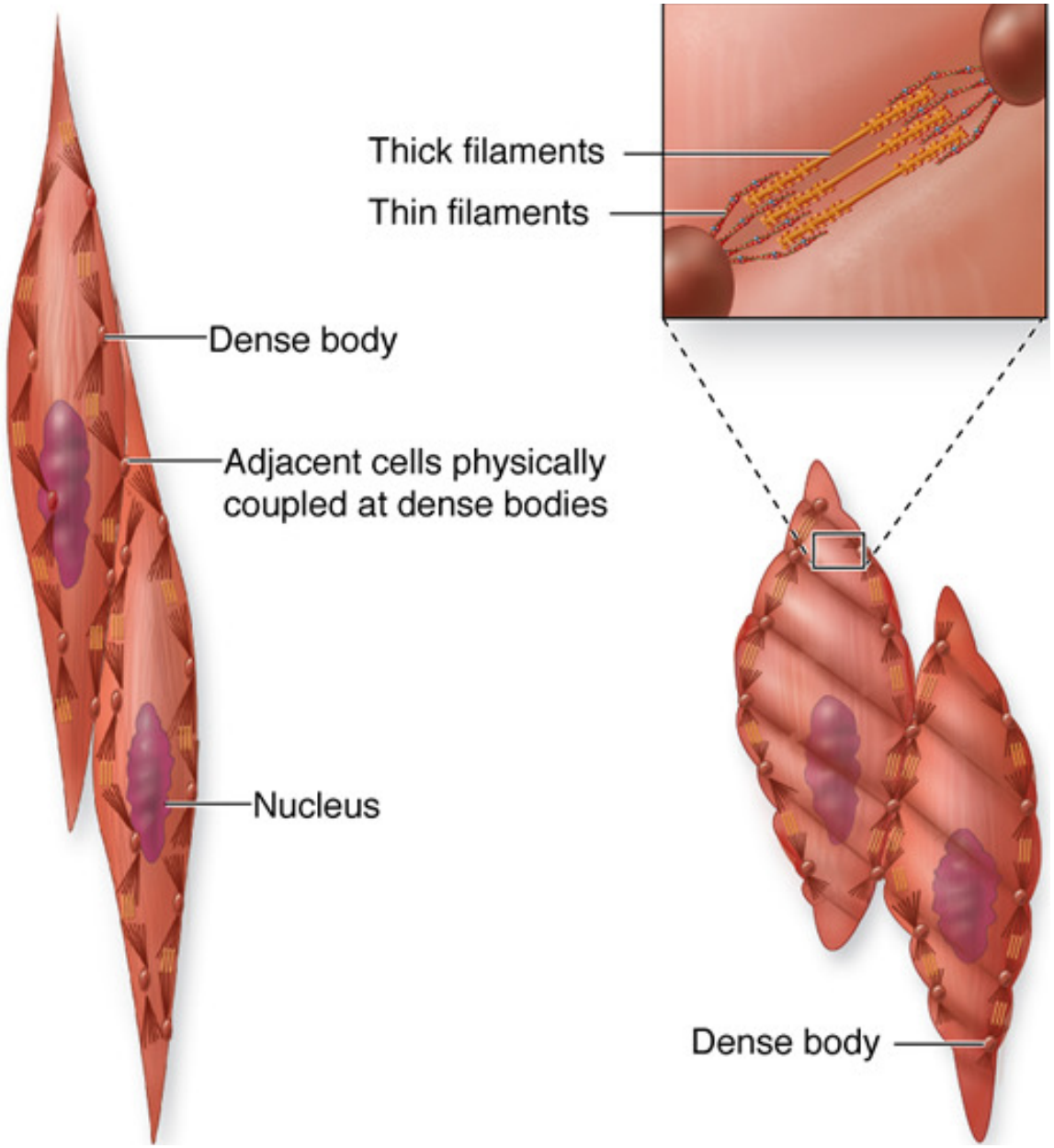
- Most smooth muscle is present in walls of hollow organs (such as intestine and uterus).
- Smooth muscle is also present in walls of larger blood vessels and in the eye.

Smooth muscle morphology

- Smooth muscle cells (fibers) are fusiform (spindle-shaped) with single central nucleus.
- The width of the fiber or cell is only slightly greater than the width of the nucleus.
- They are packed together tightly.



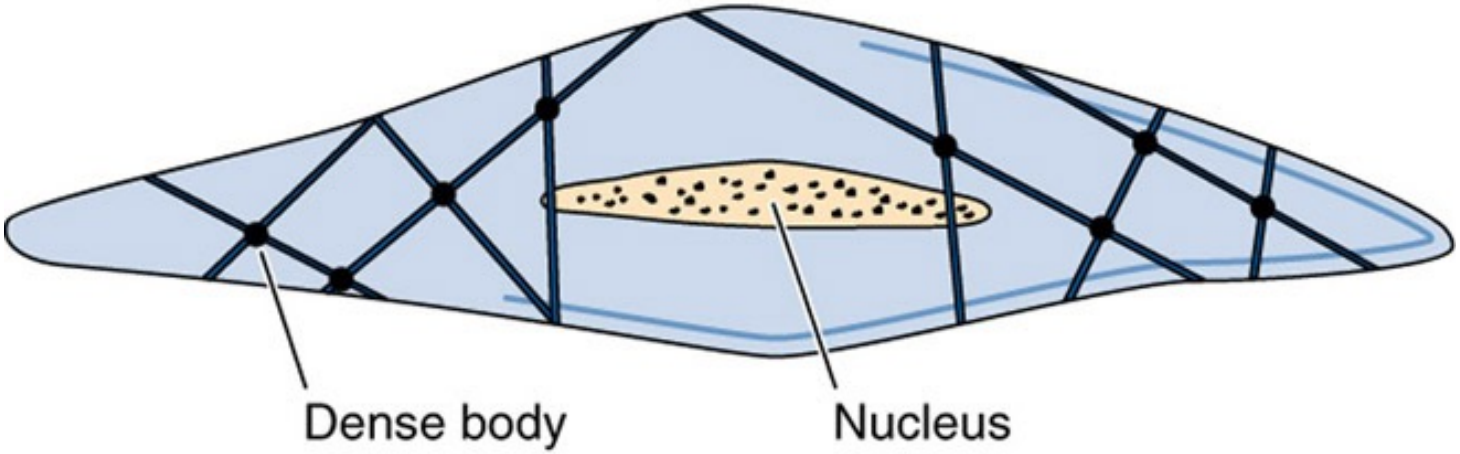
Smooth muscle: thin and thick filaments



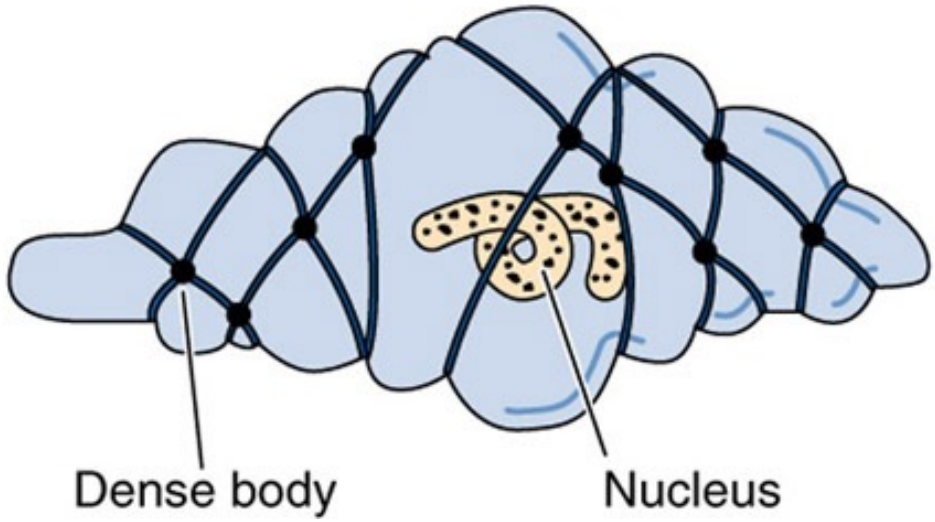
Wait, what are dense bodies?

- Anchor sites for actin-myosin filament bundles.
- Comparable to Z-disks of skeletal and cardiac muscle.
- Located along inside of sarcolemma and scattered throughout cytoplasm.

Contraction of smooth muscle



Relaxed smooth muscle cell



Contracted smooth muscle cell

Regeneration of muscle tissue

Cardiac muscle has no regenerative ability.

Death of cardiac muscle leads to replacement by dense connective tissue scar.

Skeletal muscle can undergo limited regeneration.

Satellite cells are inactive myoblasts that become activated and proliferate and fuse after injury.

Smooth muscle is capable of active regeneration.

Muscle fibers undergo mitosis and replace damaged tissue.

Summary that will make sense later

	Skeletal	**Cardiac**	**Smooth**
Location	Near bones	Heart wall	Walls of hollow organs and blood vessels
Nuclei	Many. Flat. Peripheral.	1-2 per cell. Plump. Central.	One per cell. Central.
Cell diameter	Largest	Intermediate	Smallest
Striations	Yes	Yes	No
Sarcoplasmic reticulum	Yes	Yes	No
T tubules	At junction of A-I bands. Form triads.	At Z lines. Form diads.	None

More summary that will make sense later

	Skeletal	**Cardiac**	**Smooth**
Motor control	Voluntary	Involuntary	Involuntary
Contraction	Quick and strong	Quick, strong, rhythmic	Slow, in waves
Blood supply	Moderate	Extensive	Less abundant
Other features	Prominent fascicles	Intercalated disks, branching cells	Cells overlap; can synthesize collagen and elastin

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