

Lecture Objectives:

- By the end of this lecture the student should be able to:
 - **Identify and describe the histological structure of the three types of muscle cells and list the differences between them**

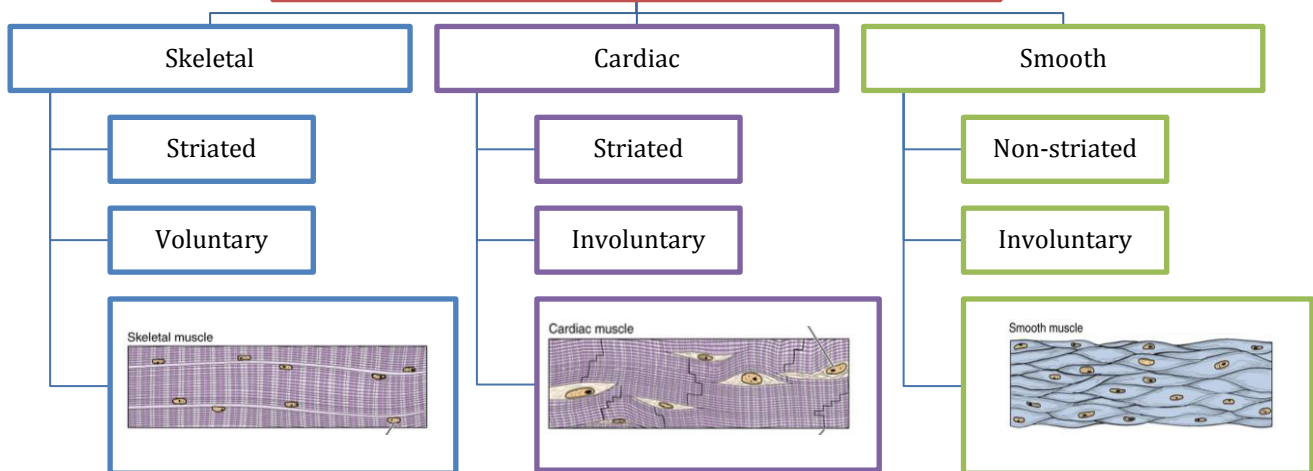
Additional notes are in green

Muscular Tissue

Features of Muscle Tissue:

- It is made of elongated muscle cells (muscle fibers)
 Note: You must differentiate between muscle fibers, which are cells, and connective tissue fibers, which are protein molecules (not cells).
- Rich in blood

Types of Muscles (Muscle Fibers):



Note: Distribution of muscle types in the body:
 Skeletal > Smooth > Cardiac

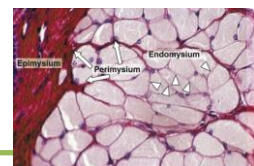
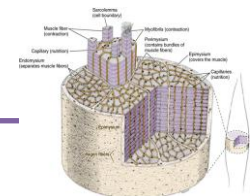
Skeletal Muscle

Skeletal Muscle Connective Tissue Sheaths: (only found in skeletal muscles)

Epimysium Covers the whole muscle. (rich in collagen type 1)
 Mysium=flesh
 Epi=outside (over)

Perimysium Septa separating bundles of parallel skeletal muscle fibers.
 Peri=between (it's thinner than the epimysium)

Endomysium Covers individual muscle fibers (loose connective tissu)



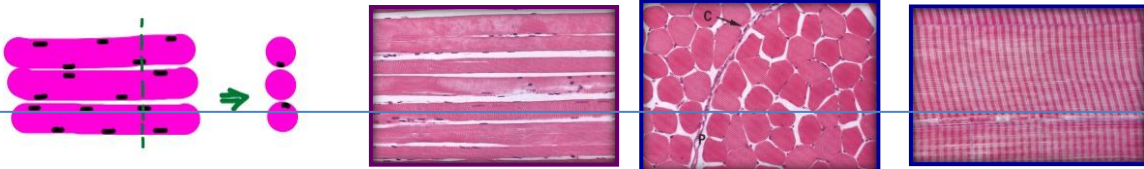
Skeletal Muscle Fibers:

L.M. Picture

- Cylindrical in shape
- Non-branched (**parallel**)
- Covered by **Sarcolemma**: a clear cell membrane (**sarco=flesh**) (**sarcolemma= cell membrane of muscle cell**)
- **Multinucleated**: nuclei are multiple and are peripherally located (close to the sarcolemma)
- Cytoplasm (sarcoplasm) is acidophilic and shows clear **transverse striations**

Note:

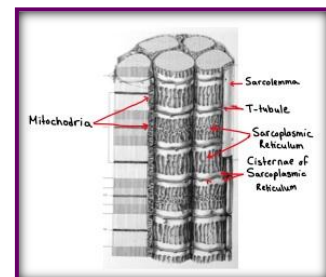
- In the cross section we don't see nuclei in all muscle fibers' periphery because as seen in the dotted line on the picture the cut might be just above or below the nuclei.
- Skeletal muscle rich in mitochondria (for energy) and smooth endoplasmic reticulum (it acts as a calcium pump and source of glycogen)
- Cytoplasm of muscle is acidophilic = pink or red



E.M. Picture

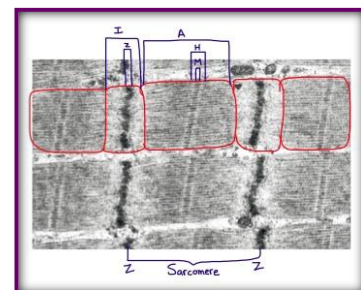
•Sarcoplasm contains:

- Parallel myofibrils (**has a contractile character as they are formed of myofilaments which are actin and myosin which are responsible of contraction**)
- Numerous mitochondria arranged in rows between myofibrils
- Well developed smooth endoplasmic reticulum (sarcoplasmic reticulum) (**Sarcoplasmic cisternae (which are dilated sarcoplasmic tubules) can be seen in the junction between dark and light bands**)



•Myofibrils:

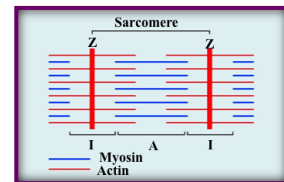
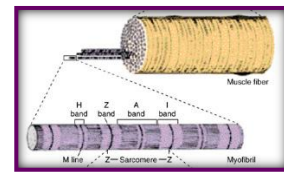
- Contractile threads (**organelles**)
- Arranged longitudinally in the sarcoplasm
- Myofibrils are formed of **myofilaments**:
 - Thick myosin
 - Thin actin
- Has alternate dark and light bands:



	Dark Band (A)	Light Band (I)
Contains:	<ul style="list-style-type: none"> • (H band): Pale area in the middle • (M line): Divides the H band 	<ul style="list-style-type: none"> • (Z line): Dark line in the middle (it is formed from the overlapping of actin)

- **Sarcomere**: the distance between 2 successive Z lines

		myofilaments)
Formed of:	<ul style="list-style-type: none"> Mainly: <u>Myosin</u>myofilaments The terminal ends of actin filaments 	<ul style="list-style-type: none"> Actin myofilaments



The TRIAD Tubular system:

- **Formed of:** 2 terminal cisternae of the sarcomplasmic reticulum and the T-tubule inbetween them
 - T-tubules:
 - They are transverse invaginations of the sarcolemma into the sarcoplasm
 - They form collars around the myofibrils at the level of the A-I junction
 - Terminal Cisternae: They are transverse wide (dilated) cisternae that the sarcoplasm forms on either side of the T-tubule
- Plays an important role during muscle contraction

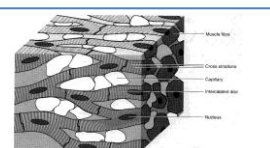
Note: During contraction:

- The z lines are approximated meaning that the actin filaments are the ones that move.
- T light bands disappear because they overlap and become darker.
- The dark bands become darker because of overlapping but do not shorten.

Cardiac Muscle

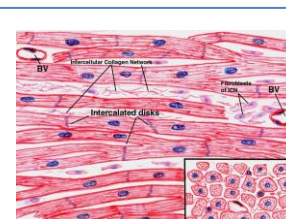
Features of Cardiac Muscle Fibers:

- Found in the myocardium
- Striated and involuntary



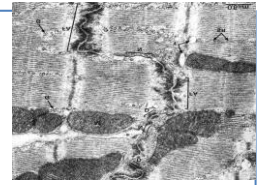
L.M. Picture:

- Cylindrical in shape
- Intermediate in diameter between skeletal and smooth muscle fibers
- Branch and anastomose
- Mononucleated: Nuclein are oval and central
- Sarcoplasm shows non-clear striations (fewer myofibrils)
- Divided into short segments (cells) by the intercalated discs



E.M. Picture:

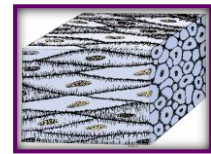
- Few myofibrils
- Numerous mitochondria
- Less abundant Sarcoplasmic reticulum
- Glycogen & myoglobin
- DIADS: T-tubules come in contact with only one cisternae of sarcoplasmic reticulum forming (not triads)
- Intercalated discs: the junctional complexes (desmosomes and gap junctions) that connect the two cell membranes of two successive muscle cells



Smooth Muscle

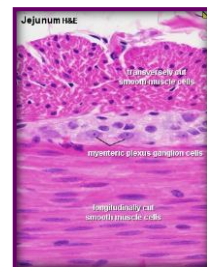
Features of Smooth Muscle Fibers:

- Present in walls of blood vessels viscera (digestive, urinary, genital..)
- Non-striated and involuntary



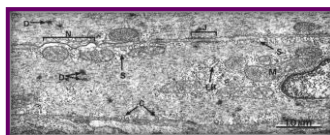
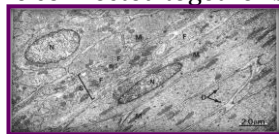
L.M. Picture:

- Fusiform in shape (spindle-shaped)
- Small diameter (smaller than cardiac and skeletal)
- Non-branched
- Thin sarcolemma
- Mononucleated: Nuclei are oval & central in position
- Sarcoplasm is non-striated



E.M. Picture:

- Sarcoplasm contains mitochondria and sarcoplasmic reticulum
- Myosin & actin filaments are irregularly arranged (that's why no striation can be observed)
- Cells are connected together by gap junctions for cell communication



Regeneration of Muscle Fibers:

Skeletal Muscel Cells	Cardiac Muscle Cells	Smooth Muscle Cells
<ul style="list-style-type: none"> •Cannot divide •Limited regeneration by satellite cells (stem cells on the muscle cell's surface) 	<ul style="list-style-type: none"> •No regenerative capacity 	<ul style="list-style-type: none"> •Can divide •Regenerate from pericytes ; active regenerative response

	Skeletal	Cardiac	Smooth
Site	Muscle attached to skeleton	Myocardium of the heart	Viscera, e.g. stomach
Shape	Cylindrical	Cylindrical	Fusiform

Clinical Application:

Cardiac Hypertrophy:

- During cardiac hypertrophy the number of cardiac muscle cells does not increase; instead they become longer and larger in diameter

Comparison between different types of muscle fibers:

Diameter	Largest	Medium-sized	Smallest
Branching	Non-branching	Branched	Non-branched
Striations	Clear	Not clear	Absent
Intercalated discs	Absent	Present	Absent
Nuclei	Numerous and peripheral	One central nucleus	One central nucleus
Action	Voluntary	Involuntary	Involuntary
Regeneration	Limited	No	Yes