EDO UNIVERSITY IYAMHO

Department of Anatomy

ANA 212: Basic Histology and Cytology

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Lectures: Monday, 8am – 9am, LT5. Wednesday 9am - 10am, LT5.

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General overview of lecture: This course aims at giving the students a thorough knowledge of histology of the types of muscles.

Learning outcomes: At the completion of this lecture, students should be able to:

- Identify muscles into 3 groups; Skeletal, Smooth and Cardiac.
- Describe the connective tissue sheaths around the skeletal muscles as- endomysium, perimysium and epimysium.
- Describe the of cardiac muscle.
- Describe the smooth muscle.
- Distinguish between skeletal, smooth and cardiac muscles.

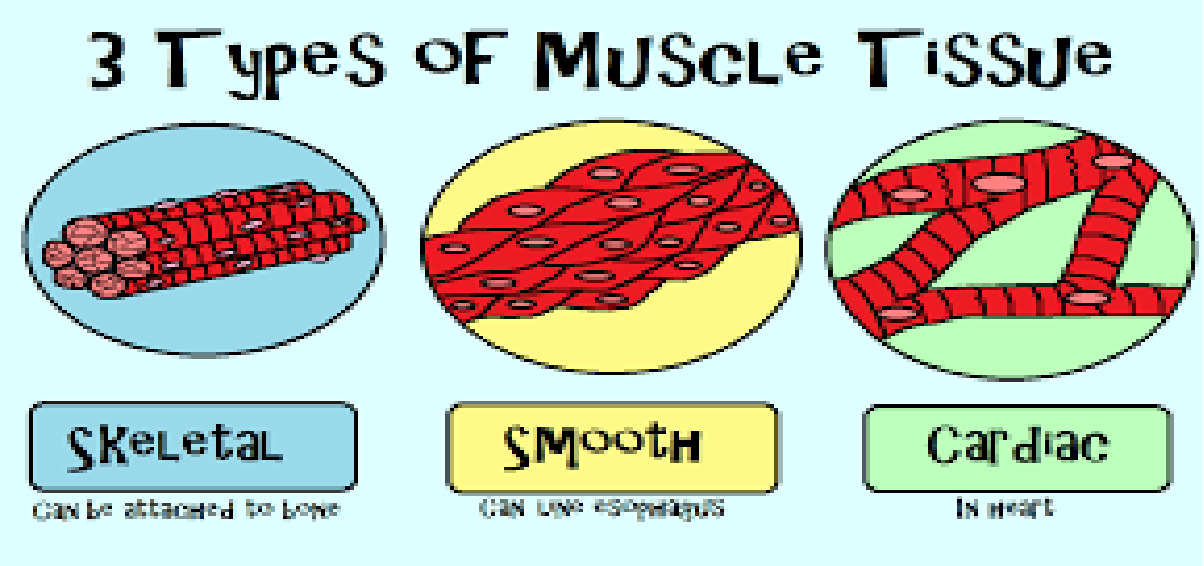
Main lecture

- MUSCLE TISSUES

Muscle tissue is composed of contractile cells

Types

- Skeletal
- Cardiac
- Smooth



General characteristics

- Contractile protein (actin and myosin)
- Cytoplasm is termed sarcoplasm
- Sarcoplasmic reticulum
- Sarcolemma

❖ **Skeletal muscle**

▪ Characteristics

- Striated tubular
- Long multinucleated fibres
- Diameter: 10-100µm
- Position of nucleus: oval and peripherally located
- Attached to the skeleton
- Voluntary action

Origin

Mesenchymal cells in myotome differentiate into myoblast, these fuse to form myotubules, contractile protein synthesis begins and ends at birth

Coverings

- Epimysium: The entire muscle is surrounded by connective tissue
- Perimysium: Individual fasciculi is surrounded by a stronger sheath of connective tissue
- Endomysium: Each muscle is surrounded by delicate connective tissue

Regenerative potential

- Scant regeneration occurs following an injury
- Regeneration occurs from stem cells (satellite cells)

Histoarchitecture

Longitudinal sections:

- Fibres are: Striated, unbranched, elongated
- Cells which possess numerous nuclei are cylindrical

Structure of the Motor end plate

- As motor neuron enters the skeletal muscle, it branches many times. On reaching the muscle fiber, the nerve loses its myelin sheath and breaks up into number of branches. Each branch is a naked axon terminal and forms the neural element of the motor end plate
- The axon is expanded here. At the site of the motor end plate is the soleplate
- The naked axon terminal and the soleplate together form motor end plate

Mechanism of contraction of Skeletal muscle

- This is done by sliding filament hypothesis of muscle contraction
- During contraction there is shortening of individual thick and thin myofilaments; but there is a degree of overlap between the fiilaments

Protein present in Skeletal muscle

- Actin filaments are attached at one end to the Z-band. Actin filament is 8 nm in diameter
- Myosin filaments are confined to the A-band. Each myosin filament is 12 nm in diameter

- Actinin is present in the region of Z discs. It binds the tail ends of actin filaments to this disc.
- Myomesin is present in the region of the M disc. It binds the tail ends of myosin filaments to the disc
- Titin links the head ends of myosin filament to the Z-disc. This is long and elastic protein that can lengthen and shorten as required. It keeps the myosin filament in proper alignment.
- Desmin is present in intermediate filaments of the cytoskeletal. It links myofibrils to each other and also to the cell membrane.

Types of Skeletal muscle Fibers

From morphological, histochemical and functional point, skeletal muscles are two types

- Red muscle fiber
- White muscle fiber

The color of red is due to the presence (in the sarcoplasm) of a pigment called myoglobin. It is present in white fibers, but in small quantity. As compared to white fibers the contraction of red muscle fibers are relatively slow. Red fibers are called slow twitch fibers, or type I fibers, while white fibers is called fast twitch fibers or type II fibers.

Blood Vessel and Lymphatics of the skeletal muscle

- Anastomosis of large blood vessels with capillaries
- The main artery to the muscle enters it at the neurovascular hilus
- Veins leaving the muscle accompany the arteries
- A lymphatic plexus extends into the epimysium and the perimysium

Innervation of Skeletal muscle

- Nerve supplying a muscle enters it (along with the main blood vessels) at an area called neurovascular hilus. The nerve break up into many branches that run through the connective tissue of the perimysium and endomysium to reach each muscle fiber.

- **Smooth muscle**
  - Elongated spindle shaped cells found in the walls of internal organs, the gut wall, blood vessels etc
  - Non-striated
  - Uninucleated fibres
  - Involuntary action

Origin

- Endodermal e.g. gut
- Mesodermal e.g. vessels
- Mesenchymal e.g. iris muscle

Histoarchitecture

- Elongated non-striated cells with tapered ends

Cytoarchitecture

- Fusiform cells with a single centrally placed nucleus

Ultrastructure

- Bundles of myofilaments composing of actin, tropomyosin and myosin crisscross to from a lattice network
- Intermediate filaments are present
- Mitochondria are sparse
- A rudimentary sarcoplasmic reticulum is present
- Endoplasmic reticulum
- Golgi apparatus
- Free ribosomes
- Caveoli are present

Regenerative potential

- Modest regeneration following injury

Variation in arrangement of smooth muscles

- Arrange in form of two layers: Inner circular and outer longitudinal e.g gut

- Arrange in form of two layers: Inner longitudinal and outer circular e.g ureter
- Arrange in form of three layers: Inner and outer longitudinal with circular layer in between e.g urinary bladder, vas deferens
- Smooth muscle occurs in the form of narrow bands e.g skin
- A thick layer of circular muscle may surround a segment of the tube forming sphincter e.g bile duct

Innervation

- Usually by both parasympathetic and sympathetic nerve of the autonomic nervous system

Blood vessel and Lymphatics

- Blood vessels and lymphatic are present in smooth muscle, but the density of blood vessels is much less than in skeletal muscle (in keeping with less activity)

Contraction of Smooth muscle

- This is based on sliding filament theory
- The myosin binds to actin only if its light chain is phosphorylated
- Caveolea present on the surface of smooth muscle cells play a role in contraction
- Actin and myosin form bundles that are attached at both ends to the points on the cell membrane called anchoring points or focal densities
- When the muscle contracts this point are drawn to each other.

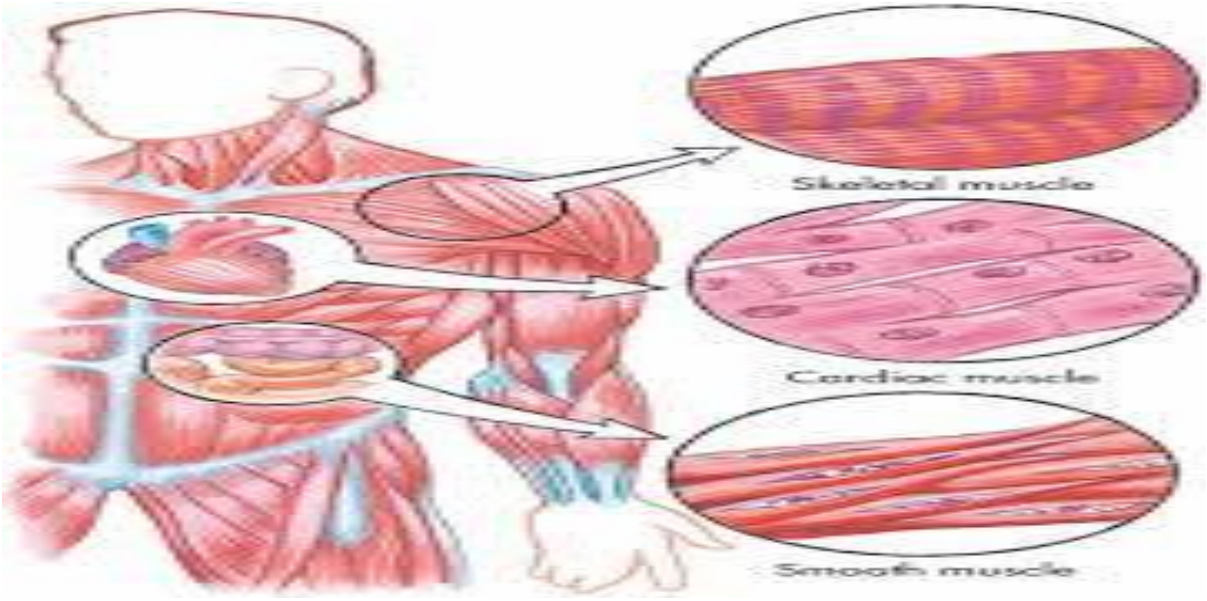
Classification

Unitary or tonic smooth muscle

- Cells regenerate their own low level rhythmic contractile e.g. gut, ureters, uterine tube

Multiunit or phasic smooth muscle

- Autonomic fibres control contraction e.g. Vas deferens, iris of the eye, some large arteries



- **Cardiac muscle**
  - Muscle fibres are in a rows, branching and anastomosing with each other
  - Nuclei are large, oval, lie in the centre
  - Long cylindrical cells found in walls of heart
  - Involuntary action
  - Within the fibers are myofibrils
  - Myofibrils show transverse striations
  - A, I ,Z and H bands can be made out of the striations
  - Has actin and myosin filaments

Origin

- Splanchnic mesoderm

Histoarchitecture

- Mature cardiac cells usually exhibit a cross striated banding pattern and branched ends

Cytoarchitecture

- Cells are cylindrical with centrally placed oval nuclei
- Uninucleated fibers
- Intercalated disc
- Special junctions:

- Fascia adherens
- Macula adherens
- Gap junctions

➢ Ionic continuity between adjacent cells

Ultrastructure

➢ The tubule system and sarcoplasmic reticulum of diads instead of the triads
➢ Mitochondria are abundant
➢ Lipofusin
➢ T-system of centrotubules

Regenerative potential

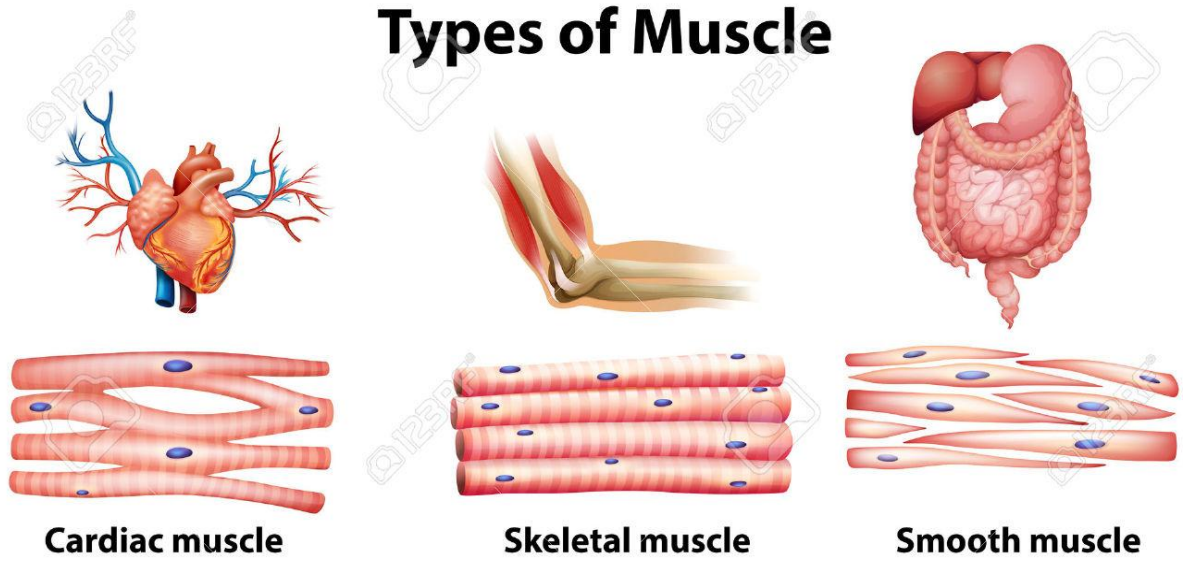
➢ Limited regenerative potential

Innervation

➢ Innervated by the autonomic fibers. Nerve endings terminate near the cardiac myocytes.

Blood supply:

➢ Coronary vessels



- **Summary/Conclusions**

There are three types of muscles namely the skeletal, smooth and cardiac. Generally they have contractile protein (actin and myosin) and sarcoplasm. Histological they have some differences. Regenerative potentials differ and their actions are either voluntary or involuntary.

- **Interactions and Questions**

  - List the types of muscles
  - Distinguish between smooth, cardiac and skeletal muscles
  - State where each muscles can be found

- **Bibliography/Further readings**

Title: Wheater's Functional Histology. A text and color Atlas. 6th Edition
Author: Young Barbara
Publisher: ELSEVIER. CHURCHILL LIVINGSTONE
ISBN: 987-0-7020-4746-6

Title: Inderbir Singh's Human Histology with Color Atlas and Practical Guide. 8th Edition
Authors: Neelam Vasudeva and Sabita Mishra
Publisher: Jaypee Brothers Medical Publishers (P) LTD
ISBN: 978-93-85999-32-1
Year: 2016 :

Title: HANDBOOK OF MICROSCOPIC ANATOMY. 1ST EDITION.
Author: Odukuma Emmanuel Igho
Publisher: Poly-Hybrid Forensic Consults
ISBN: 978-978-952-512-4
Year: 2016