HUMAN ANATOMY & PHYSIOLOGY

COMPLETE UNIT 2 NOTES

- **SKELETAL SYSTEM**
- **JOINTS**

Integumentary System

- The word Integumentary stands for covering.
- It consist of skin and acessary organs i.e., hair, nails & skin glands.
- Dermatology is the branch of science that deals with the study & treatment of integumentary system.

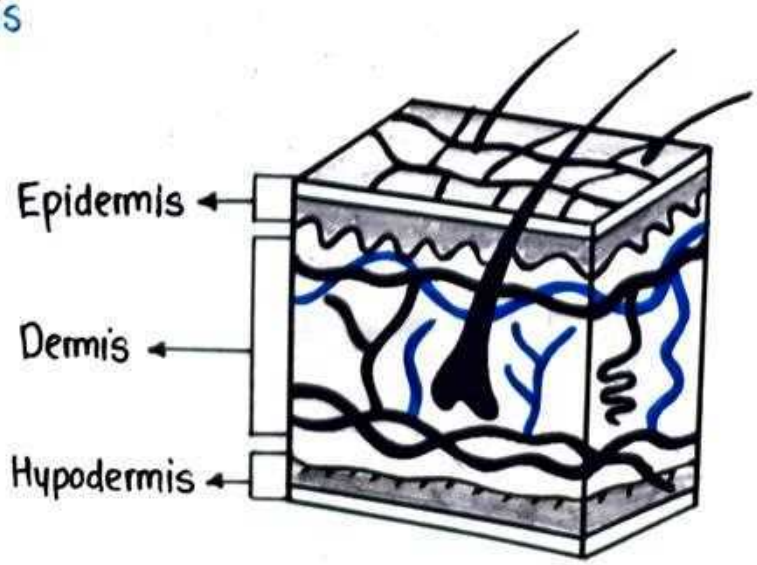
Skin

- The skin is the outer covering of the body.
- In humans, It is the largest organ of integumentary system.
- Skin consist of 12-15% of total body weight.
- The thickness of skin varies from 0.5 mm (on the eyelids) to 4.0 mm (on the sole).

Layers of Skin

Skin is composed of three layers :

① Epidermis
② Dermis
③ Hypodermis



Epidermis

- Epidermis is the outermost layer of the skin
- It is composed of keratanized stratified squamous epithelium.
- The epidermis has no blood vessels.
- They get nourished by diffusion of nutrients from underlying dermis layer
- Epidermis consist of 4 major types of cells.

① keratinocytes
② Melanocytes
③ Langerhan's Cells
④ Markel Cells

Keratinocytes

- About 90% of epidermal cells are keratinocytes which produces 'keratin'
- It is tough, fibrous protein that provides hardness and make skin waterproof.

Melanocytes

- About 8% of epidermal cells are melanocytes which produces 'melanin'
- Melanin is yellowish to brownish pigment that contributes to skin colour and protect from UV light.

Langerhan's Cells

- They arise from red bone marrow and involves in immune responses to protect our skin from microbes.

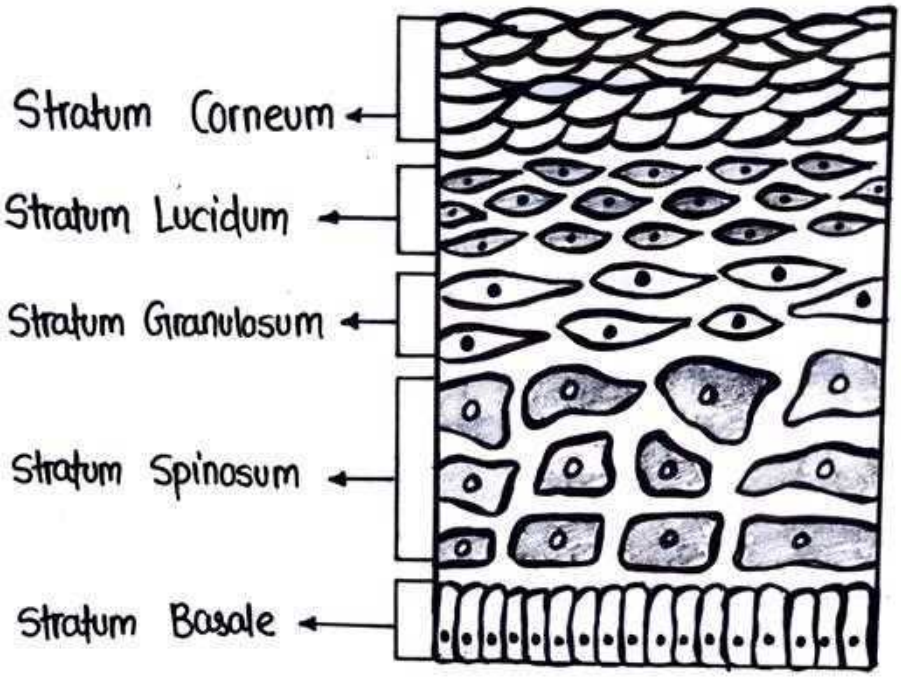
Merkel Cells

- They are specialized cells that receives the sensation of touch, pain etc.

Layers of Epidermis

Epidermis is composed of five layers

① Stratum Corneum
② Stratum Lucidum
③ Stratum Granulosum
④ Stratum Spinosum
⑤ Stratum Basale



[EPIDERMIS]

Stratum Corneum

- It is the uppermost layer of epidermis
- It consist of 25-30 layer of flat, dead, keritinized cells.
- It acts as a barrier against heat, water & many other chemicals

Stratum Lucidum

- It is found only in thick skin
- It contains flat, dead, kerutinized cells.

Stratum Granulosum

- It is present in the middle of the epidermis.
- It consist of 3-5 layers of flat keratinocytes cells.

Stratum Spinosum

- It is present above the stratum basale.
- It consist of 8-10 layer of keratinocytes

Stratum Basale

- It is the deepest layer of epidermis.
- It forms a strong bond between epidermis and dermis.
- It helps in the formation of fingerprints.

Dermis

- It is second deeper layer of the skin
- It is mainly consist of connective tissue
- It contains blood vessels, Glands, hair follicles and nerve endings.
- The dermis can be divided into two sub layer

① Pepillary Layer
② Reticular Layer

Pepillary Layer	Reticular Layer
• It mainly consist of loose connective tissue • It is rich in small blood vessels • It contains nerve endings that receives sensation of touch, pain, hot, cold etc.	• It is mainly consist of dense connective tissue • It contains fat cells, blood vessels, glands & hair follicles • It provides strength to the skin

Hypodermis / Subcutis

- It is not actually the part of the skin and present below the dermis layer.
- It attach the skin to underlying bones and muscles.
- It helps in the storage of fat.

Functions of Skin

Protection

- The skin provides protection to the body in various ways
- keratin protects underlying tissues from bacteria, virus, heat & other chemicals
- The melanin pigment helps ~~skin~~ to protect skin from harmful UV rays.

Absorbtion

- The skin is the route by which substance can inter inside the body.
- It helps in the absorbtion of various drugs that are in the form of lotion, gel and ointments.

Regulation of Body Temperature

- Skin regulates the body temperature by various mechanism.
- Sweat glands release sweat to cool the body when body temperature exceeds above 37°C.
- Blood vessels dilates when body temperature rises and requires cooling
- Blood vessels contracts when body temperature falls and requires heating.

Secretion

- Sweat glands secrete sweat to excrete small amount of salt.
- Sebaceous glands produce sebum which protects body from dehydration.

Sensation

- Skin contains millions of nerve endings that act as sensory receptors.
- Sensory reaction includes sensation of touch, heat, cold, pain pressure etc.

Division of Skeletal System

The adult human skeleton usually consist of 206 bones. These bones can be divided into two divisions

- axial skeleton
- appendicular skeleton

SKELETAL SYSTEM

- The skeletal system is the structural framework that supports the whole body and protect internal organs
- An adult human skeleton consist of 206 bones.
- Bone tissues make up about 18% of total body weight.
- Osteology is the branch that deals with the structure and function of skeletal system.
- A skeletal system is mainly composed of :

① Bones
② Cartilage
③ Joints
④ Ligaments

Functions of Skeletal System

Support : Hard structural framework that supports body.

Protection : Protect internal organs such as brain, heart, spinal cord.

Movement : Provide movement as they are attached with skeletal muscles.

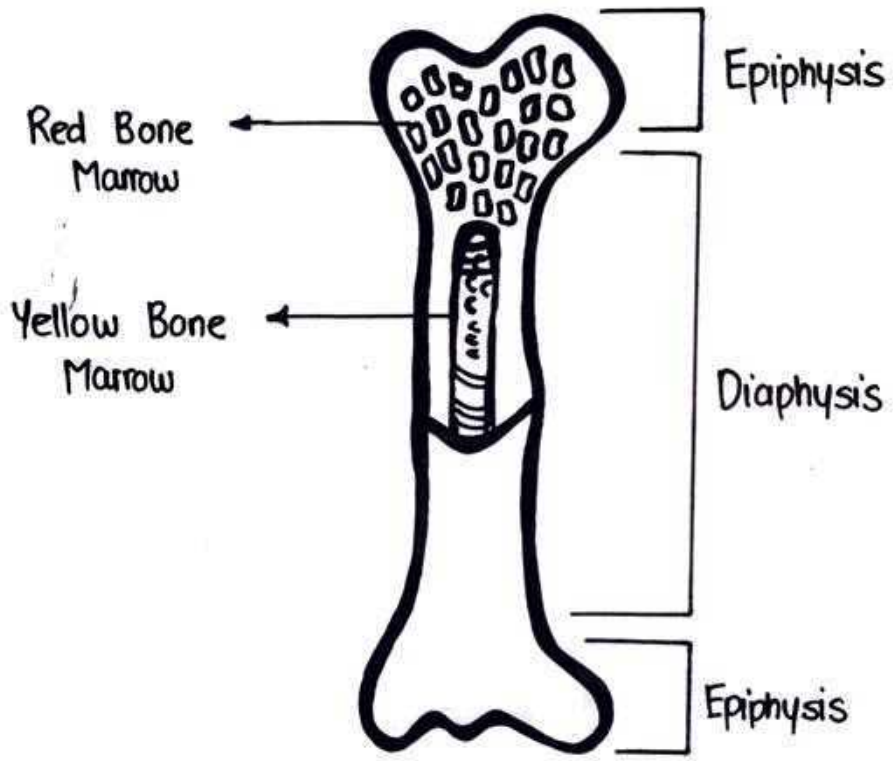
Storage : Stores minerals such as calcium, phosphate and fat storage.

Blood Production : Blood cells are produced in the red bone marrow.

Structure of Bone

- Bone is the hardest connective tissue that is capable of growth & perform various functions.
- It basically consist of two parts :

① Diaphysis
② Epiphysis



Diaphysis

- It is the long, cylindrical and main portion of the body.
- It mainly consist of red bone marrow and yellow bone marrow.
- Red bone marrow produced blood cells.
- Yellow bone marrow stores fat and in emergency it converts into red bone marrow.

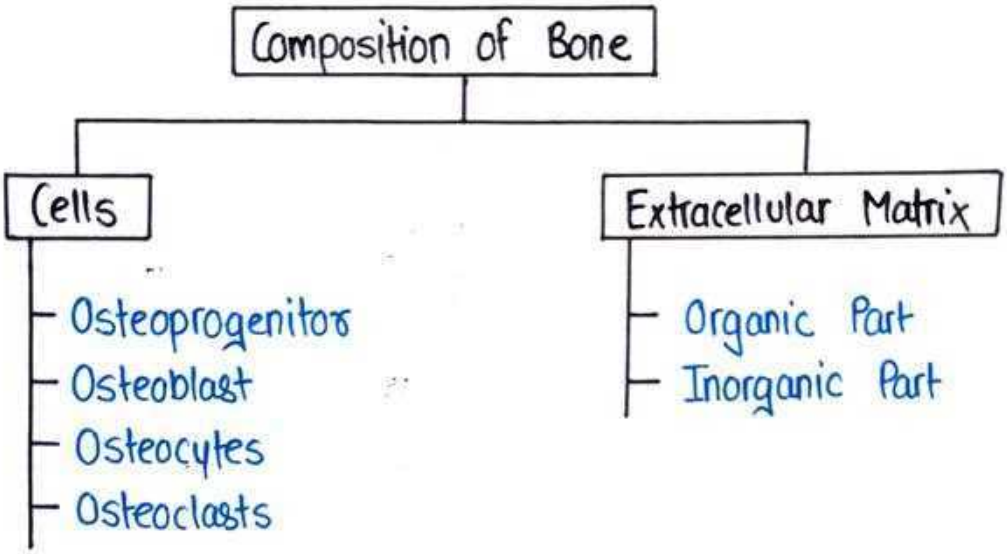
Epiphysis

- These are the end parts of the bones and consist of spongy bones.

Composition of Bone

A bone is mainly composed of two parts :

- Cells
- Extracellular Matrix



Cells :

Osteoprogenitor

- Osteoprogenitor cells , also known as osteogenic cells are stem cells in the bone that plays vital role in bone repair and growth.
- These cells undergo cell divisions and develops into **osteoblasts**.

Osteoblasts

- These are bone building cells
- They produce organic part of the extracellular matrix in the bones.

Osteocytes

- These are main cells in bone tissue and maintain its daily metabolism such as exchange of nutrients with blood.

Osteoclasts

- These are large multinucleated cells.
- These cells are responsible for resorption of bones.

Extracellular Matrix :

Organic Part

The organic part of extracellular matrix is mainly consist of collagen (Type -I) and Non- collagen including glycoprotein, lipid etc.

Inorganic Part

The inorganic part of extracellular matrix is mainly consist of calcium, phosphate, magnesium and other trace elements.

Types of Bones

There are mainly five types of bones :

① Long bones
② Short bones
③ Flat bones
④ Irregular bones
⑤ Sesamoid bones

Long Bones

- Long bones mainly supports the weight of the body and allow movement.
- Example : Femur

Short Bones

- These are cube shaped bones having equal length and wide.
- They mainly provide stability and movement.
- Example : Carpals and Tarsals

Flat Bones

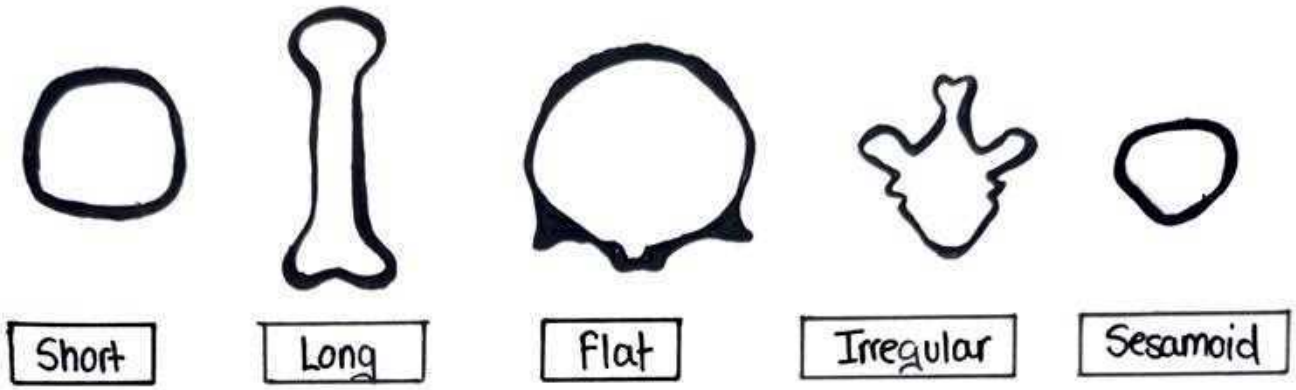
- These are thin and flat shaped bones.
- They mainly protect the internal organs.
- Example : Skull Bones

Irregular Bones

- These bones are vary in shape and size and having complex structure.
- They mainly provide protection and support.
- Example : Vertebarae.

Sesamoid Bones

- These are small rounded bones present in tendons
- example : Patella.



AXIAL SKELETON

The axial consist of

- Skull
- Vertebral Column
- Thoracic Cage / Rib Cage
- Sternum
- Auditory ossicles / Ear bones
- Hyoid Bones

SKULL

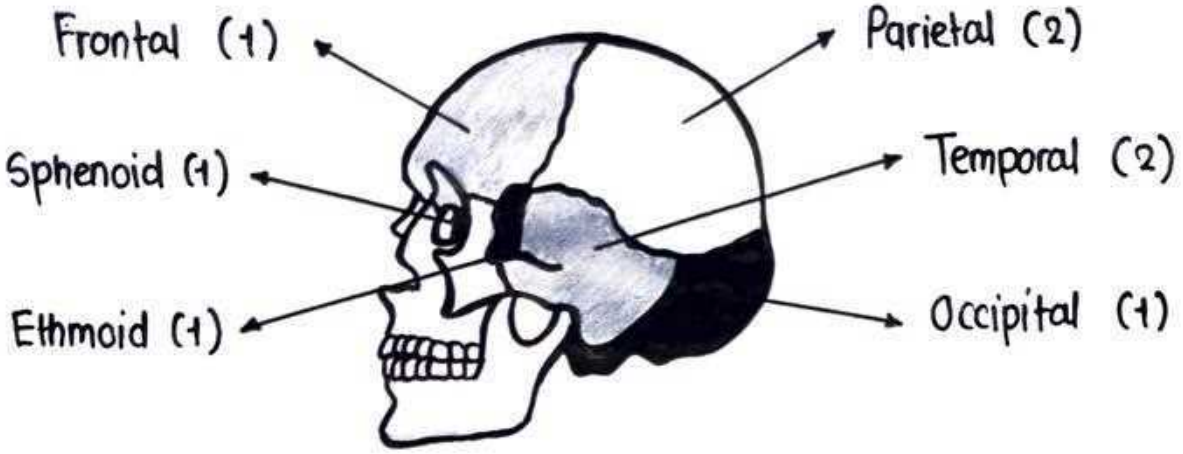
- The skull is situated on the upper end of vertebral column which supports and protects brain and structure of face.
- It is divided into two parts

① The cranium
② The Face

The Cranium

It is formed by flat and irregular bones that provide protection to brain
The cranium consist of following 8 bones :

① Frontal Bone	It forms the forehead and parts of eye socket
② Parietal Bones	It forms the side and roof of the skull
② Temporal Bones	It forms immovable joints of the skull
① Occipital Bone	It forms back of head and base of skull
① Sphenoid Bone	It occupies middle portion of base of skull
① Ethmoid Bone	It forms nasal septum and lateral wall of nose

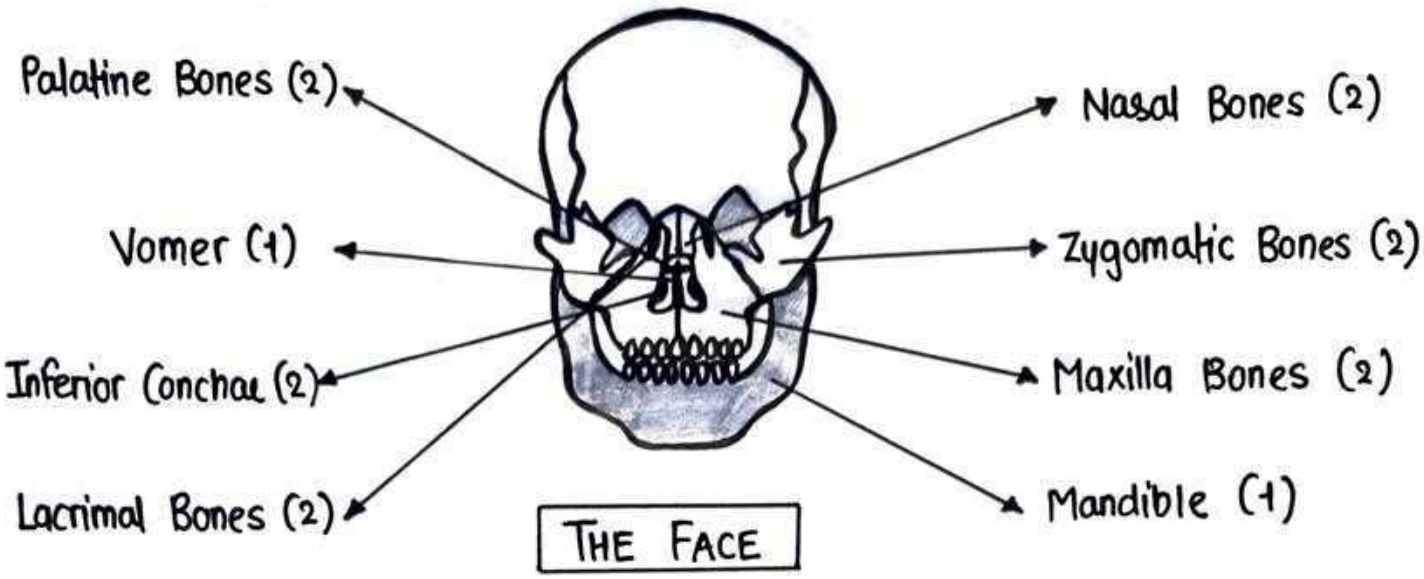


THE CRANIUM

The Face

- Facial bones form framework of face.
- Forms cavities for sense organs (eye, mouth, nose).
- Provide attachment for facial muscles.
- Hold the teeth
- Protect the eyes
- It consist of following 134 bones :

② Zygomatic Bones	It forms the prominences of the cheeks.
② Maxilla Bones	It forms the upper Jaw and carries upper teeth
② Nasal Bones	It forms lateral and superior surfaces of the nose
② Lacrimal Bones	It supports the structures of lacrimal apparatus
② Inferior Conchae	It forms the part of nasal cavity
② Palatine Bones	It forms floor of the nasal cavity
① Mandible Bone	It is only movable bone of skull carries lower teeth
① Vomer Bone	It is thin flat bone that divides the nasal cavity

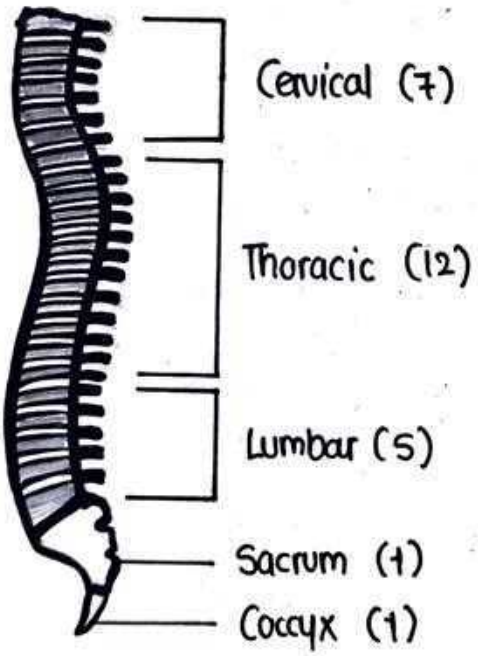

Palatine Bones (2)
Vomer (1)
Inferior Conchae (2)
Lacrimal Bones (2)
Nasal Bones (2)
Zygomatic Bones (2)
Maxilla Bones (2)
Mandible (1)

THE FACE

VERTEBRAL COLUMN

- Vertebral column is also known as backbone
- It is made up of series of bones called as Vertebrae.
- The vertebral consist of spinal cord.
- The adult vertebral column consist of 26 vertebrae.

① 7 Cervical Vertebrae
② 12 thoracic Vertebrae
③ 5 Lumbar Vertebrae
④ 1 Sacrum
⑤ 1 Coccyx



Cervical Vertebrae

- It consist of first seven vertebrae
- They are smaller and present in the neck region
- First vertebrae is called 'Atlas'
- Second vertebrae is called 'Axis'
- Joint between atlas and axis is called as 'Atlanto- axial joint'

Thoracic Vertebrae

- They are larger and stronger than cervical vertebrae.
- They consist of 12 thoracic vertebrae from which ribs is connected

Lumbar Vertebrae

- Lumbar Vertebaraе are the strongest and largest.
- It consist of 5 vertebrae.

Sacrum

- It is present in the peluic region.
- Female sacrum is wider than male sacrum.

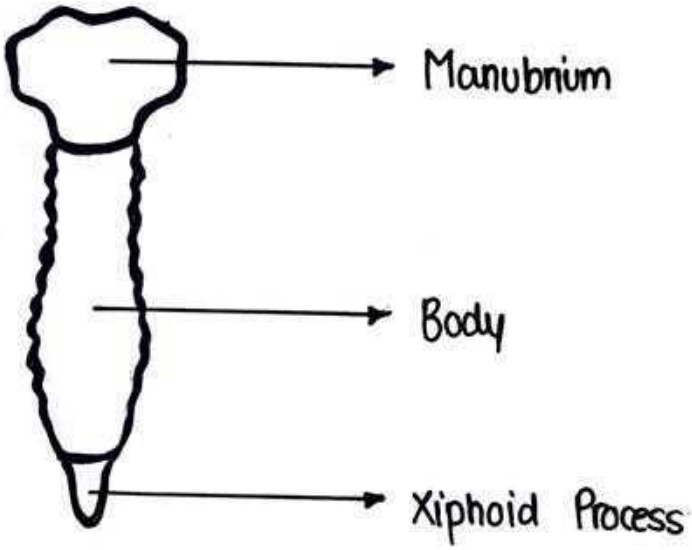
Coccyx

- It is also known as tailbone
- It is the final segment of the vertebral column.

STERNUM

- It is also known as breast bone
- It is a flat bone present under the skin in the middle of front of the chest.
- It gives attachment to the ribs
- It consist of three parts

① Manubrium (Uppermost Section)
② Body (Middle Part)
③ Xiphoid Process (End Part)

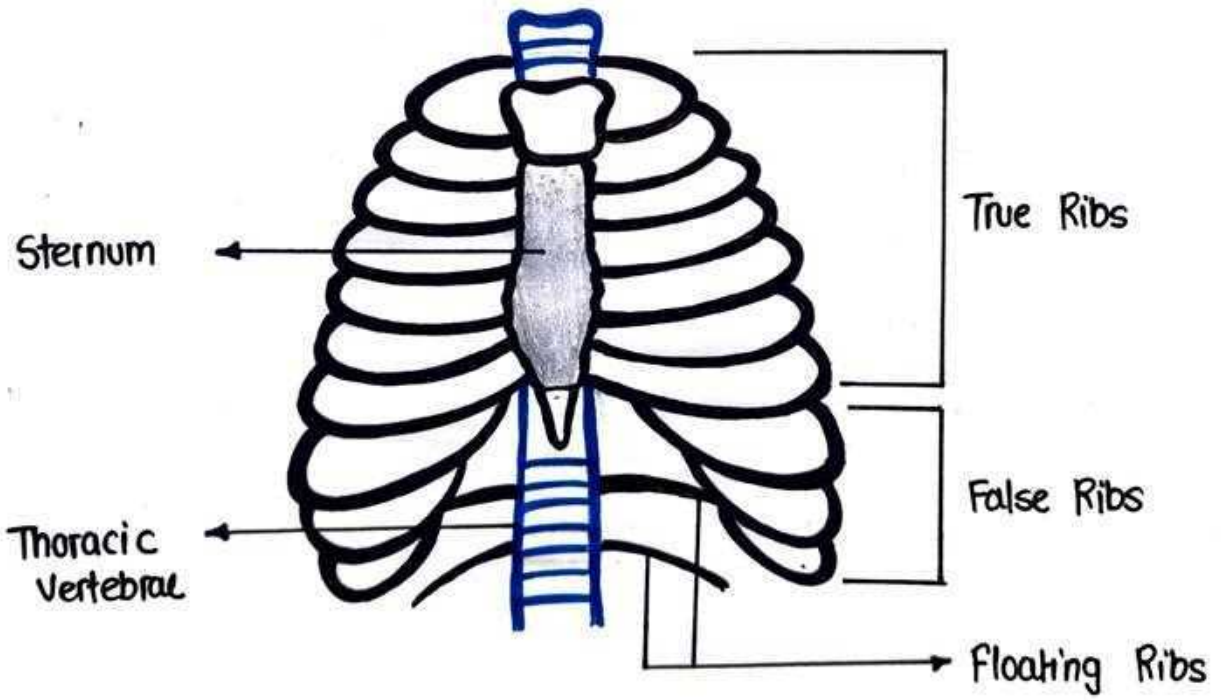


STERNUM

THORACIC CAGE

- It is also known as Rib Cage
- Thoracic cage includes (1 Sternum + 12 Pair of Ribs + 12 Thoracic Vertebrae)
- Ribs are the main bone of thoracic cage.
- Rib is a thin flat bone
- There are 12 pair of ribs
- From backside it is attached with vertebral column and from front it is joint with sternum
- There are three types of ribs present in thoracic cage.

① True Ribs
② False Ribs
③ Floating Ribs



THORACIC CAGE

True Ribs

- First seven pair of ribs are called true ribs.
- From front they are attached with sternum and from back they are attached with thoracic vertebrae.

False Ribs

- 8^{th}, 9^{th} and 10^{th} pair of ribs are called False ribs.
- They are joint with th 7^{th} pair of ribs

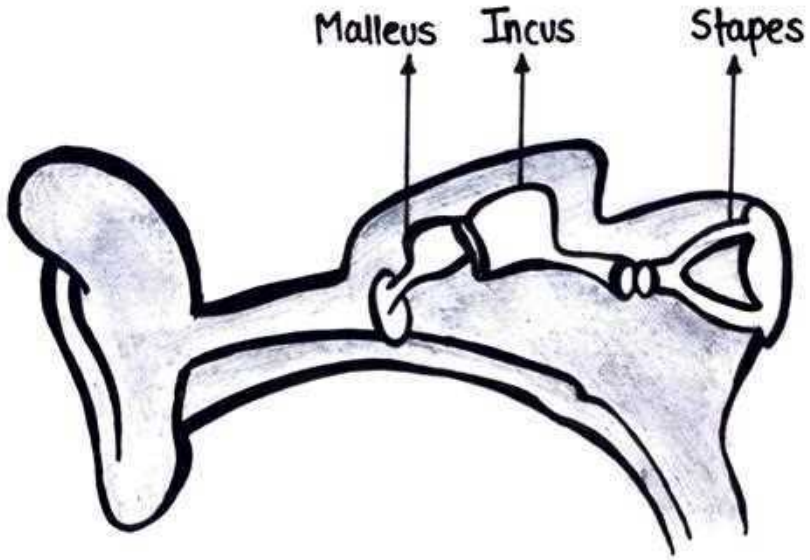
Floating Ribs

- 11^{th} and 12^{th} pair of ribs are called Floating ribs.
- One end of the rib is attached with thoracic vertebrae and other end is free.

AUDITORY OSSICLES

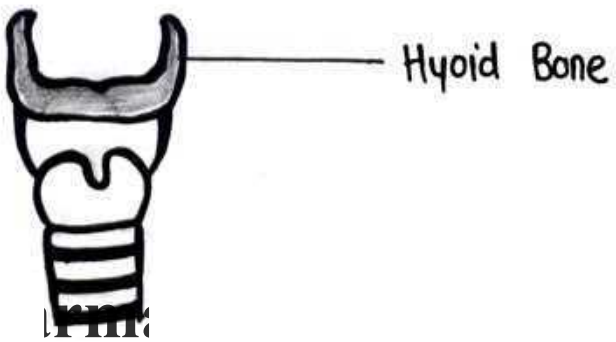
- These are three smallest bone of the human body found in the ears.
- They allow the transmission of sound waves.
- These are as follows :

① Malleus
② Incus
③ Stapes



HYOID BONE

- The Hyoid bone is a U-shaped bone located in front of the neck just below the lower jaw.
- It carried the weight of the tongue and playing a vital role in speech and swallowing.



APPENDICULAR SKELETON

Appendicular skeleton consist of

- Pectoral Girdle
- Peluic Girdle
- Limb Bones

PECTORAL GIRDLE

- The human body consist of two pectoral girdle that attach the bones of the upper limbs to the axial skeleton.
- The pectoral Girdle consist of

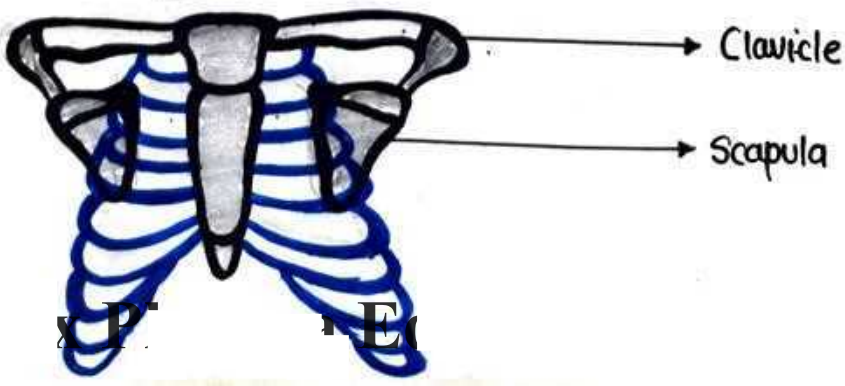
① Clavicle
② Scapula

Clavicle

- It is 'S' shaped long bone that has a double curve.
- Its one end is attached with scapula and other end is attached with sternum.

Scapula

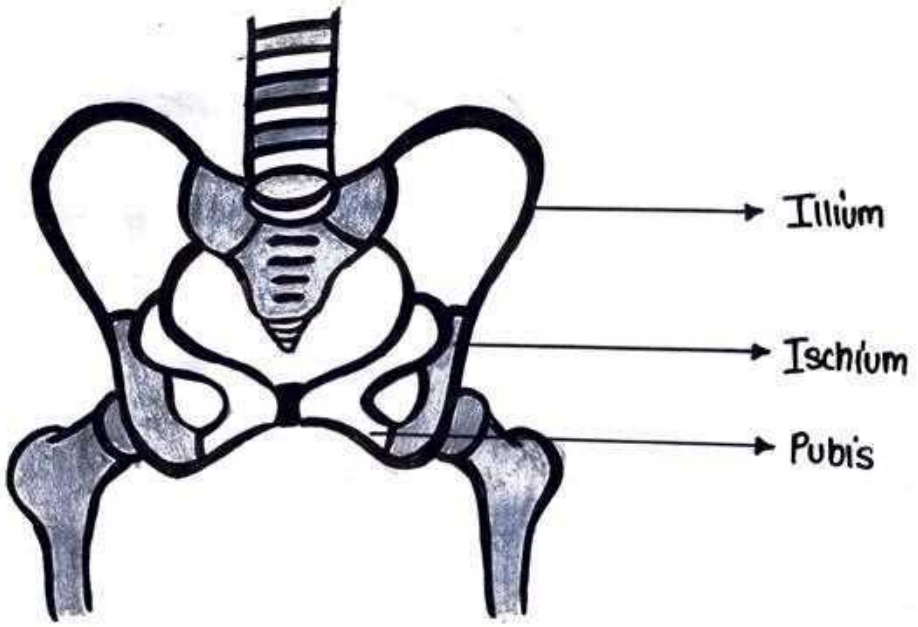
Scapula is a flat triangular bone that connects the clavicle to the humerus. It is also known as **shoulder blade**.



PELVIC GIRDLE

- It consist of two hip bones called as 'Pelvic Bones'
- It provides a strong support for the vertebral column and lower abdominal organs.
- A hip is a fusion of three bones.

① Ilium
② Ischium
③ Pubis



PELVIC GIRDLE

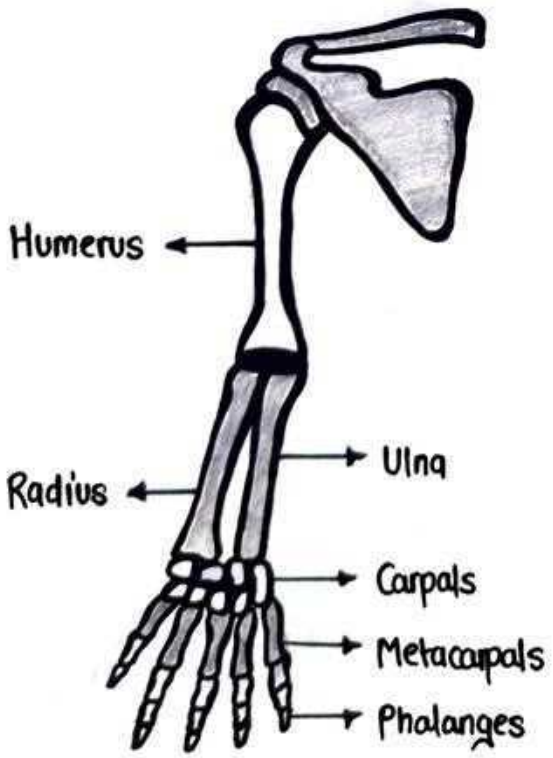
LIMB BONES

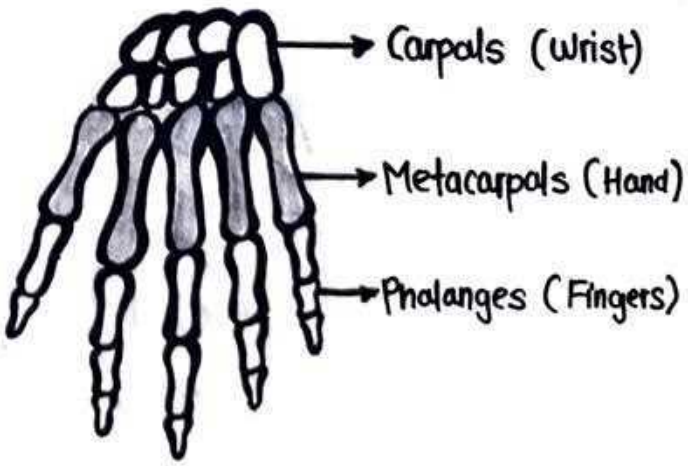
Limb bones are divided into two parts

- Upper Limbs
- Lower Limbs

UPPER LIMBS

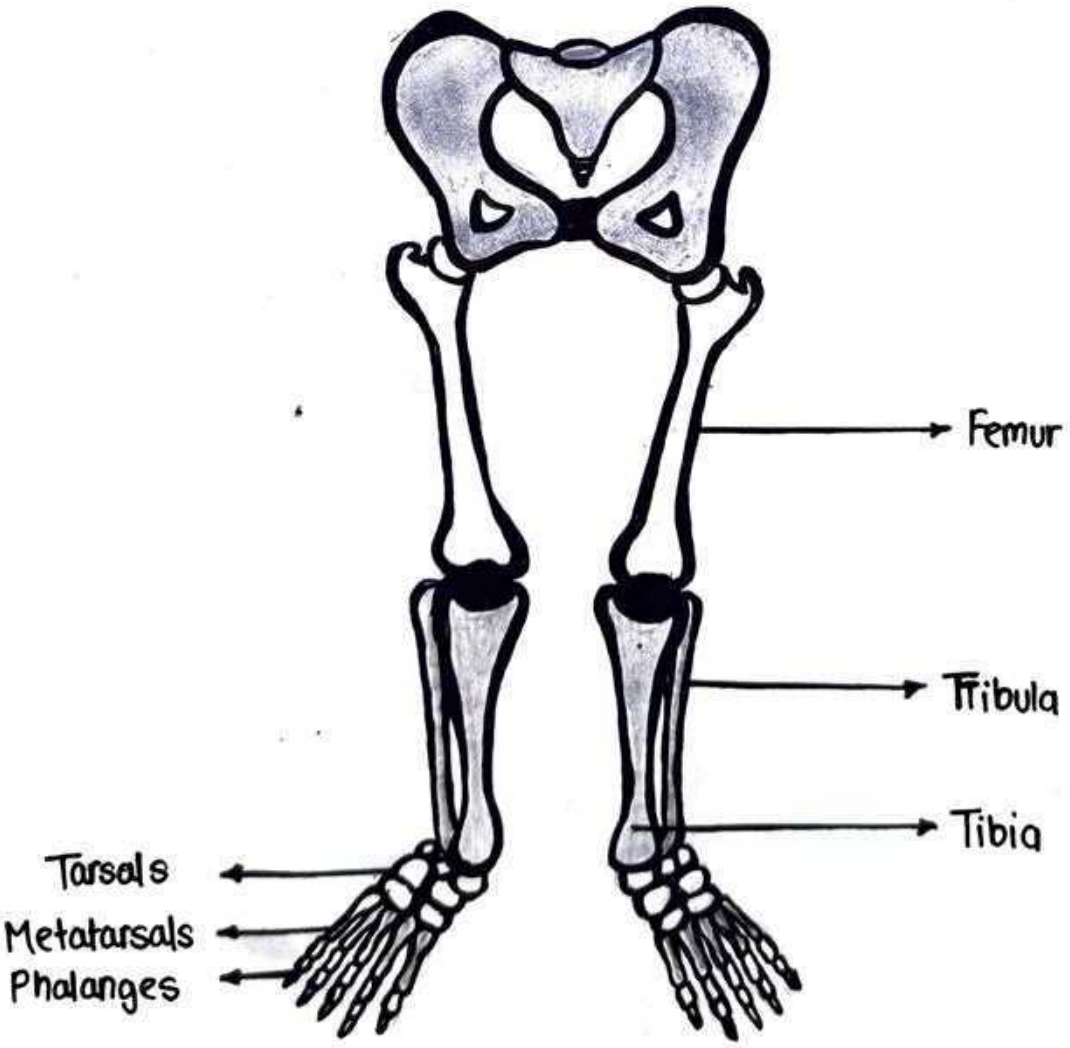
- They are present in a pair.
- Each upper limb has 30 bones
- Single long bone of upper arm is called 'Humerus'
- The two bones present at the lower arm are 'Ulna' & 'Radius' Radius is shorter than Ulna
- Carpals are wrist bones consist of 8 small bones.
- Metacarpals are hand bones present in the intermediate region consist of 5 bones.
- Phalanges are finger bones consist of 14 bones.





LOWER LIMB

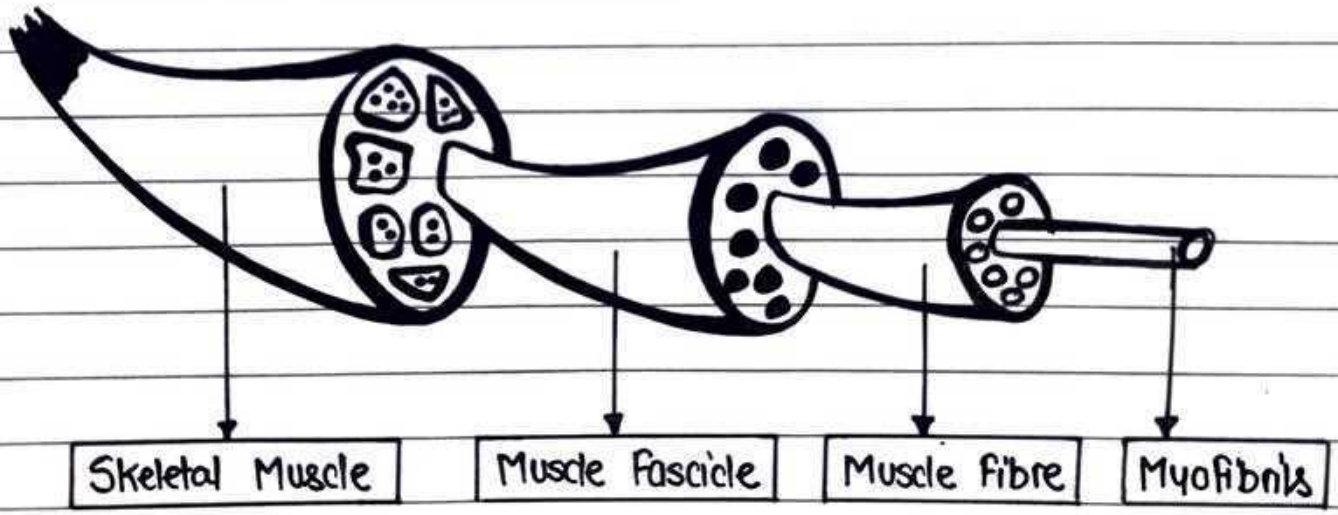
- They are also present in a pair.
- Each lower limb has 30 bones
- Single longest and strongest bone is called **Femur**.
- The two bones that are present in the lower region are called **Tibia** and **Fibula**.
- A small, triangular bone present at the knee joint is called **Patella**.
- 7 bones of the ankles are called **Tarsals**.
- 5 bones of the sole are called **Metatarsals**.
- 14 bones that form toes are called **Phalanges**.



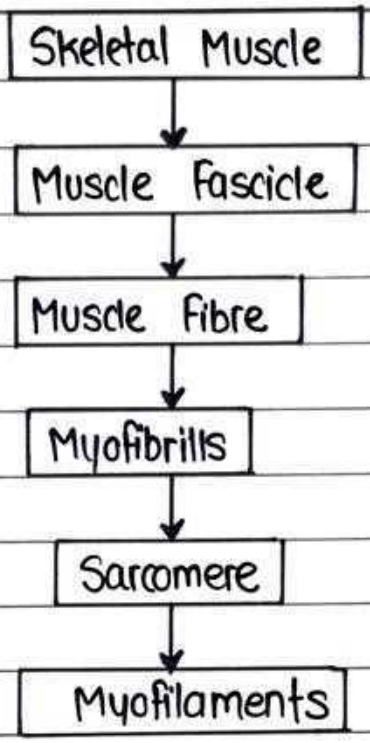
SKELETAL MUSCLE

- Skeletal Muscles are those muscles which are attached to the skeleton / bones.
- Skeletal Muscle composed 40% of body mass
- Skeletal Muscle are mainly responsible for locomotion, contraction and relaxation
- Skeletal muscles are voluntary in nature

STRUCTURE OF SKELETAL MUSCLE



- The outer covering / layer of skeletal muscle is epimysium.
- The outer covering of muscle fascicle is perimysium.
- The outer covering of muscle fibre is endomysium.



Muscle fibres

- The cells of skeletal Muscles are called muscle fibres
- Muscle cells contain many nuclei.
- The cytoplasm of muscle cells is called Sarcoplasm.
- The plasma membrane of muscle cells is called Sarcolemma.

Myofibrils

- The muscle fibre of skeletal muscle contains myofibrils.
- Myofibrils consist of protein chains called myofilaments.
- These myofilaments are of two types

① Thick Myofilament (Myosin)
② Thin Myofilament (Actin)

- Saromere is the unit of myofibrils containing both Actin and Myosin.

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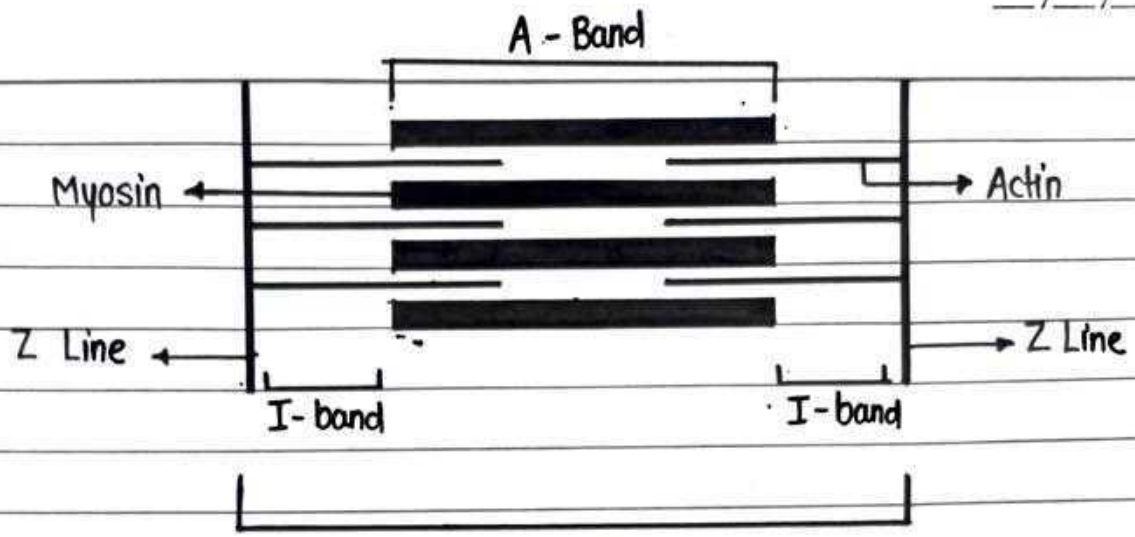
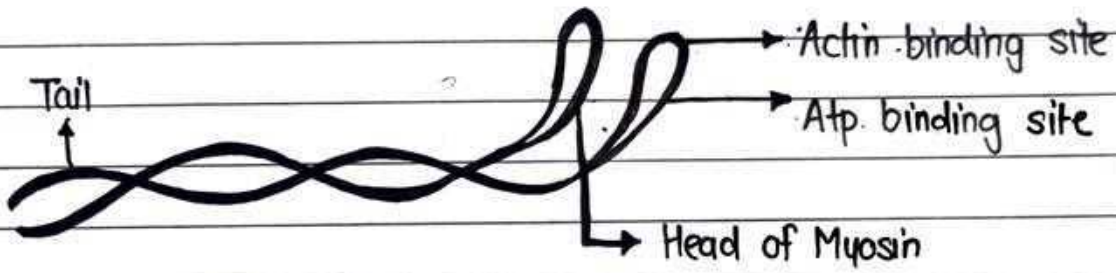
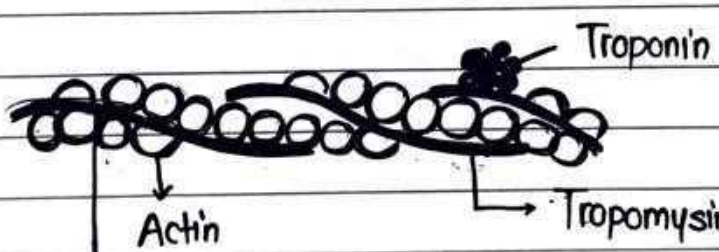


SARCOMERE



MYOSIN



Myosin binding site (covered by tropomysin)

ACTIN

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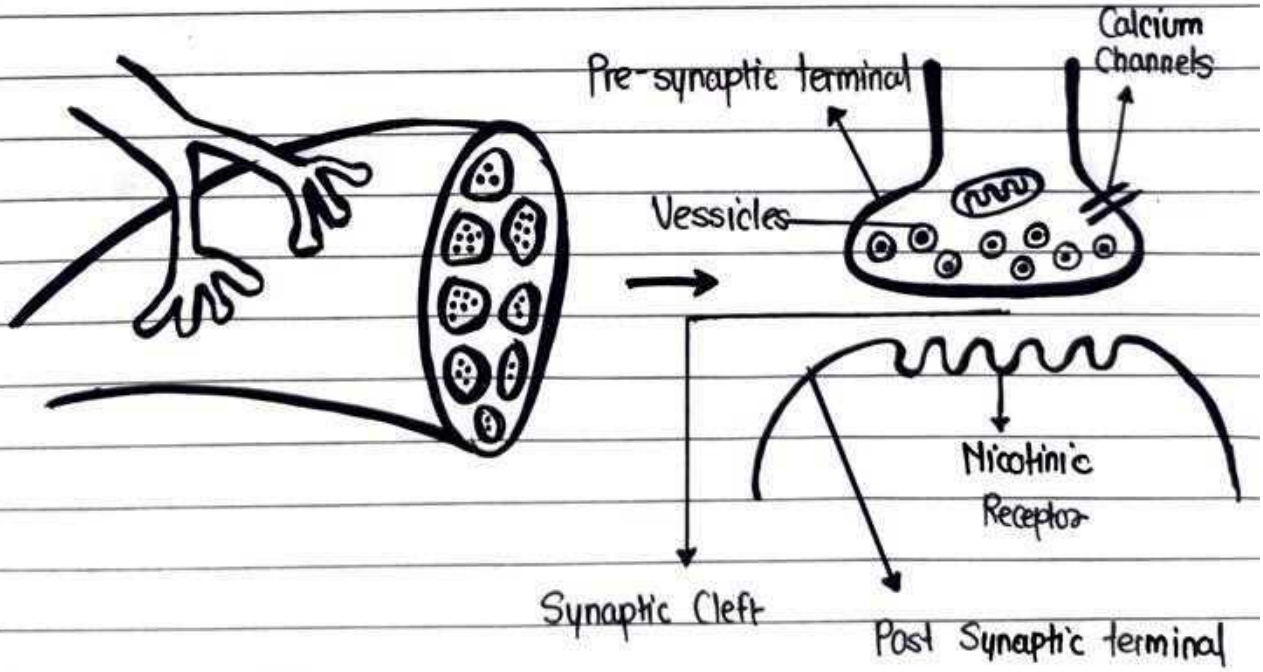
NEUROMUSCULAR JUNCTION

- The junction between neuron cells and skeletal muscle is called Neuromuscular Junction.
- In neuromuscular junction the end part of neuron (axon terminal) is connected with skeletal muscle
- The axon terminal of neuron is known as Pre-synaptic terminal
- The axon terminal contains acetylcholins packed inside the vessicles.
- The axon terminals also contain calcium channels which allows the movement of calcium.

- The site of skeletal muscle where axon terminal binds is called Post-synaptic terminal.
- Skeletal muscle contains nicotinic receptors where acetylcholine get binds during the process of muscle contraction.



MUSCLE CONTRACTION

- The length of skeletal muscle shortens during contraction because the thick & thin filaments slide over one another. The process is known as Sliding Filament Mechanism.
- The thick filaments contain 300 myosin molecules.
- Myosin consist of two parts

① Myosin Tail
② Myosin Head

A cycle of muscle contraction consist of 4 steps

- ATP hydrolysis.
- Attachment of myosin to Actin to form cross bridge
- Power stroke
- Detachment of myosin from actin

ATP Hydrolysis

- The myosin head include an ATP binding site and an ATPase (an enzyme that converts ATP into ADP & a phosphate group)
- This conversion (ATP → ADP + Phosphate) gives energy to the myosin head.

Attachment of Myosin to Actin to form cross-bridge

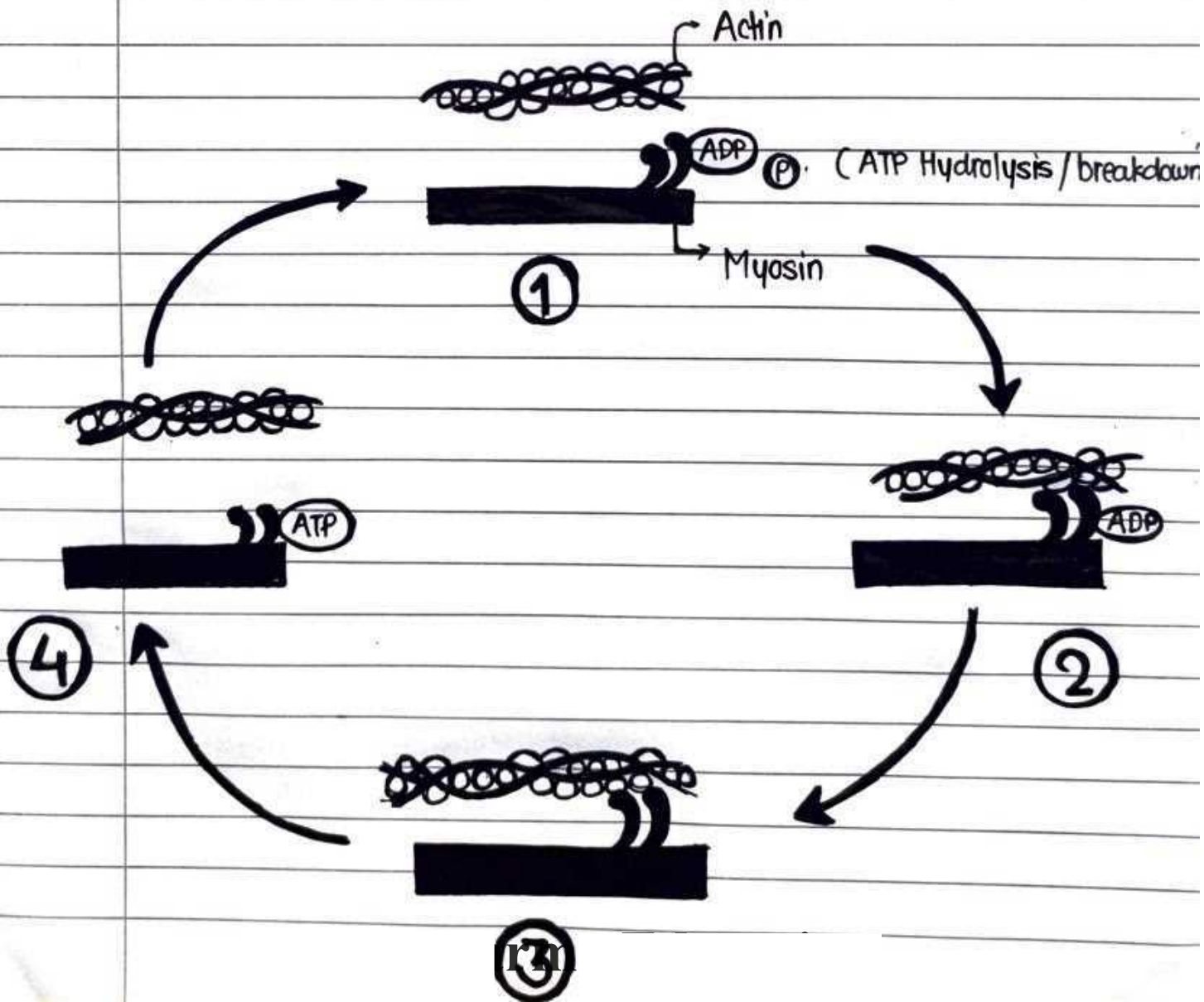
- The energized myosin head attached with the actin on myosin binding site.
- Now this attachment is reffered to as cross-bridge.

Power Stroke

- Once the cross-bridge are formed, the power stroke occurs.
- In power-stroke the cross-bridge rotates towards the centre of sarcomere and contraction occurs.
- The power stroke generates a force which slide the thin filament over the thick filament.

Detachment of Myosin from Actin

- Once the contraction ends, the ATP again binds on the ATP binding site on myosin head & myosin get detaches from the actin.



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JOINTS

- A Joint is simply known as a connection between bones in the skeletal system.
- It is a site at which two or more bones meets together.
- They allow different types of movement in the bones.

Classification of Joints

Joints can be classified on the basis of two categories :

① On the basis of structure
② On the basis of function

On the basis of structure

On the basis of structure joints are classified into three types:

(1) Fibrous Joints
(2) Cartilaginous Joints
(3) Synovial Joints

Fibrous Joints

- Fibrous Joints is also known as Immovable Joints.
- They are fixed joints and there is no movement allowed between the bones in fibrous joints.
- example: Cranial sutures between bones of the skull

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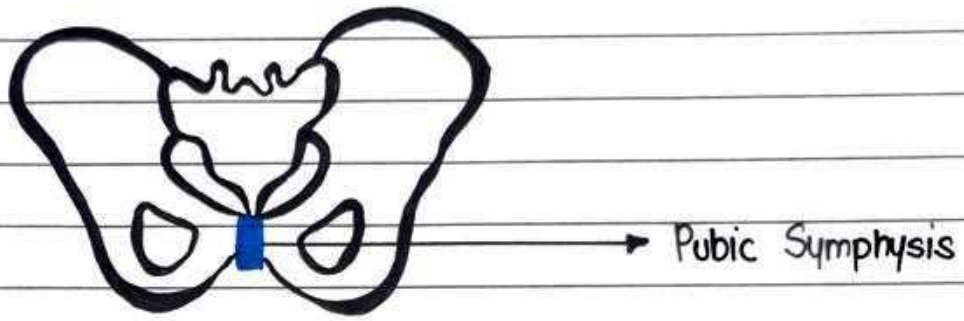
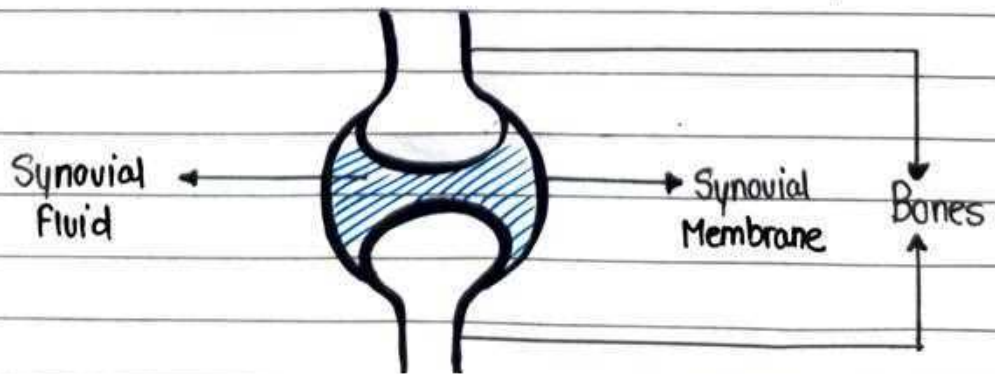
Cartilaginous Joints

- Cartilaginous joints are slightly movable joints.
- They allow little or no movement.
- In cartilaginous joint bones are connected to each others by cartilage.
- example : Pubic Symphysis



Synovial Joints

- The synovial joints are the most common type of joints as this joints helps to perform various functions such as walking, running etc.
- They are freely movable joint which allows movement in one or more direction.
- These joints are covered by a membrane called Synovial Membrane.
- There is a fluid present in the synovial membrane, called Synovial fluid which allows the movement of the bones.



Classification of Synovial Joints

Synovial joints are further classified into 6 types :

① Ball & Socket Joint
② Saddle Joint
③ Hinge Joint
④ Pivot Joint
⑤ Gliding Joint
⑥ Condyloid Joint

Ball & Socket Joint

- They are the most freely movable joint
- In this ball of one bone is fitted into the socket of other bone.
- example : Shoulder Joint

Saddle Joint

- It is basically a type of ball and socket joint.
- In this convex head of one bone fixes into the other bone.
- example : Thumb Joint

Hinge Joint

- They allow movement only in one plane.
- In this One bone is of convex shape & other one is of concave shape.
- Convex end of one bone attached with concave end of other bone.
- example : Elbow Joint, knee Joint.

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Pivot Joint

- This joint allows movement only in 1 plane.
- In pivot joint one bone is rounded or pointed shaped in which other bone is attached.
- Rounded bone is fixed and other bone rotates over it.
- example : Atlas and Axis joint.

Gliding Joint

- In Gliding joint bones are flat shaped.
- In this bones easily glides or slides over each other.
- They are also known as planar joint.
- example : wrist joint.

Condyloid Joint

- It is also known as ellipsoid joint.
- In this ends of both the bones are concave shaped.
- example : Carpals joint.

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Classification on the basis of function

On the basis of function joints can be classified into three categories :

- Synarthrosis
- Amphiarthrosis
- Diarthrosis

Synarthrosis

- It is an immovable joint.
- They are generally fibrous joints.
- example : sutures of the skull

Amphiarthrosis

- It is a slightly movable joint.
- They are generally cartilaginous joint.
- example : Pubic Symphysis.

Diarthrosis

- It is a freely movable joint.
- It is a type of synovial joint
- example : Shoulder joint , knee joint etc.