

INTEGUMENTARY SYSTEM

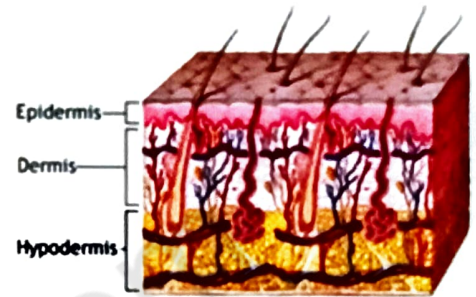
Points to be covered in this topic

1. INTRODUCTION

2. STRUCTURE OF SKIN

3. FUNCTIONS OF SKIN

4. REGULATION OF BODY TEMPERATURE



INTRODUCTION

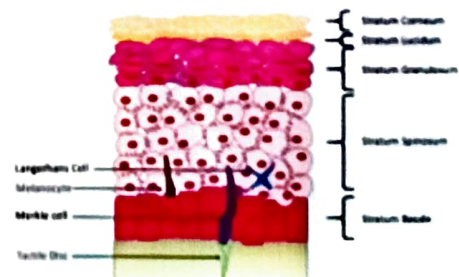
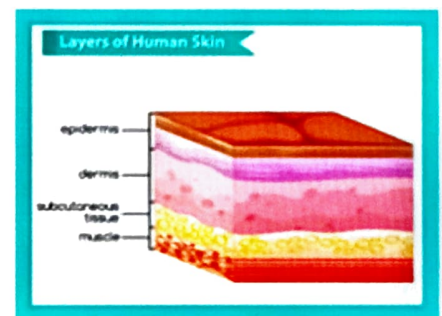
- The integumentary system is the **largest organ** in the body.
- It forms a **protective covering** for the body which is in contact with the **external environment**.
- Skin plays an important role in the **regulation** of **body temperature**.
- Skin consists of **two layers**
 - i. The **outer layer** is called **epidermis**
 - ii. The **inner layer** is called **dermis**

STRUCTURE OF SKIN

➤ EPIDERMIS

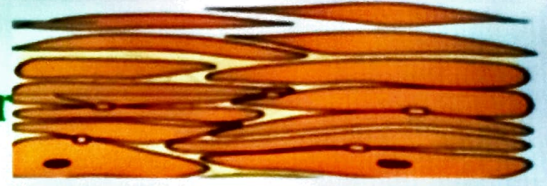
- It is the **outer layer** of the skin.
- It is composed of **stratified squamous epithelium**.
- Epidermis is divided into **five layers**, namely

- 1) **Stratum corneum**
- 2) **Stratum lucidum**
- 3) **Stratum granulosum**
- 4) **Stratum spinosum**
- 5) **Stratum germinativum**



1) STRATUM CORNEUM

- This is the most **superficial layer**
- **Keratin** is **present** in the cells.
- The **nuclei** are **absent**.



2) STRATUM LUCIDUM

- This is a **thin**, more or **less transparent, glistening layer**
- The cell contains **cytoplasm**.

3) STRATUM GRANULOSUM

- This layer contains **spindle-shaped** cells.
- The **cytoplasm** and **nucleus** are present in these cells.

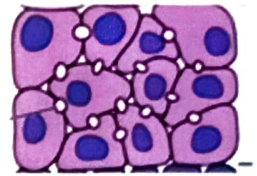
4) STRATUM SPINOSUM

- It contains **polyhedral cells**.



5) STRATUM GERMINATIVUM

- This layer is composed of single layer of **columnar epithelium** or **cuboidal cells**.
- This layer is **connected** to the **dermis**
- **Melanin pigments** are present in this layer

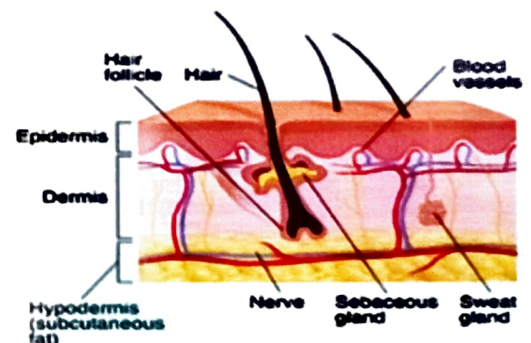


□ DERMIS

- It is composed of **connective tissue** and is **highly vascular**.
- It is made up of **fibroelastic tissue** which **maintains** the **texture** of the skin.

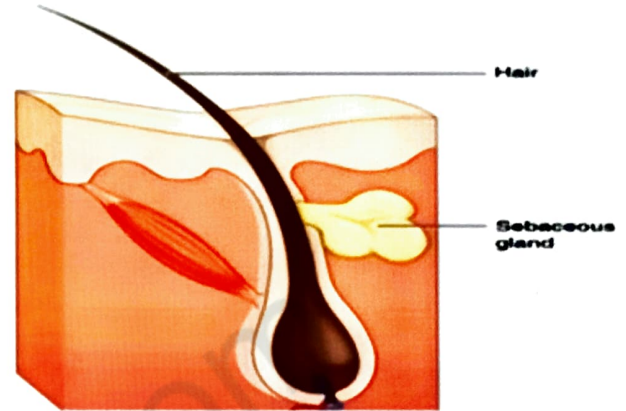
➤ Gland of the dermis

- 1) **Sebaceous gland**
- 2) **Sweat gland**
- 3) **Ceruminous gland**
- 4) **Hair roots and erector pili muscles**



1) SEBACEOUS GLAND

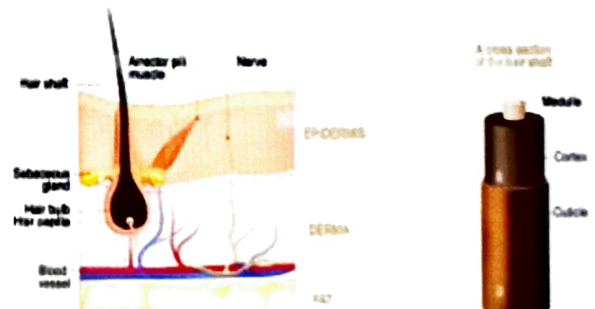
- They are **flask shaped** glands .
- They secrete on **oil** like material called **sebum**
- They have a duct which opens into a **hair follicle** .
- It prevents excess evaporation of water from the skin and **prevents drying of skin** .
- Sebaceous glands are present in the skin of many parts of the body except **skin** of **palms** of hands soles of feet .



2) SWEAT GLAND

- There are two types of sweat glands **Ecrine glands** and **Apocrine glands** .
- **Ecrine glands** are present all **over the body**. **Apocrine glands** are present in **axilla, female genitalia** and **round the nipples**,
- **Ecrine glands** secrete **watery sweat** and **apocrine glands** secrete **milky sweat**.

Hair anatomy



3) CERUMINOUS GLAND

- They secrete wax in the external ear.

4) HAIR ROOTS AND ERECTOR PILI MUSCLES

- Contraction of these muscles produces straightening of the hair.

❑ **FUNCTION OF SKIN**

1. The skin **protects the body** against **injury** and **bacterial invasion**.
2. It **regulates body temperature**.
3. The skin serves as a medium for **receiving the sensations** like **touch, pressure** and **temperature**.
4. It **excretes sodium chloride** and **metabolites** like urea.
5. It maintains water and **electrolyte balance**.
6. The skin synthesizes **vitamin D** from ergosterol of skin by the **action of ultraviolet** rays of sunlight.
7. It **synthesizes melanin** from tyrosine.
8. It **secretes sweat** and **sebum** which keeps the skin soft.
9. It stores fat, **water, chorides** and sugar.

❖ **REGULATION OF BODY TEMPERATURE**

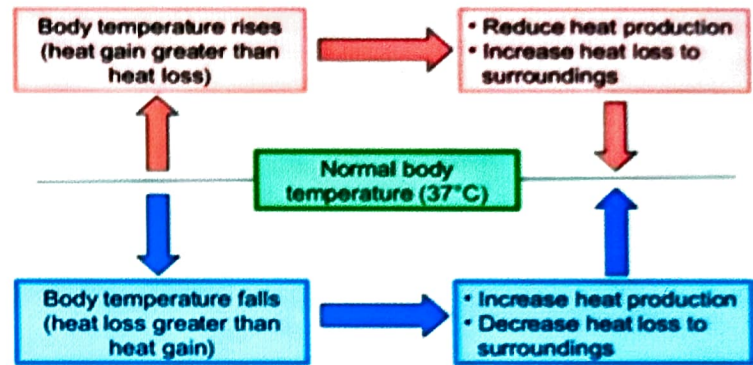
- The normal body temperature is **98.4°C (37°C)**.
- The normal body temperature is maintained by a balance between **heat production** and **heat loss**.
- Body temperature is controlled by **Heat regulating centre** present in the **hypothalamus**.

✓ **HEAT PRODUCTION**

1. During **severe exercise**, by the increased **activity of muscles**.
2. By the increased **activity of liver** and other **glands** in the body.
3. Increased **intake of food** (proteins).
4. Increased metabolism, like **oxidation of food stuffs** and **combustion of fat**.
5. Endocrine secretions like **adrenaline** and **noradrenaline**.

✓ HEAT LOSS

1. **Radiation**, body heat (temperature) is lost to the surrounding air.
2. **Conduction**, body heat is lost through clothing, bedding etc.
3. **Convection**, the hot air around the body moves up and it is replaced by cool air, and thus body heat is lost.
4. **Sweating**, the skin becomes cool and this leads to heat loss.
5. **Evaporation** of water from the skin, mucous membranes and respiratory passages, the body heat is lost.



JOINTS

Points to be covered in this topic

→ 1. INTRODUCTION

→ 2. CLASSIFICATION OF JOINTS

→ 3. MOVEMENT OF JOINTS

→ 4. JOINTS OF THE UPPER LIMB

→ 5. JOINTS OF THE LOWERLIMB

INTRODUCTION

- A joint or **articulation** is the **connection** made between **bones** in the **body** which link the **skeletal system** into a functional whole.
- They are constructed to allow for **different degrees** and types of **movement**.

□ CLASSIFICATION OF JOINTS AND THEIR FUNCTION

1. Fixed or fibrous joints

- **Synovial cavity** and **ligament absent**, fixed by **sutures**
- **No movement** occur (Immovable)
- Eg. **Bones of skull**, Bones of **pelvic girdle**



❖ Functions

- Fibrous joints strongly unite **adjacent bones** and thus serve to **provide protection** for internal organs, strength to body regions, or weight-bearing stability.
- Fixed joints **permit stability** to certain areas of the body, although they do not move.

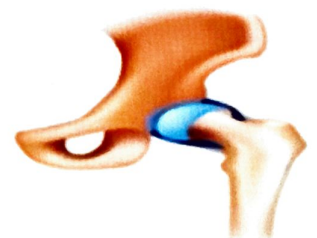
2. Cartilagenous or slightly movable gland

- Bones separated by **cartilage**, **synovial cavity absent**
- Cartilagenous or **imperfect joints**
- Allow **little movements**
- Eg. Between **center of 2 vertebra**, **ribs** and **sternum**



❖ Function

- Cartilage is a **tough**, **elastic connective tissue** that helps to **reduce friction** between bones.



3. Freely movable or synovial joints

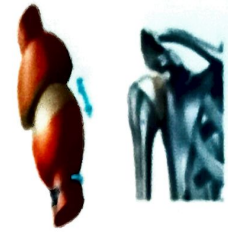
- **Perfect joints**
- Allow freely movements in **one** or **more directions**

Synovial
(freely moveable)

Freely movable or synovial joints are classified in six types

(a) Ball and socket joints

- A joint in which the **rounded** surface of a bone moves within a **depression** on another bone, allowing **greater freedom** of movement than any other kind of joint.
- **Eg. Hip joints**



Ball-and-Socket Joint

(b) Gliding joints

- It is a common type of **synovial joint** built between bones that meet on **flat** or **nearly flat articular surfaces**
- **Eg. Between vertebra, wrist and ankle bones**



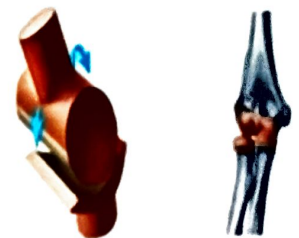
Gliding Joint

Wrist Bones

(c) Hinge joints

- A type of joint that functions much like the **hinge** on a **door**, allowing bones to **move** in **one direction** back and forth with limited motion along other planes.

Eg. Knee joint, elbow joints

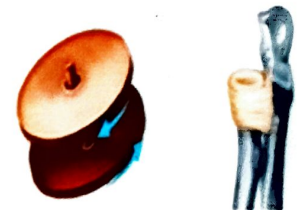


Hinge Joint

(d) Pivot joints

- Pivot joints are joints that **permit rotatory movement** of bones, around a **single axis**. Pivot joint is a **synovial joint** in which the ends of **two bones** connect.

Eg. between radius and ulna and atlas and axis vertebrae

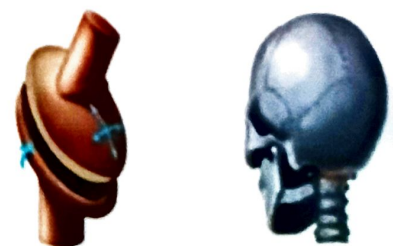


Pivot Joint

(e) Ellipsoid joint

- A synovial joint in which an **oval-shaped** process of **one bone** fits into an **elongated** or **ellipsoidal** cavity of the other, allowing movements such as **flexion**, **extension**, **abduction** and **adduction**

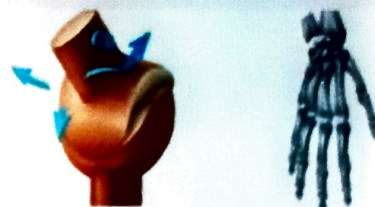
Eg. Wrist or radio carpal joints



Ellipsoid Joint

(f) Saddle joints

- A saddle joint is a type of synovial joint in which the **opposing surfaces** are **reciprocally concave and convex**.
- Eg. Carpo metacarpal joints of human thumb



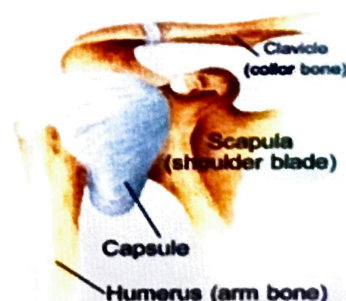
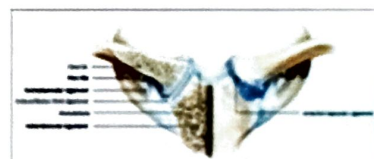
Saddle Joint

Movements of joints

1. **Flexion** : **Bending movement**. Usually forward but occasionally backward. **ex.: Knee joint**.
2. **Extension**: **Straightening** or **bending backwards**.
3. **Abduction**: It is the movement away from the **midline** of the body.
4. **Adduction**: It is the movement towards the **midline** of the body.
5. **Circumduction**: It is the combination of **flexion, extension, abduction and adduction**.
6. **Rotation**: It is the movement round the **long axis** of a bone (a) **Medial rotation**.(b) **Lateral rotation**
7. **Pronation** : It means turning the **palm** of the **hand down**.
8. **Supination**: It means turning the **palm** of the **hand up**.
9. **Inversion**: It is turning the **sole** of the foot inwards.
10. **Eversion**: It is turning the sole of the foot outwards.

Joints of the upper limb

1. **Sterno-clavicular joints**: It is a **gliding joint** between **sternum** and **clavicle**. A pad of **cartilage** is present in the **joint** cavity between the **bones**.
2. **Acromio-clavicular joint**: It is formed by **outer** end of **clavicle** **articulating** with **acromion** process of scapula.
3. **Shoulder joint**: It is a **ball and socket** type of joint. It occurs between. **head of humerus** and **glenoid cavity of scapula**.
 - **Movements of the shoulder joint**: All types of movements like **flexion, extension, adduction, abduction, rotation and circumduction** are possible at this joint



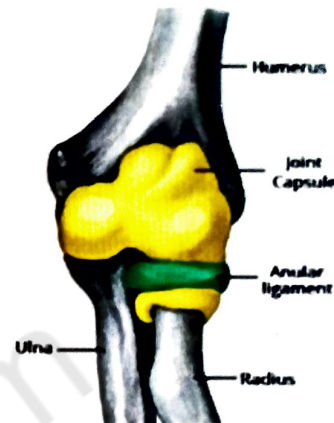
4. Elbow joint: It is a **hinge joint**. It is formed by **humerus** above and **radius** and **ulna** below.



Movements of the

elbow joint: Flexion and extension.

5. Radio-ulnar joint: This is formed by the articulation of **radius** and **ulna** at their upper and lower extremities.



Movements of radio-ulnar joint : Pronation and supination.

6. Wrist joint: It is a **condyloid joint**. It is formed by the **lower** end of **radius** and three **carpal bones**



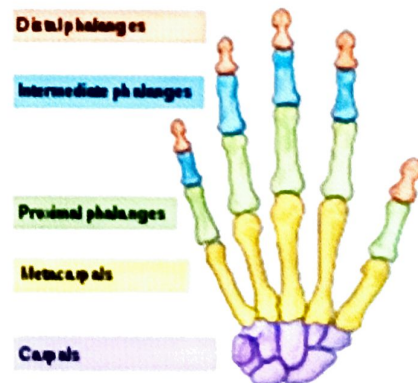
Movements of the wrist joint: Flexion, extension, adduction and abduction are the movements which occur at this joint

7. Metacarpo - phalangeal joint: They occur between **metacarpal** and **phalangeal bones**.



The movements at these joints are **flexion**, extension, adduction and abduction.

8. Inter-phalangeal joints: They occur between **phalangeal bones** of the same finger.



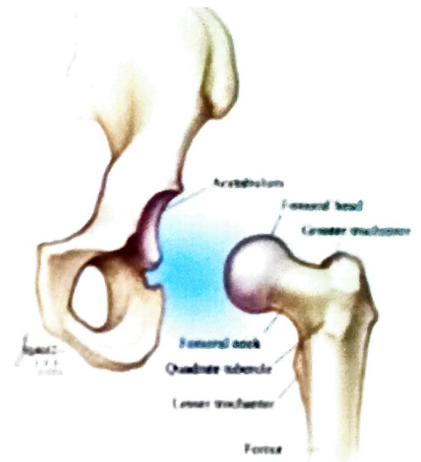
Flexion and **extension** are the movements possible at this joint.

Joints of the lower limb

1. Hip joint

It is a **ball and socket** type of joint. It occurs between **acetabulum** of **innominate bone** and head of femur the joint capsule is strengthened by three ligaments. They are:

- (a) "**Ilio-femoral ligament**" in the front.
- (b) "**Pubo-femoral ligament**" below.
- (c) "**Ischio-femoral ligament**" at the back.
- (d) **Movements of the hip joint:** Flexion, extension, adduction, abduction, rotation and circumduction occur at this joint.

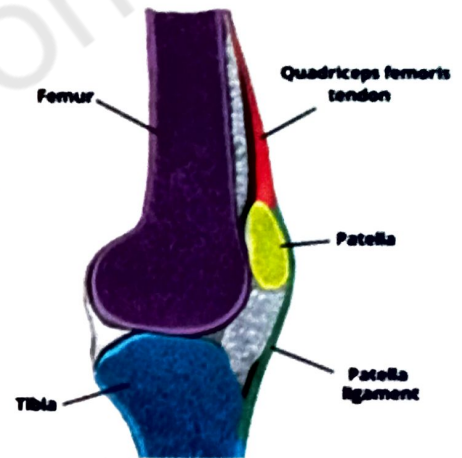


2. Knee joint

It is a **hinge joint** formed by

- (a) **Two condyles** of femur articulating with the **condyles of tibia**, and
- (b) **Patella**.

Movements of the knee joint: Flexion and extension.



3. Ankle joint

It is a hinge joint formed by:

- (a) Tibia and its medial malleolus.
- (b) Lateral malleolus of fibula. both from a socket
- (c) Talus below

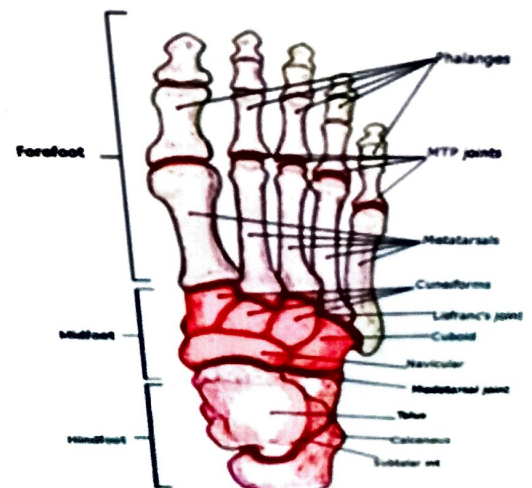


Movements of the ankle joint

- (a) Dorsi flexion.
- (b) Plantar flexion

4. Joints of the foot They are:

- (a) Tarsal joints
- (b) Tarso-metatarsal joints
- (c) Metatarso-phalangeal joints
- (d) Inter-phalangeal joints



SKELETAL SYSTEM

Points to be covered in this topic

1. INTRODUCTION

2. FUNCTIONS OF THE SKELETON SYSTEM

3. DIVISIONS OF SKELETAL SYSTEM

4. DISORDERS OF THE SKELETAL SYSTEM

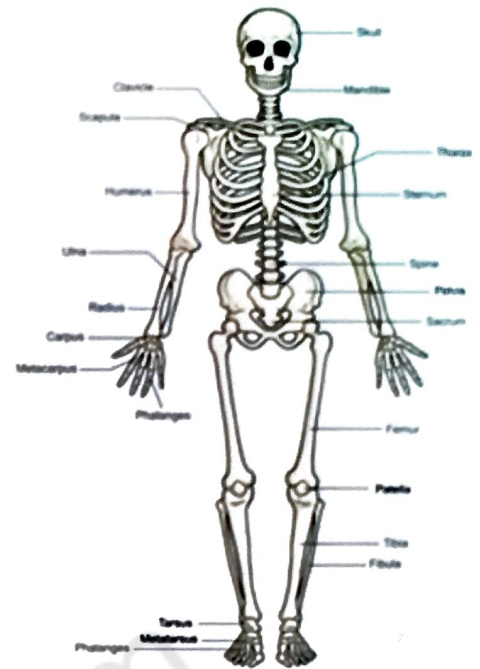
5. SKELETAL MUSCLE

6. PHYSIOLOGY OF MUSCLE CONTRACTION

7. NEUROMUSCULAR JUNCTION

INTRODUCTION

- The skeletal system includes all of the **bones** and **joints** in the body.
- Each bone is a complex **living organ** that is made up of **many cells**, **protein fibers**, and **minerals**.
- The skeletal system **supports** and **protects** the body while giving it **shape** and **form**.
- This system is composed of **connective tissues** including **bone**, **cartilage**, **tendons** and **ligaments**.

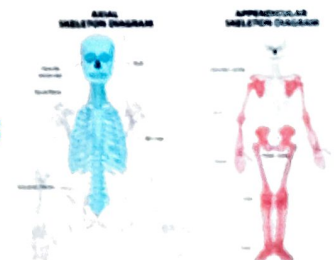


❖ FUNCTIONS OF THE SKELETON SYSTEM

- ✓ **Support** - The skeleton serves as the **structural framework** of the body by **supporting** soft tissues and **providing attachment** points for the tendons of skeletal muscles
- ✓ **Protection** - The skeleton protects the **internal organs** from injury.
- ✓ **Assistance in movement** - Most **skeletal muscles** are **attached to bones**, when these **muscles contract**, they pull the attached bones to **produce movement**.
- ✓ **Blood cell production** - Blood cells are produced in the **bone marrow**.
- ✓ **Triglyceride storage** - **Yellow bone marrow** consists mainly of adipose cells, which store triglycerides.
- ✓ **Mineral homeostasis** - Bone tissue stores several minerals, especially **calcium** and **phosphorus**, which contribute to the strength of bone.

❖ DIVISIONS OF SKELETAL SYSTEM

- ✓ The skeleton is subdivided into **two major divisions**
 1. **Axial skeletal system**
 2. **Appendicular skeletal system**

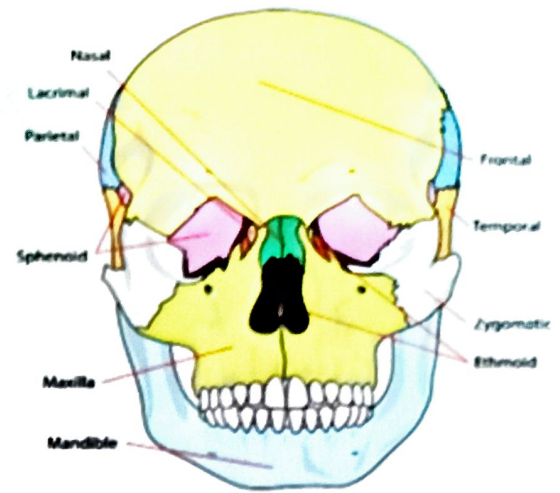


1. AXIAL SKELETON

I. Skull

- The skull is situated on the upper end of **vertebral column** and its **bony structure** is divided into **two parts**

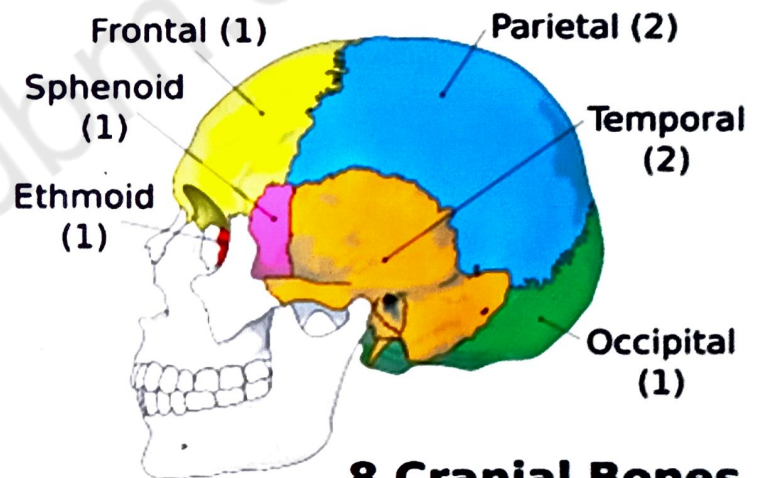
- Cranium
- Face



A. Cranium

- It is formed by **flat** and **irregular bones** that provide a **bony protection** to the brain.
- It has a base on which the **brain rests** and a **vault** that **surrounds** and **covers it**.
- In adults the sutures between the **bones** are **immovable**.
- The **cranium** consist of

- 1 Frontal bone**
- 2 Parietal bones**
- 2 Temporal bones**
- 1 Occipital bone**
- 1 Sphenoid bone**
- 1 Ethmoid bone**

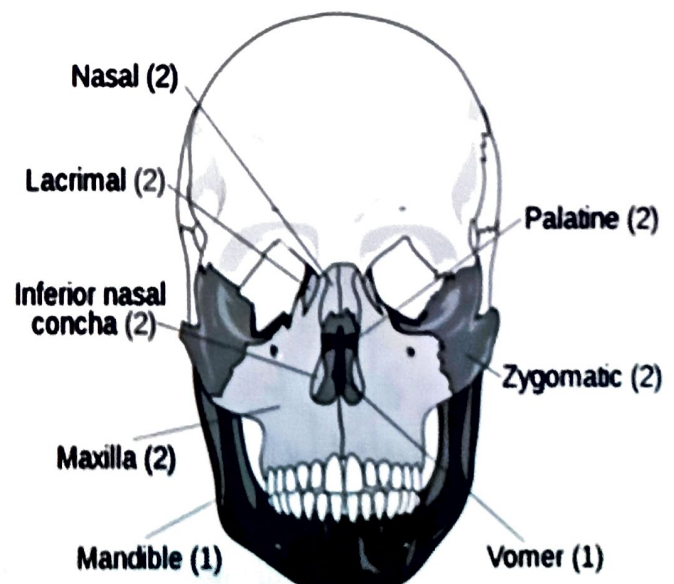


8 Cranial Bones

B. Face

The face is formed by **13 bones** in addition to the **frontal bone**. This includes:

- 2 Cheek bones**
- 1 Maxilla**
- 2 Nasal bones**
- 2 Lacrimal bones**
- 1 Vomer**
- 2 Palatine bones**
- 2 Inferior conchae**
- 1 Mandible**



II VERTEBRAL COLUMN

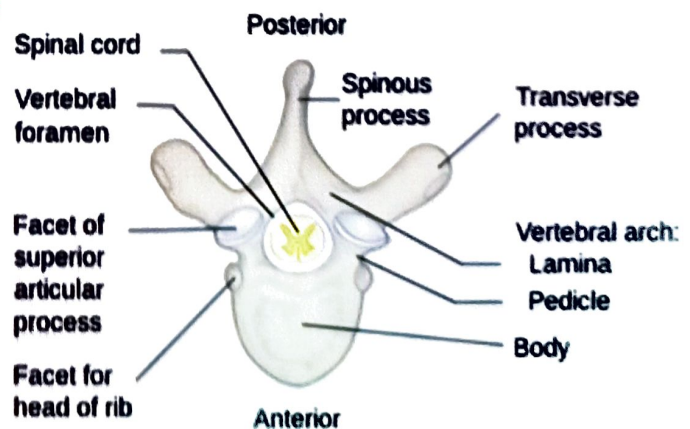
- It is composed of a **series of bones** called as vertebrae.
- The **vertebral column**, the **sternum**, and the **ribs** form the skeleton of the **trunk of the body**
- The vertebral column consists of **spinal cord**.
- It **supports** the **head** and **serves** as a point of attachment for the **ribs, pelvic girdle and muscles** of the back and upper limbs
- The adult vertebral column consists of **26 vertebrae**
 - 7 cervical vertebrae**: These are in the **neck region**.
 - 12 thoracic vertebrae**: These are posterior to the **thoracic cavity**.
 - 5 lumbar vertebrae**: It supports the **lower back**.
 - 1 sacrum**: It consists of **five bones** fused with **sacral vertebrae**.
 - 1 coccyx**: It consists of **four fused** coccygeal vertebrae.

➤ FUNCTIONS OF VERTEBRAL COLUMN

- It provides a **strong bony protection** for the **spinal cord**.
- The pedicles of **adjacent vertebrae** form intervertebral foramina providing access to the spinal cord for **spinal nerves, blood vessels** and **lymph vessels**.
- It **supports the skull**.
- The intervertebral discs act as **shock absorbers, protecting the brain**.
- It forms the axis of the trunk, **giving attachment** to the **ribs, shoulder girdle, upper limbs, the pelvic girdle and lower limbs**.

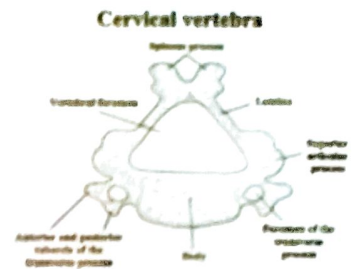
➤ PARTS OF A TYPICAL VERTEBRA

- **Body**
- **Vertebral arch**
- **Vertebral foramen**
- **Pedicles**
- **Processes**
- **Atlas vertebrae**
- **Axial vertebrae**



➤ Cervical Vertebrae

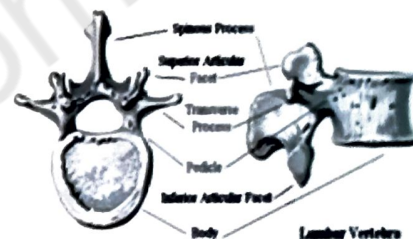
- The body of the **cervical vertebrae** is **smaller** and the **vertebral arches** are **larger**.
- The cervical vertebrae have **three foramina one vertebral foramen** and **transverse foramina**



- The vertebral foramen is the **largest** in the **spinal column**
- **Processes** are split into **two parts**. Each cervical transverse process contains a **transverse foramen** through which the **vertebral artery, vertebral vein** and **nerve fibers** pass

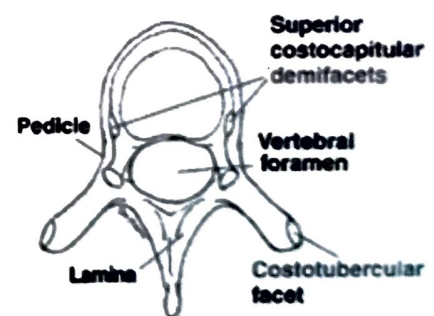
➤ Lumbar Vertebrae

- The lumbar vertebra is the **largest** and **strongest** vertebrae of the vertebral column.
- The projections are **short** and **thick**.
- The superior articular processes are **directed medially** instead of **superiorly** and the **inferior articular processes** are **directed laterally** instead of **inferiorly**.
- The spinous processes are **quadrilateral** in shape, thick and broad and project straight



➤ Thoracic Vertebrae

- These are **larger** and **stronger** than **cervical vertebrae**.
- The **spinous processes** are **long** and **flattened**.
- Thoracic vertebrae have **longer** and **larger transverse processes**.
- The bodies of thoracic vertebrae have facets for **articulation** with the **head of the ribs**.

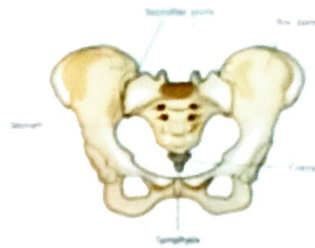


➤ Sacrum

- It consists of five **vertebrae fused** to form a **triangular bone**.
- The upper part of **sacrum articulates** with the **5th lumbar vertebra**.
- On each side it articulates with the **ilium** to form a **sacroiliac joint**, and at its **inferior tip** it articulates with the **coccyx**.

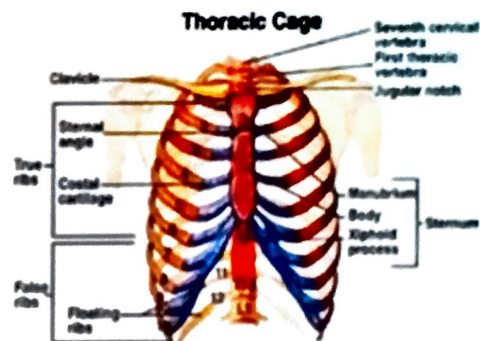
➤ Coccyx

- It consists of **four terminal** vertebrae fused to form a small **triangular bone**, the broad base of which articulates with the **tip of the sacrum**.



➤ Thoracic cage

- The bones of thoracic cage are divided in to
 - ✓ 1 sternum
 - ✓ 12 pairs of ribs
 - ✓ 12 thoracic vertebrae



2. APPENDICULAR SKELETON

Human body has two **pectoral girdles** that The appendicular skeleton consists of the **pectoral girdle** with the **upper limbs** and the **pelvic girdle** with the **lower limbs**.

➤ Pectoral (Shoulder girdle)

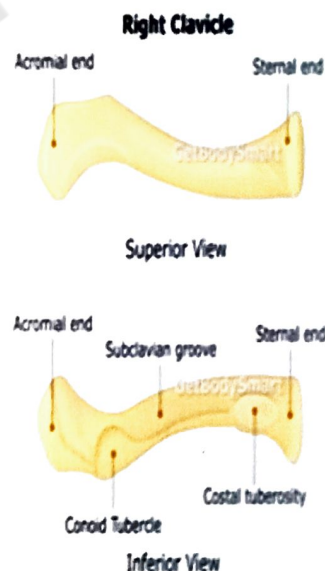
- pectoral girThe attach the bones of the **upper limbs** to the **axial skeleton**.
- The dles consists of

1 Clavicle

1 Scapula

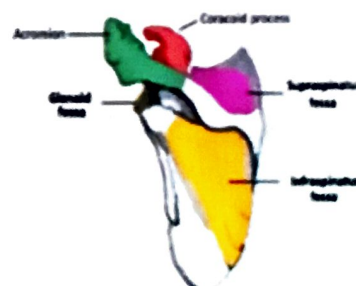
✓ Clavicle (Collar bone)

- The clavicle is located between the **ribcage** (sternum) and the **shoulder blade** (scapula).
- It is the bone that connects the **arm** to the **body**.
- The clavicle lies above several important **nerves** and **blood vessels**.



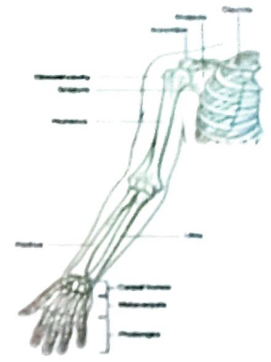
✓ Scapula

- Scapula, also called **shoulder blade**, either of **two large bones** of the shoulder girdle in vertebrates.
- In humans they are **triangular** and **lie** on the upper back between the levels of the **second** and **eighth ribs**.



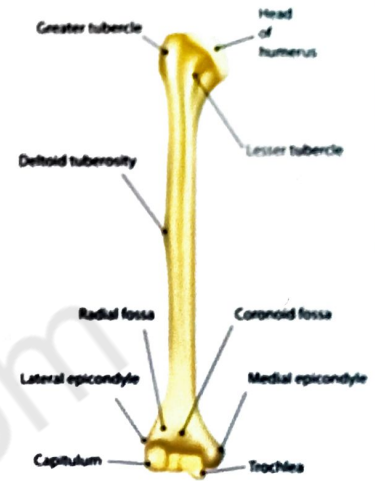
➤ Upper limbs (upper extremity)

- The upper extremity or arm is a **functional unit** of the **upper body**.
- It consists of **three sections**, the **upper arm**, **forearm**, and **hand**.
- It extends from the shoulder joint to the fingers and **contains 30 bones**.



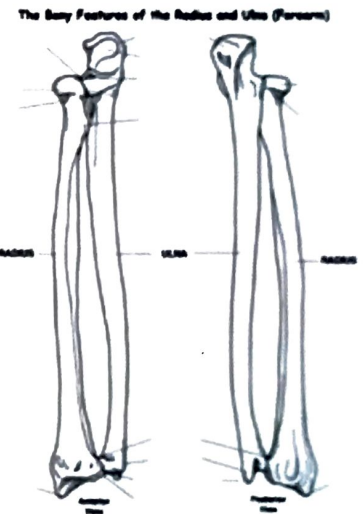
✓ Humerus

- The humerus is the bone in your upper arm that's located between your **elbow** and **your shoulder**.
- Its main function is to provide **support** for your **shoulder** and a wide variety of **movements** for your **arm**.



✓ Ulna

- The ulna is one of **two bones** that make up the **forearm**, the other being the **radius**.
- It forms the **elbow joint** with the **humerus** and also **articulates** with the **radius** both proximally and distally.
- The main **function** of the ulna, along with the radius, is to assist with **rotation**.

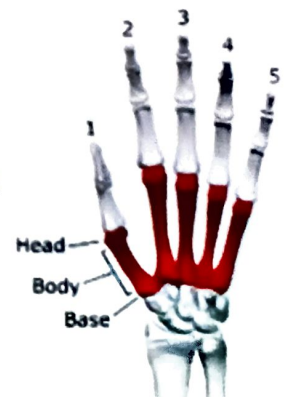


✓ Radius

- The radius, also known as the **radial bone**, is one of the **two forearm** bones in the human body, with the other one being the **ulna**.
- It is **instrumental** in the **shaping** and use of hands

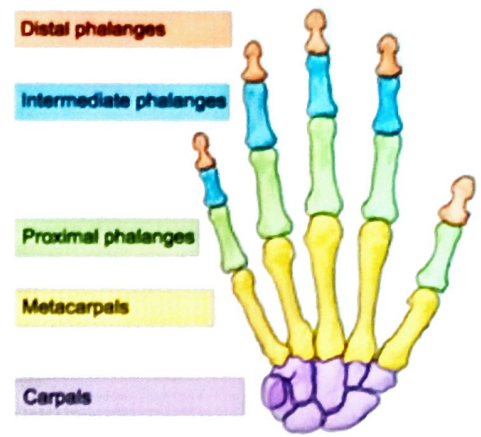
✓ Carpals

- The carpal bones are bones of the wrist that **connect** the **distal aspects** of the **radial** and **ulna** bones of the **forearm** to the bases of the **five metacarpal** bones of the hand.
- It consist of
 - **Proximal row**
 - **Distal row**



✓ Metacarpus (palm)

- It consists of **five bones** called metacarpals
- It consists of
 - ✓ **Proximal base**
 - ✓ **Intermediated shaft**
 - ✓ **Distal head**

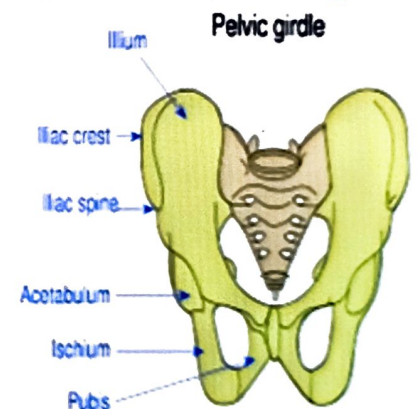


✓ Phalanges (finger bones)

- The phalanges are the bones that make up the **fingers** of the **hand** and the **toes** of the **foot**.
- There are **56 phalanges** in the human body, with **fourteen** on each **hand** and **foot**.
- **Three phalanges** are present on each **finger**, and **toe**

✓ Pelvic

- The pelvis is the area of the body **below** the **abdomen** that is located between the **hip bones** and **contains** the **bladder** and **rectum**.
- In **females**, it also **contains** the **vagina**, **cervix**, **uterus**, **fallopian tubes**, and **ovaries**.
- It consist of **three bones**
 - ✓ **Ilium**
 - ✓ **Pubis**
 - ✓ **Ischium**



➤ Lower limb (lower xtremity)

- Each lower limb consists of **30 bones** in **four locations**.
- They consist of
 - ✓ **Femur in the thigh**
 - ✓ **Patella (knee cap)**
 - ✓ **Tibia and fibula in the leg**
 - ✓ **7 tarsals in the tarsus (ankle)**
 - ✓ **5 metatarsals in the metatarsus**
 - ✓ **14 phalanges (bones of the digits) in the foot**

✓ Femur

- The femur is the **largest** and **strongest** bone in the human body.
- It is commonly known as the **thigh bone** and **reaches** from the **hip** to the **knee**
- The main function of the femur is **weight bearing** and **stability of gait**. An essential component of the lower kinetic chain.

✓ Patella (knee cap)

- The patella is a **small bone** located in front of the **knee joint** where the **thighbone** (femur) and **shinbone** (tibia) meet.
- It **protects** the **knee** and **connects** the **muscles** in the front of the thigh to the tibia.

✓ Tibia and fibula

- Tibia and fibula are the two **long bones** located in the **lower leg**.
- The **tibia** is a **larger bone** on the **inside**, and the **fibula** is a **smaller bone** on the **outside**.
- The tibia is much **thicker** than the **fibula**.

✓ Tarsals

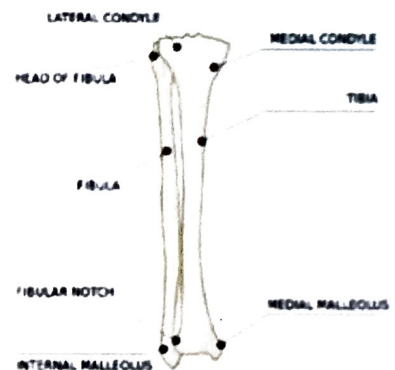
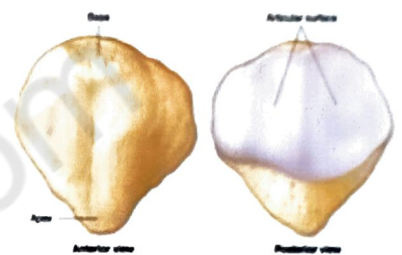
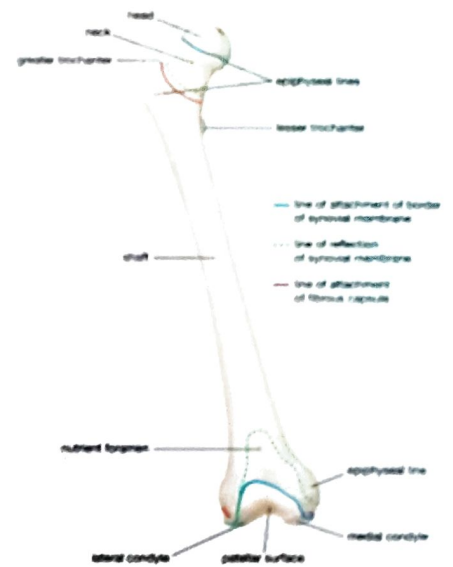
- The tarsal bones consist of **seven short** bones located at the **proximal region** of the **foot**.
- They are arranged in **proximal** and **distal** rows.
- **1. Calcaneus bone**: The largest tarsal bone that projects posteriorly as the heel.

✓ Metatarsals

- The metatarsal bones, or metatarsus, are a group of **five long bones** in the **foot**, located between the **tarsal bone** of the hind- and mid-foot and the phalanges of the toes

✓ Phalangs

- The **14 bones** that are found in the **fingers** of **each hand** and also in the **toes** of **each foot**.



DISORDERS OF THE SKELETAL SYSTEM

1. Herniated (Slipped) disc

- If the anterior and posterior ligaments of the **discs become injured**, the **pressure developed** in the **nucleus pulposus** may be great enough to **rupture** the **surrounding fibrocartilage**.

2. Abnormal Curves of the Vertebral Column

- Various conditions may exaggerate the normal curves of the **vertebral column**, or the column may acquire a lateral bend, resulting in **abnormal curves** of the vertebral column.

3. Scoliosis

- It is a lateral bending of the **vertebral column**, usually seen in the **thoracic region**.

4. Kyphosis

- It is an **increase** in the **thoracic curve** of the vertebral column.

5. Lordosis

- It is an **increase** in the **lumbar curve** of the vertebral column.

6. Spina Bifida

- It is a **congenital defect** of the vertebral column in which laminae of L5 and/or S1 fail to develop normally and unite at the midline.

SKELETAL MUSCLE

- A muscle which is **connected** to the skeleton to form part of the **mechanical system** which moves the limbs and other parts of the body.
- They play an essential role in **respiratory mechanics** and help in **maintaining posture** and **balance**.
- They also **protect** the **vital organs** in the body.

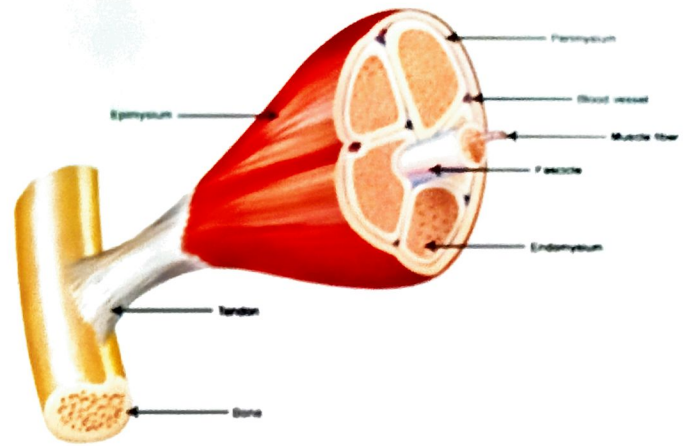
❖ Structure of Muscle

- Each skeletal muscle is an organ that **consists** of various **integrated tissues**.
- These tissues include the skeletal **muscle fibers**, **blood vessels**, **nerve fibers**, and **connective tissue**.
- Each muscle is wrapped in a **sheath of dense**, irregular **connective tissue** called the **epimysium**, which allows a muscle to contract and move powerfully while **maintaining** its **structural integrity**.
- Inside each **skeletal muscle**, **muscle fibers** are organized into bundles, called **fascicles**, surrounded by a middle layer of connective tissue called the **perimysium**.
- Inside each fascicle, each muscle fiber is encased in a **thin connective tissue** layer of collagen and reticular fibers called the **endomysium**.
- The endomysium surrounds the **extracellular matrix** of the cells and plays a role in **transferring force** produced by the **muscle fibers** to the **tendons**.
- In **skeletal muscles** that work with **tendons** to pull on **bones**, the collagen in the **three connective tissue** layers intertwines with the collagen of a tendon.

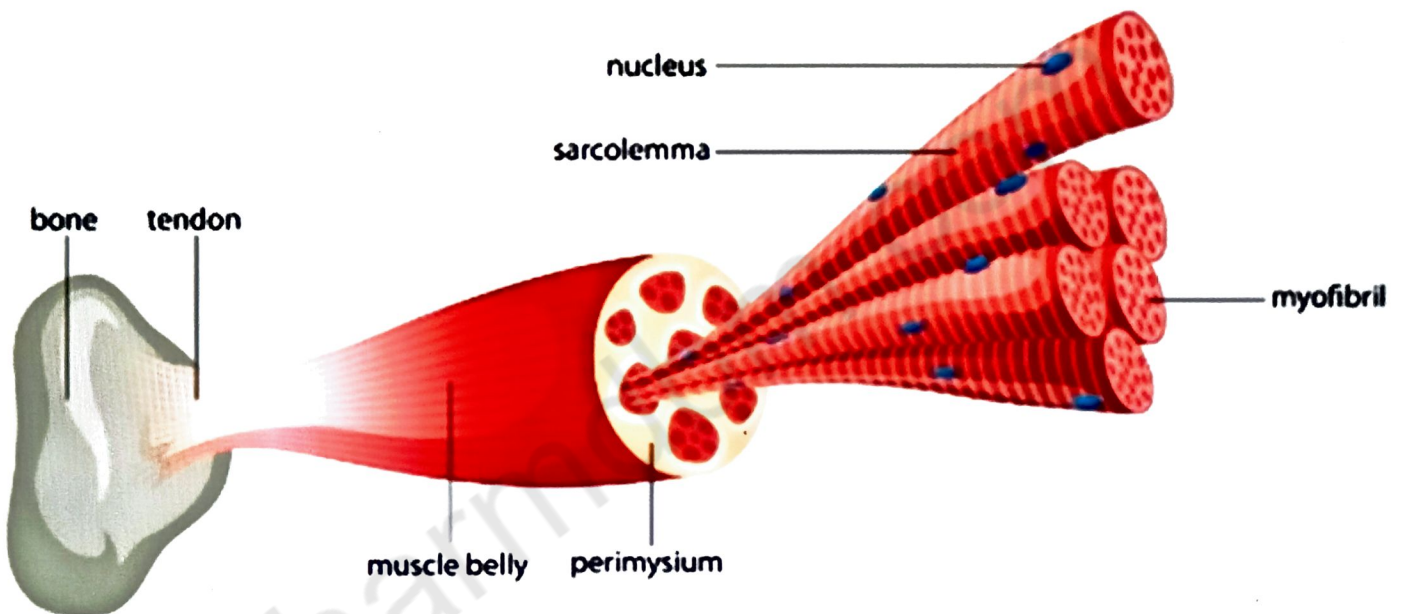
❖ Function of muscle

- Move the skeleton
- Maintain body posture
- Support soft tissues.
- Guard body entrances/exits.
- Maintain body temperature.
- Store nutrients.

Structure of a Skeletal Muscle



Structure of Human Muscle



PHYSIOLOGY OF MUSCLE CONTRACTION

Step 1: Motor Neuron Sends Message to Muscle to Contract

- The motor neuron sends an impulse in the form of a neurotransmitter to the muscle to contract.
- The neurotransmitter involved is acetylcholine which floats between an area of the neuron and muscle called as synapti cleft.

Step 2: Muscle Depolarizes

- **Acetylcholine** present in the **synaptic cleft** floats across to the motor end plate.
- It then **attaches** to the **receptors** on **transport** proteins on the motor end plate.
- When **acetylcholine** attaches to the **transport proteins**, it responds by **opening** and **letting** sodium into the cell.
- The rushing of **sodium inside** the cell changes its **potential** as sodium is **positively charged**.
- The cell **potential changes** and become **less negative**.

Step 3: Release of Calcium by the Sarcoplasmic Reticulum

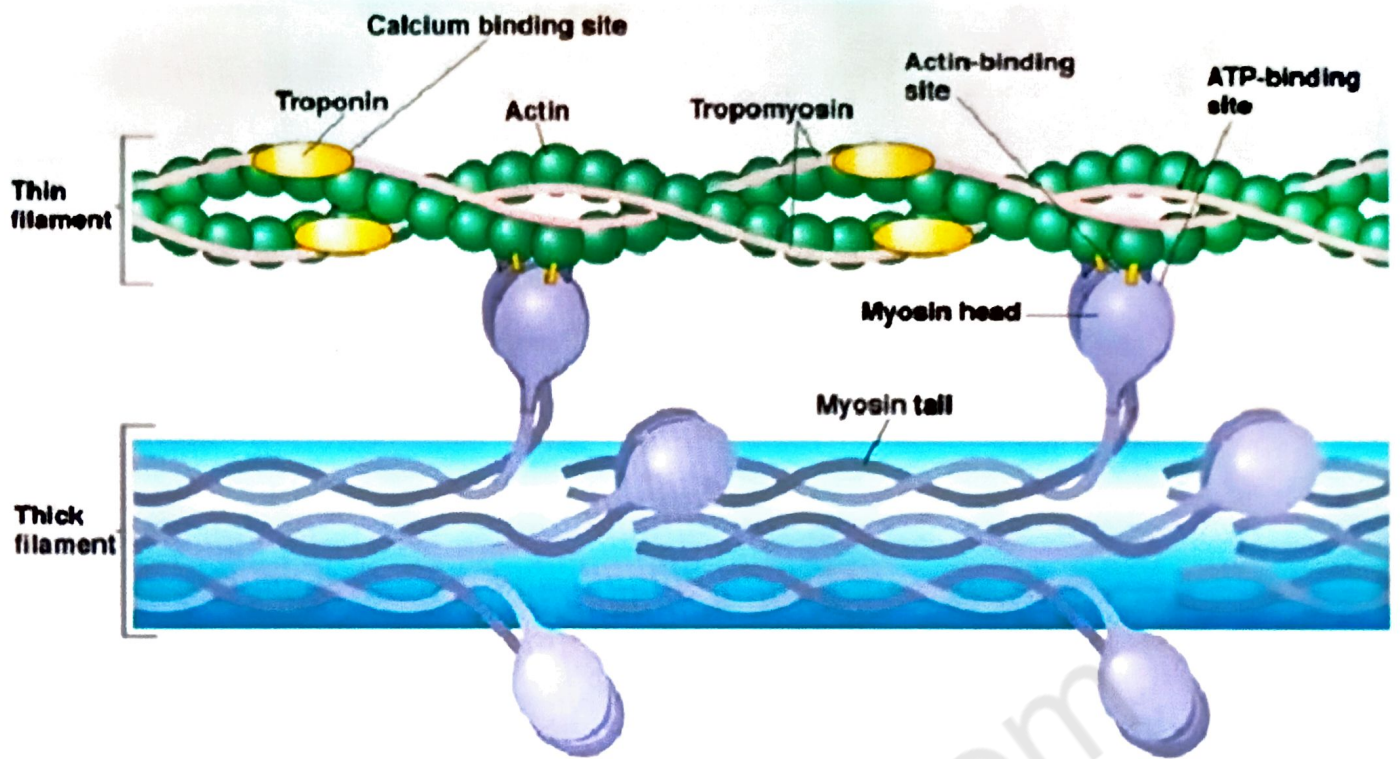
- The **sarcolemma** contains tube like structures called **T-tubules**.
- Inside the **sarcoplasmic reticulum** the **calcium concentration** is very high almost **2000 times** greater than inside the muscle cell.
- When the **cell depolarizes** the sarcoplasmic reticulum responds by **opening** the **calcium channels** in the **terminal cisternae** of the sarcoplasmic reticulum
- The **opening** of **calcium channels** results in rushing of calcium into the **sarcoplasm** of the muscle cell.
- This process is known as **excitation-contraction coupling**.

Step 4: Calcium Binds to the Troponin on the Actin

- **Calcium present** in the **sarcoplasm** of the muscle cell attaches to the **troponin** on the **troponin-tropomyosin** complex wrapped around the actin.
- This **changes** the position of the **troponin** that exposes the **myosin binding** site on the actin.
- The **myosin** can now bind with **actin** and forms what is known as a **cross-bridge**.

Step 5: Myosin Pulls Actin Along

- **Myosin** can now **move** at its **hinge region** and **subsequently** move the **actin along**. It causes actin and myosin to slide past each other.
- The cycle of movement ends when the **myosin releases** from **actin** and **return** to its **original position**.
- The energy required for **one cross-bridge** cycle is one **ATP molecule**.
- **ATP binds** with the **myosin head** that has **ATPase activity**.
- The **ATP decomposes** into **ADP** and a **phosphate**.
- **Calcium binds** to **troponin** and **exposes** the binding site of the **myosin** which binds to **actin** and **releases phosphate** while extracting energy from the **phosphate bond**.
- When **myosin pulls** actin along, **ADP** is released from the **myosin head**.
- **ATP binds** with **myosin head** and **breaks** it into **ADP** and **phosphate** which remain on the **myosin head**.
- Now the **myosin head releases** from the **actin** and regains its **resting position** with ADP and phosphate still on it.
- The **energy released** from the **ATP** is now stored in the **myosin head**.
- In **resting muscles** energy from **ATP** is stored in the **myosin heads** while they wait for another **contraction**.
- **Muscle contraction** usually **stops** when signaling from the motor neuron ends, which **repolarizes** the sarcolemma and Ttubules, and **closes** the **voltage-gated calcium channels** in the SR.
- **Ca⁺⁺ ions** are then **pumped** back into the SR, which causes the **tropomyosin** to reshield the binding sites on the actin strands.
- A muscle also can **stop contracting** when it runs out of **ATP** and **becomes fatigued**.



NEUROMUSCULAR JUNCTION

- Neuromuscular junction is a **junction** between a **nerve ending** and the **skeletal muscle**.
- At this site, the **nerve loses** its **myelin sheath** and gets expanded to nerve endings.
- These nerve endings pierce the **sarcolemma** and come in contact with the **sarcoplasm** of the **muscle cell**.
- **Acetyl choline** is **produced** and **stored** in some vesicles present in this expanded portion.
- **Motor end plate** is the part of the **muscle facing** the expanded nerve terminal.
- The surface of **motor end plate** is convoluted and it has the enzyme **Acetylcholinesterase**.
- Acetylcholine is **inactivated** by this enzyme , if it is **produced in excess**.