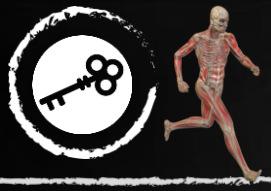
# Aakash + BYJU'S NOTES

## Locomotion and Movement

# Key Takeaway

1. Locomotion
2. Movements
3. Muscle
4. Structure of muscle
5. Structure of contractile proteins



6 Light and dark bands

Cross bridge cycle 7

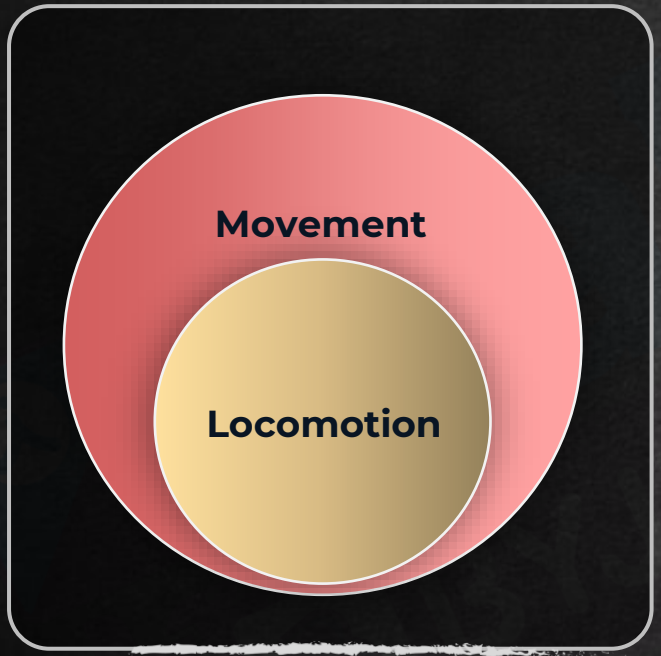
8 Sliding filament theory

Human skeletal system 9

- **Axial skeleton**
  - Skull
  - Vertebral column
  - Sternum
  - Ribs
- **Joints**
  - Synovial joints
- **Appendicular skeleton**
  - Pectoral girdle
  - Bones of arms
  - Pelvic girdle
  - Bones of legs
- **Disorder of muscular and skeletal system**

**Summary**

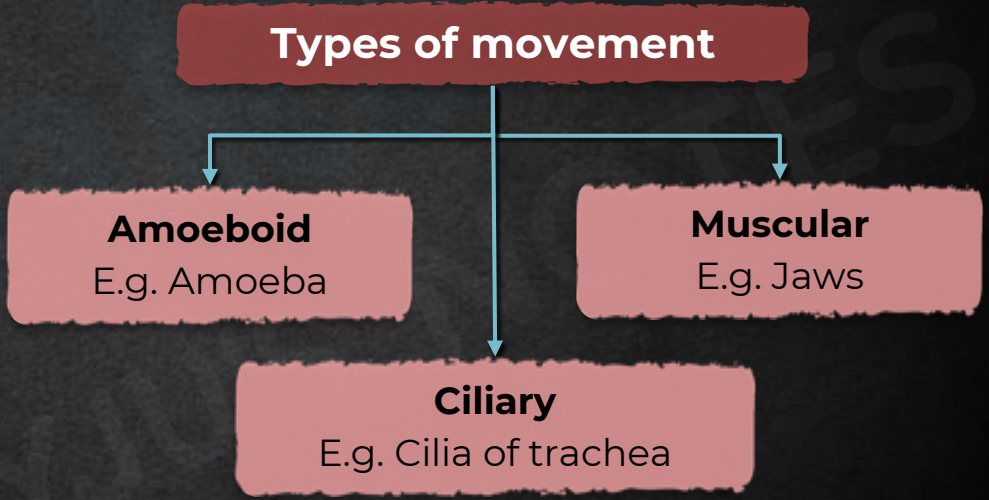
# Locomotion




- Locomotion: It is the ability of an entity or organism to move from **one place to another**.
- Locomotion is a type of movement, but **not all movements are locomotory**.
- **Locomotion** is a special type of movement where the organism **changes** its **position**.
- Examples:
  - Limbs in humans for walking
  - Cilia in *Paramecium*

# Movements

- It is the **change of position** in an organism. It is essential for all living organisms including humans.
- Examples:
  - Pumping of blood
  - Breathing through lungs
  - Mobility of vesicles inside a vessel



# Movements

| Amoeboid movements | Ciliary movements | Muscular movements |
|---|---|---|
| • It occurs with the help of **pseudopodia**.<br>• Pseudopodia is formed by **cytoplasmic streaming**.<br>  ○ **Cytoskeletal** elements such as microfilaments aid in cytoplasmic streaming.<br>• Examples: Amoeba, macrophage, etc. | • This type of movement occurs in some internal organs.<br>  ○ The organs that are lined with ciliated epithelium show this movement.<br>• Examples: Trachea, female reproductive system | • It is the movement shown by limbs, jaws, tongue, etc.<br>• The **contractile property of muscles** is utilised for this **movement**.<br>• Examples: Humans and majority of multicellular organisms. |

# Movements

## Types of movements based on control

### Voluntary movements

- These **movements** can be controlled consciously.
- They are associated with skeletal components and controlled **voluntarily**.

### Involuntary movements

- They are under the control of the **autonomic nervous system**.
- These **movements** are **involuntary**, i.e., they cannot be controlled by our will.

# Muscle


- **Contractility:** It is a property that allows it to shorten and return to its original state.

- It is a type of specialised tissue originating from **mesoderm**.
- It is made up of cells known as **myocytes**.
- Myocytes provide **contractility** and allow muscles to gain the ability to contract.
- The stimulus provided by a myocyte spreads to the neighbouring myocyte.

# Muscle

## Unique properties of muscles

### Contractibility

- It is the property that allows a muscle to shorten and return to its original state.

### Excitability

- It is the ability of a muscle to respond to a stimulus.

### Elasticity

- It is the ability of a muscle to recoil or bounce back to its original length.

### Extensibility

- It is the ability of a muscle to stretch itself.

# Muscle

## Types of muscles

### Smooth muscles

- **Tapering ends**: The cells taper at both the ends.
- **Striations are absent**: The altering light and dark bands are absent, giving a smooth appearance to the muscles.

### Cardiac muscles

- It is present only in the heart.
- It is a **contractile tissue** that aids in the beating of the heart.
- Cardiac muscle helps in maintaining the cardiac cycle.
  - It has continuous rhythmic heart movements: contraction and relaxation.

### Skeletal muscles

- It is closely associated with skeletal components of the body.
- **Voluntary muscle**: The movements of this muscle are under the control of the nervous system.
- Muscle fibres have a **striated appearance** under microscope.
- It enables the movements of body parts.

# Muscle

## Types of muscles

### Smooth muscles

- It is also known as the following:
  - **Visceral muscle**: As it forms the lining of hollow organs
  - **Non-striated muscle**: As it lacks striation
  - **Non-stripped muscle**: As it appears smooth
  - **Involuntary muscle**: As it is involuntary in nature
- It assists in:
  - **Transport of food** through digestive tract
  - **Transport of gametes** through female genital tract

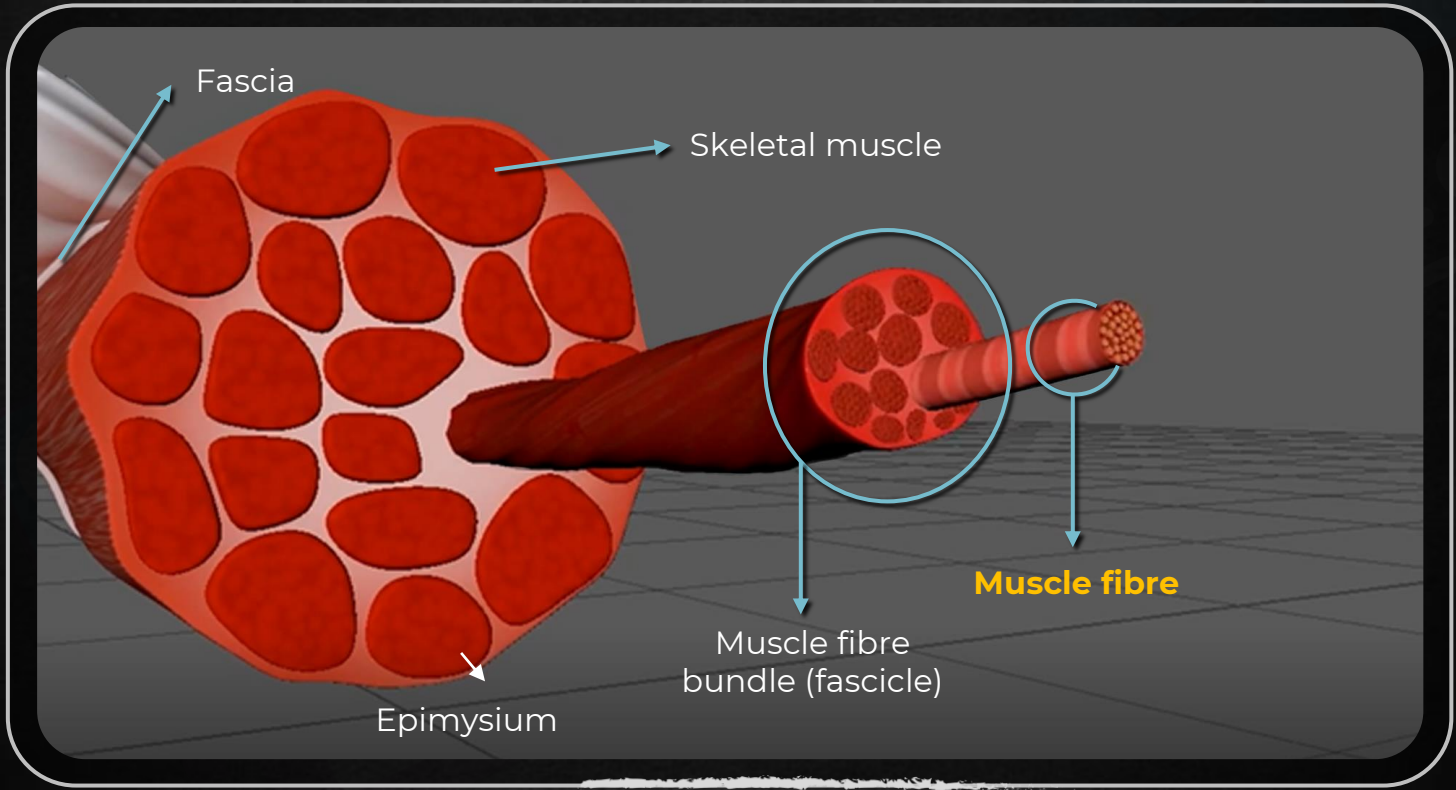
### Cardiac muscles

- It is also known as the following:
  - Striated muscle
  - Involuntary muscle

### Skeletal muscles

- It is also known as the following:
  - Striped muscle
  - Striated muscle
  - Voluntary muscle
- Examples:
  - Muscles of tongue
  - Muscles of limbs

# Structure of Muscle



# Structure of Muscle

## Fascia

- The **collagenous sheath** surrounding the muscle which holds together muscle bundle fibres.

## Epimysium

- It is a **dense connective tissue sheath** surrounding a muscle.

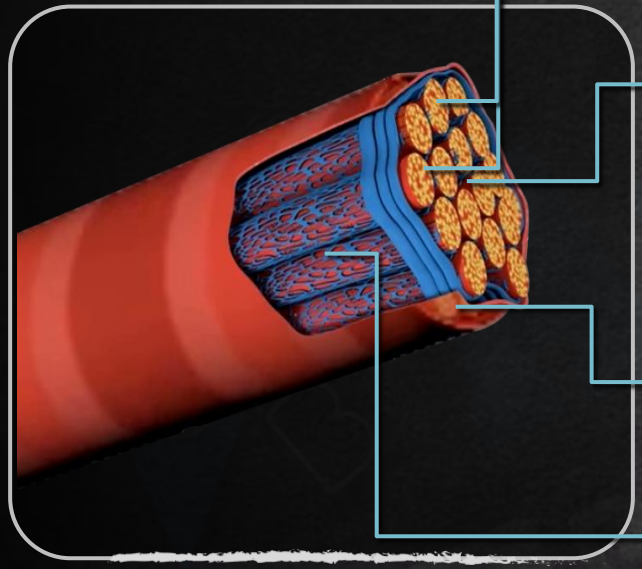
## Muscle bundle fibre

- The muscle fibres are arranged parallelly in the form of a bundle known as a muscle bundle fibre or **fascicle**.

## Muscle fibre

- Each fascicle has many muscle fibres.
- Muscle fibres are arranged parallel to each other.

# Structure of Muscle



## Myofibril

- A muscle fibre contains many filamentous myofibrils/myofilaments.

## Sarcoplasm

- It is the **cytoplasm** of the striated muscle.
- Sarcoplasm contains lots of nuclei. Hence, it is termed as **syncytium** (multinucleated).

## Sarcolemma

- Muscle fibres are covered by a layer of **plasma membrane** known as sarcolemma.

## Sarcoplasmic reticulum

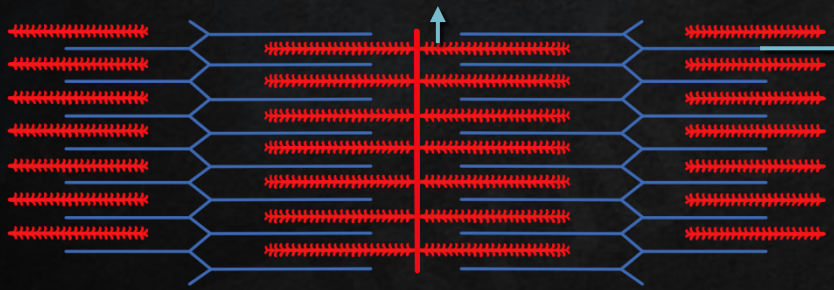
- Sarcoplasm has the endoplasmic reticulum known as a **sarcoplasmic reticulum** that **stores calcium.**
- This calcium aids in muscle contraction.

# Structure of Muscle

**Myofibril**

- Each muscle fibre has many myofibrils.
  Each myofibril contains many proteins.

**Thick filament:** Constitutes myosin



**Thin filament:**
Constitutes actin

- Myofilaments are made up of actin and myosin that are also known as **contractile proteins**.
- Myosin and actin both are rod-like structures arranged parallel to each other.
  - They are longitudinal to myofibrils. The actin filaments are thinner than myosin filaments.

# Structure of Contractile Proteins

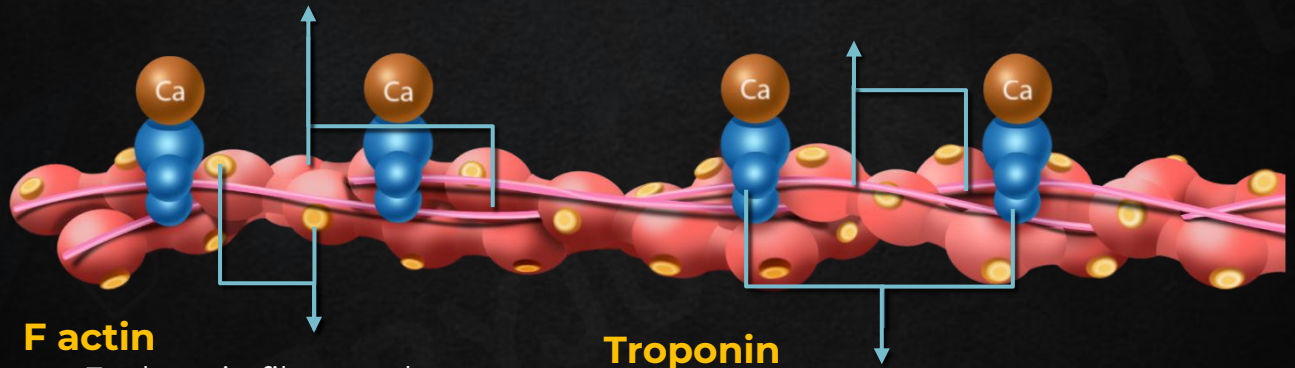
## Structure of actin

### G actin

- Each F actin is a polymer of monomeric units known as **G (globular protein) actin**.

### Tropomyosin

- It is the protein that runs close to F actin.




### F actin

- Each actin filament has two filamentous actin known as **F actin** helically wound to each other.

### Troponin

- It is the filament that holds the tropomyosin and is present in regular intervals.
- It blocks the active binding sites of actin.

# Structure of Contractile Proteins

## Structure of myosin

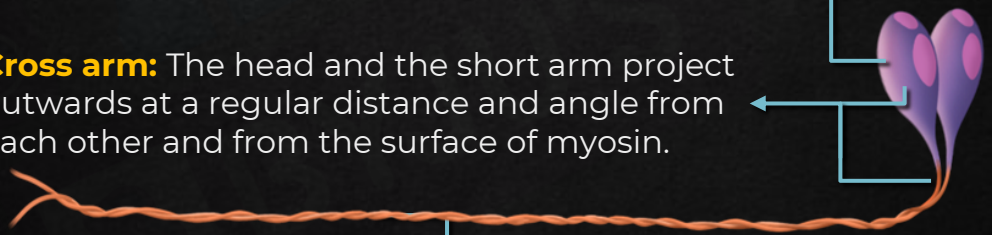
### Myosin

- Myosin is also known as the thick filament.
- It is the polymer of meromyosin. Monomeric proteins are known as **meromyosins**.
- Each meromyosin has two parts: HMM and LMM.

### HMM: Heavy meromyosin

- Globular head: It is an active ATPase enzyme. It has binding sites for ATP and active sites for actin.
- It has a short arm.

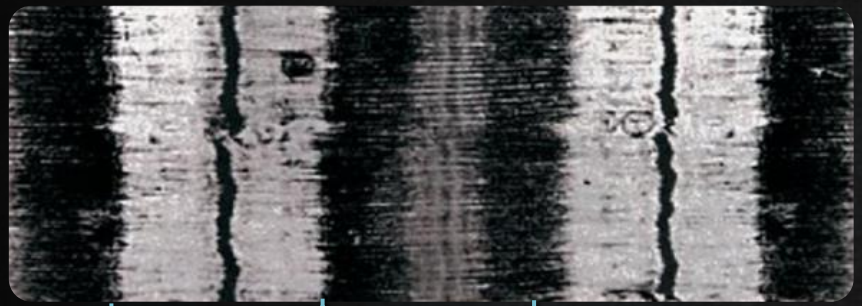
**Cross arm:** The head and the short arm project outwards at a regular distance and angle from each other and from the surface of myosin.



### LMM: Light memomyosin

- It is the tall.

# Light and Dark Bands



**Light band**
Constitutes actin

**Dark band**
Constitutes myosin

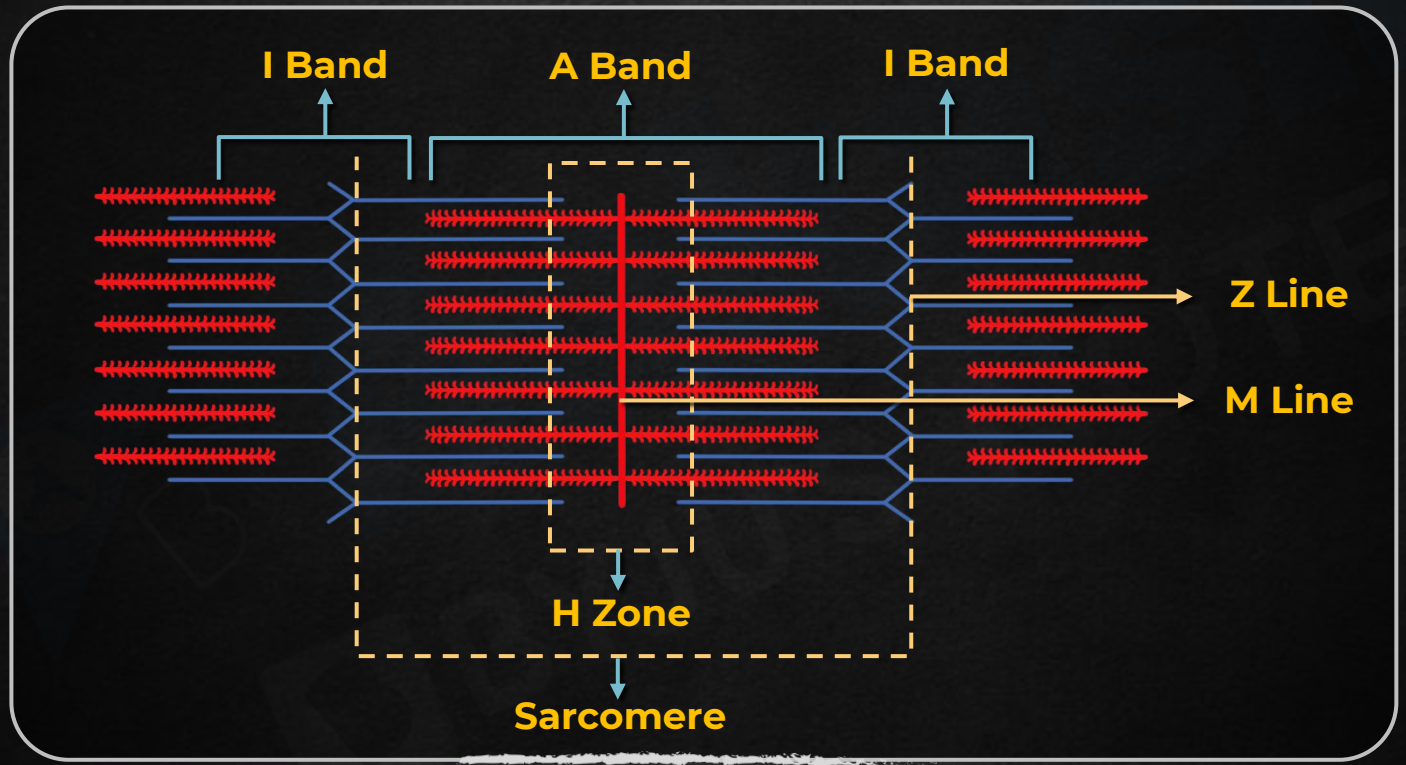
- Actin and myosin are arranged in the myofibril in such a way that they appear as **light** and **dark bands**. This gives the skeletal muscles a **striated appearance**.

# Light and Dark Bands

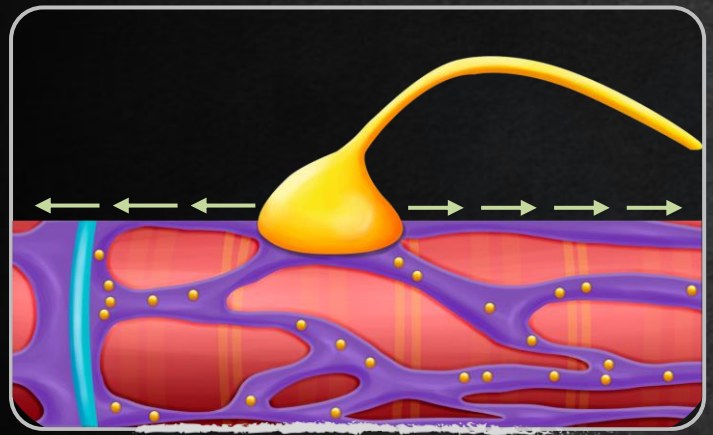
**Sarcomere** is the portion between the successive Z lines.
A sarcomere is a functional unit for contraction.

- **I band**
  - The light band contains **actin**.
  - It is also known as the **I band or isotropic band**.
- **M line**
  - It is a thin, fibrous membrane.
  - It holds the dark bands together.
- **H zone**
  - It is the central part of the thick filament that **has only myosin** or the thick filament.
  - The overlapping thin filaments are not present in this region.
- **Z line**
  - The I band is bisected by an elastic fibre known as the **Z line**.
  - The zigzag line cuts through the I band.
- **Dark band**
  - The dark band has **myosin**. It is overlapped by actin filaments at the periphery.
  - It is also known as the **A band or anisotropic band**.
  - A band and I band are arranged alternately throughout the myofibril.

# Light and Dark Bands

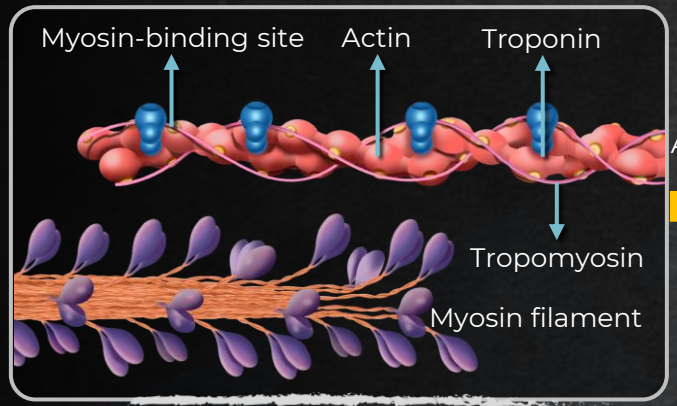


# Muscle Contraction



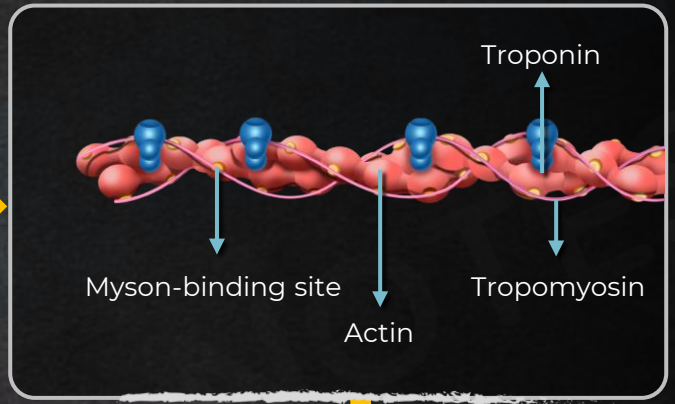
- When an electrical signal reaches the neuromuscular junction, the neurotransmitter molecules are released.
- The neurotransmitter molecules bind to the receptors on the sarcolemma. This generates an action potential in the muscle fiber.
- **Action potential** - It is an electrical impulse that propagates on the muscle fiber.
- The action potential spreads to both sides from the neuromuscular junction.
- An action potential causes the sarcoplasmic reticulum to release calcium ions.
- These calcium ions ultimately bring about the contraction of the muscle, by means of the **cross-bridge cycle**.

# Cross-Bridge Cycle

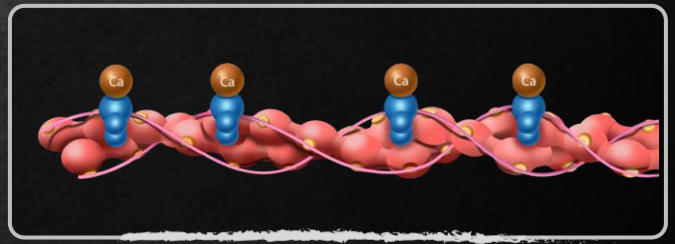



Actin filament

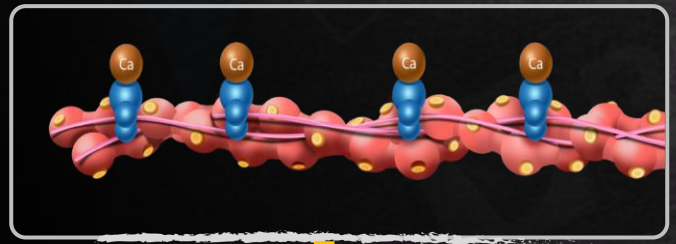
**Myosin-binding site masked at resting state**




**During action potential $Ca^{2+}$ binds to troponin causing conformational change**

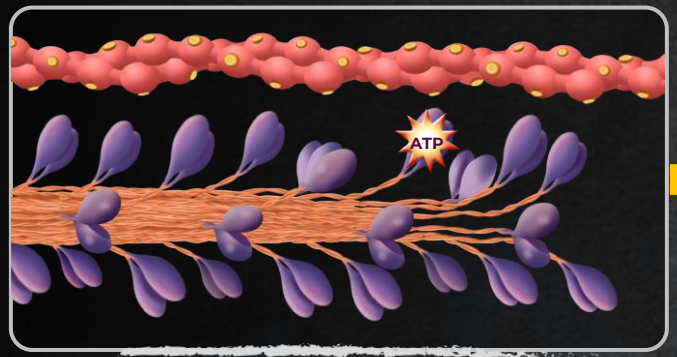



**Myosin-binding sites exposed**

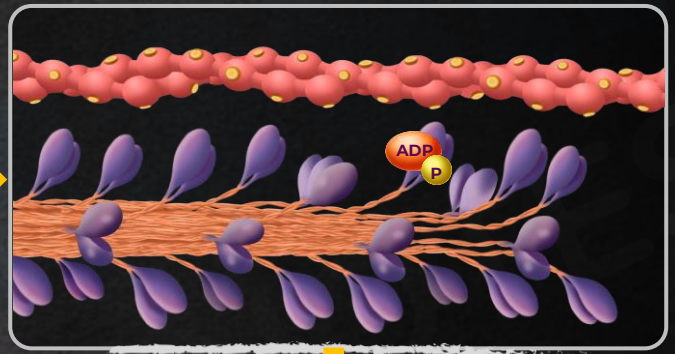


# Cross-Bridge Cycle

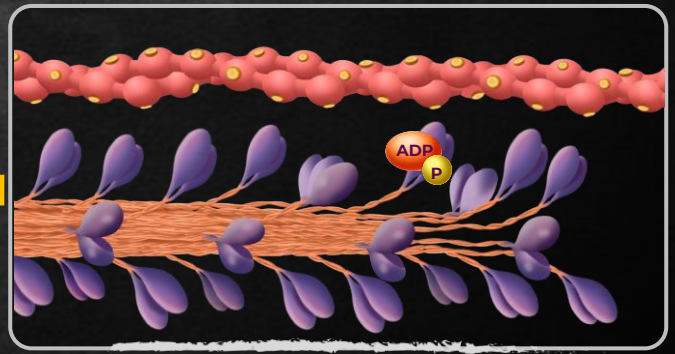
Myosin head binds ATP



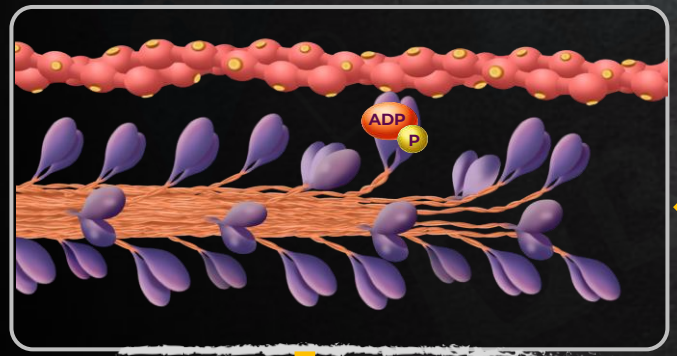

Myosin head hydrolyses ATP and is full of energy




Myosin head binds actin

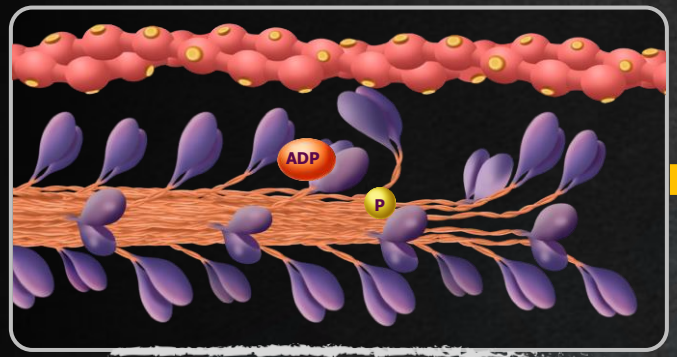



Myosin head pulls actin filament

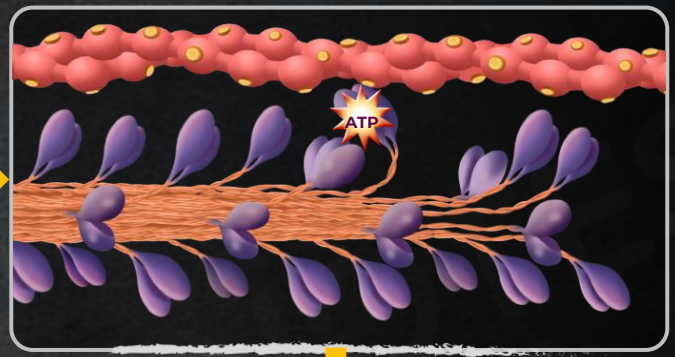


# Cross-Bridge Cycle

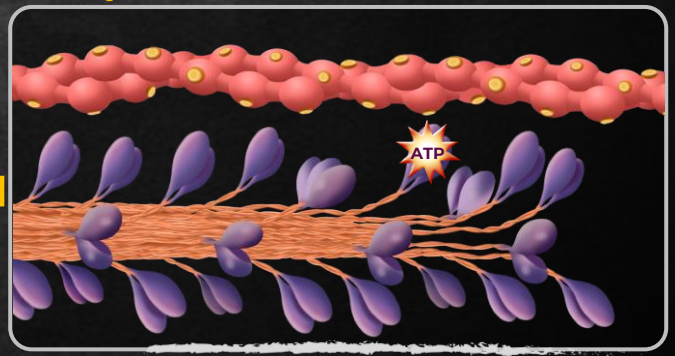
Myosin head releases ADP and P



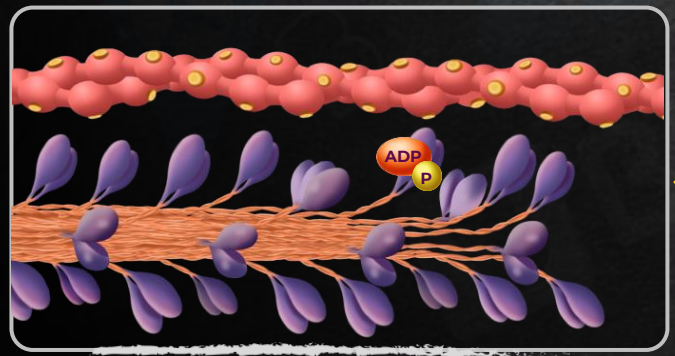

Myosin head binds fresh ATP



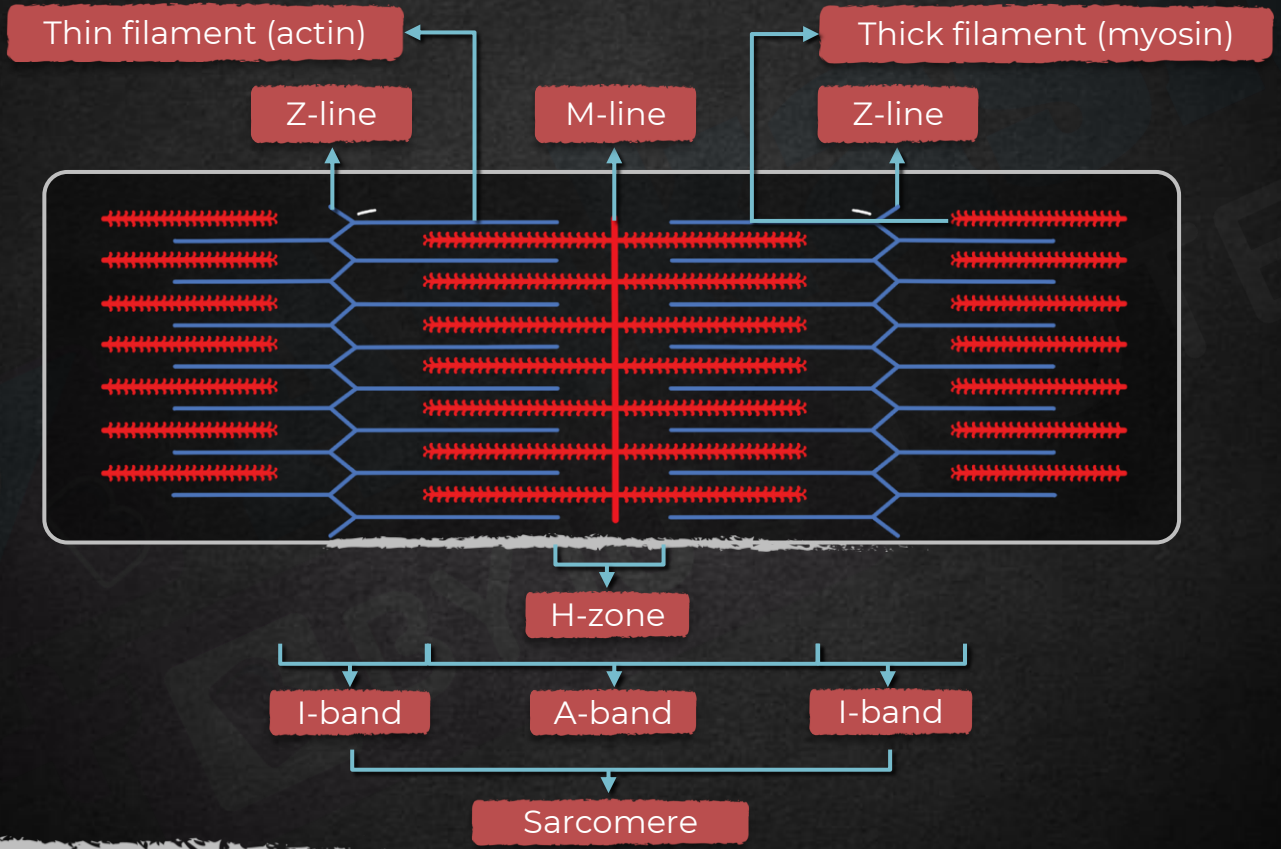

Myosin detaches from actin filament




Myosin hydrolyses ATP

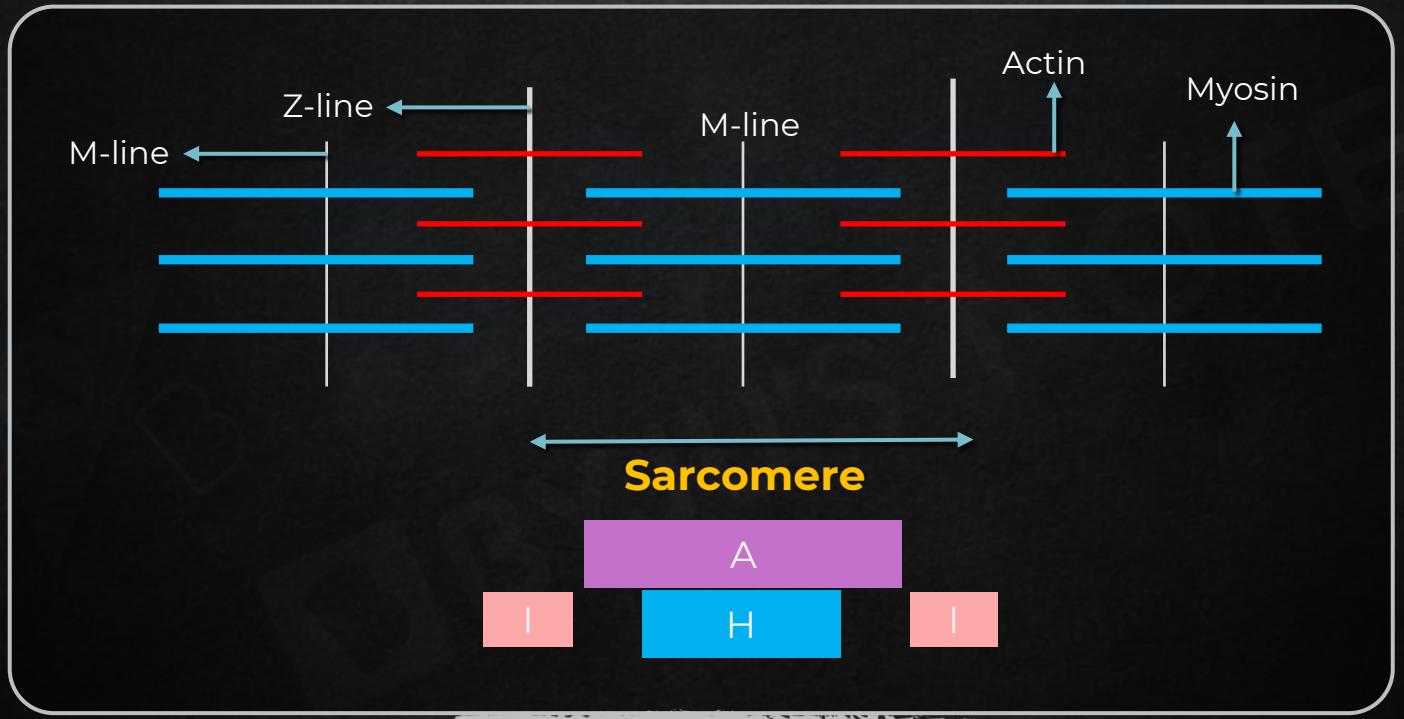


# Sliding Filament Theory



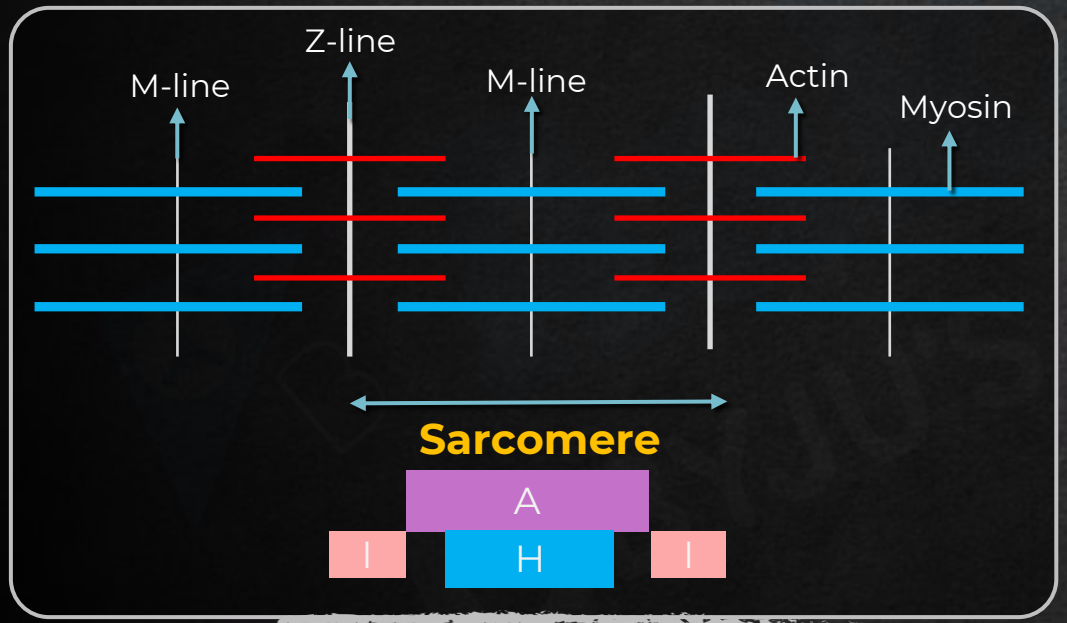
# Sliding Filament Theory

## Relaxed state of muscle



# Sliding Filament Theory

## Contracting state of muscle



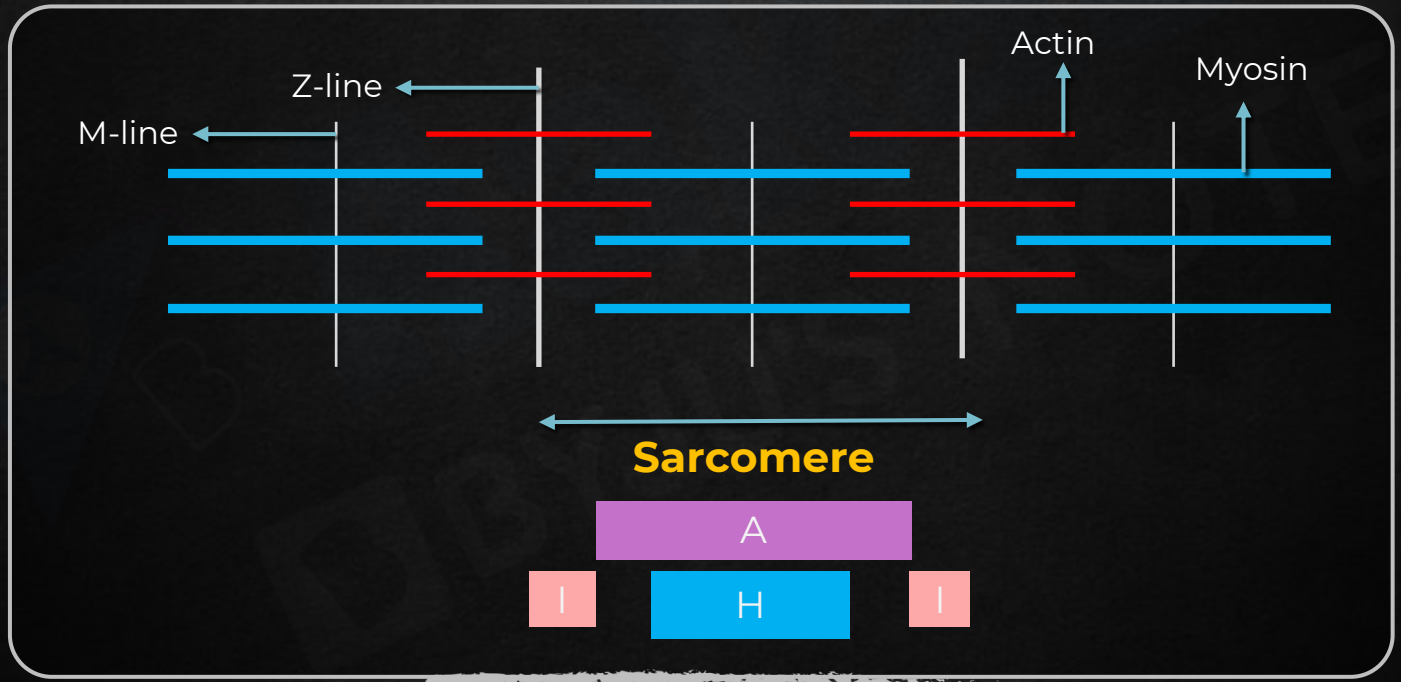

When the myosin head binds and pulls at the actin filament, the **actin filaments come closer to the M-line.**

a. The Z-lines come closer
b. The length of the sarcomere shortens.
c. The lengths of the **I bands shortens.**
d. The length of the A band remains the same.

# Sliding Filament Theory

## Maximally contracted state of muscle

In this state of the muscle, the length of the sarcomere is the shortest.



# Sliding Filament Theory

## Relaxation of muscle

- After a muscle contracts, it has to come back to its original relaxed state.
- The steps of contraction are reversed as follows:
  - **Calcium ions are pumped back** into the sarcoplasmic reticulum.
  - **Tropomyosin masks myosin-binding** sites on actin once again.
  - So, myosin is no longer able to bind the actin filament.
  - Z lines go back to their original position.
  - Hence, the sarcomere goes back to its original length.
- The **lengthening** of the sarcomere means the **relaxation** of the muscle.

# Tetanus or Tetanic Contraction

- In a normal condition, an electric impulse comes from a motor neuron, the muscle contracts and then relaxes.
- When the **electric impulses come too fast**, the **muscle does not get the time to relax**.
- It is then in a state of continuous contraction. This is called **tetanic contraction** or tetanus.

# Muscle Fatigue

- While exercising, the glycogen stored in the muscles is readily converted to its monomer glucose, which then undergoes cellular respiration in order to produce energy.
- **Glycogen levels** become **depleted** in the exercising muscles after **prolonged or strenuous exercise**.

# Red and White Muscle Fibres

Every muscle of the body is composed of two types of muscle fibers: **red and white**, named so because of their colors.

| Red muscle fibre | White muscle fibre |
|---|---|
| • More blood vessels - more oxygen | • Less blood vessels - less oxygen |
| • More mitochondria - more aerobic respiration | • Less mitochondria - more anaerobic respiration |
| • Large amounts of myoglobin - stores oxygen - red in color | • Less amount of myoglobin |
| • Less sarcoplasmic reticulum - slow release of $Ca^{2+}$ - slow muscle contraction | • Extensive sarcoplasmic reticulum - rapid release of $Ca^{2+}$ - fast muscle contraction |
| • Marathoners born with more red fibres | • Sprinters born with more white fibres |

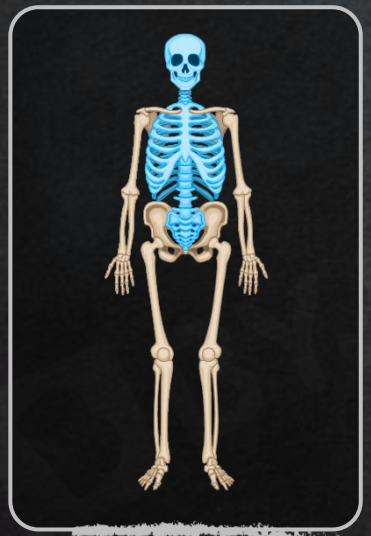
# Human Skeletal System

- The **hard, supportive, or protective elements** of the animal body constitute the skeletal system or skeleton.
- It consists of a **framework of bones (206) and a few cartilages**.
- **Functions**
  - It supports the internal softer organs.
  - It protects the delicate parts.
  - It helps in movement.
  - It provides attachment for muscles.
  - It gives the body its shape and form.
  - It helps in the formation of blood cells in bone marrow.
  - It helps in breathing (tracheal rings, sternum, and ribs).
  - It helps in hearing as ear bones (middle ear) transmit sound vibrations.

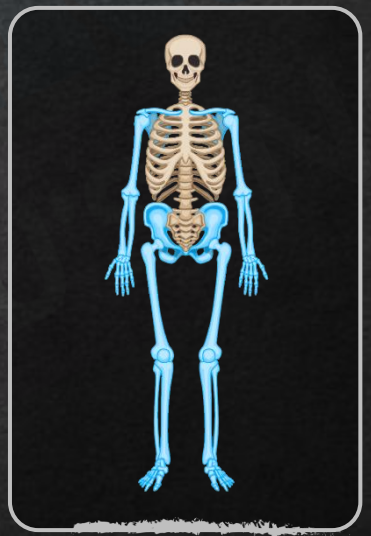
# Human Skeletal System

On the basis of **the position of the skeletal structures** in the body, the skeleton is divided as follows:

- Axial (80 bones)
  - Skull
  - Vertebral column
  - Sternum
  - Ribs



- Appendicular (126 bones)
  - Pectoral girdle
  - Arm bones
  - Pelvic girdle
  - Leg bones



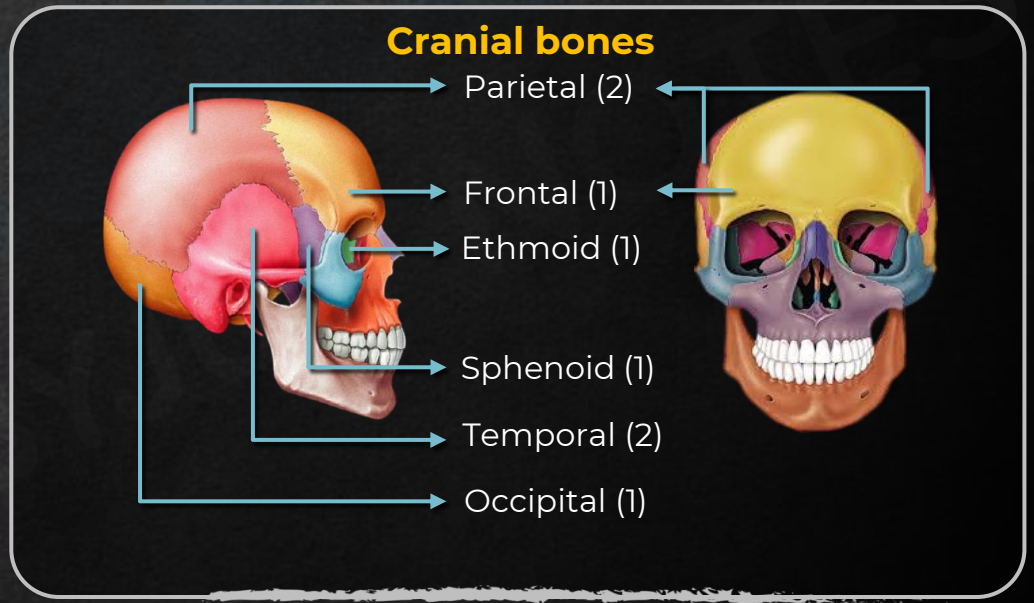
# Axial Skeleton

## Skull

- It is the bony framework of the head.
- The skull is composed of the following set of bones:

### Cranial bones

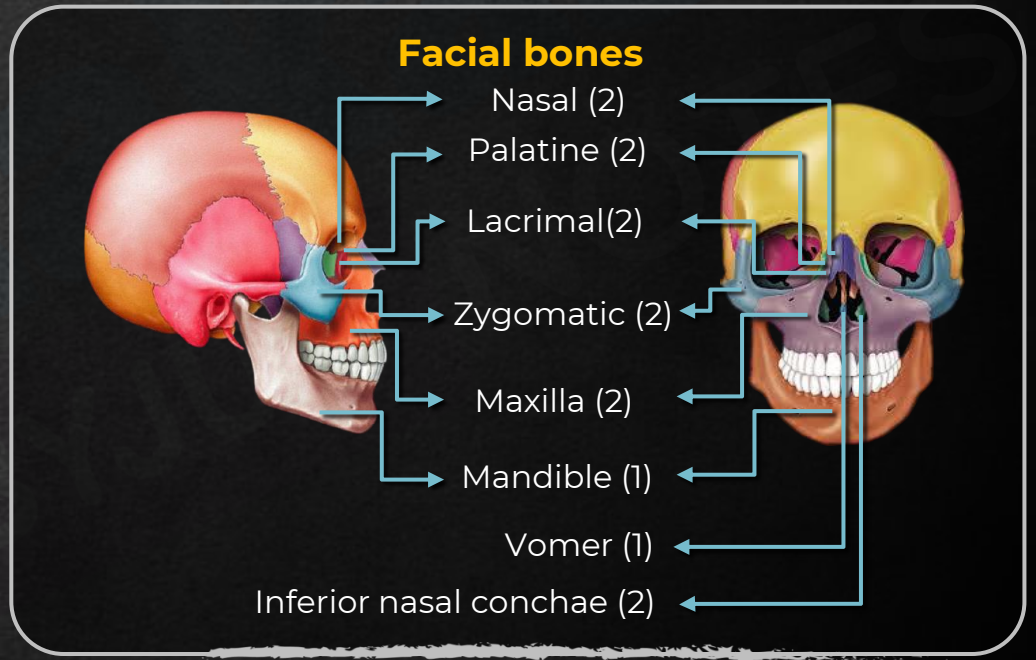
- Cranium is the **skeleton of the head**.
- It is the **outer protective covering** of the brain.
- It is made of **8 cranial bones**.



# Axial Skeleton

## Facial bones

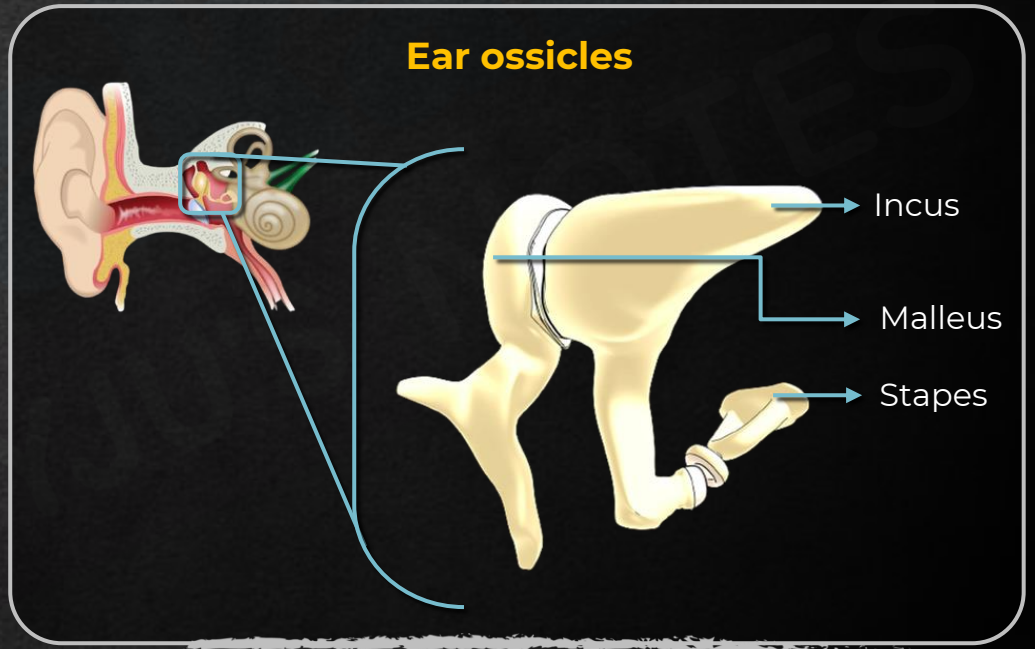
- It forms the front part of the skull.
- There are **14 facial bones**.



# Axial Skeleton

## Ear ossicles

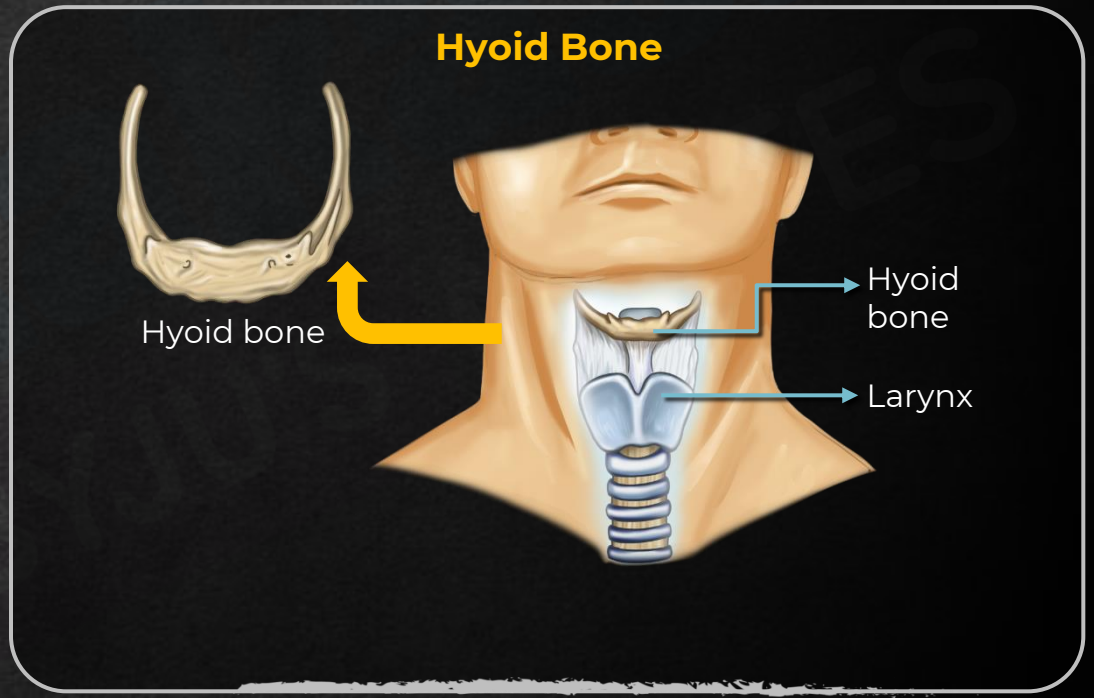
- Ear ossicles are also known as **auditory ossicles**.
- They are the 3 bones present in the **middle part** of human ears.
- So, there are a total of six ear ossicles in the body.
- The ear ossicles are the three of the smallest bones in the human body.



# Axial Skeleton

## Hyoid

- It is a **U-shaped** bone.
- It is present at the **base of the buccal cavity** above the larynx.
- It is the **only bone** that is **not in contact with any other bone**.
- It is also known as the **tongue bone**.
- It acts as a point of attachment for certain tongue muscles and the floor of the mouth.



# Axial Skeleton

## Mnemonics

### Bones of cranium

**F**luffy **P**uppies **O**n **E**very **T**hird **S**treet

- **F**rontal
- **E**thmoid
- **P**arietal
- **T**emporal
- **O**ccipital
- **S**phenoid

### Bones of face

**V**ictor **C**an **N**ot **M**ake **M**y **P**et **Z**ebra **L**augh

- **V**omer
- **M**andible
- **C**onchae (inferior)
- **P**alatine
- **N**asal bone
- **Z**ygomatic
- **M**axilla
- **L**acrimal

# Axial Skeleton

## Skull

Based on the number of articulations, skulls are of two types:

### Monocondylic

- 1 occipital condyle
- E.g. - birds, reptiles


### Dicondylic

- 2 occipital condyle
- E.g. - humans

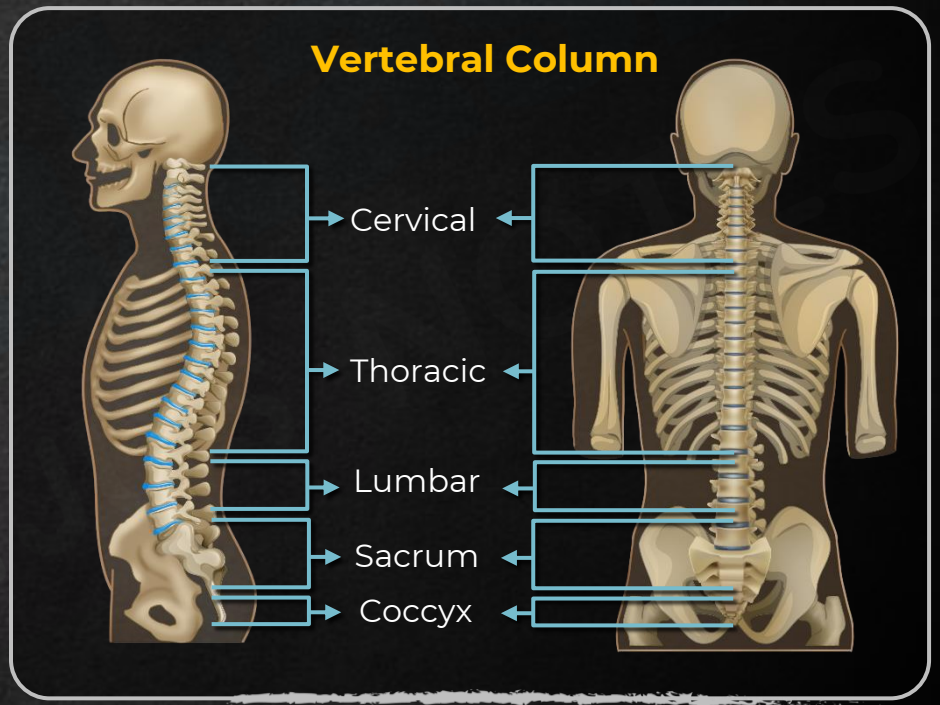

- Occipital condyles are **bony articulations** that are projections on the occipital bone.

- **Humans have dicondylic skulls**.
- In the posterior end, there are these two rounded occipital condyles.
- They attach with the first vertebrae.

# Axial Skeleton

## Vertebral column

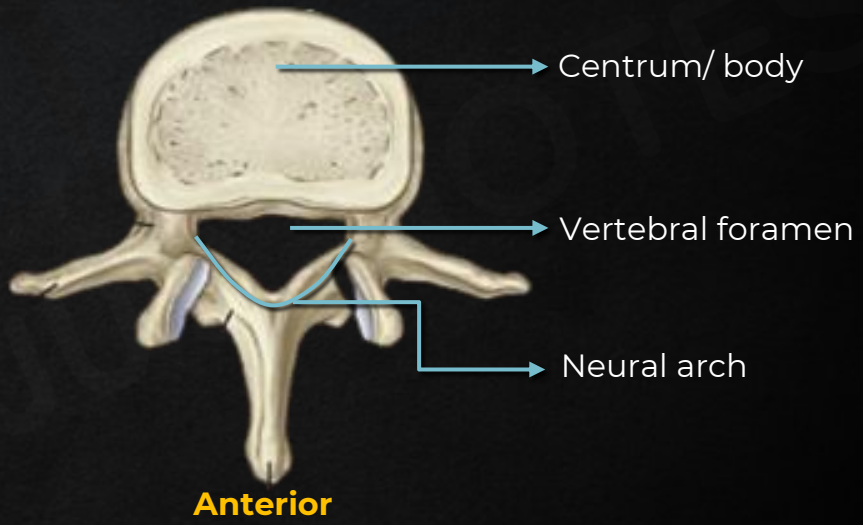
- The **vertebral column or the backbone** is curved and lies dorsally in our body.
- It comprises **26 serially arranged units called vertebrae**.
- It extends from the **base of the skull and forms the framework of the trunk**.
- **Functions**
  - It bears the bodyweight in the standing position and while the body is in motion.
  - **It protects the spinal cord.**
  - It supports the head.
  - It serves as the point of attachment for the ribs.



# Axial Skeleton

## Vertebral column

- The **components of the vertebral column** are known as **vertebrae**.
- The anterior with a large disc-like flattened part is known as the body or **centrum**.
- The posterior portion is known as **neural arch**.
- The neural arch forms a hole known as **vertebral foramen**.
- The **24 vertebral foramen** together **form vertebral canal/neural canal**. The spinal cord passes through this neural canal.



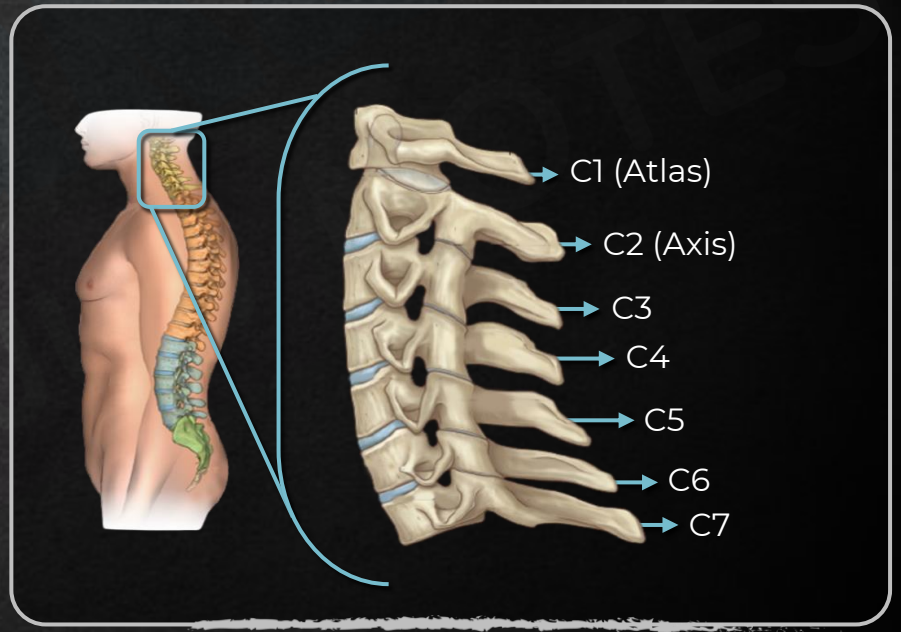
# Axial Skeleton

## Vertebral column

The vertebrae are grouped into **five types**, depending on the level of the vertebral column where they are found:

### Cervical (7)

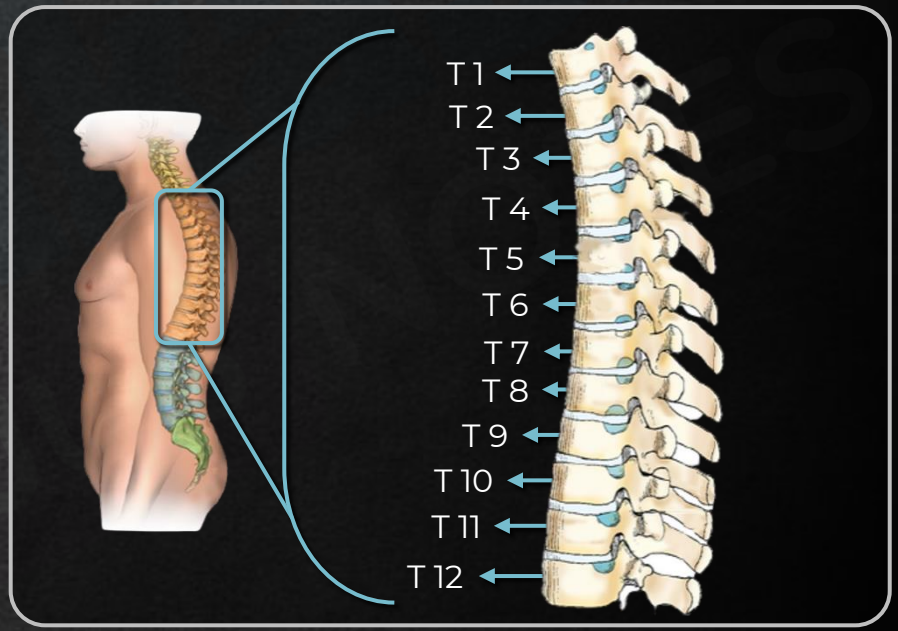
- It is present in the neck.
- They are **7** in number in almost all mammals.
- The **first cervical vertebra is the atlas**. It articulates with the occipital condyles and supports the head.
- **The second vertebra is known as the axis.**



# Axial Skeleton

## Thoracic (12)

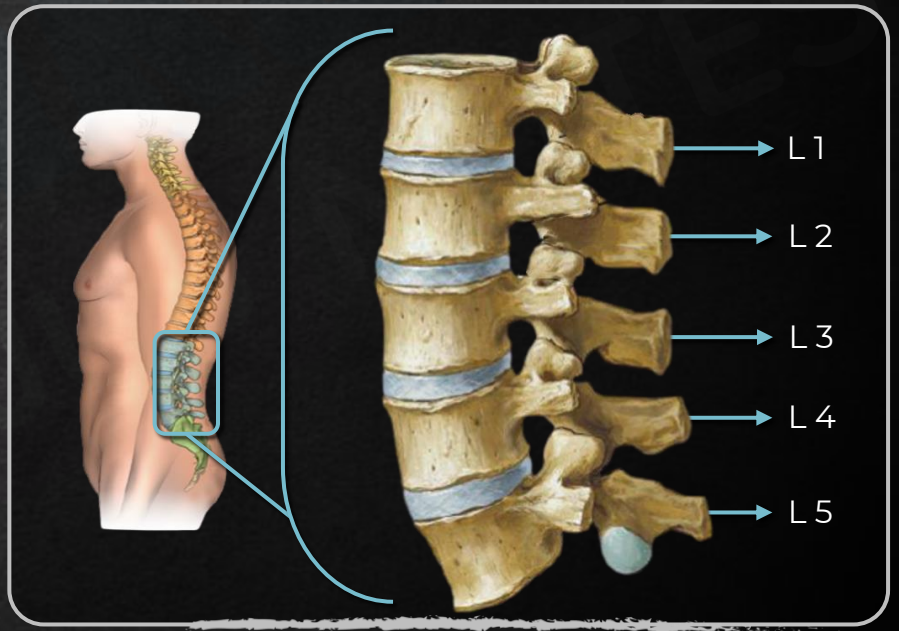
- They are present in the chest level.
- They are **12** in number.
- They are larger and stronger than cervical vertebrae.
- They are **joined with the ribs**.



# Axial Skeleton

## Lumbar (5)

- Lumbar vertebrae are present in the **lower back**.
- They are **five** in number.
- They are the largest and strongest of all vertebrae.
- They have to bear the weight of the whole body when the body is in a standing position.



# Axial Skeleton

## Sacrum (1) (Fused)

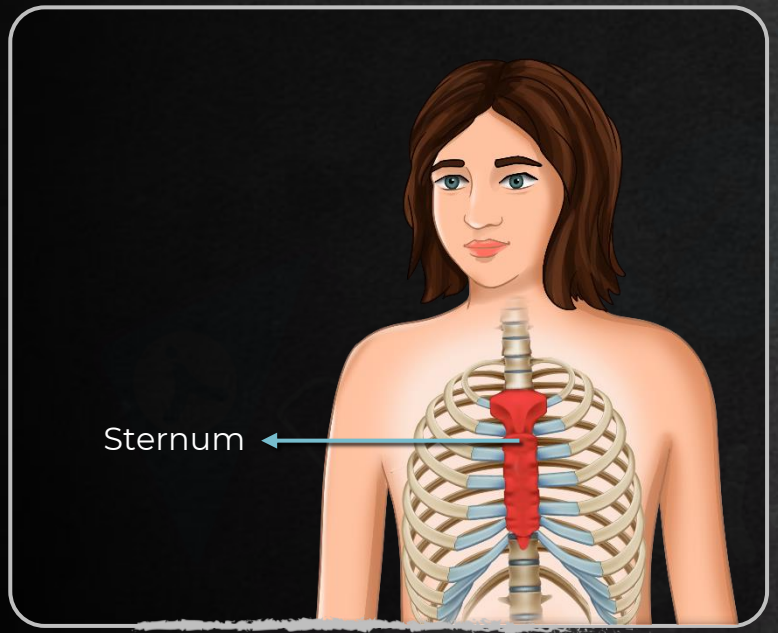
- **Five sacral vertebrae are fused**, forming the sacrum.
- The vertebrae are separate in the beginning, but start to fuse during adolescence.
- The sacrum lies between the innominate or hip bones.

## Coccyx (1) (Fused)

- The **four coccygeal vertebrae fuse** to form the coccyx.
- The vertebrae separate in the beginning, but start to fuse during adolescence.
- The coccyx is considered to be the **vestigial tail** in humans.

# Axial Skeleton

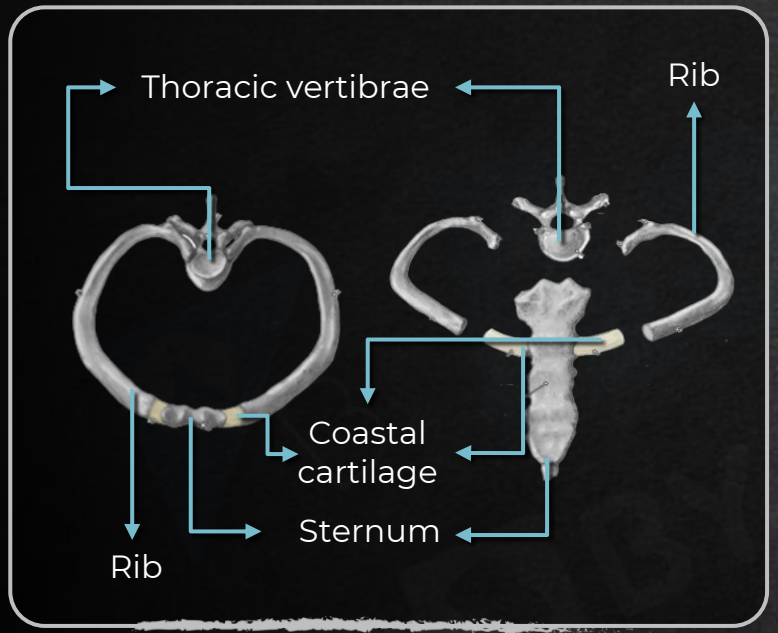
## Sternum




- The sternum is also known as the **breastbone**.
- It is a flat dagger-shaped bone.
- It is present just under the skin in the front and middle of the chest.
- It provides the **point of attachment for ribs**.
- It also protects the organs in the thoracic region and helps in respiration.

# Axial Skeleton

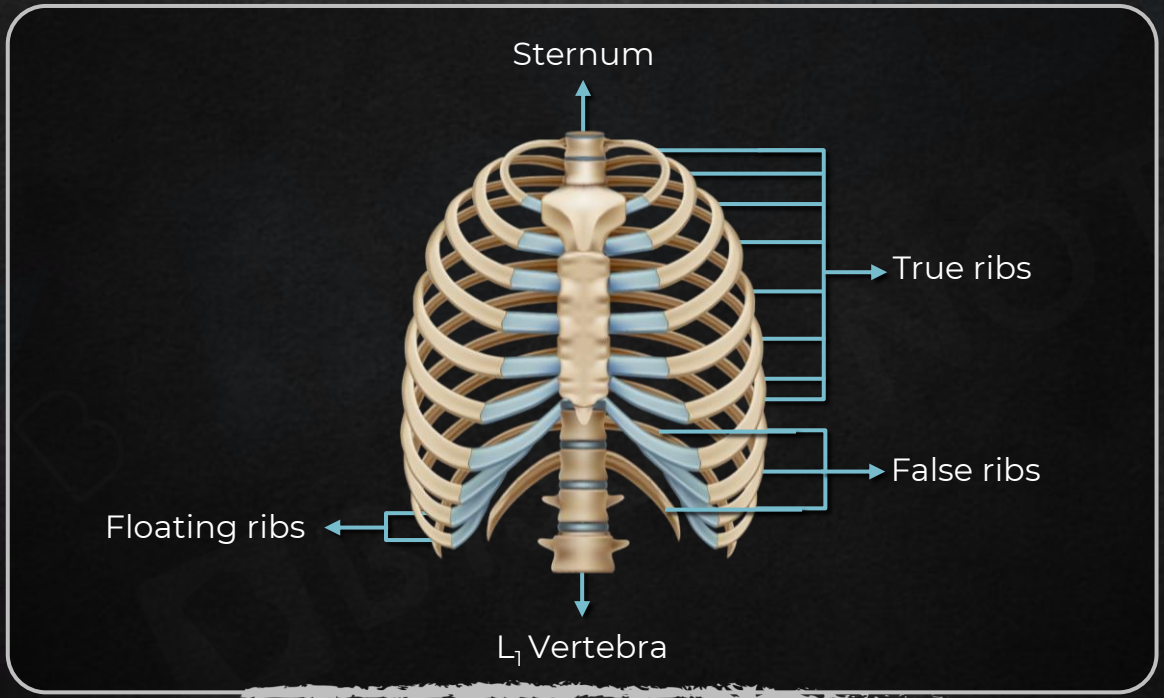
## Ribs




- They are the thin, flat, and curved bones that form a **protective cage** around the organs of the upper body.
- The ribs are composed of 24 bones arranged in **12 pairs**.
- They are **dorsally connected** to the **vertebral column** (thoracic vertebrae) and **ventrally to the sternum**.
- They have **two articulations/attachment surfaces** on their dorsal ends. Hence, they are known as **bicephalic**.
- **Functions:**
  - They **protect the organs** present **in** the **thoracic cavity** and the **kidneys**.
  - They also **help** in the **respiration** process.

# Axial Skeleton

## Ribs

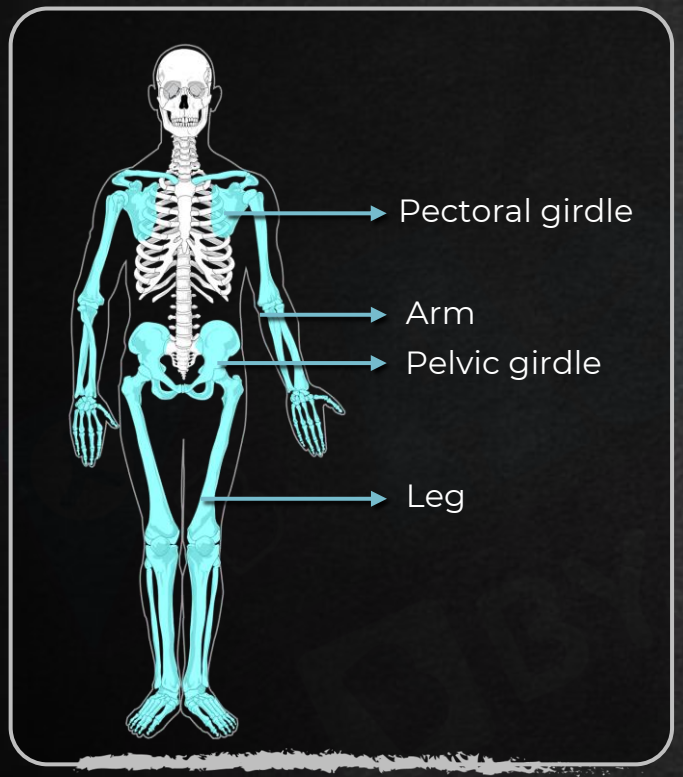


# Axial Skeleton

## Ribs

| True ribs | False ribs | Floating ribs |
|---|---|---|
| • The **first seven pairs** of ribs are known as true ribs.<br>• They are dorsally **attached to the thoracic vertebrae**.<br>• They **are ventrally connected to the sternum** with the help of **hyaline cartilage**, known as costal cartilage. | • The **eighth, ninth, and tenth pairs** are known as **vertebrochondral (false) ribs**.<br>• They do not articulate directly instead anteriorly connect indirectly with the sternum by costal cartilage of the seventh rib. | • The last two pairs (11th and 12th) of ribs are **not connected ventrally to** the **sternum or the cartilage**. Therefore, they are known as floating ribs.<br>• Thoracic vertebrae, ribs, and sternum together form the rib cage. |

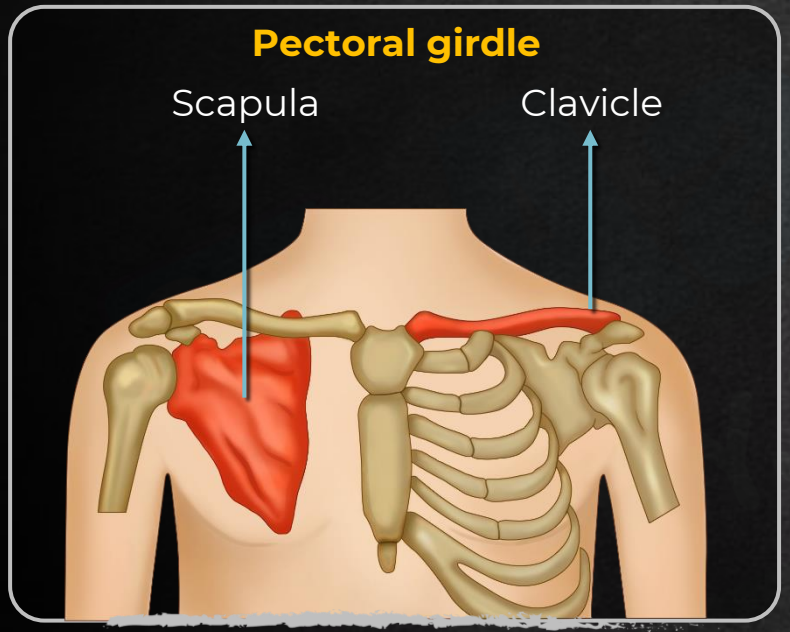
# Appendicular Skeleton




- It lies along the **transverse (side) axis**.
- The bones of the limbs along with their girdles constitute the appendicular skeleton.
- It is called so because it **gives support to the appendages**.
- It comprises **126 bones**.

# Appendicular Skeleton

## Pectoral girdle

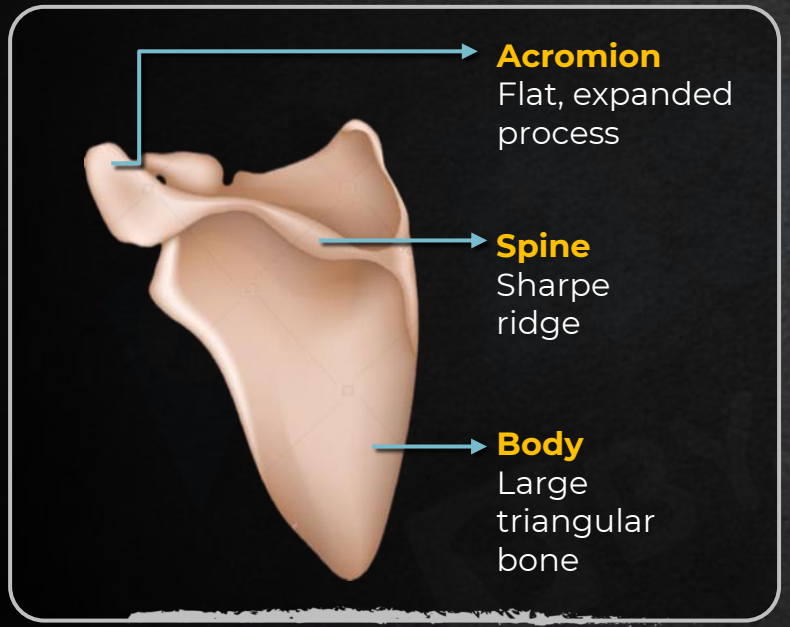



- Also known as the **shoulder girdle**
- Acts as a point of attachment for the upper limbs and the arm muscles
- Made up of two halves
  - **Scapula**
  - **Clavicle**
- The scapula is a **large triangular flat bone**.
- It consists of a **spine** and a **body.**
- The slightly **elevated ridge is known as the spine**.

# Appendicular Skeleton

## Pectoral girdle

### Scapula

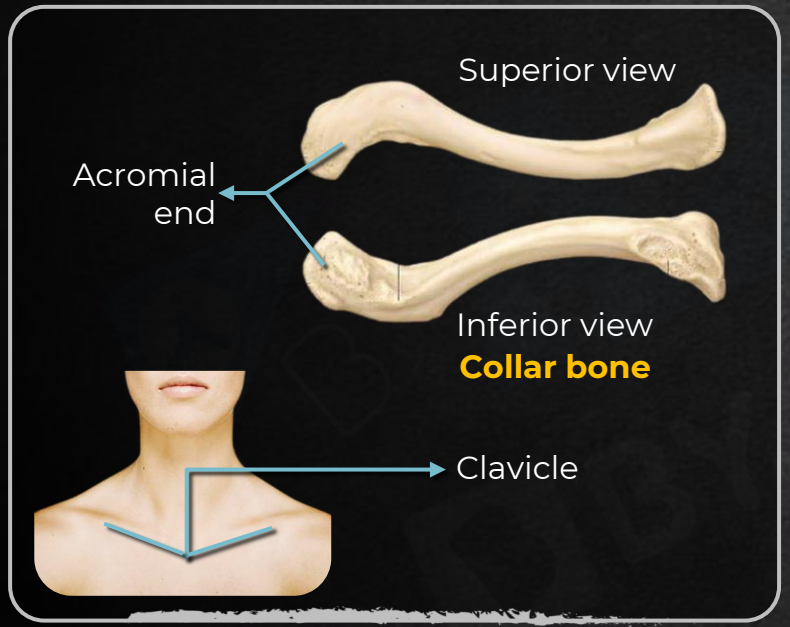



- The spine projects as a flat expanded process known as the **acromion**.
- The scapula is situated in the dorsal part of the thorax.
- It lies between the **second and the seventh rib**.
- Below the acromion is a depression known as the **glenoid cavity**.
  - It articulates with the head of the humerus to form the **shoulder joint**.

# Appendicular Skeleton

## Pectoral girdle

### Clavicle

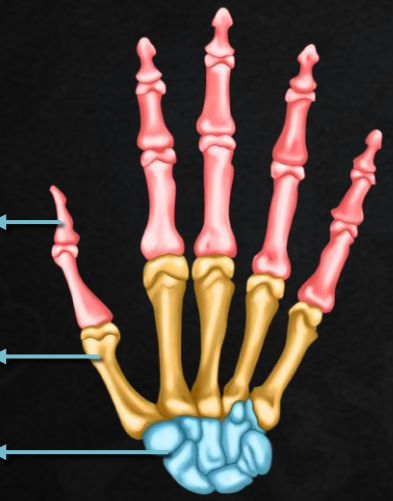



- Pectoral girdle has **two clavicles**.
- Each clavicle is a long slender bone with two curvatures.
- This bone is commonly known as the **collar bone**.
- The clavicle **articulates with** the **acromion** of the scapula.
- The clavicle and the scapula together make the pectoral girdle.

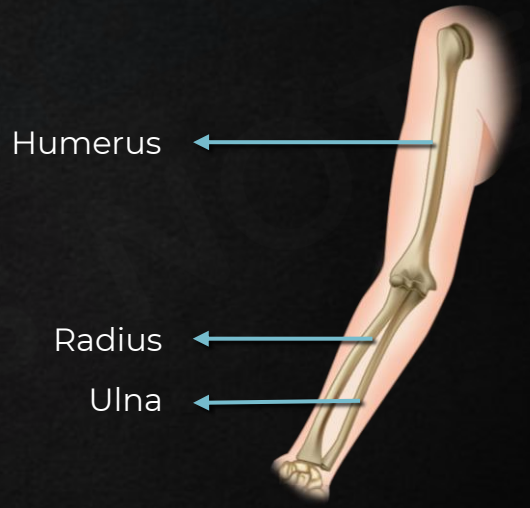
# Appendicular Skeleton

## Bones of arms

- Each arm is made of **30 bones**



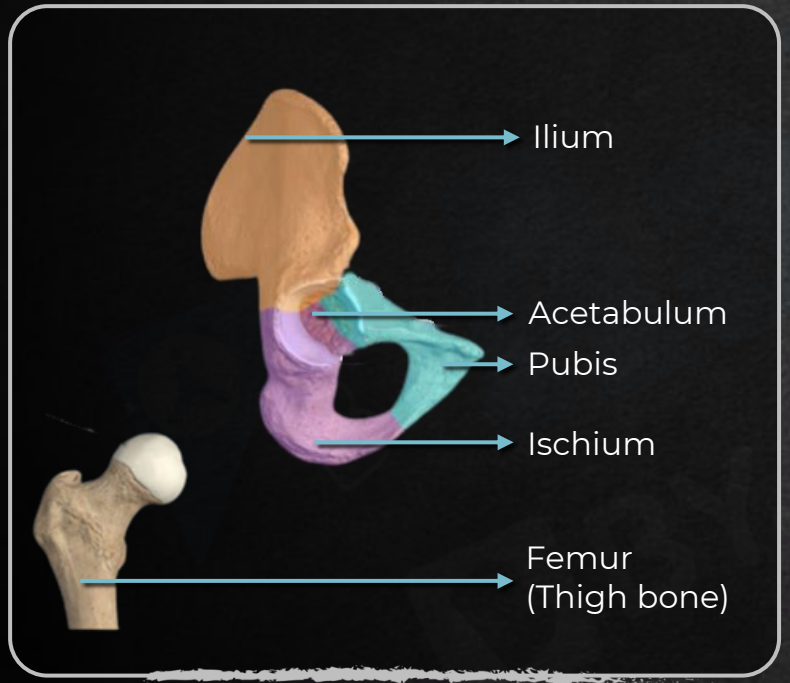

**Bones of wrist**




**Bones of arm**

# Appendicular Skeleton

## Pelvic girdle




- The pelvic girdle bones help in the articulation of the lower limbs.
- It is formed by **two innominate bones**. They are also known as the **coxal** or **hip bones**.
- Each **hip bone** is made by the fusion of three bones:
  - **ilium**
  - **ischium**
  - **pubis**
- At the point of fusion of the above bones is a cavity known as **acetabulum**, to which the **thigh bone articulates**.

# Appendicular Skeleton

## Pelvic girdle


The pubic symphysis is made of **fibrous cartilage** that joins the two **coxal (hip) bones** ventrally.

# Appendicular Skeleton

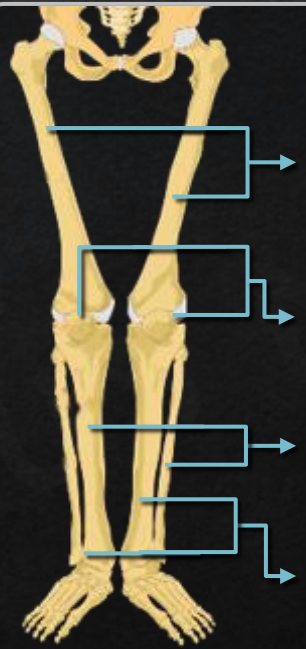
## Bones of legs

- Each leg is made of **30 bones**.

**Phalanges (14)**
Digits (5)

**Metatarsals (5)**

**Tarsals (7)**
Ankle bones



**Femur (2) (Thigh bone)**
Longest and strongest in the body

**Patella (2) Knee cap**
Cup-shaped bone

**Fibula (2)**
Shorter, thinner, deeper

**Tibia (2)**
Longer, thicker, front

# Total Number of Bones

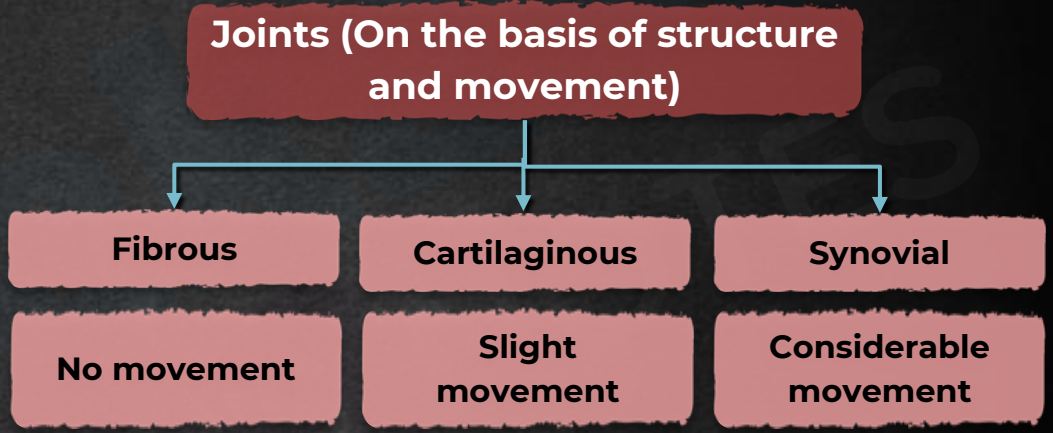
| Bones | Number |
|---|---|
| Cranial bones | 8 |
| Facial bones | 14 |
| Ear ossicles | 6 |
| Hyoid | 1 |
| Vertebral column | 26 |
| Sternum | 1 |

| Bones | Number |
|---|---|
| Ribs | 24 |
| Scapula | 2 |
| Clavicle | 2 |
| Arm bones | 60 |
| Hip bones | 2 |
| Leg bones | 60 |

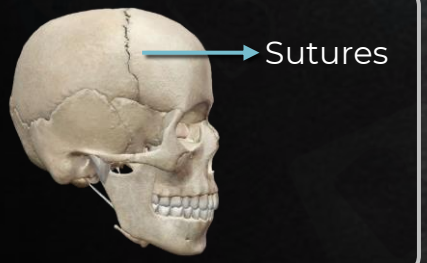
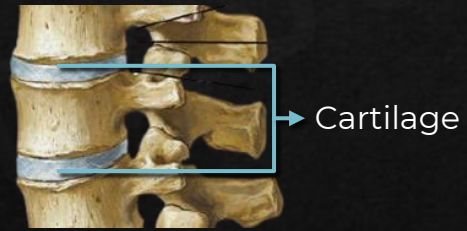
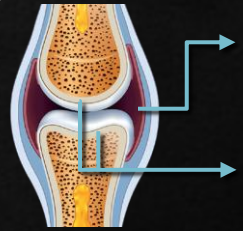
| | |
|---|---|
| **Total** | **206** |

# Joints

- Joints are the points of contact between:
  - Bones
  - Bones and cartilages
- Functions of joints:
  - Hold bones together
  - Bear weight of the whole body
  - Allow movements in coordination with muscles



# Joints

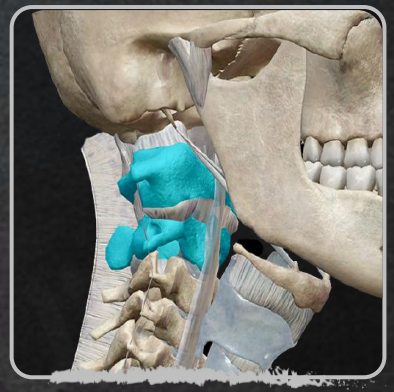
| Fibrous | Cartilaginous | Synovial |
| --- | --- | --- |
| • Fibrous joints **do not allow any movement**.<br>• **Sutures** are a type of fibrous joints in the skull.<br>• Skull bones are fused end to end with the help of **dense fibrous connective tissues** to **form sutures**. | • These joints permit **limited movements**.<br>• The bones are joined together with the help of a cartilage.<br>• Example: **The joint between the adjacent vertebrae** in the vertebral column. | • These joints **allow considerable movement**.<br>• They have a **fluid-filled synovial cavity** between the articulating surfaces of the two bones.<br>• Examples: Movement of head, wrist movement etc. |
|  |  |  |

# Synovial Joints

## Types of synovial joints

### Pivot joint

- Also known as **rotary joint**
- A ring-like movement is seen
- E.g. - **Joint between atlas and axis**



**Pivot joint**

### Gliding joint

- Also known as the **plane joint**
- Characterised by smooth surfaces that can glide over one another
- E.g. - **Joint between the carpals**

**Gliding joint**

# Synovial Joints

## Condyloid joint

- The condyloid joint allows movement but **not rotation**.
- E.g. - **Wrist joint**

## Saddle joint

- The saddle joint does **not allow rotation**.
- It enables back-and-forth and side-to-side movements.
- E.g. - **Joint between the carpals and the metacarpals of thumb**

**Condyloid joint**

**Saddle joint**

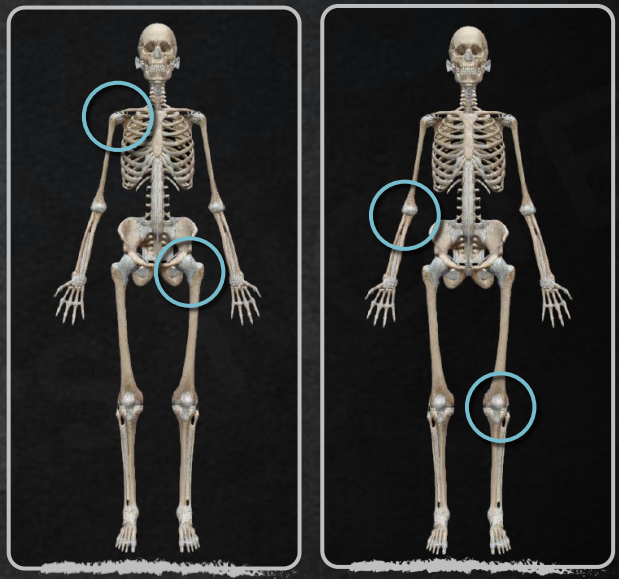
# Synovial Joints

## Ball and socket joint

- Permits **movement in all directions**
- E.g. - **Shoulder joint, hip joint**

## Hinge joint

- Allows the opening and closing in one direction, along one plane
- E.g. - **Elbow joint, knee joint**



**Ball and socket joint**

**Hinge joint**

# Disorders of Muscular and Skeletal System

## Myasthenia gravis

- Myasthenia gravis is a rare **autoimmune neuromuscular disorder** that causes **weakness in skeletal muscles**.
- It can also lead to **paralysis**.
  - An autoimmune disease is a condition where the body's immune system mistakenly attacks its own organs.
- The most commonly affected muscles are those of the eyes, face, and the ones involved in swallowing.

## Muscular dystrophy

- It is a **genetic-inherited disorder**.
- It causes **progressive degeneration of skeletal muscles**.
- Muscles are damaged in this disorder.
- It causes difficulty in:
  - Walking
  - Swallowing
  - Breathing

# Disorders of Muscular and Skeletal System

## Tetany

- **Rapid spasms** (wild contractions) occur in muscles due to **low $Ca^{++}$** in body fluid.
- Spasms are rapid contractions

## Arthritis

- The **articulating cartilage wears away** in this condition, leading to more friction between the bones.
- Symptoms:
  - Joint pain
  - Stiffness

## Osteoporosis

- It is an age-related disorder, characterised by **decreased bone mass** and increased chances of fractures.

## Gout

- It is the **inflammation of joints** due to the **accumulation of uric acid crystals**.

# Summary

## Types of movement

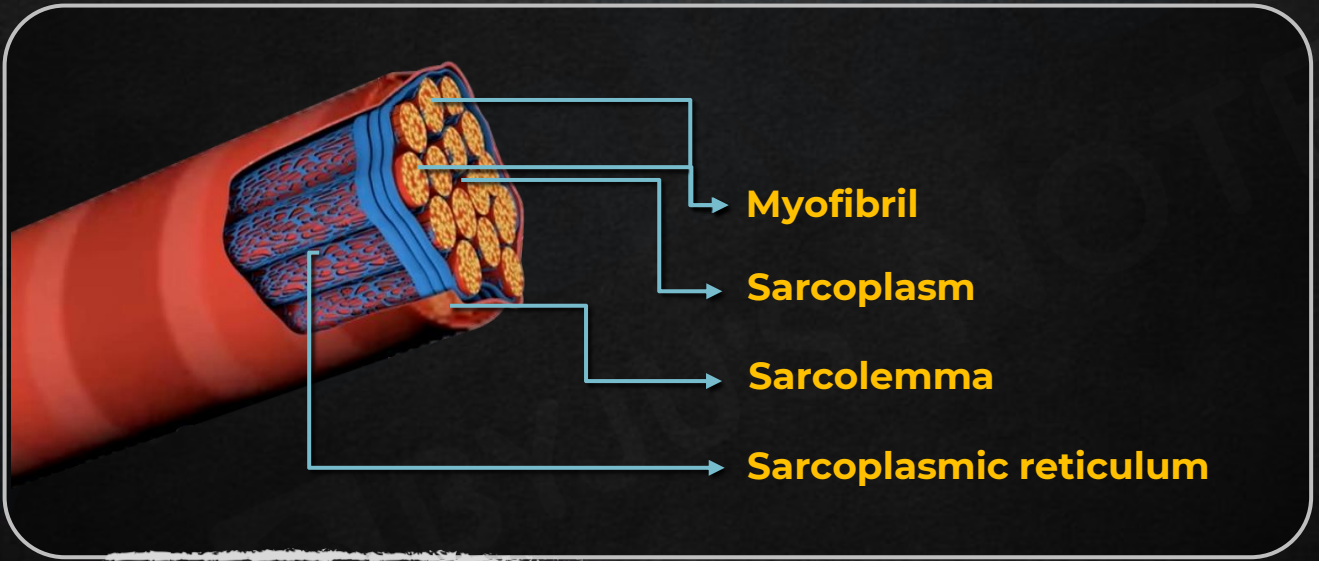
- **Amoeboid**
  E.g. - Amoeba
- **Ciliary**
  E.g. - Cilia of trachea
- **Muscular**
  E.g. - Jaws

## Types of muscles

- **Smooth muscles**
  E.g. - Muscles of digestive tract
- **Cardiac muscles**
  E.g. - Muscles of heart
- **Skeletal muscles**
  E.g. - Muscles of limbs

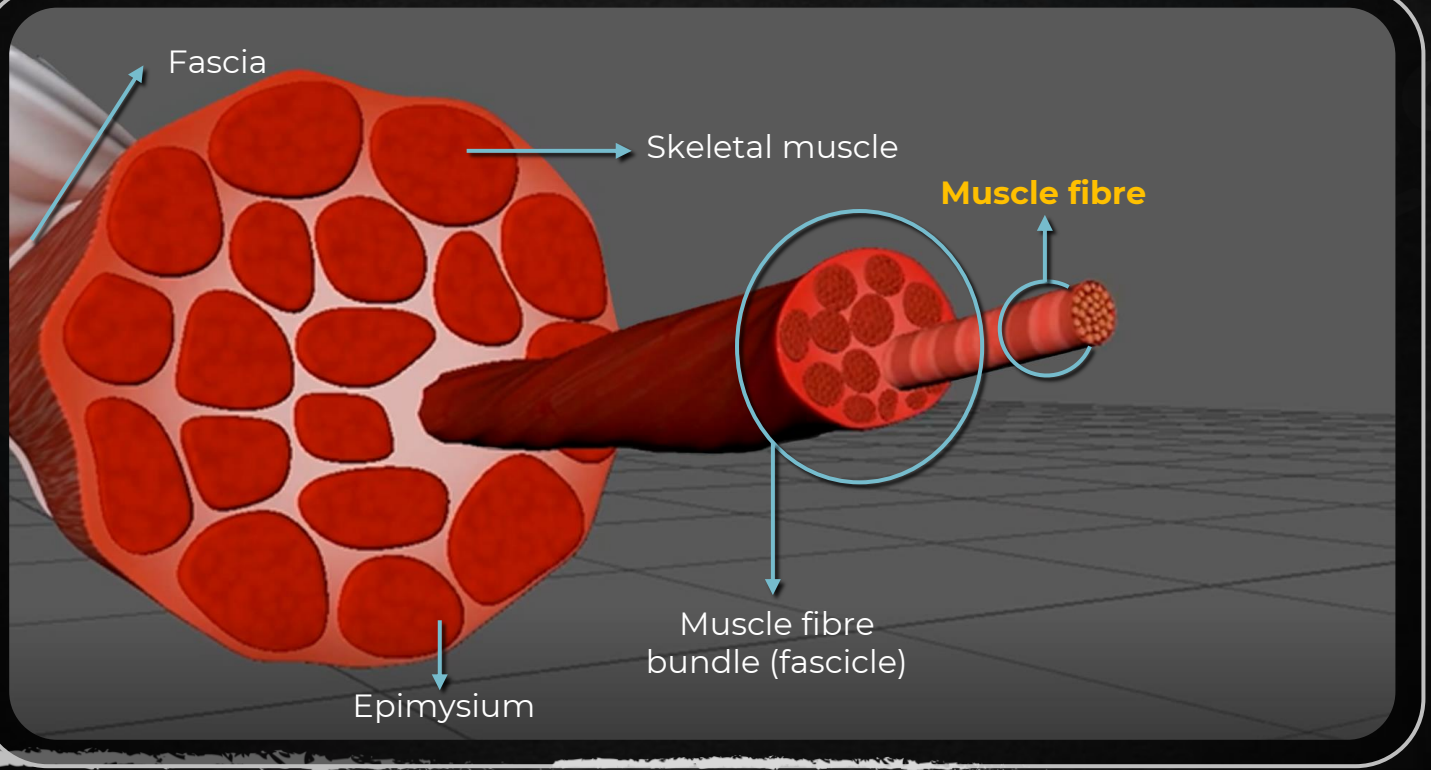
# Summary

## Structure of muscle fibre



# Summary

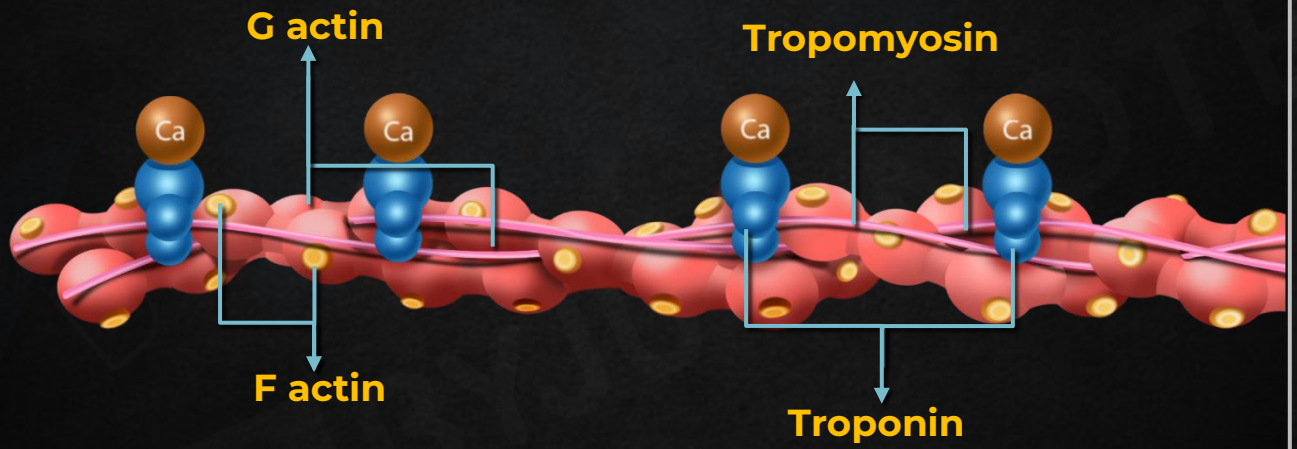
## Structure of skeletal muscle



# Summary

## Structure of actin

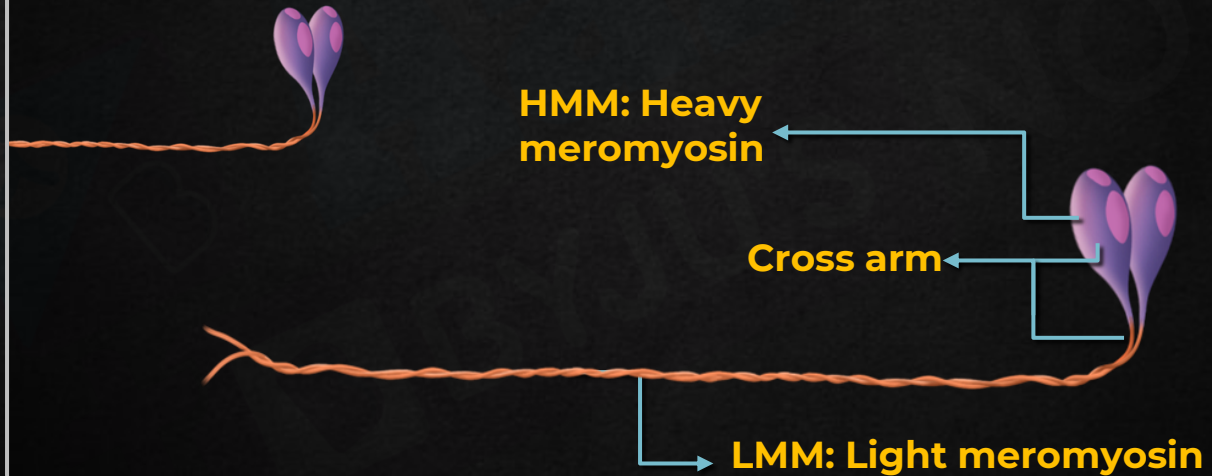
- Also known as the thin filament



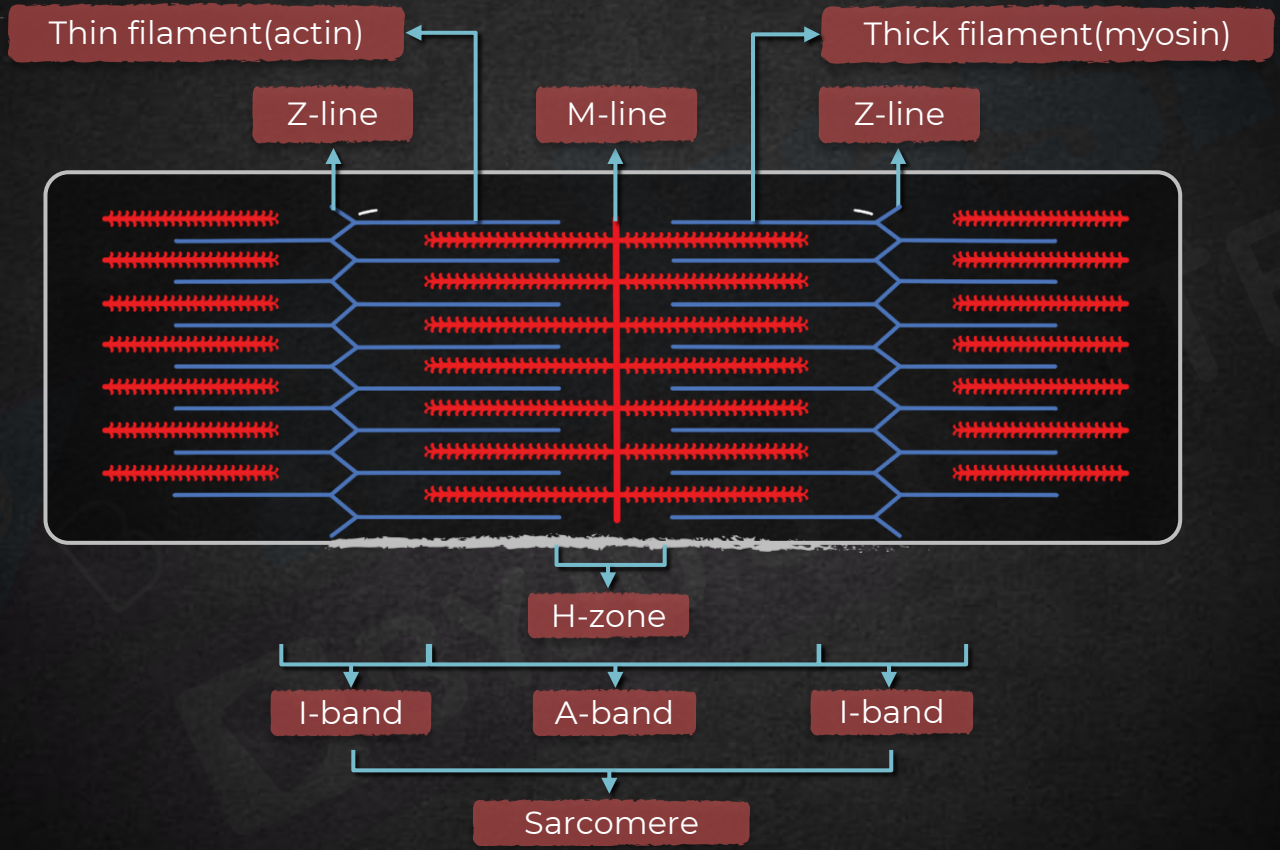
# Summary

## Structure of myosin

- Myosin is also known as the thick filament.
- It is the polymer of monomeric proteins called **meromyosin**.
- Each meromyosin has two parts: HMM and LMM



# Summary



# Summary

## Muscle contraction

- **Neuromuscular junction**- The place where the end-point of a motor neuron meets the sarcolemma of the muscle is called a neuromuscular junction or motor end plate.
- **Action potential**- Action potential is an electrical impulse that propagates on the muscle fibre.

## Tetanus/ Tetanic contraction

- When the electric impulses come too fast, the muscle does not get the time to relax.
- It is then in a state of continuous contraction. This is called tetanic contraction or tetanus.

# Summary

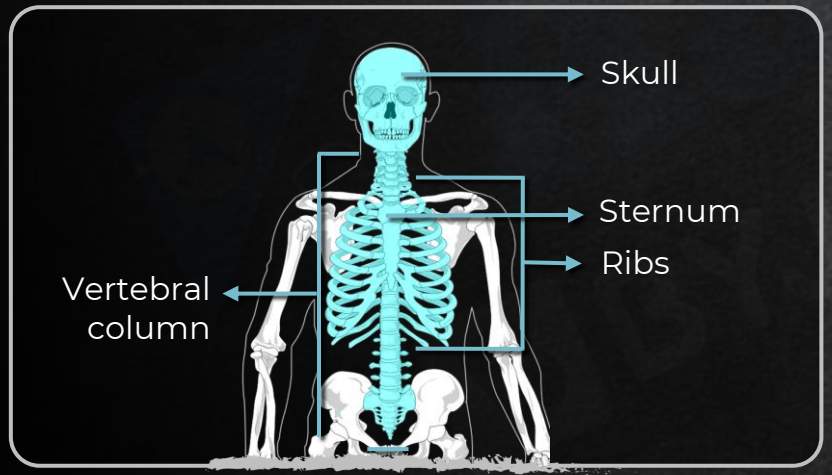
## Cross-bridge cycle

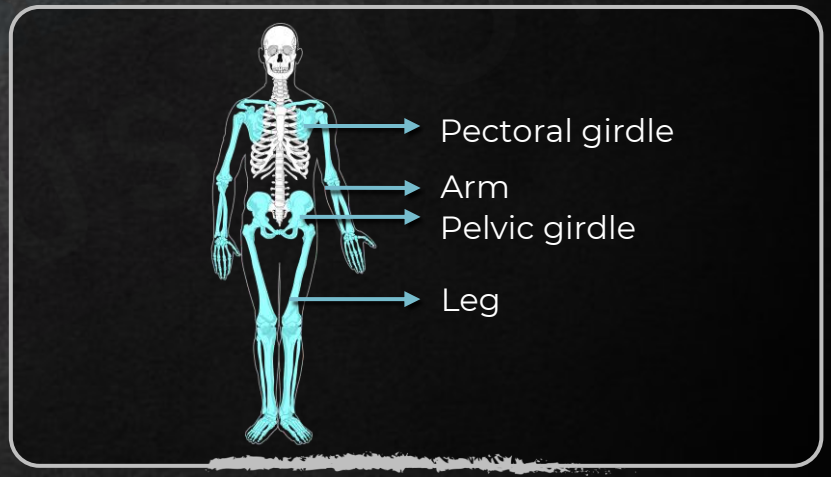
A. Myosin-binding site masked at resting state.
B. During action potential Ca2+ binds to troponin causing conformational change.
C. Myosin-binding sites exposed.
D. Myosin head binds ATP.
E. Myosin head hydrolyses ATP and is full of energy.
F. Myosin head binds actin.
G. Myosin head pulls actin filament.
H. Myosin head releases ADP and P.
I. Myosin head binds fresh ATP.
J. Myosin detaches from actin filament.
K. Myosin hydrolyses ATP.
L. Myosin binding and releasing cycle continues as long as there is $Ca^{2+}$.

# Summary

**On the basis of the position of the skeletal structures in the body, the skeleton is divided as follows:**

- **Axial**
- **Appendicular**



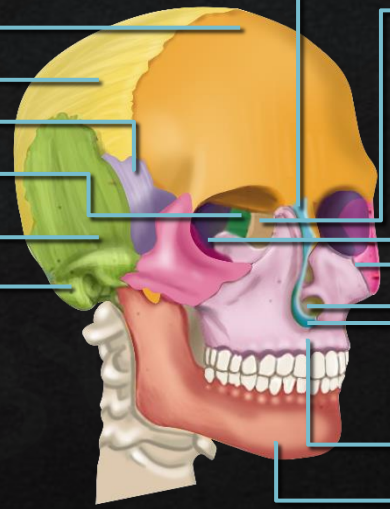



# Summary

## Skull

**Cranial bones(8):**

- Frontal
- Parietal
- Sphenoid
- Ethmoid
- Temporal
- Occipital

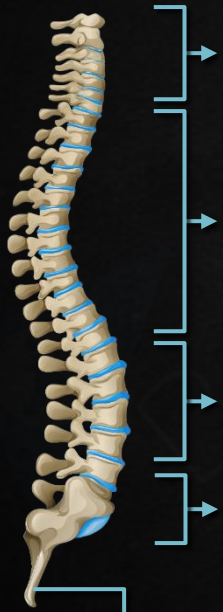


**Facial bones(14):**

- Nasal
- Lacrimal
- Palatine
- Zygomatic
- Inferior nazal concha
- Vomer
- Maxilla
- Mandible

# Summary

## Vertebral column



True ribs (1-7)

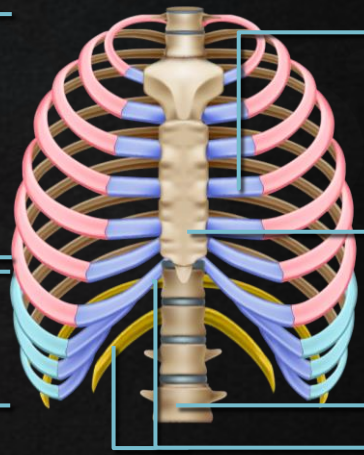
Thoracic vertebrae(12)

Lumbar vertebrae(5)

Sacrum(1)

Coccyx(1)

## Rib cage



True ribs (1-7)

False ribs (8-10)

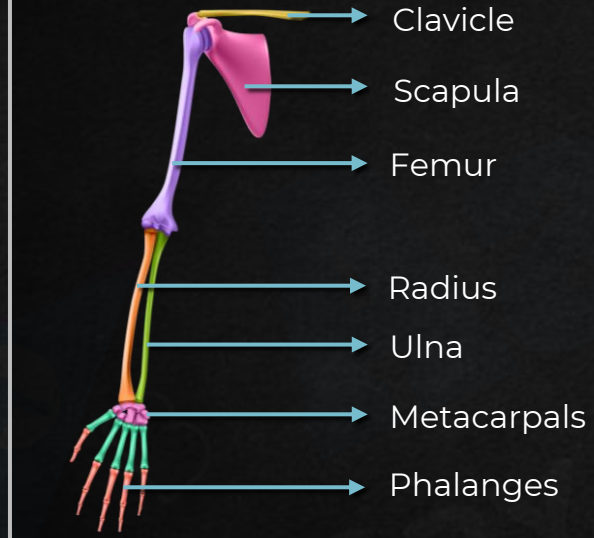
Hyaline cartilage

Sternum

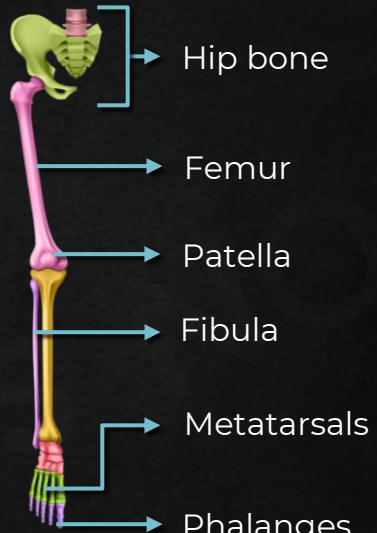
Thoracic vertebrae

Floating ribs (11-12)

# Summary




**Bones of upper limb and pectoral girdle**




**Bones of lower limb and pelvic girdle**

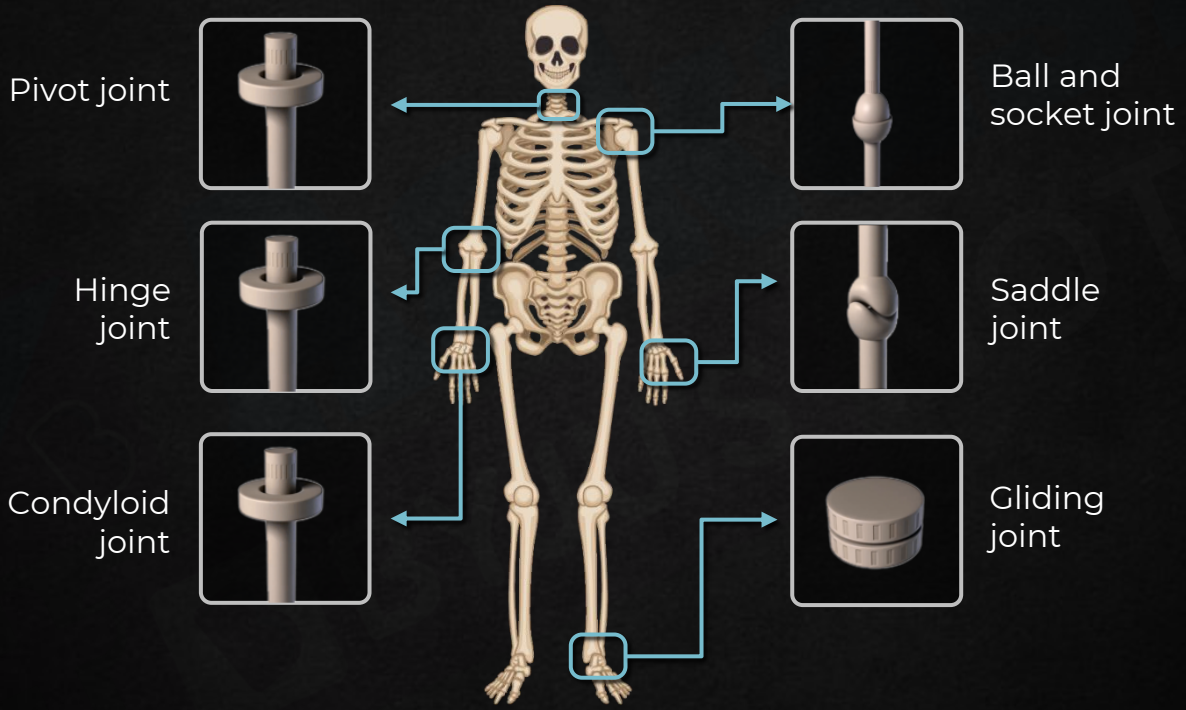
# Summary

**Joints (On the basis of structure and movement)**

- **Fibrous** → **No movement**
- **Cartilaginous** → **Slight movement**
- **Synovial** → **Slight movement**

# Summary

## Types of synovial joints



# Summary

## Disorders of muscular and skeletal system

| | |
|---|---|
| **Myasthenia gravis** | Autoimmune neuromuscular disease causing muscle weakness |
| **Muscular dystrophy** | Progressive degeneration of skeletal muscle |
| **Tetany** | Rapid spasms in muscles due to low calcium ions |
| **Arthritis** | Inflammation in joints |
| **Osteoporosis** | Decrease in the bone mass increases the risk of fractures |
| **Gout** | Inflammation of joints due to the accumulation of uric acid crystals |