PRACHAND NEET

ONE SHOT

ZOOLOGY

Locomotion and Movement

By: Vipin Sharma Sir

Topics *to be covered*

1. Locomotion and Movement
2. Muscle Contraction
3. Joints and Disorders of Locomotion
4. Questions and PYQs


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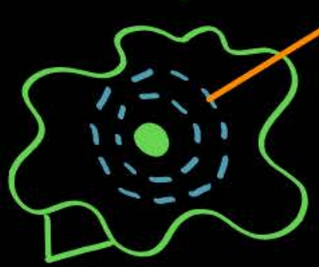
Movement and Locomotion

- Significant feature of all living organisms

e.g., Humans: limbs, eyelids, jaws, tongue
Cilia: Paramecium
Flagella: Euglena, sperm. Sponges- canal system
Protoplasmic streaming: Amoeba
Tentacles: Hydra



Microfilaments (actin filaments)

Pseudopodia
False feet

Movements that changes location of an organism

Pattern of locomotion depends upon habitat & organisation

Why locomotion: Food
Shelter
Mate
Breeding ground
Protection from enemies

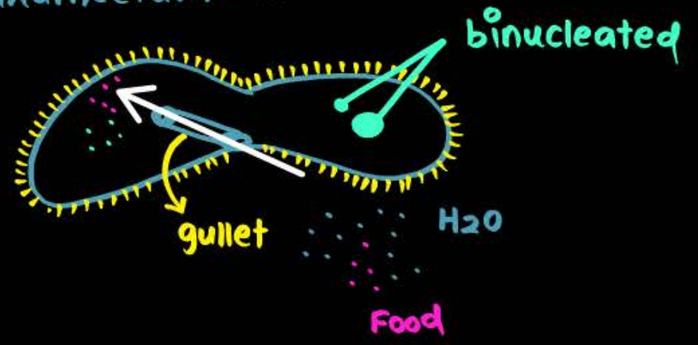
* All locomotions are movement but all movements are not locomotion

Locomotion and Movement

- Structures for movement and Locomotion need not to be different

Structures for locomotion & movement can be same

- Paramecium: cilia



- Humans: Limbs
- Hydra: Tentacles

- In humans, the locomotion requires the coordination b/w
  - Nervous system
  - Muscular system
  - Skeletal system

Types of Movements

Amoeboid Movement

- Microfilaments contributes & pseudopodia formed

e.g., Leucocyte (WBC), Macrophage ⇓ Phagocytosis

Ciliary Movement

- coordinated movement of cilia
- Cilia & flagella are outfoldings of cell-membrane

e.g., Trachea → moves dust particles

Movement of ovum in fallopeantube

Muscular Movement

in complex animals

Muscles

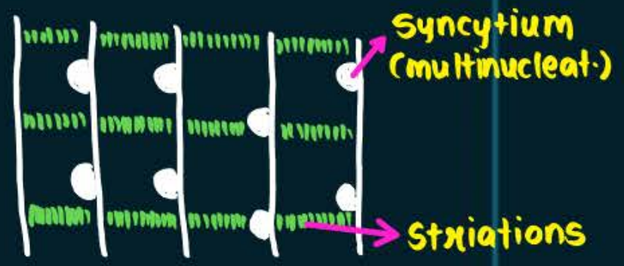
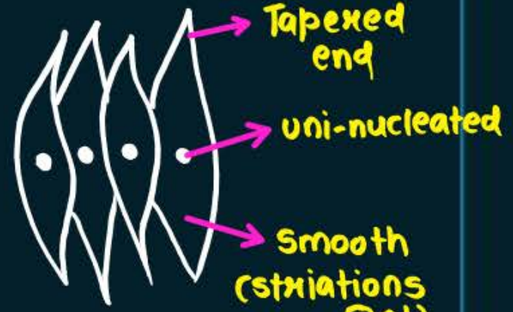
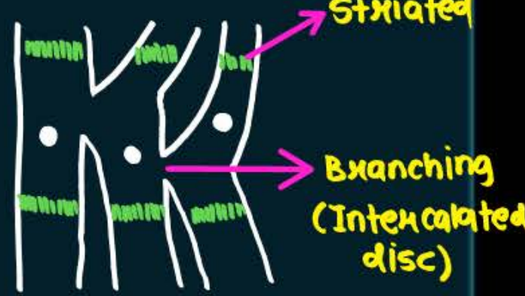
- Locomotory requires coordination among: Neural system, Muscular system, Skeletal system

- Origin of Muscular Tissue: Mesodermal in origin

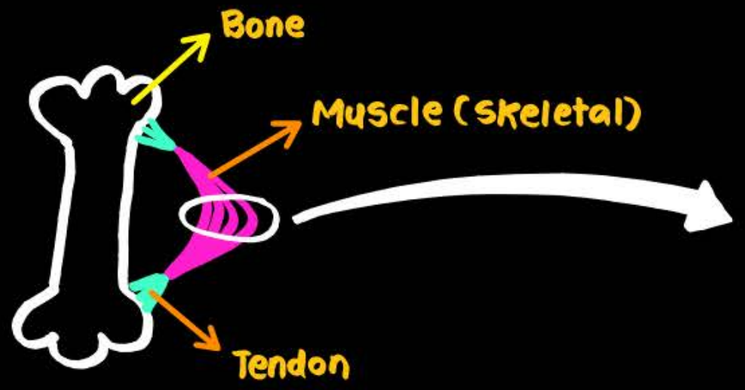
- Contribute 40-50% of body weight of an adult human.

- Features of Muscular Tissue: CEEE
  - Elasticity
  - Excitability
  - Contractability
  - Extensibility

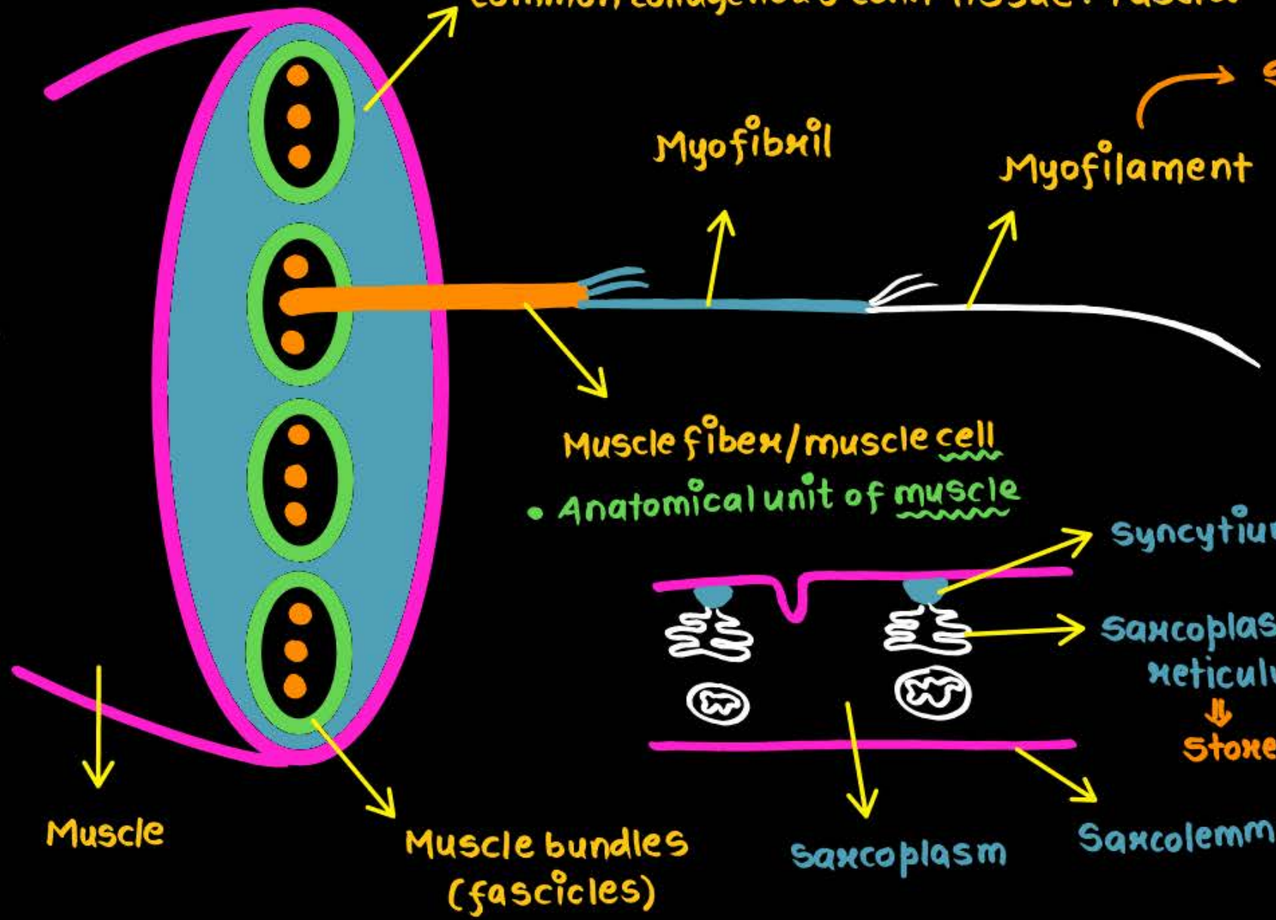
Types of Muscles

Characters	Skeletal/ Striated Muscles	Smooth/ Visceral Muscles	Cardiac Muscles
Striations	⊕nt	⊖nt	⊕nt
Shape	Cylindrical	Fusiform (Tapered end)	Cylindrical
Branching	No	No	Yes
Control	Voluntary	Involuntary	Involuntary
Figure			

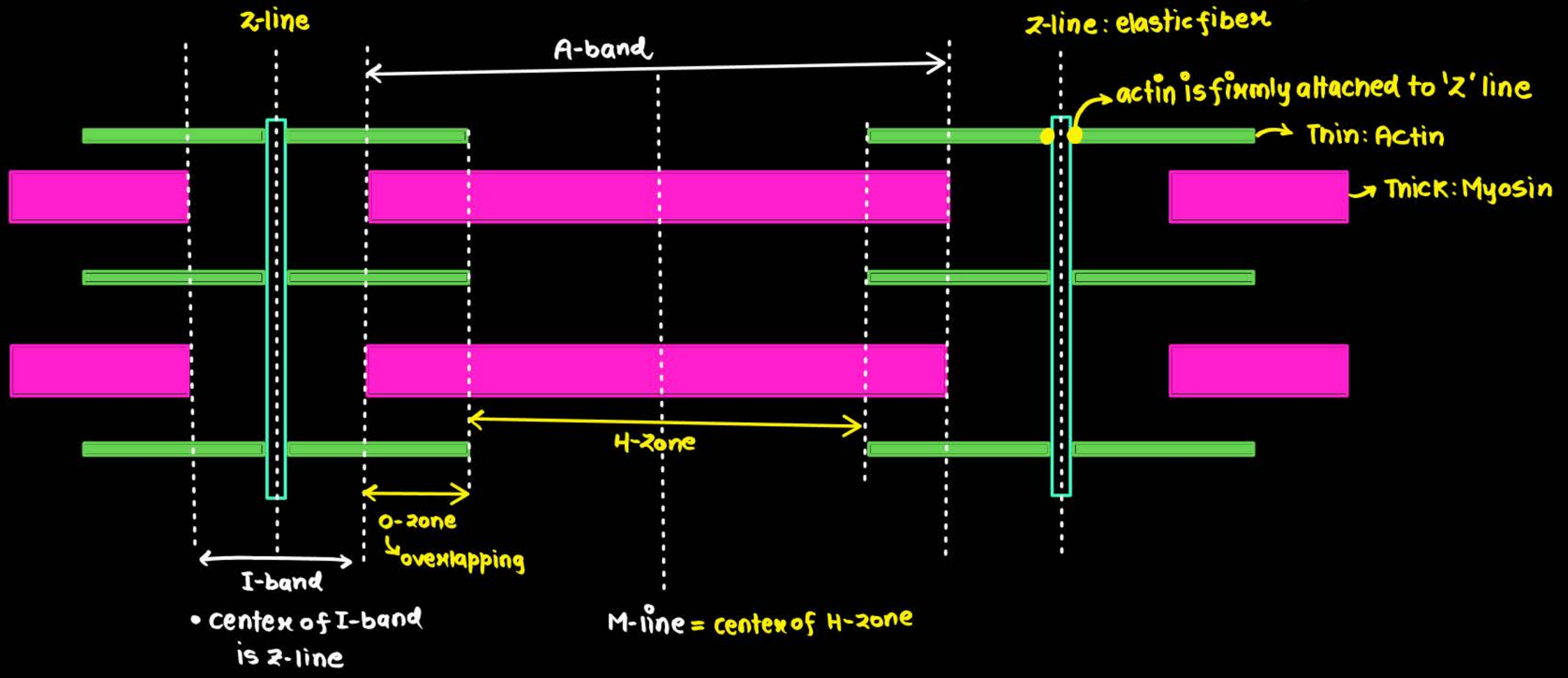
Structure of Skeletal Muscle

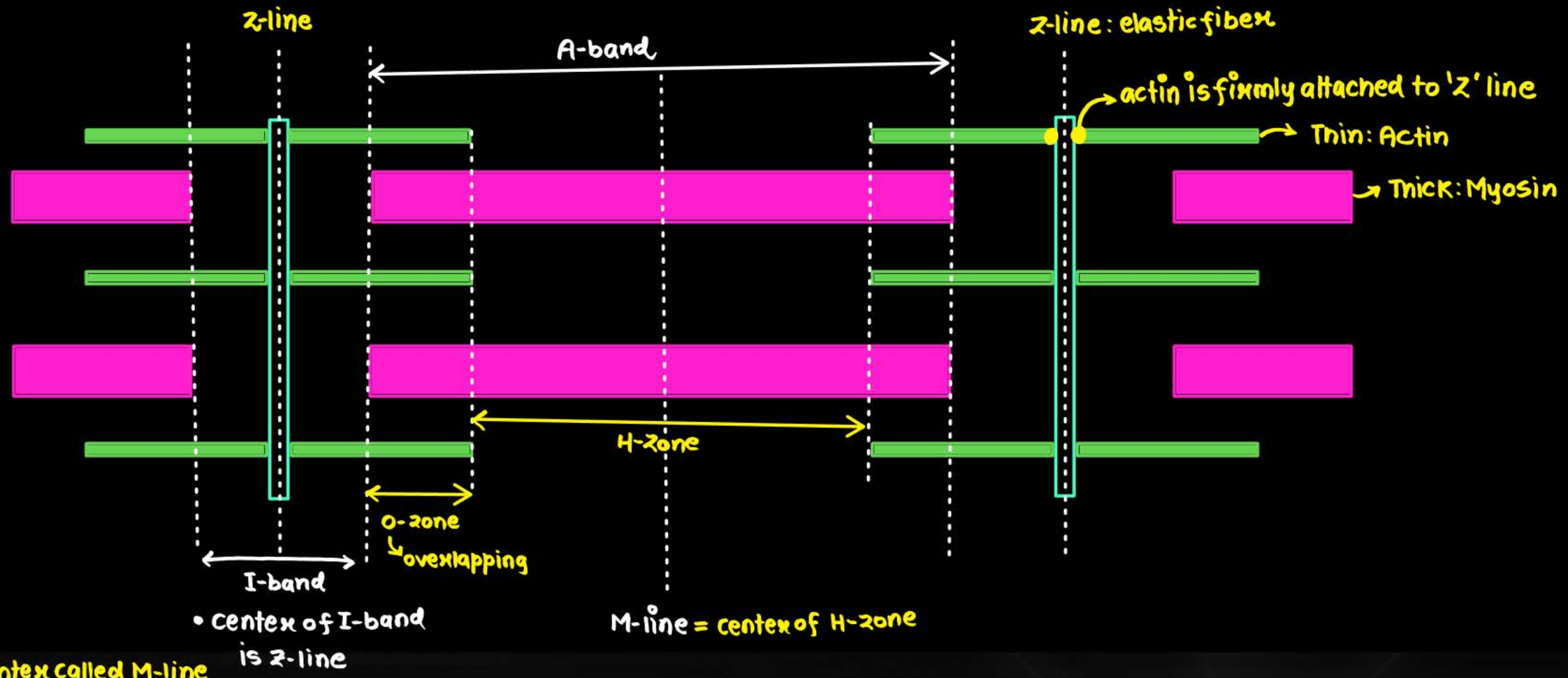


Muscle → bundles → fibers → fibrils → filaments *



Structure of Myofibril





↳ centex called M-line

- H-zone : only myosin
- O-zone : Actin + myosin
- I-band : only actin
  ↳ centex is called 'Z-line'

* Saxcomexe : unit of contxaction ; distance b/w 2 'Z' lines
Muscle unit

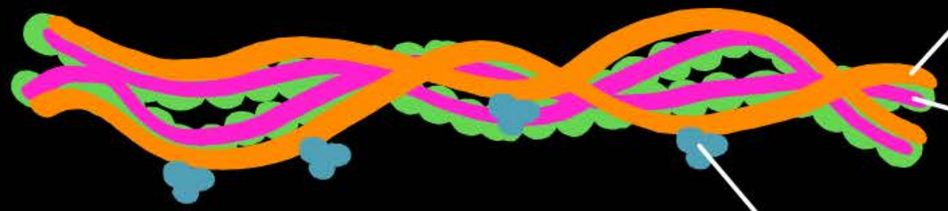
$\frac{1}{2}I + A + \frac{1}{2}I = (I+A)$

Actin

- a small unit or monomer called 'G' actin (globular)

polymerise → forms 'F'-actin or filamentous actin

2-'F'-actin chains intertwined → Actin



Tropomyosin: Runs parallel to F-actin

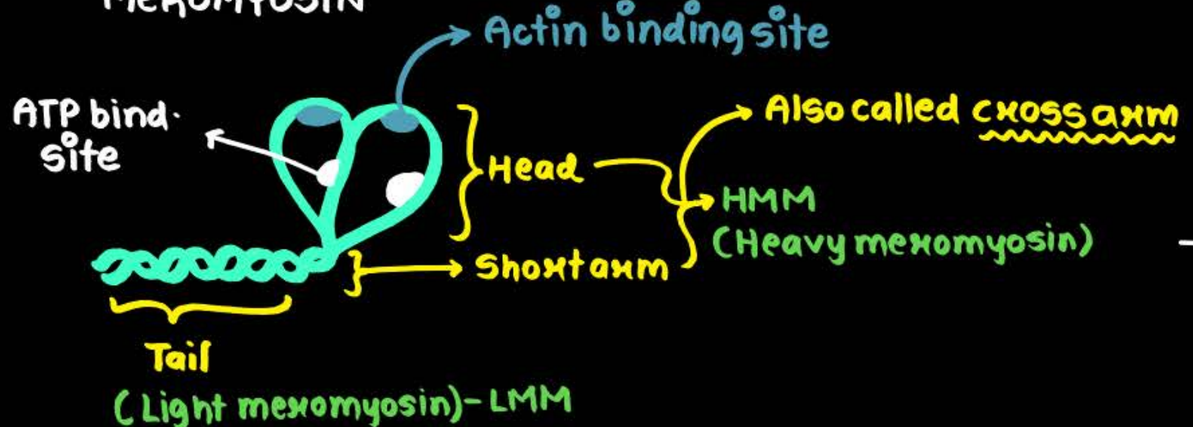
Actin

Complex protein called Troponin

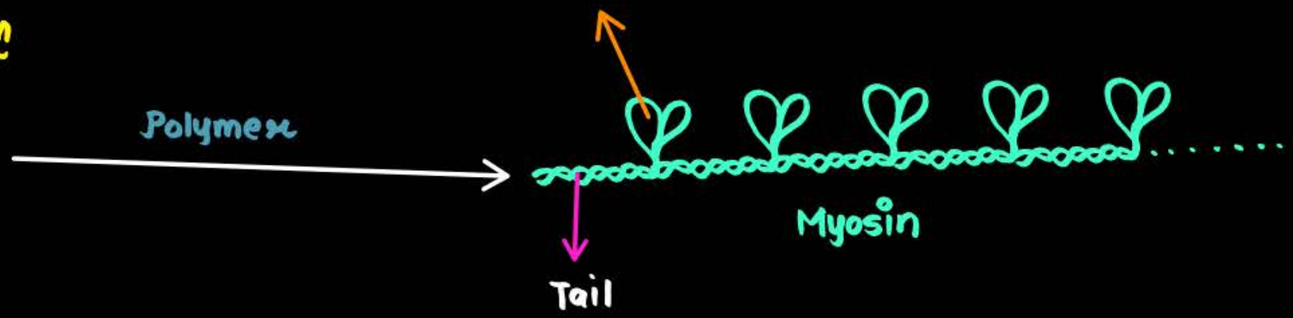
- sits on Tropomyosin
- Masks the myosin binding site on actin

Myosin

- Monomer is called MEROMYOSIN

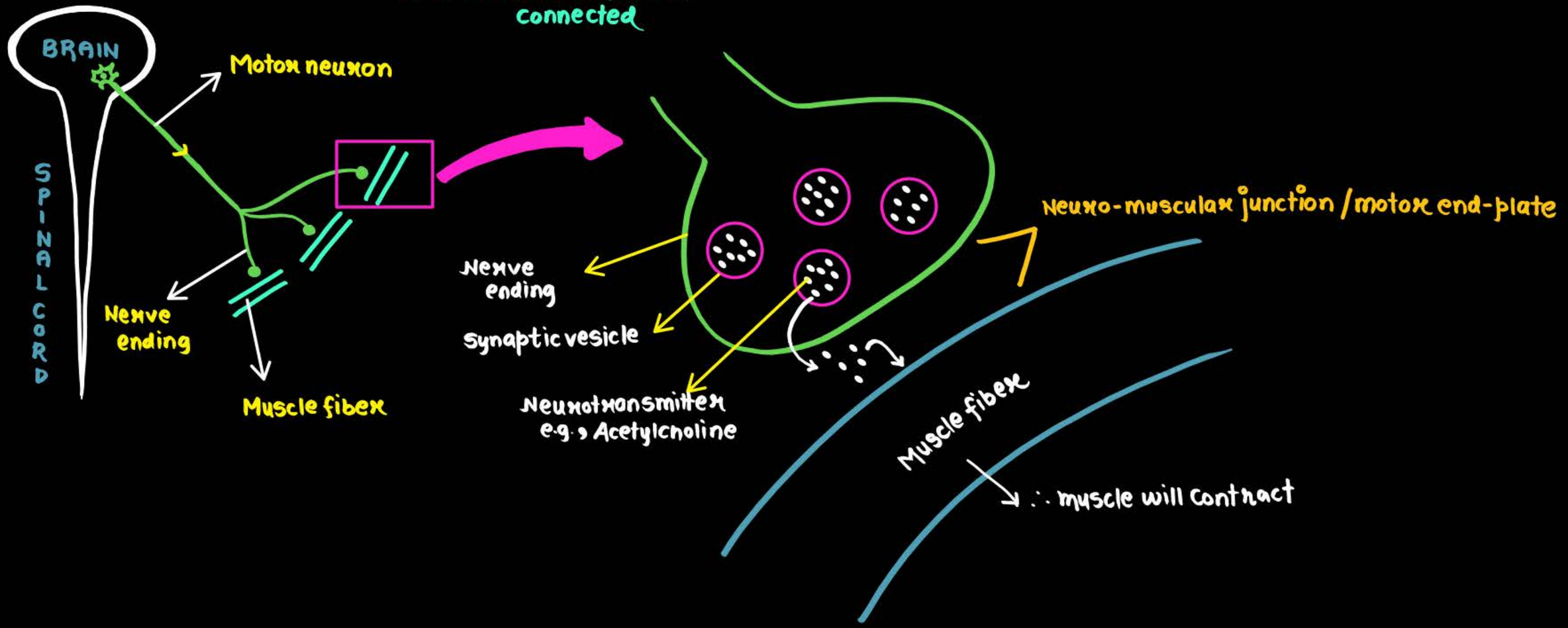


cross arm is projected outwards at regular intervals at a particular angle



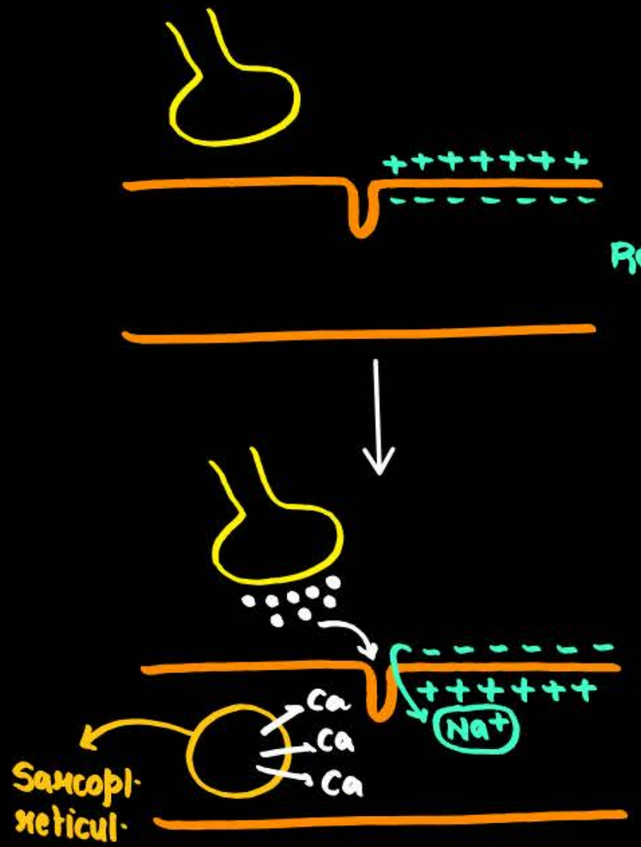
Motor Unit and Motor End Plate

Motor neuron + fibers connected



Sliding Filament Theory

- Thin filament slides over thick filament



Ca^{2+} ions binds with troponin & engages it

Myosin binding site of actin exposes

Myosin hydrolyses ATP & gains energy : ATP → ADP + Pi

Myosin raises its head & binds with actin & pulls it toward M-line

∴ Z-lines also comes close to each other

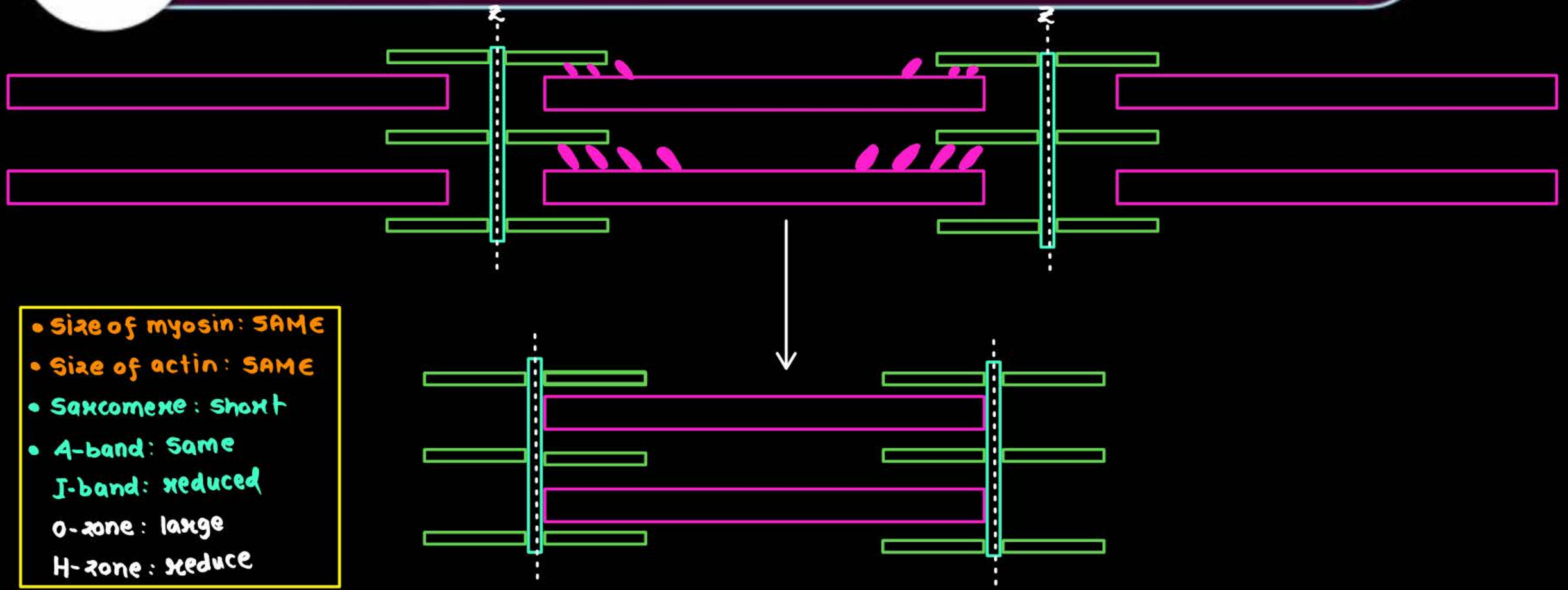
∴ Sarcomere shortens

∴ Muscle contracted

Relax : Ca^{2+} ions pumped back to Sarcoplasmic reticulum ∴ Troponin again masks myosin binding site

∴ Actin & myosin can't interact now ∴ muscle relax

Sliding Filament Theory



- Size of myosin: SAME
- Size of actin: SAME
- Sarcomere: short
- A-band: same
  I-band: reduced
  O-zone: large
  H-zone: reduce

Red and white Muscle Fibers

Feature	Red Muscle	White Muscle
Speed of reaction	Slow	Fast
Colour due to	Myoglobin amount: ↑ ↳ stores O_2	Myoglobin amount: ↓
Aer./ Anaer.	Aerobic*	Anaerobic
Lactate	Not formed	Formed ↑
Fatigue	↓	↑
Diameter	Small	Large
Mitochondria and Sarcoplasmic reticulum	Mitochondria ↑ SR ↓	Mitochondria ↓ SR ↑

Skeletal System

- **Skeletal System consists of:** Bones + cartilage (206)
  - in embryo : 300+
- **Helps in:** Locomotion, movement
  change or adjustment in position
- **Total Number of Bones in Adult Human:** 206

Skeletal System (206)

Axial Skeletal → 80

Axis

- **Skull**
  - 29-bones
    - Cranium = 8
    - Facial = 14
    - Ear = 6
    - Hyoid = 1
- **Sternum** (1)
- **Vertebral column** $C_7 T_{12} L_5 S_1 C_1$ (26)
- **Ribs** (24)

Appendicular Skeletal → 126

- **Forelimb** → 30×2
  - \+ Pectoral girdle (4)
- **Hindlimb** → 30×2
  - \+ Pelvic girdle (2)

Skull (29)

Cranial bone (8)

P : Parietal (2)
E : Ethmoid - 1
S : Sphenoid - 1
T : Temporal (2)
O : occipetal - 1
F : Frontal - 1

Cranium

PT-2

Facial Bone (14)

M : Maxilla (2)
P : Palatine (2)
Ne : Nasal (2)
Zyado : Zygomatic (2)
Co : Chonchae (2)
La : Lacrimal (2)
Mangayi : Mandible (1)
Vomit : Vomer (1)

Hyoid (1)

Base of buccal cavity

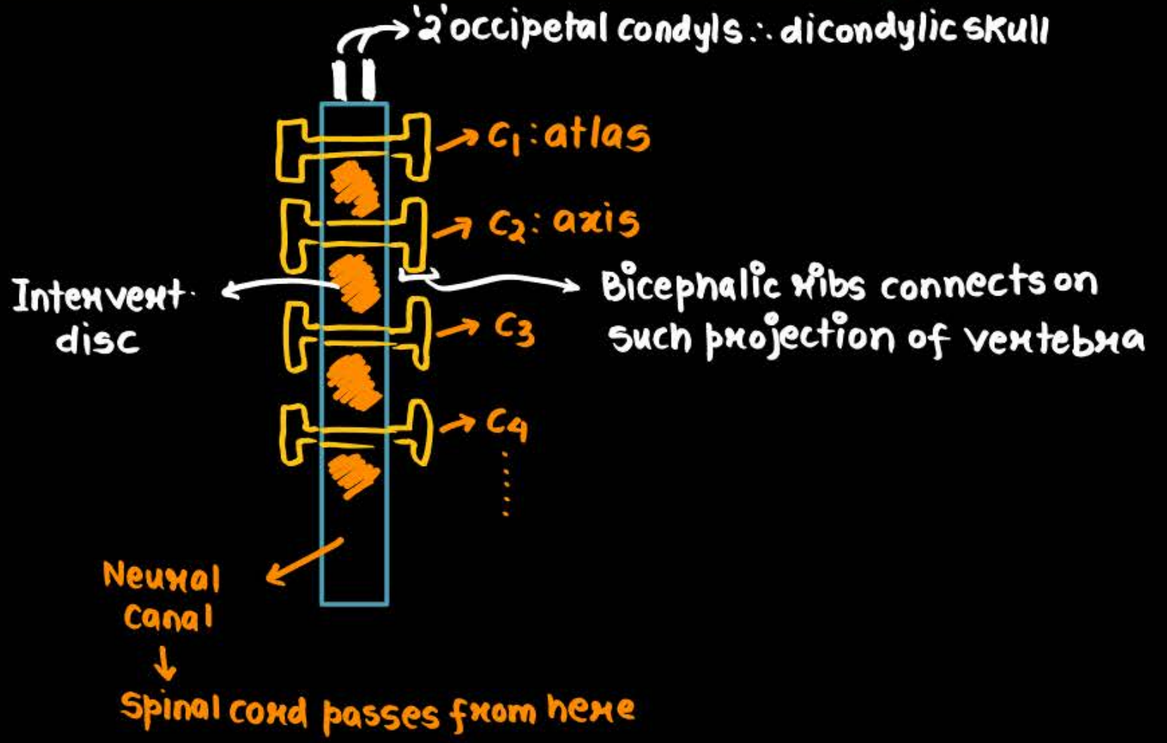
Ear ossicles (6)

M : Malleus
I : Incus
S : Stapes (smallest)

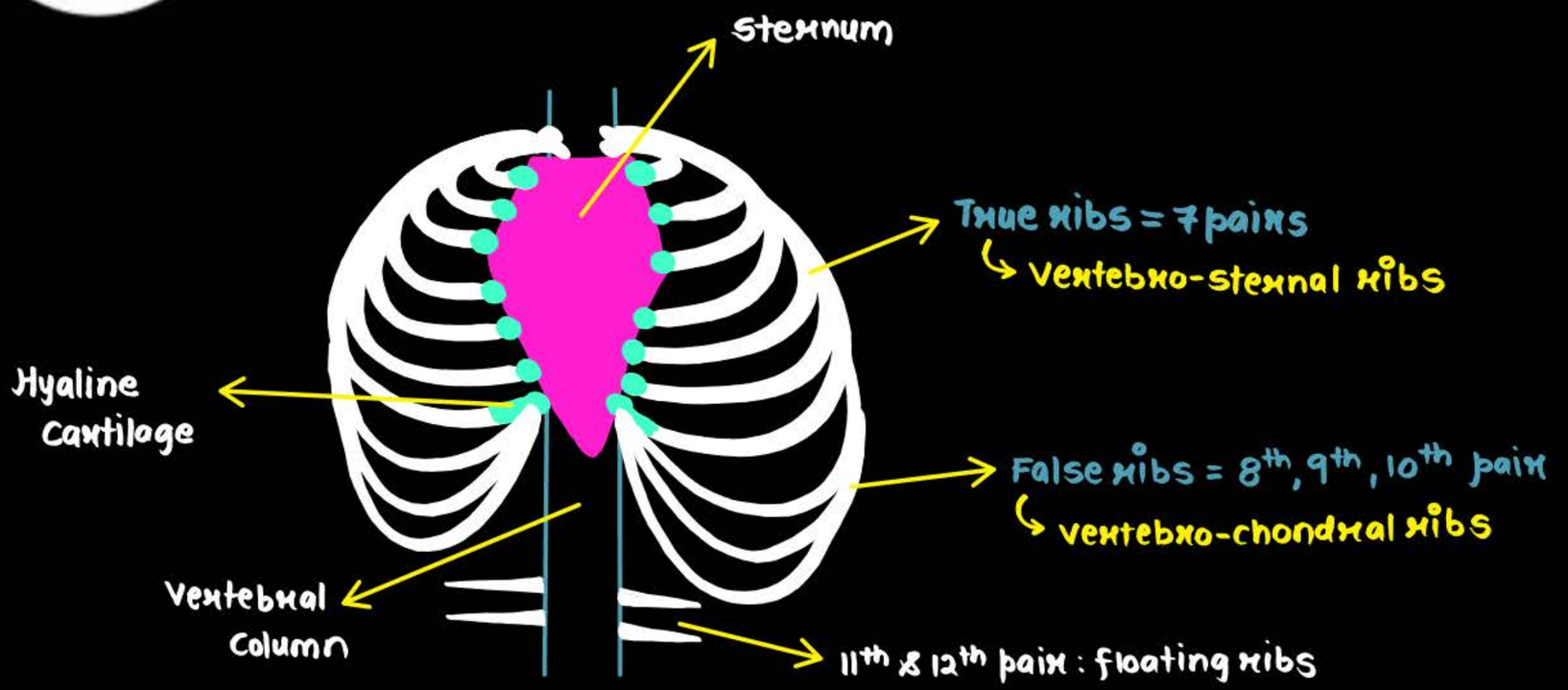
} × 2

Vertebral Column (26)

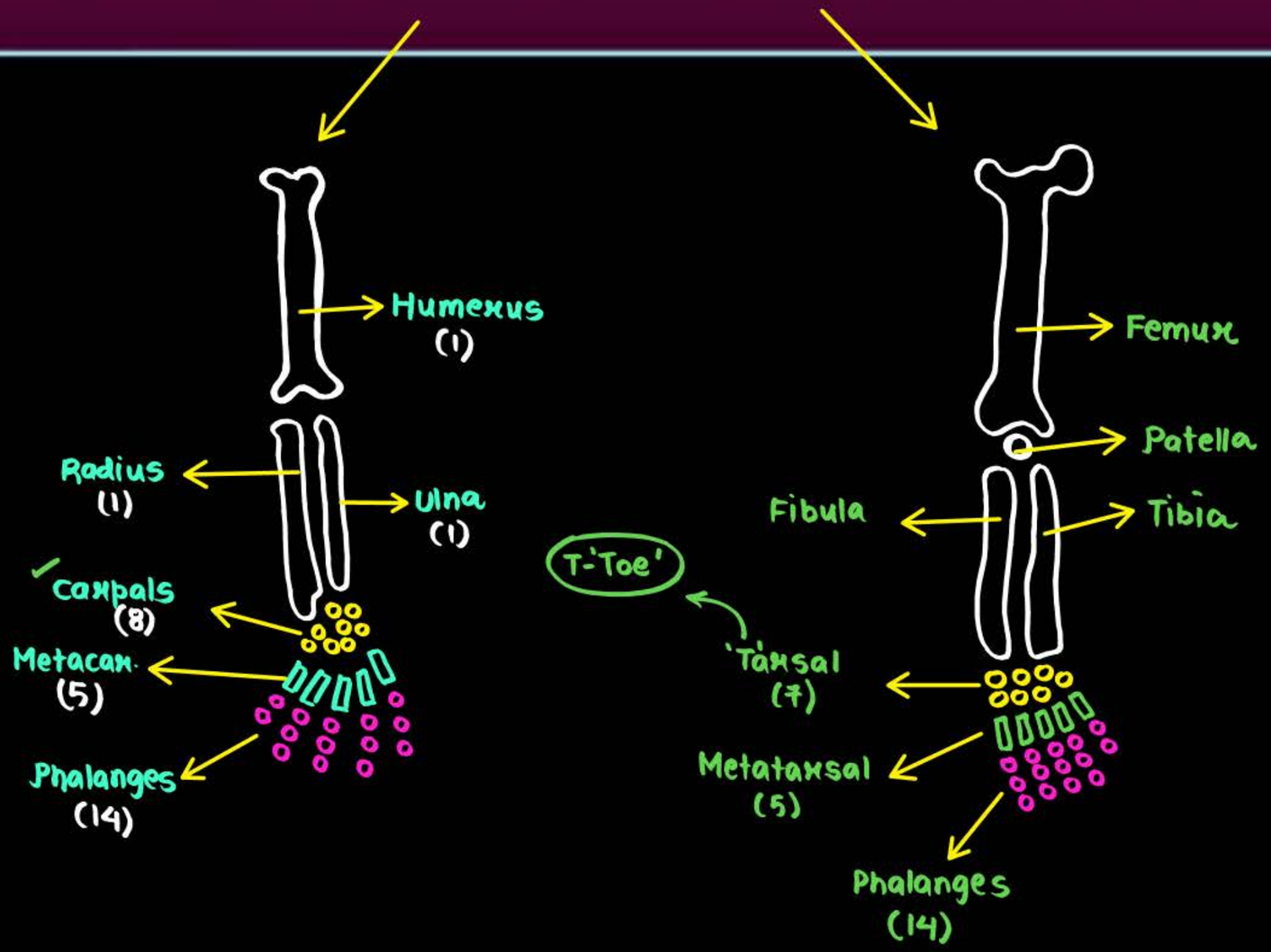
	Embryonic	Adult
Cervical:	7	7
Thoracic:	12	12
Lumbar:	5	5
Sacral:	5	1
Coccyx:	4	1
	33	26



Ribs (24)


Sternum
True ribs = 7 pairs
Vertebro-sternal ribs
Hyaline Cartilage
False ribs = 8th, 9th, 10th pair
Vertebro-chondral ribs
Vertebral Column
11th & 12th pair : floating ribs

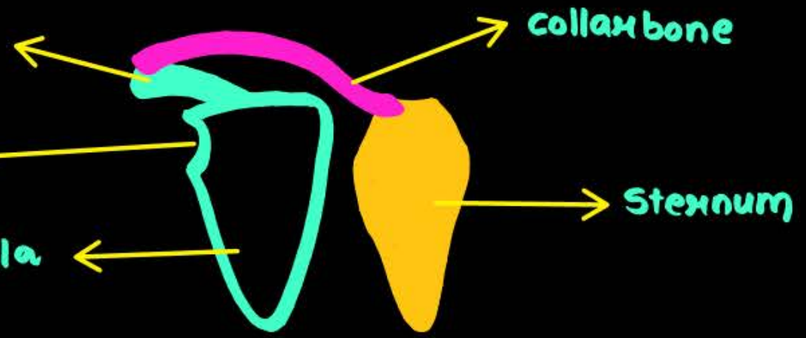
Forelimb and Hindlimb (120)



Pectoral Girdle (4)

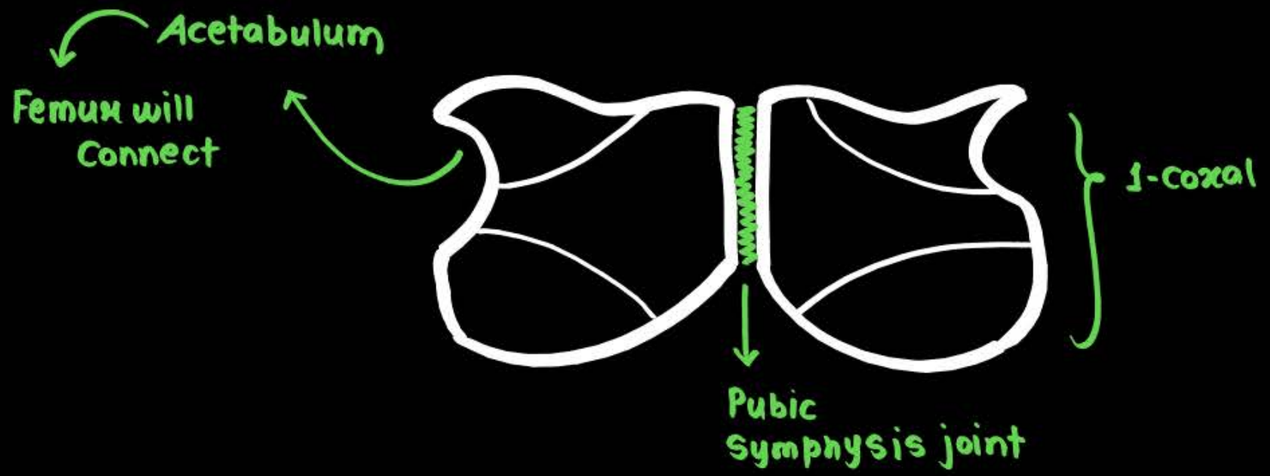
- Clavicle: collar bone (2)
- Scapula: Flat, triangular bone on dorsal bone
  - length: 2nd - 7th rib

Elevated, ridge like str. of scapule where clavicle binds
⇑
Acromion process

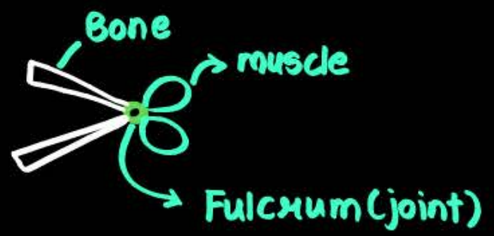


Pelvic Girdle (2)

- Ilium, ischium & Pubis makes one coxal
- Both sides of body have a coxal



Joints



- present b/w bones & b/w bones & cartilage
- act as a fulcrum

Fibrous Joints

Immovable joints

- Cranial bones

Cartilaginous Joints

- provide movement : limited
- Inter-vertebral region

Synovial Joints

provide considerable movement

Synovial fluid ⊕nt

Types of Joints

Type of Joint	Example
Ball and Socket	Between Humerus and Pectoral girdle
Hinge	Knee Joint
Pivot	Between Atlas and Axis (C_1 C_2)
Gliding	Between Carpals
Saddle	Between Carpals and Metacarpals of thumb

Disorders of Skeletal System

S. No.	Disease	Features
1	Myasthenia gravis	Auto immune disorder affecting neuromuscular junction leading to fatigue, weakening and paralysis
2	Muscular dystrophy (gene)	Progressive degeneration of skeletal muscle mostly due to genetic disorder
3	Tetany	Rapid spasms (wild contractions) in muscles due to low Calcium in body fluids
4	Arthritis (Rheumatoid: Auto-immune)	Inflammation of Joints

Disorders of Skeletal System

S. No.	Disease	Features
5	Osteoporosis (↓ Bone, ↳ pone)	Age related disorder characterised by decreased bone mass and increased chance of fractures. Decreased level of oestrogen is a common cause.
6	Gout	Inflammation of Joint due to accumulation of uric acid* crystals
7	Systemic Lupus Erythematosus (SLE)	* Autoimmune disorder due to genetic and environmental factors

Movement and Locomotion

- Significant feature of living
  1. Amoeba: Simple protoplasmic streaming
  2. Hydra: Tentacular movement
  3. Human: Eyelids, tongue, jaw, limbs

Types of Movements

1. Amoeboid: in macrophages & WBC (Actin filament helps in this)
2. Ciliary: To move dust particles in trachea & ovum in oviduct
3. Muscular: Here, proper coordination of muscular, skeletal & neural system is needed

NOTE

- Cilia and flagella are outgrowths of cell membrane.
- Flagella helps in movement of sperm, maintenance of water canal system in sponge and locomotion in Euglena.

Movement that leads to change in location

∴ All locomotions are movements but all movements are not locomotions.

- The structures of locomotions need not to be different from structures of movement e.g., Cilia in Paramecium, Tentacles in Hydra & limbs in humans.

- Locomotion is done for: finding food, shelter, mate, breeding ground, favourable climate, escape from predators

Muscle

- Mesodermal in origin; contribute 40-50% of our body weight
- Muscles are: contractile, elastic, extensible, excitable

Features	Skeletal/ Striated	Smooth/ Visceral	Cardiac
Actions	Voluntary	Involuntary	Involuntary
Speciality	Attached to skeletal system	Found in visceral organs	Have intercalated discs (thus branched)

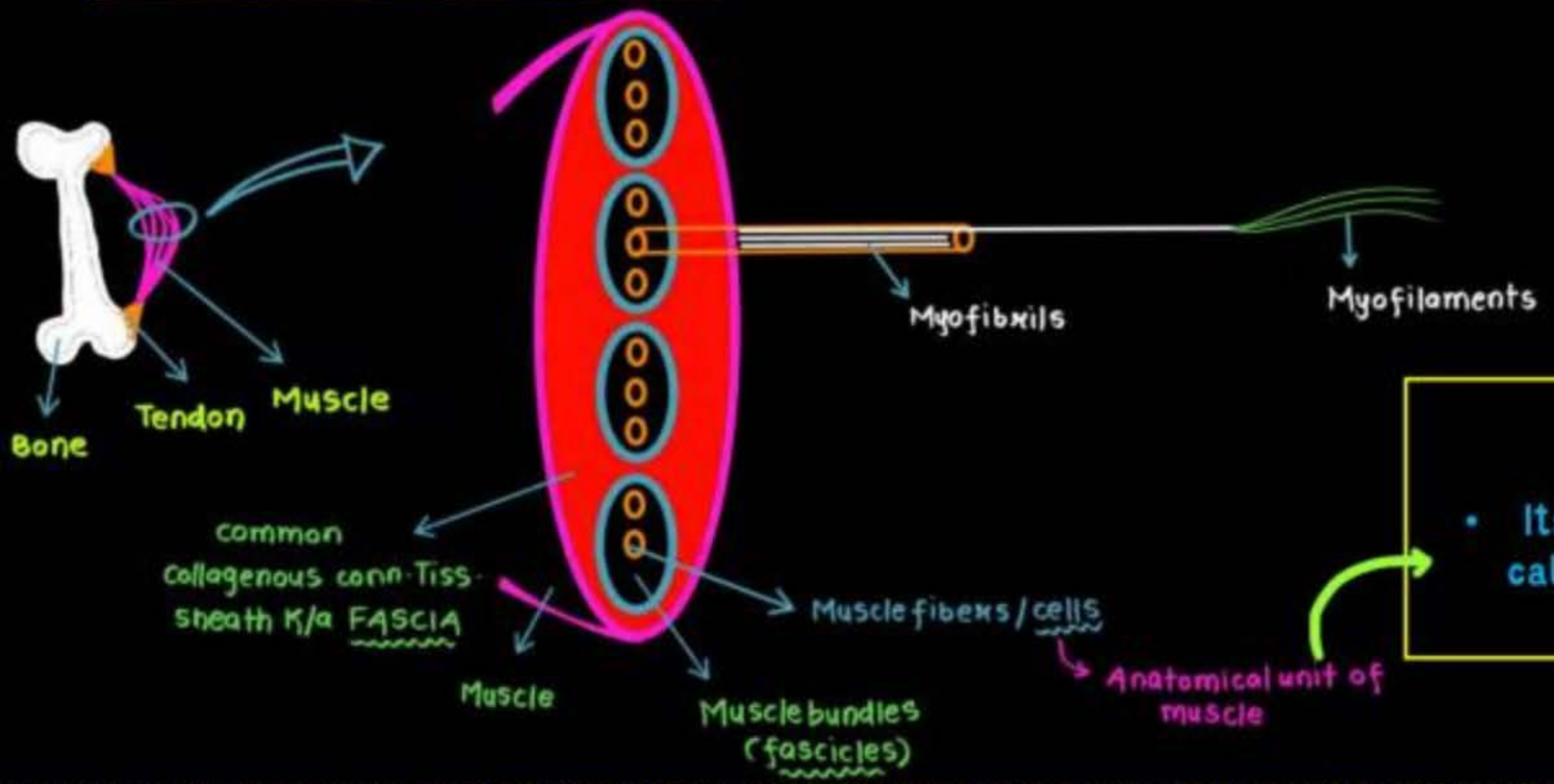
Structure of Muscle

→ Muscle > Muscle bundles > Fibers > Fibrils > Filaments

↓

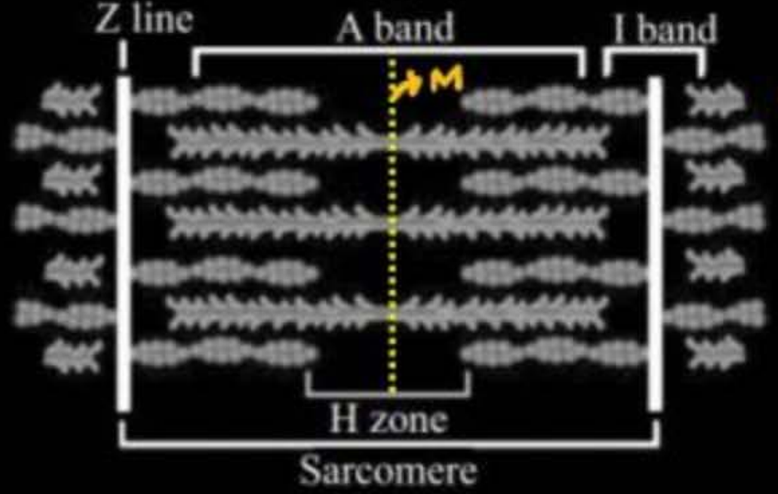
contain alternate light & dark band

- I-band → Actin (thin)
- A-band → Myosin (thick)



NOTE

- Muscle fibre is a syncytium;
- Its membrane is called SARCOLEMMA; its ER is called SARCOPLASMIC RETICULUM (storehouse of Calcium);



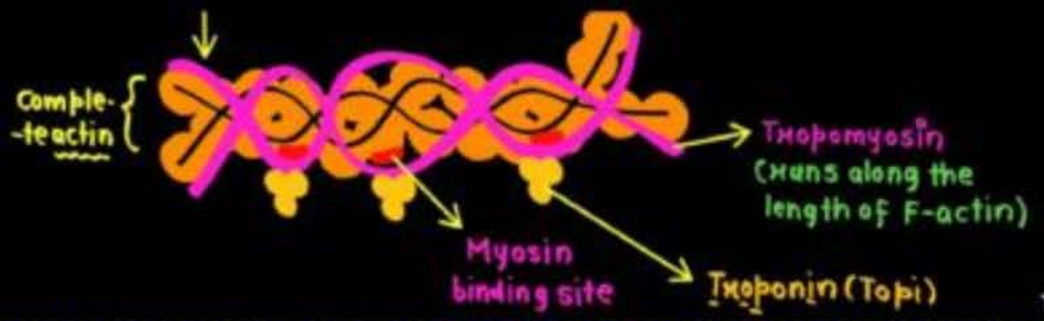
- *I-band: only actin
  A-band: myosin or myosin + actin
- *O-zone: Actin + myosin
  H-zone: only myosin

Structure of Contractile Proteins

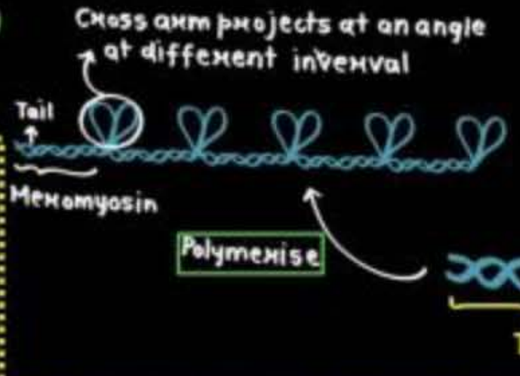
- Light band
  - I-band: formed of thin proteins called 'Actin'

: G-actin / Globular actin / monomer

: F-actin / Filamentous actin / Polymer

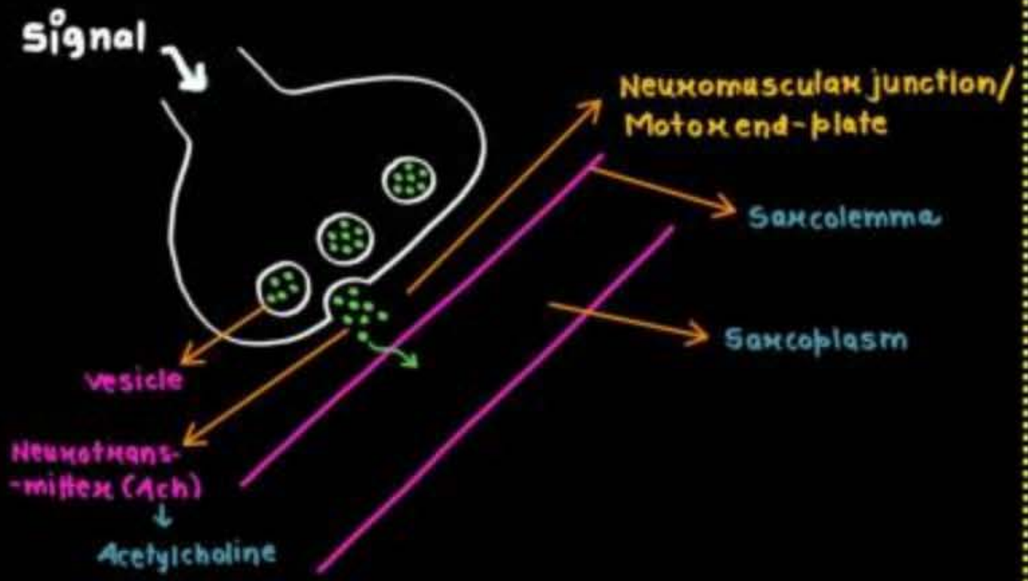


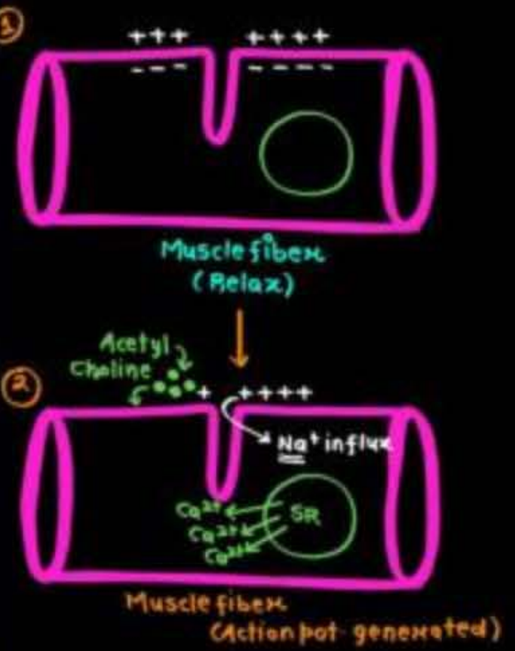
• Dark Band:
↳ A-band: Thick band: made of up myosin protein
↳ is a polymer formed from monomers called 'meromyosin'



Mechanism of Muscle Contraction

- Explained by sliding filament theory;
  Thin filament slides over thick filament
- Signal from CNS is sent to muscle via motor neuron
- Motor unit = Motor neuron + all muscle fibers it is connected with





3 Ca^{2+} ions released from sarcoplasmic reticulum engages 'troponin protein'

4 ∴ Myosin binding site of actin becomes EXPOSED

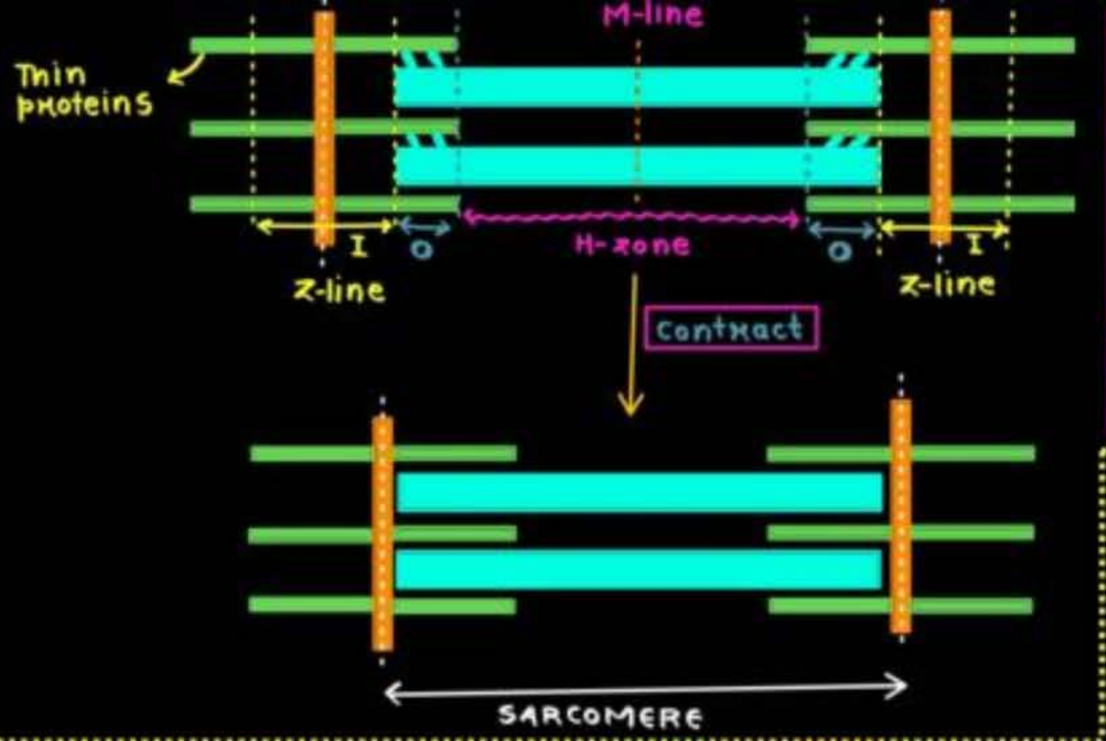
5 • Myosin hydrolyse ATP to release energy

$$ATP \xrightarrow[Mg^{2+}]{H_2O} ADP + P_i$$

6 Myosin head binds with actin & slides it

7 • Myosin utilise more ATPs to continue this sliding & contraction

8 • When muscle needs to relax:
↳ Ca^{2+} are pumped back to sarcoplasmic reticulum
• Tropin mask the myosin binding site of actin
∴ muscle RELAX



- Length of Actin : SAME
  Length of Myosin : SAME
- I-band : Shorten ↓
- A-band : SAME
- Sarcomere : Shorten
  (Z lines comes closer)
- O-zone : increase ↑
- H-zone : decrease ↓

Red Muscle Fiber	White Muscle Fiber
Myoglobin: very high	Myoglobin: very less
Mitochondria: Numerous	Mitochondria: Few; Sarcoplasmic reticulum is high
Aerobic muscle	Anaerobic muscle

Skeletal System

- 206 bones & few cartilages
  - ↓ non-pliable
  - ↳ Pliable

Skull

Cranial bones (8)

- They make cranium / brainbox
  - Protects brain

P : Parietal (2)
E : Ethmoid (1)
S : Sphenoid (1)
T : Temporal (2)
O : Occipetal (1)
F : Frontal (1)

Cranium

Facial bones (14)

M : Maxilla (2)
P : Palatine (2)
Ne : Nasal (2)
Zyada : Zygomatic (2)
Co : Conchae (2)
La : Lachrimal (2)
Mangayi : Mandible (1) - Freely movable
Vomit : Vomer (1)

Hyoid Bone (1)

- U-shaped bone below buccal cavity
- Not conn. to anyother bone

Earossicles (6)

(Small bones in middle ear)

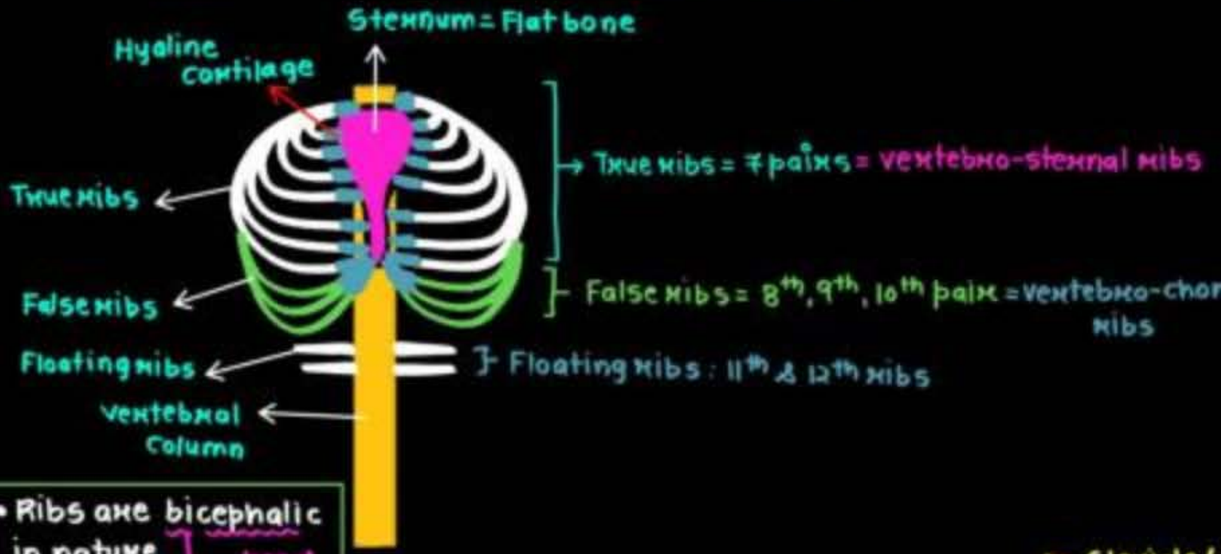
M : Malleus
I : Incus
S : Stapes (smallest)

Vertebral Column

Cat : Cervical = 7
Took : Thoracic = T_{12}
5-Little : Lumbar (5)
Sparrow & : Sacral (1)
Crow : Coccyx (1)

Embryo : $C_7 T_{12} L_5 S_5 C_4 = 33$
Adult : $C_7 T_{12} L_5 S_{(1)} C_{(1)} = 26$

Ribs

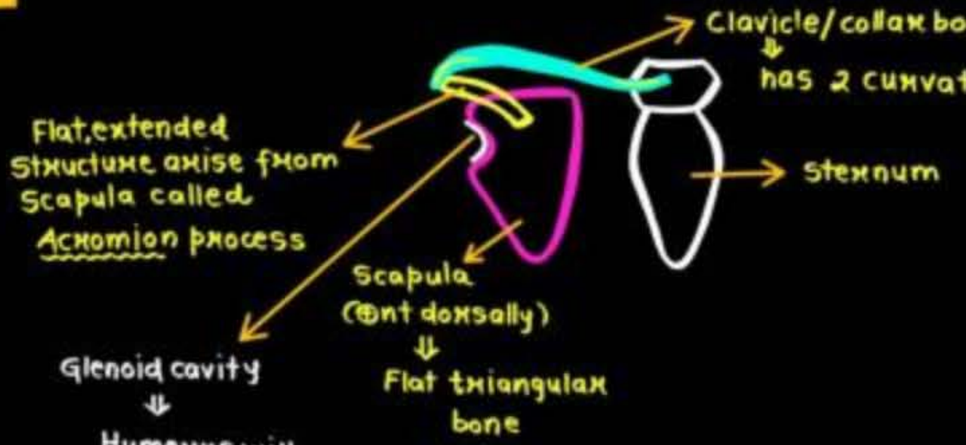


- Ribs are bicephalic in nature → head (2)

Forelimb and Hindlimb

- H : Humerus - 1 → Bicep bone
- R : Radius - 1 → Towards thumb
- U : Ulna - 1
- Carpals : (8) - wrist bone
- Metacarpals : 5 - Palm bones
- Phalanges : 14 - digits

⇓



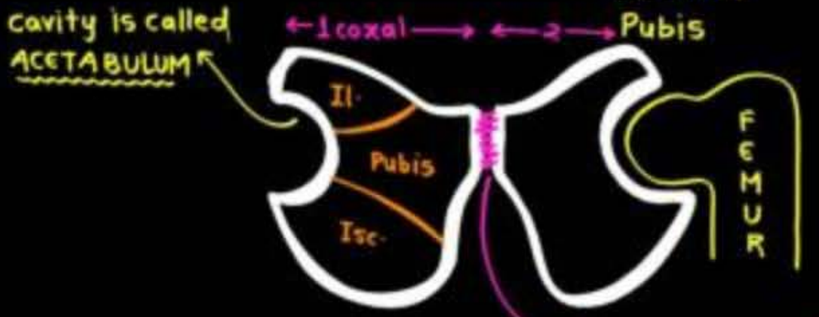
- Femur : 1 → Largest bone
- Tibia : 1 → Towards thumb
- Fibula : 1
- Patella : 1 → Knee cap
- Tarsal : (7) → Toe
- Metatarsal : 5
- Phalanges : 14

⇓

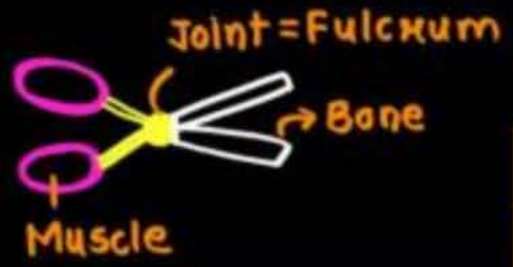
- 2 coxals make pelvic girdle

one coxal : formed by fusion of 3-bones
- Ilium
- Ischium
- Pubis

cavity is called ACETABULUM



Pubic symphysis joint



Joints

Joints	Details
Fibrous Joints	• Do not allow any movements • E.g., cranial bones
Cartilaginous Joints	• Permit limited movements • E.g., Adjacent vertebrae
Synovial Joints	• Allow considerable movements Ball and socket: between humerus and pectoral girdle Hinge joint: knee joint Pivot joint: between atlas and axis Gliding joint: between carpals Saddle joint: between carpal and metacarpals of thumb

Disorders

Myasthenia Gravis	Autoimmune disorder affecting neuromuscular junction leading to weakness, fatigue and paralysis of muscle
Muscular Dystrophy	Progressive degeneration of skeletal muscle mostly due to genetic disorders
Tetany	Spasm/ wild contraction due to low calcium in body fluids
Arthritis	Inflammation of joints
Gout	Inflammation of joints Due to accumulation of urate crystals
Osteoporosis	Age related thinning of bones; mainly due to low oestrogen levels

QUESTION (NEET PYQ EXAM 2024)

Match List I with List II :

	List I		List II
A.	Fibrous joints	I.	Adjacent vertebrae, limited movement
B.	Cartilaginous joints	II.	Humerus and Pectoral girdle, rotational movement
C.	Hinge joints	III.	Skull, don't allow any movement
D.	Ball and socket joints	IV.	Knee, help in locomotion

Choose the correct answer from the options given below :

(1) A-IV, B-II, C-III, D-I

(2) A-I, B-III, C-II, D-IV

(3) A-II, B-III, C-I, D-IV

(4) A-III, B-I, C-IV, D-II

QUESTION (NEET PYQ EXAM 2024)

Which of the following are Autoimmune disorders?

A. Myasthenia gravis

B. Rheumatoid arthritis

C. Gout

D. Muscular dystrophy

E. Systemic Lupus Erythematosus (SLE)

Choose the most appropriate answer from the options given below:

(1) A, B & D only

(2) A, B & E only

(3) B, C & E only

(4) C, D & E only

QUESTION (NEET PYQ EXAM 2024)

Match List-I with List-II:

	List I Location of Joint		List II Type of Joint
A.	Joint between humerus and pectoral girdle	I.	Gliding joint
B.	Knee joint	II.	Ball and Socket joint
C.	Joint between atlas and axis	III	Hinge joint
D	Joint between carpals	IV.	Pivot joint

Chose the correct answer from the options given below:

(1) A-II, B-III, C-IV, D-I

(2) A-III, B-II, C-I, D-IV

(3) A-I, B-IV, C-III, D-II

(4) A-II, B-I, C-III, D-IV

QUESTION (NEET PYQ EXAM 2023)

Match **list-I** with **list-II**. **(2023)**

List-I (Type of Joint)		List-II (Found between)	
A.	Cartilaginous Joint	I.	Between flat skull bones
B.	Ball and Socket Joint	II.	Between adjacent vertebrae in vertebral column
C.	Fibrous Joint	III.	Between carpal and metacarpal of thumb
D.	Saddle Joint	IV.	Between Humerus and Pectoral girdle

Choose the **correct** answer from the options given below.

(1) A-II, B-IV, C-I, D-III (2) A-I, B-IV, C-III, D-II

(3) A-II, B-IV, C-III, D-I (4) A-III, B-I, C-II, D-IV

QUESTION (NEET PYQ EXAM 2023)

Which of the following statements are **correct** regarding skeletal muscle? **(2023)**

A. Muscle bundles are held together by collagenous connective tissue layer called ~~fascicle~~. fascia

B. Sarcoplasmic reticulum of muscle fibre is a store house of calcium ions. ✓

C. Striated appearance of skeletal muscle fibre is due to distribution pattern of actin and myosin proteins. ✓

D. M line is considered as functional unit of contraction called sarcomere. ✗

Choose the most appropriate answer from the options given below.

(1) B and C only ✓
(2) A, C and D only
(3) C and D only
(4) A, B and C only

QUESTION (NEET PYQ EXAM 2022)

Which of the following is a **correct** match for disease and its symptoms? **(2022)**

(1) Muscular dystrophy - An auto immune disorder causing progressive degeneration of skeletal muscle

(2) Arthritis - Inflammed joints

(3) Tetany - ~~high~~ Ca^{2+} level causing rapid spasms

(4) Myasthenia gravis - Genetic disorder resulting in weakening and paralysis of skeletal muscle

QUESTION (NEET PYQ EXAM 2022)

Given below are two statements: one is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**.

Assertion (A): Osteoporosis is characterised by decreased bone mass and increased chances of fractures.

Reason (R): Common cause of osteoporosis is increased levels of estrogen.

In the light of the above statements, choose the most appropriate answer from the options given below. **(2022)**

(1) **Assertion (A)** is not correct but **Reason (R)** is correct.

(2) Both **Assertion (A)** and **Reason (R)** are correct and **Reason (R)** is the correct explanation of **Assertion (A)**.

(3) Both **Assertion (A)** and **Reason (R)** are correct but **Reason (R)** is not the correct explanation of **Assertion (A)**.

(4) **Assertion (A)** is correct but **Reason (R)** is not correct.

QUESTION (NEET PYQ EXAM 2021)

Chronic auto immune disorder affecting neuromuscular junction leading to fatigue, weakening and paralysis of skeletal muscle is called as; **(2021)**

(1) muscular dystrophy

(2) myasthenia gravis

(3) gout

(4) arthritis

QUESTION (NEET PYQ EXAM 2020)

Match the **list-I** and **list-II** and select the **correct** option. **(2020)**

List-I		List-II	
A.	Floating ribs	I.	Located between second and seventh ribs
B.	Acromion	II.	Head of the humerus
C.	Scapula	III.	Clavicle
D.	Glenoid cavity	IV.	Do not connect with the sternum

(1) A-I, B-III, C-II, D-IV

(2) A-III, B-II, C-IV, D-I

(3) A-IV, B-III, C-I, D-II

(4) A-II, B-IV, C-I, D-III

QUESTION (NEET PYQ EXAM 2020)

Match the following **list-I** and **list-II** to select the **correct** option. **(2020 Covid)**

List-I		List-II	
A.	Gout	I.	Decreased levels of estrogen
B.	Osteoporosis	II.	Low Ca^{++} ions in the blood
C.	Tetany	III.	Accumulation of uric acid crystals
D.	Muscular dystrophy	IV.	Auto immune disorder
		V.	Genetic disorder

(1) A-III, B-I, C-II, D-V

(2) A-IV, B-V, C-I, D-II

(3) A-I, B-II, C-III, D-IV

(4) A-II, B-I, C-III, D-IV

QUESTION (NEET PYQ EXAM 2019)

Which of the following muscular disorder is inherited?

(2019)

(1) Tetany

(2) Muscular dystrophy

(3) Myasthenia gravis

(4) Botulism

QUESTION (NEET PYQ EXAM 2019)

Select the **correct** option. **(2019)**

(1) 8^{th}, 9^{th} and 10^{th} pairs of ribs articulate directly with the sternum

(2) 11^{th} and 12^{th} pairs of ribs are connected to the sternum with the help of hyaline cartilage

(3) Each rib is a flat thin bone and all the ribs are connected dorsally to the thoracic vertebrae and ventrally to the sternum

(4) There are seven pairs of vertebrosternal, three pairs of vertebrochondral and two pairs of vertebral ribs


THANK YOU