LOCOMOTION AND MOVEMENT

1 MOVEMENT AND LOCOMOTION

- **Movement** • Significant feature of living beings.
- **Locomotion** • Voluntary movements resulting in change in place/location.
- Locomotion is performed by organisms for variable reasons, e.g ..

★Their habitats.

★ Demand of situation like search of food, mate, breeding ground, escape from enemies/predators.

2 MUSCLES

- **Muscle tissue:** Mesodermal in origin
- **40-50%** of body weight of a human adult is contributed by muscles.
- **Properties.** • Excitability • Contractility • Extensibility • Elasticity
- Many cardiac muscle cells assemble in branching pattern to form a cardiac muscle

Basis	Locationt	Appearance	Regulation	Example
• Classification of Muscles	• Skeletal	Striated	Voluntary	Muscles of limbs
	• Visceral	Non-striated/ smooth	Involuntary	Inner walls of visceral organs
	• Cardiac	Striated	Involuntary	Muscles of heart

2 TYPES OF MOVEMENT / LOCOMOTION

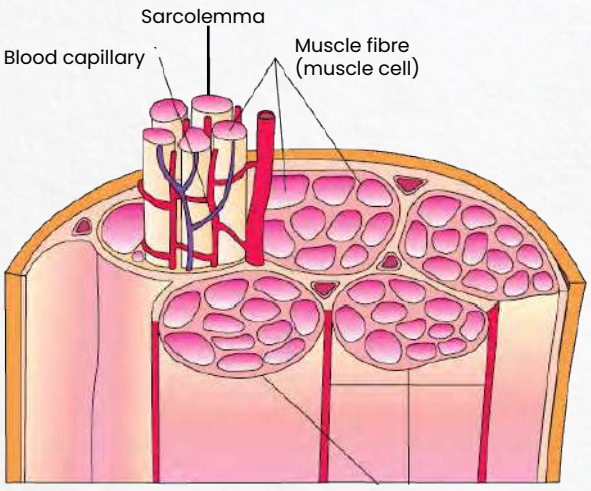
Type	Structure	Examples and functions
Amoeboid	Pseudopodia involve microfilaments and streaming of protopalsm	• Leucocytes, macrophages, *Amoeba*
Ciliary	Cilia	• Removing dust particles from trachea • Passage of ova through female reproductive tract
Flagellar	Flagella	• Maintenance of water current in canal system of sponges • Locomotion in *Euglena* • Swimming of spermatozoa
Muscular	Muscles	• Movement of Limbs, jaws, tongue • Running, walking, climbing, flying

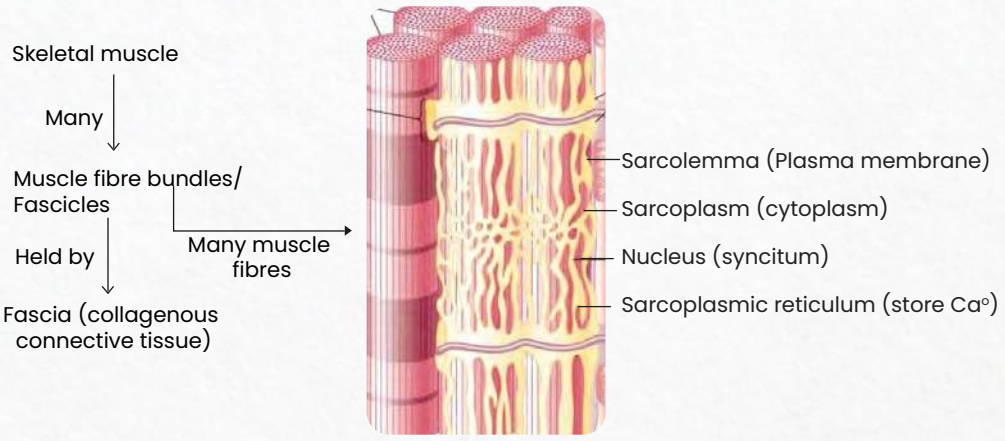
All locomotions are movements but all movements are not locomotion.

- **In Paramoecium** - Cilia helps in movement of food through cytopharynx and in locomotion as well.
- **In Hydra** - Tentacles are used for capturing or prey & also for locomotion.
- **Locomotion** requires a perfect coordinated activity of **muscular, skeletal** and **neural** systems.

4 SKELETAL MUSCLE FIBRES & ITS TYPES

Skeletal muscles are closely associated with the skeletal components of the body



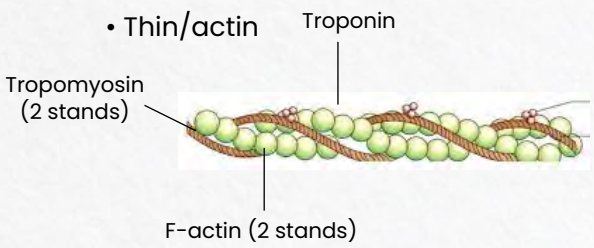
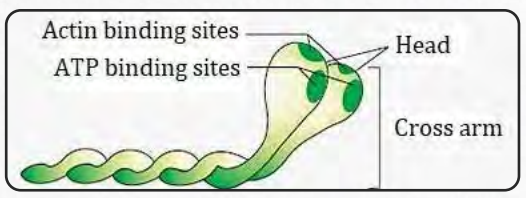


	Types	
	Red	White
Myoglobin	↑	↓
Mitochondria	↑	↓
SR	↓	↑
Respiration	Mainly aerobic	Mainly anaerobic

- Each muscle fibre have many parallelly arranged myofibrils/myofilaments.
- **Muscle fibre: Anatomical unit of muscle.**
- Skeletal muscles are primarily involved in locomotion and change in body posture.

5 MYOFILAMENTS AND STRUCTURE OF CONTRACTILE PROTEINS

Each myofibril has dark and light bands due to actin and myosin distribution that establish striated appearance.

Filament	Held by	Protein	Monomer	Polymer	Typical
• Thin/actin 	Z-line (bisect I-band)	Actin (contractile Tropomyosin Troponin	Globular 'G'-actin 3	Filamentous	• F-actin helically arranged • Tropomyosin run close to F-actin throughout its length • Troponin distributed at regular intervals on tropomyosin. • Mask active binding sites for myosin.
• Thick 	M-line (thin fibrous membrane)	Myosin (contractile)	Meromyosin (MM)	HMM -Head (Heavy)- **Short arm** LMM – Tail (Light)	Project outward at regular distance and angle from each other from the surface of polymerised myosin filament and is known as cross arm.

6 MECHANISM OF MUSCLE CONTRACTION/SLIDING FILAMENT THEORY

• Contraction of muscle fiber takes place by the sliding of thin **filaments over the thick filaments.**
A motor neuron along with the muscle fibres connected to it constitute a **motor unit.**

CNS → via → Motor neuron → Neurotransmitter Acetylcholine

At Neuromuscular Junction/Motor end plate, action potential is generated in sarcolemma that causes release of Ca^{2+} in sarcoplasm from SR leading to **Ca^{2+} increase i**n sarcoplasm

↓

Ca^{2+} binds to troponin subunit, change in its confirmation, unmask active site for myosin binding on actin filament

↓

Energised myosin (Myosin – ADP + Pi) binds to actin

↓

Cross bridge = Actin-myosin-ADP + Pi

↓

Result Shortening contraction of sarcomere
- Pull thin filaments toward centre
- Pull Z-line
- Length of I-band reduced
- Length of A-band retained

↓

ADP + Pi released from myosin head

↓

New ATP binds to myosin head

↓

Cross bridge broken

↓

ATP hydrolysis on myosin head

↓

Cycle repeats

↓

Process will continue till Ca^{2+} pumped back to sarcoplasmic cisternae

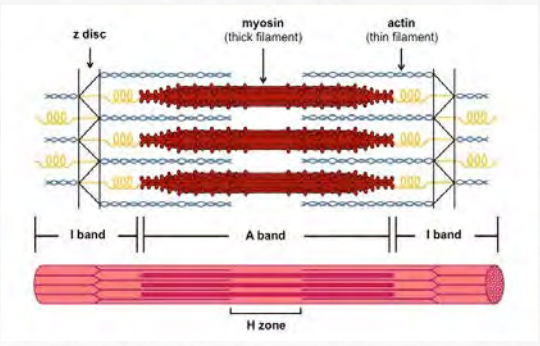
↓

Z-line return to original position

- **Reaction time** of fibres vary in different muscles
- Repeated activity of muscle leads to accumulation of **lactic acid** due to **anaerobic** breakdown of **glycogen** in them, causing fatigue.
- **Globular head** is active **ATPase enzyme** and has binding sites for ATP and active sites for actin.
- Thin filaments make I/Isotropic band-actin
  Thick filaments make A/Anisotropic band – actin + myosin

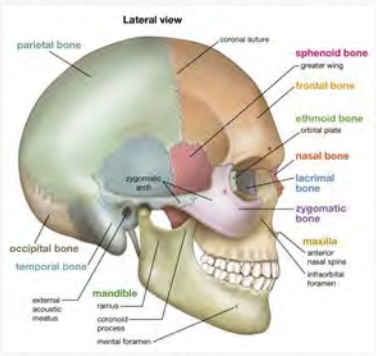
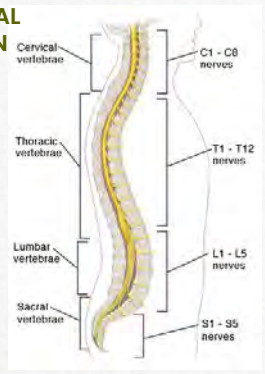
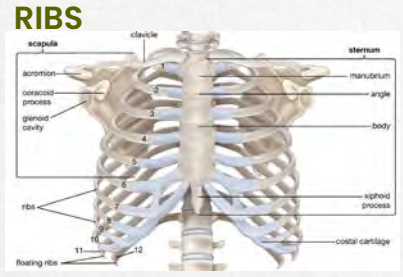
- **Sarcomere: Functional unit** of contraction between 2-Z lines (elastic fibres)
- H-zone is non overlapped part of thick filament by thin filaments.

  Arranged alternately throughout the length of myofibrils parallel to each other and to longitudinal axis of myofibrils



7 SKELETAL SYSTEM

- This system has significant role in movement shown by the body.
- **Framework of 206 bones & few** cartilages.
- **Principle division** • Appendicular skeleton • Axial skeleton.
- Axial skeleton (Bones-80).
- Bones distributed along main axis.

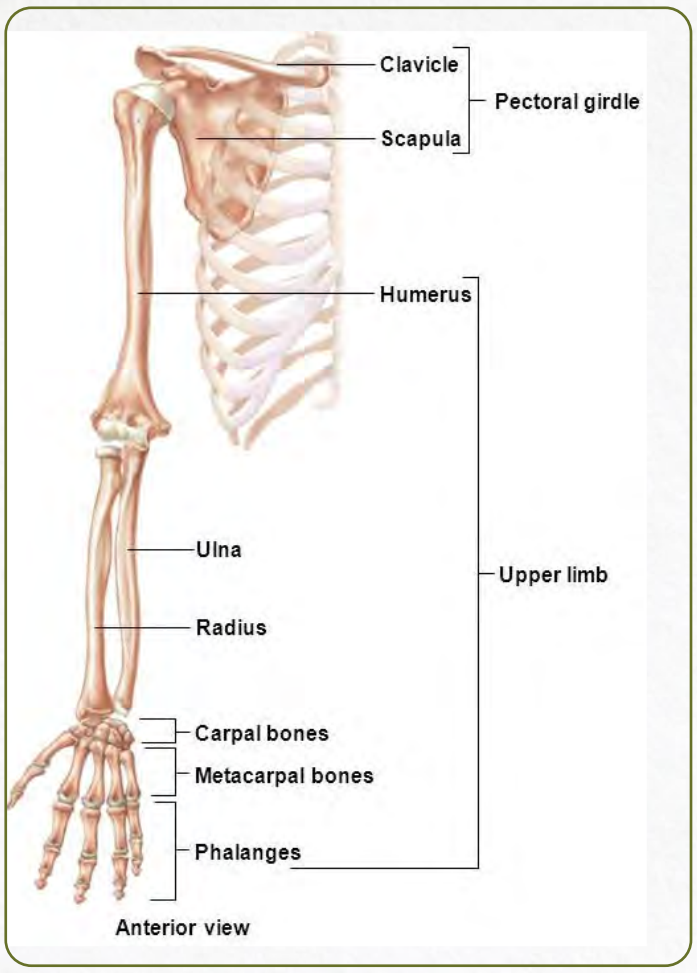
Structure	Bones Included	No.	Name of bones	Typical feature or basic function
SKULL 	Cranium	8	1-Frontal 1-Occipital 2-Parietal 1-Ethmoid 2-Temporal 1-Sphenoid	• Protect brain • Articulates with superior region of vertebral column by 2 occipital condyles **(Dicondylic skull)**
	Facial	14	2-Nasal 1-Mandible 2-Lacrimal 2-Maxilla 2-Zygomatic 5-others	• Form front part of skull
	Hyoid	1	1-U-shaped	• Present at the base of buccal cavity
	Ear Ossicles	6	2-Malleus 2-Incus 2-Stapes	• Present in the middle ear
VERTEBRAL COLUMN 	Dorsal Vertebra (serially arranged units)	26	7-Cervical 12-Thoracic 5-Lumbar 1-Sacral-Fused 1-Coccygeal-Fused	• Main framework of trunk • Protects spinal cord Supports head • Point of attachment of ribs and muscles of back • **1"** vertebra is **atlas** that articulates with **occipital condyles** • **Seven cervical vertebrae** exist in almost all mammals. • **Neural canal** of vertebrae - site
STERNUM	Chest bone	1	1-Flat bone	• On ventral, midline of thorax
RIBS 	True ribs False ribs Floating ribs	24	14-Vertebrosternal 6-Vertebrochondral 4-Vertebral	• Attach dorsally to vertebrae and ventrally to sternum with **hyaline cartilage** • Not directly attached to sternum but to 7th rib with **hyaline cartilage** (8th to 10th pair) • Not connected ventrally (11th and 12th pair) • All ribs are bicephalic thin flat bones i.e., they have 2 articulating ends on dorsal side • Vertebral column + Sternum + Ribs = Rib Cage

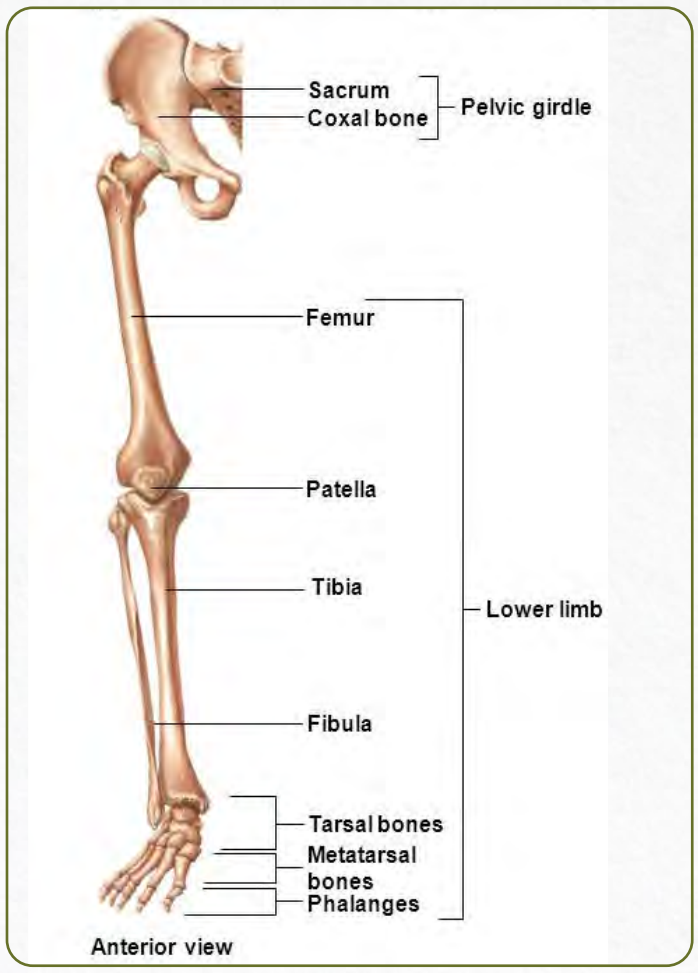
8 APPENOICULAR SKELETON(BONES · 126)

Consists of bones of limbs (30 × 4 = 120) and girdles (6)

Pectoral girdle & upper arm

Pelvic girdle & lower arm





- Girdles helps in the articulation of limbs with axial skeleton
- Scapula, a dorsal triangular flat bone, have elevated ridge/spine expanded to form acromion process that articulates with clavicle
- Glenoid cavity in scapula articulates with humerus head to form shoulder joint
- Acetabulum, formed by fusion of ilium, ischium and pubis, articulates with femur to form hip joint
- 2 halves of pelvic girdle meet ventrally to form pubic symphysis containing fibrous cartilage

9 JOINTS

- They are essential for all types of movements involving bony parts of the body.
- Point of contact between bones or bones and cartilages.
- Force generated by muscle is used to carry out movement through joint, where joint acts as fulcrum.
- Types of joints (Basis - Major structural forms).

TYPES	BONES JOINED BY	MOVEMENT	EXAMPLES
Fibrous	Dense fibrous connective tissue	Do not allow any movement	Flat skull bones fused end to end via sutures to form cranium
Cartilaginous	Fibrous cartilage	Limited movement	Adjacent vertebrae
Synovial	Fluid filled synovial cavity between 2 bones	Considerable movement, helps in locomotion and many other movements	• Humerus & pectoral girdle **(Ball and socket joint)** • Knee joint **(Hinge joint)** • Atlas & axis **(Pivot joint)** • Between carpals **(Gliding joint)** • Carpal & metacarpal of thumb **(Saddle joint)**

10 DISORDERS

DISEASE	CAUSES	IMPACT
Fibrous	Autoimmunity	• Affect neuromuscular junction • Fatigue, weakening and paralysis of skeletal muscles
Muscular dystrophy	Genetic	• Progressive degeneration of skeletal muscles
Tetany	Low Ca^{2+} in body fluid	• Rapid spasms in muscle (wild contractions)
Arthritis		• Inflammation of joints
Gout	Accumulation of uric acid crystals	• Inflammation of joints
Osteoporosis	Age related Decreased levels of estrogen	• Decreased bone mass increased chances of fracture