

Locomotion And movement

Types of movement

Ciliated → Cilia → Trachea → cilia → trap the dust
 female reproductive tract → fallopian tube
 Amoeboid → Pseudopodia → microfilaments, cytoplasmic streaming → amoeba, leucocytes, macrophages
 flagellar → sperm Euglena
 muscular → limbs, jaws → muscles + bones
 Cilia → e.g. paramecium cytopharynx
 flagella → hydra → tentacles → to push H₂O to its H₂O vascular system → locomotion.

Properties of muscles

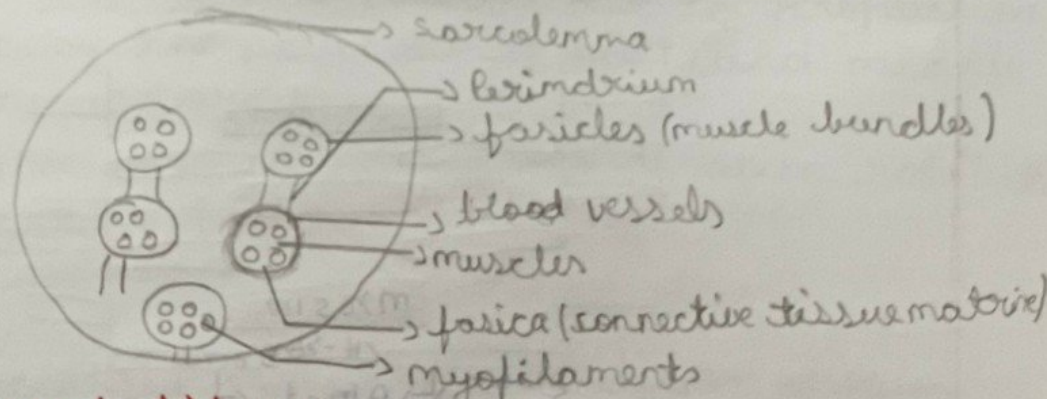
Excitability
 Extensibility
 Elasticity
 contractibility } → E³C

Types of muscles

1. visceral muscles → inner wall of → involuntary → non striated muscles
 visceral organs
2. Skeletal muscles → limbs & other → voluntary → striated
 body parts
3. Cardiac muscles → heart → involuntary → striated

muscle cell

PM → Sarcolemma ER → Sarcoplasmic reticulum
 nucleus → myofibril
 cytoplasm → sarcoplasm



Types of muscle fibres

Red muscle
 myoglobin
 white muscle
 myoglobin (less amount)

MT ↑
 SR ↓
 Type of respiration → aerobic

↓
 ↑
 Type of respiration → anaerobic

Actin (Thin filaments) $\rightarrow$ Contractile proteins $\leftarrow$ myosin (Thick filament)

Globular - G - protein
 $\downarrow$
 filamentous - F - actin

$\times 2$

myosin

Hmm

heavy
myosin

Lmm

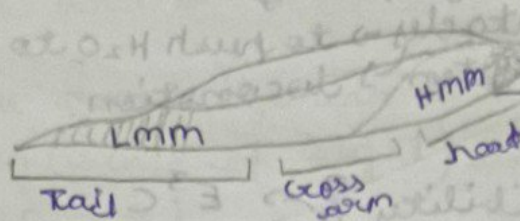
light
myosin

$\rightarrow$ Actin

troponin

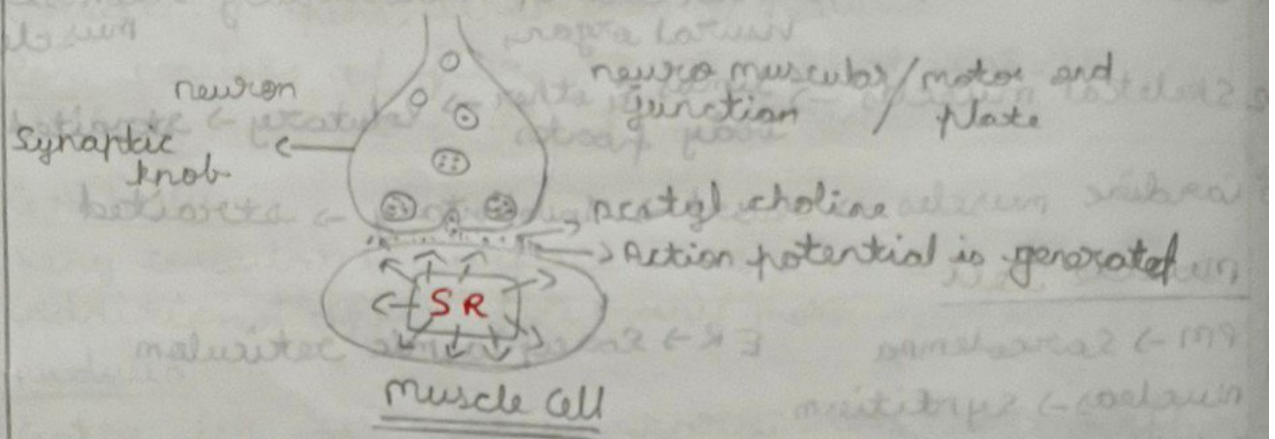
$\rightarrow$ Actin binding site

$\rightarrow$ ATP binding site

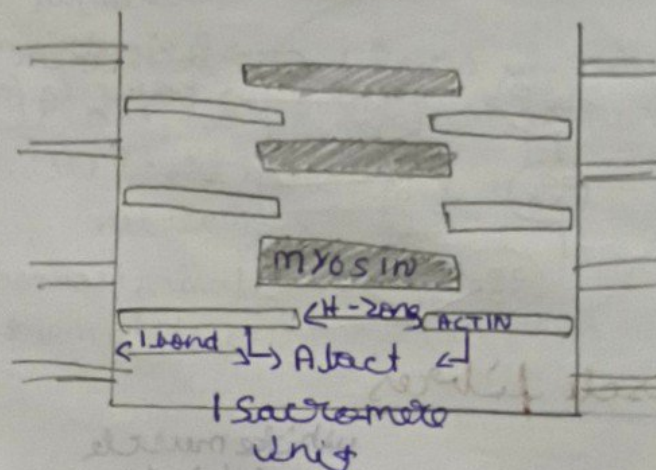


Sliding filament theory - Huxley

- sliding of thin filament over thick filament



- ~~movement is the~~



- movement is one of the basic features of living beings.
- streaming of protoplasm which occurs in amoeba is a simple form of movement

- Movement of cilia, flagella & tentacles are shown by many organisms.
- Some voluntary movement results in the change of place or location are called locomotion.
- eg walking, running, flying etc
- All locomotions are movement but all movements are not locomotion.
- This is seen in paramecium where the cilia helps in the movement of food through cytopharynx and also in locomotion.
- Hydra can use its tentacles for capturing its prey and also for locomotion.

Types of movements:-

- Amoeboid:- occurs due to pseudopodia formed by cytoplasmic streaming. It is shown by the macrophages and leucocytes in blood and cytoskeletal elements like microfilaments.
 - Ciliary movement:- It is shown by the cilia present in the upper respiratory tract of humans to keep the microbes and dust particles out. Cilia in fallopian tube and cilia in Kasa Efferentia helps in transport of ova and spermatozoa in later.
 - Muscular movement:- movement of limbs, jaws, tongue etc occurs due to contraction and relaxation of muscles.
 - Flagellar movement:- It occurs due to propulsion of dough by the movement of tail and middle piece of human sperm.
- locomotion requires a perfect coordination activity of muscular, skeletal & neural system.

Muscle:-

- It's a specialized tissue of mesodermal origin.
- 40-50% of body weight of a human adult is caused by muscles.
- Muscles have excitability, contractility, extensibility and elasticity

Types of muscles based on location

1 Skeletal muscles :-

- Closely associated with the skeletal component of the body.
- Also known as straighter straited muscles
- Eg limbs, body wall, tongue, pharynx & beginning of oesophagus.
- Voluntary movement involved in locomotion.

2 Cardiac muscles :-

- Found in the walls of heart and in the walls of large veins.

Eg Pulmonary veins & superior venacava

- They are cylindrical, straited, branched, uninnervate fibres and are involuntary in nature.

3 Smooth muscles :-

- Also known as visceral or unstraight or non-straited muscles.
- They are spindle shape.
- Found in the inner walls of hollow visceral organs of body like posterior part of oesophagus, stomach, intestine, lungs, urogenital tract, urinary bladder and blood vessels, iris of eyes, dermis of skin etc.
- They are not connected with the skeletal.
- Controlled by autonomic nervous system.

Structure of skeletal muscle :-

- Each organised skeletal muscle in our body is made up of no. of muscle bundles of fascicles.
- Fascicles are held together by a collagenous connective tissue layer called fascia.
- Each muscle bundle contains a number of muscle fibre.
- Each muscle fibre is long, cylindrical and surrounded by a cell membrane called sarcolemma.
- The cytoplasm of the muscle is called sarcoplasm.
- muscle fibre is a syncytium as the sarcoplasm contains many nuclei.
- It contains numerous mitochondria known as sarcosomes and smooth surface of endoplasmic

reticulum called sarcoplasmic reticulum which is store house of calcium ions.

- muscle fibres contain 100 to several 1000 ~~para~~ parallelly arranged filaments in the sarcoplasm called myofilaments or myofibrils.
- Each myofibril has alternative dark and light bands on it.
- The striated appearance is due to the distribution pattern of 2 important proteins actin & myosin.
- The light band contains actin and is called I band or isotrophic band.
- The dark band contains myosin and is called A or an isotrophic band.
- Both actin and myosin proteins are arranged as rod like structures, parallel to each other and also to the longitudinal axis of myofibres.
- Actin filaments are thinner as compared to myosin filaments so commonly called thin & thick filaments.
- In the centre of each myofibril is an elastic fibre called Z line or Z disc or ~~or~~ Kraus's membrane which bisects it.
- The thin filaments are strictly attached to the Z-line.
- The thick filament in the A band is also held together in the middle of the band by a thin fibrous membrane called M-line.
- The portion of the myofibril that lies b/w 2 successive Z-lines is called as sarcomere.
- It is the functional and contractile unit of myofibril.
- The centre of thick filament is not ~~the~~ overlapped by thin filament called H-Zone.

Structure of contractile proteins

- 1 Thin myofilament is made up of 3 different proteins:-
- i Actin:-
- The backbone of actin filament is a double stranded F-actin protein molecule.
- Each actin filament is made of 2 filamentous actin. Helically wound to each other.
- F-actin is a polymer of monomeric G-actin.

ii) Troponin:

- It is double stranded a helical coil that attaches to F-actin.
- In the resting state, the troponin molecules lie on top of the active sites on the actin strands to avoid attraction between the actin & myosin filaments that causes contraction.

iii) Tropomyosin:

- A complex ~~thin~~ protein tropomyosin is distributed at regular intervals on the troponin in the resting state, a sub unit of tropomyosin masks the active binding sites for myosin on the actin filaments.

Thick myosin filaments

- It mainly consists of myosin.
- It is composed of units of meromyosin, heavy meromyosin (HMM) and light meromyosin (LMM).
- Globular subfragments of HMM contains ATP binding sites and actin binding sites.
- It can form a cross bridge with the active site present on the actin.

Mechanism of muscle contraction

- It is best explained by the sliding filament theory. This theory states that the contraction of muscle fibres take place by the sliding of thin filaments over the thick filaments.
- Sliding filament theory of muscle contraction was proposed by the group of 2 workers i.e., A.F. Huxley and Ralph.
- It is initiated by a signal sent by CNS or motor neuron.
- A motor neuron along with the muscle fibre connected to it constitute a motor neuron.

Neural Junction

- The junction between the motor neuron and the sarcolemma of the muscle fibre is called the neuromuscular junction or motor end plate.
- A neural signal reaching this junction releases a

potential in the sarcolemma. This spreads through the muscle fibre and causes the release of cations into the sarcoplasm.

- Increase in Ca^{2+} level leads to the binding of Ca^{2+} with the subunit of troponin on actin filament and thereby removes the masking of active sites for myosin.
- Utilizing the energy from ATP hydrolysis the myosin head now binds to the exposed active site on actin ~~filaments~~ and thereby removing to form a cross bridge.
- This pulls the attached actin filaments towards the centre of A band the Z lines attached to these actins are also pulled inwards thereby causing shortening of sarcomere i.e., contraction.
- During shortening of the muscle contraction the I bands get reduced, whereas the A band retains its length.
- The myosin, releasing the ADP and inorganic phosphate goes back to its relaxed phase a new ATP binds and the cross bridge is broken.
- The ATP is again hydrolysed by the myosin head and the cycle of cross bridge formation and the breakage repeated causing further sliding.
- The process continues till the Ca^{2+} ions are pumped back to the sarcoplasm cisternae resulting in the masking of actin filaments.
- This causes the return of Z lines back to their original position i.e., relaxation.
- Repeated activation of the muscles can lead to the accumulation of lactic acid due to anaerobic

breakdown of glycerol in form of fatty acids.

Skeletal System

- It is made up of bones and cartilage and plays an significant role in the body movements.
- There are totally 206 bones and few cartilage.
- Principal division involves appendicular skeleton and axial skeleton.

Axial skeleton :- 80

- Bones here are distributed along the main axis

Cranium :- (8)

- 1- frontal, 2- parietal, 2- temporal, 1- occipital, 1- sphenoid, 1- sphenoid.
- It protects the brain
- It articulates with superior region of vertebral column by 2 occipital condyles. (dicondylar skull)

Facial :- (14)

- 2- nasal, 2- lacrimal, 2- sphenoid, 1- mandible, 2- maxilla, 5 others.
- Embryonic part of the skull.

Hyoid :- (1)

- 1-U shaped bone present at the base of laryngeal cavity.

Ear ossicles :- (6)

- 2- Malleus, 2- Incus, 2- stapes
- Present in the middle ear

Vertebral Column :- (26)

- 7- cervical, 12- thoracic, 5- lumbar, 1- sacral, 1- fused, 1- sacral (fused) 1 coccyx
- Main frame work of trunk
- Protects spinal chord, supports head
- Point of attachment of ribs and muscles of back

Sternum :- (1)

- It has 1 flat bone also called as chest bone.
- Present on ventral, midline of thorax

Ribs :-

Cervical ribs :-

- It has 14 vertebrae sternum bones.

Attached dorsally to vertebrae and ventrally to the sternum with the hyaline cartilage.

False ribs:-

- It has 6 vertebrae costal horns 8th to 10th horns make up the false ribs.
- Not directly attached to the sternum but the 7th ribs with hyaline cartilage

Eleating ribs:-

- It has 11 vertebral horns.
- Not connected ventrally (11th & 12th pair)
- All ribs are thin flat horns and are called luciphalic i.e., they have 2 articulation ends on dorsal side.

- Rib cage = vertebral column + sternum + ribs
- 1st vertebrae is atlas that articulates with scapula condyles
- 7 cervical vertebrae exist in almost all mammals
- Neural canal of vertebrae - right or left process where spinal chord passes.

Appendicular skeleton horns:- (126)

- consists of horns of limbs (30 x 14 = 120) and girdles (6). There are 2 types of girdles.

i) Pectoral girdle in upper arm

ii) Pelvic girdle in lower arm

- Upper arm has clavical or collar horns, scapula horns 2nd and 7th ribs

- 1 - humerus, 1 - scapula, 1 - Alna, 8 - Carpal, 5 + metacarpals & 14 - Phalanges are present.

- Girdles help in the articulation of limbs with axial skeleton.

- Scapula, a dorsal triangular flat horn have elevated rich, expanded to form
- Acromion process that articulates with clavical
- Glenoid cavity in scapula articulates with humerus head to form shoulder joint.

Elbow girdle & lower arm

- Metacarpals formed by fusion of ~~met~~ ilium, radius & ischium, There 3 are called carpal horns.

- Coracoclavicular joint.
- 2 halves of pelvic girdle meet ventrally to form pubic symphysis containing fibrous cartilage
- Femur - largest bone (1), patella - knee (1), 1 - Tibia, 1 - Fibula, 7 - tarsals, 5 - metatarsals, 14 phalanges.

Joints:-

- They are essential for all types of movement involving every part of the body.
- Joint of contact between bones or bones & cartilage
- Force generated by muscle is used to carry out movement through joint where joints acts as a fulcrum.

Types of Joints

1. Fibrous:-

- It is made up of dense fibrous connective tissue. They do not allow any movement, Eg include flat skull bones fused and to and via sutures to form cranium.

2. Cartilaginous Joint:-

- made up of fibrous cartilage.
- Has limited movement. Found in adjacent vertebrae

3. Cerebral Joint:-

- Fluid filled cerebral cavity is formed between 2 bones.

- It allows considerable movement, helps in locomotion and many other movements.
- humerus and scapula girdle :- ball and socket joint

Eg

- knee joint :- hinge joint
- Atlas & Axis :- Pivot joint
- Coracoclavicular of thumb :- saddle joint