

Locomotion and Movement



> streaming of protoplasm in the unicellular organisms like amoeba is a simple form of movement.
 > in paramecium cilia helps in movement of food through cytopharynx and in Locomotion as well.
 > hydra can use its tentacles for capturing its prey and also use them for locomotion.
 > locomotion is generally for search of food, shelter, mate, suitable breeding grounds, favourable climate, escape from enemies. **Method of locomotion depend on habitat & demand of situation.**

MUSCLE

Flagellar movements help in the swimming of spermatozoa, maintenance of water current in the canal system of sponges and in locomotion of protozoans like euglena.

Muscle is a specialised tissue of mesodermal origin (40-50% body wt. = muscle).

They are excitable, contractile, extensible and elastic.

TYPES OF MOVEMENT

AMOEBOID

Eg-macrophages & leucocytes.
 It is effected by pseudopodia formed by streaming of protoplasm.
 Cytoskeletal elements like microfilaments are also involved in it.

CILIARY

Occur in internal organs which are lined by ciliated epithelium. Eg-trachea (coordinated), fallopian duct

MUSCULAR

Their contractile property is effectively used for locomotion or movement. Eg-limbs, jaw, tongue movement.

Locomotion requires a perfect coordinated activity of muscular, skeletal and neural systems.

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TYPES OF MUSCLE

SKELETAL

> striated, voluntary (under nervous system)
 > primary involved in locomotory action.
 > skeletal components of the body.

VISCERAL

> located in the inner walls of hollow visceral organs (alimentary canal/respiratory tract)
 > smooth, involuntary, non striated
 > assist in transportation.

CARDIAC

> heart muscles, striated, branched and involuntary in nature as the nervous system does not control their activities directly.

STRUCTURE AND MECHANISM OF MUSCLE CONTRACTION

Skeletal muscle is made of a no. Of muscle bundles/fascicle held together by common collagenous connective tissue layer called fascia. Each muscle bundle contains a no. Of muscle fibres. (**Synctium => multinucleated**)

Plasma membrane —> sarcolemma

Cytoplasm —> sarcoplasm

Endoplasmic reticulum —> sarcoplasmic reticulum (store house of Ca^{2+})

They have large no. Of parallel arranged filaments called myofibrils or myofilaments.

Striated appearance is due to the distribution pattern of two important proteins -> **ACTIN & MYOSIN.**

The light bands contain actin and is called isotropic or I-Band. Whereas the dark band called A or Anisotropic band contains myosin. Both the proteins are arranged rod like structures parallel to each other and also to the longitudinal axis of the myofibrils, actin filaments are thinner as compared to myosin filaments.

Z line bisects I-band, made of elastic fibres and attaches thin filament. Thick filaments are held by M line.

SARCOMERE - functional unit of contraction/portion of myofibril b/w two successive Z line.

Central part of thick filament, not overlapped by thin filament is called the H zone.

STRUCTURE OF CONTRACTILE PROTEINS

Each actin (thin) filament is made of two F (filamentous) actins helically wound to each other. Each F actin is a polymer of monomeric G (globular) actins. Two filaments of another protein, tropomyosin also run close to F actins throughout its length. A complex protein troponin is distributed at regular intervals on the tropomyosin in resting state a subunit of troponin masks the active site for myosin on the actin filaments.

Each myosin (thick) filament is polymerised protein of monomers as meromyosin (cone thick filament)

Meromyosin —> tail (light meromyosin) + short arm + globular head (heavy meromyosin)

The head and short arm projects outward at regular distance and angle from each other from the surface of a polymerised myosin filament and is known as cross arm.

Globular head has active site for ATP, Active ATPase enzyme and actin.

MECHANISM OF MUSCLE CONTRACTION

(Sliding filament theory)

> sliding of thin filaments over thick filaments.
 > muscle contraction is initiated by signal sent by CNS.
 > the junction b/w a motor neuron and sarcolemma is called neuromuscular junction or motor end plate.
 > neural signal releases acetylcholine
 > action potential is generated in sarcolemma.
 > it spreads through the muscle fibre & causes release of Ca^{2+} in the sarcoplasm.
 > Ca^{2+} binds with troponin unmasking the binding site.
 > using ATP myosin head binds to exposed active sites on actin to form cross bridge.
 > z line are pulled inwards (shortening of sarcomere) i.e. contraction (A band are as it is only I band come closer)
 > new ATP binds and cross bridge is broken and the cycle continues till Ca^{2+} are pumped back to sarcoplasmic reticulum.
 > masking again takes place, Z lines return to their position i.e. relaxation.

Repeated activation of muscle may lead to formation of lactic acid because of anaerobic break down of glycogen causing fatigue.

MUSCLES

Red fibres

- > myoglobin (red coloured O₂ storing pigment) content is high
- > more amt. of mitochondria
- > use O₂ for ATP production
- > aerobic muscles

White fibres

- > myoglobin content is less
- > less amt. of mitochondria
- > do not use O₂ for ATP production
- > Amt. of sarcoplasmic reticulum is high

SKELETAL SYSTEM

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Bones have hard matrix due to Ca salts & cartilage have slightly pliable matrix due to chondritin salts.
Total 206 bones are present in skeletal system

AXIAL SKELETON (80 bones)

- > 80 bones distributed along the main axis.
- > skull + vertebral column + sternum + ribs

APPENDICULAR SKELETON (126 Bones)

- > bones of limbs along with their girdles constitute the appendicular skeleton.
- > each limb have 30 bones

Points regarding skeletal system

- > SKULL(22 bones) = 8 Cranial bones + 14 facial bones
- > single U shaped bone called hyoid is present at the base of buccal cavity. (Included in skull)
- > each middle ear contains 3 tiny bones - Malleus incus and stapes (smallest) collectively called ear ossicles.
- > the skull articulates with superior region of vertebral column with the help of 2 occipital condyles (dicondylic skull)
- > vertebral column attaches ribs, supports head, protects spinal cord & musculature.
- > our vertebral column is formed by 26 vertebrae (dorsally placed).
- > each vertebra have neural canal (central hollow portion).
- > atlas (1st vertebrae) articulates with occipital condyles.
- > vertebral column = cervical (7) + thoracic (12) + lumbar (5) + sacral {(5)=1} + coccyx {(4)=1}
- > sternum is a flat bone on the ventral midline of thorax.
- > 12 pair of ribs dorsally connected to vertebrae and ventrally to sternum (Hence it is known as bicephalic)
- > 12 pair of ribs = 7 true ribs + 3 false ribs (vertebrochondral ribs) + 2 floating ribs
- > the bones of fore limb are humerus, radius, ulna, 8 carpals (wrist bones), 5 metacarpals (palm bones), 14 phalanges (digits)
- > bones of hind limb are femur (longest), tibia, fibula, 7 tarsals (ankle bone), 5 metatarsals, 14 phalanges, 1 cup shaped patella over knee (knee cap)
- > pectoral and pelvic girdle bones help in articulation of the upper and lower limbs respectively with axial skeleton.
- > each girdle is formed of 2 halves.
- > each half of pectoral girdle include clavicle (collar bone with 2 curvature) & scapula (triangular shaped dorsal flat bone present b/w 2nd & 7th rib).
- > the scapula has slightly elevated ridge called spine which forms acromion process (clavicle articulates with it). Below acromion a depression glenoid cavity is present which articulates with the head of humerus to form shoulder joint.
- > pelvic girdle is formed of 2 coxal bones each is formed of 3 bones (ilium, pubis, ischium). At the point of fusion a cavity acetabulum to which thigh bone articulates. 2 halves meet to form pubic symphysis (help in parturation) ventrally containing fibrous cartilage.

JOINTS

Force generated by muscles is used to carry movements through joints where joint act as fulcrum.

Fibrous joints

Do not allow any movement.
Eg- sutures connected with fibrous connective tissue.
(Flat skull bone)

Cartilaginous joints

Eg- joint b/w adjacent vertebrae (permits little movement)

Synovial joints

Characterised by fluid filled synovial cavity b/w bones.
These joints help in locomotion

BALL AND SOCKET JOINT
Eg- b/w humerus & pectoral girdle

HINGE JOINT
Eg- knee joint

PIVOT JOINT
Eg- b/w atlas & axis

GLIDING JOINT
Eg- b/w carpals

SADDLE JOINT
Eg- b/w carpal and metacarpal of thumb