

## LOCOMOTION AND MOVEMENT

### **MOVEMENT**

movement refers to the change in position of any part of an organism's body.

- Eg:-Hydra can use its tentacles for capturing its prey and also use them for locomotion

### **LOCOMOTION**

- If the movements result in a change of place, such movements are called **locomotion**.
- Eg. Walking, running, climbing, flying, swimming

### **TYPES OF MOVEMENT**

- Cells of the human body exhibit three main types of movements.

- **1.Amoeboid**

- **2.Ciliary**

- **3.Muscular**

1.Amoeboid- **effected by pseudopodia formed by the streaming of protoplasm** (as in Amoeba).

(e.g.movement of leucocytes, macrophages (a type of white blood cell))

2.Ciliary movement .eg mvmt of ova & sperm, movmt of particles through trachea

3.MUSCULAR MOVEMENT eg.movement of our limbs, jaws, tongue, etc,

### **MUSCULAR MOVEMENT**

### **MUSCLE PROPERTIES**

### **EXCITABILITY, CONTRACTILITY, EXTENSIBILITY AND ELASTICITY**

### **Types of Muscle Tissue**

- **1,Skeletal Muscle**
- **2.Cardiac Muscle**
- **3.Smooth Muscle**

### **Skeletal Muscle**

- Long cylindrical cells
- Attached to skeletal system
- Striated appearance
- Voluntary in action
- Function -muscular movement

### **2.Cardiac Muscle**

- Present in heart
- Branching cells
- One or two nuclei per cell
- Striated present but faint
- Involuntary
- The junction between two cardiac muscle fiber is called **intercalated disc** it allows rapid spreads of impulse from one fiber to next throughout heart.

### **Smooth Muscle(Visceral muscles) (nonstriated muscles)**

- Present in hollow organs like alimentary canal, ovary ,urinary bladder etc
- Fusiform cells
- uninucleus
- Involuntary in action
- Striations absent
- Not attached to skeletal system
- Function- in the transportation of food through the digestive tract and gametes through the genital tract

### **Microanatomy of Skeletal Muscle**

Muscle contains muscle cells

Muscle cells are called **muscle fibers**

A number of Muscles fibres are bundled to form muscle bundles or fascicles

Each bundle covered by **fascia** ( a connective tissue layer)

- Each skeletal muscle in our body is made of a number of **muscle bundles or fascicles** held together by a common connective tissue layer called **fascia**.

### **Muscle cell or Muscle fibre Structure-**

Lined by sarcolemma (plasma membrane)

Syncytium-ie.Contains many nucleus

Sarcoplasmic reticulam contains Ca<sup>+</sup> ions

A number of myofilaments or myofibrils present in cytoplasm

Each myofibril has Striations with a dark band - A band (anisotropic band)

### **Striations of myofibril-A close view**

Dark and light bands arranged alternatively

Light band- **I band**

In the centre of I band-**Z line**

Actin filaments attached to Z line

### **Dark band A band**

In the central part of A band a lighter region –H zone

In the centre of H zone –M line

Myofibrils contains two proteins, Rod like structures and arranged parallel to each other

Two types

1, Actin (thin filament)

2,Myosin(Thick filament)

The striations of myofibril is due to the distribution pattern of Actin and myosin

**I band contains only thin Actin filament**

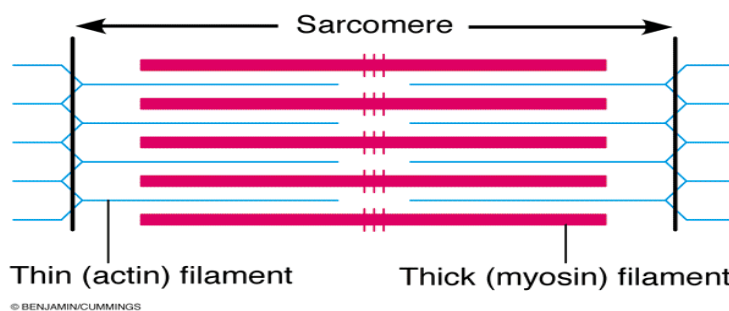
**A band contains overlapped Thick and thin filaments (hence dark)**

**H zone of A band contains only thick filament (relatively lighter)**

### Sarcomere

The portion of myofibril between two successive Z lines is called sarcomere.

It is the functional unit of contraction



### Structure of contractile proteins

#### ACTIN

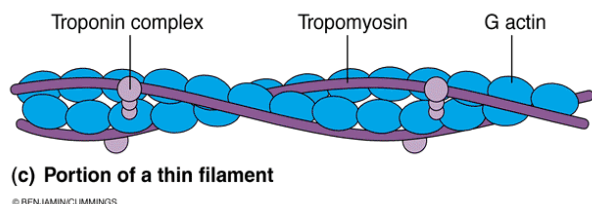
Made of two **F actin** (filamentous actins) helically wound to each other

F actin is the polymer of G actin (globular actin)

Two filaments of another protein **Tropomyosin** also wound around it

A protein **Troponin** distributed at regular intervals on the tropomyosin

**In the resting time troponin masks the binding site for myosin on the actin.**

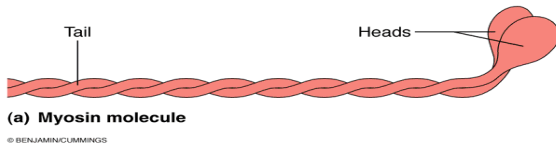


#### MYOSIN

Composed of many monomeric proteins called meromyosin

Each meromyosin has 2 parts

1. Globular head with a short arm (Heavy meromyosin-HMM)
2. A Tail (Light meromyosin-LMM)



The head and short arm projects outwards from the surface of the myosin filament.

So known as cross bridges

### **Myosin head is an active ATPase enzyme**

Has 2 binding sites

1. for ATPase and
2. site for binding of actin

### **Muscle contraction**

1. Signal from brain reaches neuromuscular junction through motor neuron
2. Releases neurotransmitter, generates action potential in sarcolemma.
3. Sarcoplasmic reticulum releases Ca ions.
4. Ca ions bind to the troponin on the actin filament
5. This causes the exposing of the active site on actin
6. Myosin attaches to the actin utilizing energy by ATP hydrolysis.
7. Pulls the actin filaments towards the centre of A band.
8. Z-line also pulls inward. Results in the contraction of sarcomere.
9. Myosin goes back into a relaxed state, cross bridge broken
10. New ATP molecule attaches myosin heads and the reaction repeats

### **Results of a muscle contraction**

Shortening of the z line and the muscle

I band get reduced

A band retain its length

H zone get reduced

Actin filaments slides over the myosin filaments .

So this is known as the sliding filament theory

### **Relaxation**

Ca<sup>+</sup> ions pumped back to sarcoplasmic reticulum

Troponin masks the actin filaments

Return of z lines to its original position

### **Muscle Fatigue**

- Repeated activation of the muscles needs lot energy and oxygen
- Lack of oxygen leads to anaerobic breakdown of glucose
- Lactic acid accumulated due to anaerobic respiration.
- This causes fatigue
- **RED MUSCLE & WHITE MUSCLE**
- **RED MUSCLE**
- Myoglobin content is high
- Reddish appearance
- Contain plenty of mitochondria which can utilise the large amount of oxygen stored in them for ATP production
- Aerobic muscles
- **WHITE MUSCLE**
- Less quantity of myoglobin.

- Pale or whitish appearance.
- Less Number of mitochondria.
- Amount of sarcoplasmic reticulum is high.
- They depend on anaerobic process for energy (Anaerobic Muscle)

## **SKELETAL SYSTEM**

- Skeletal system consists of a framework of bones and a few cartilages
- Bone and cartilage are specialised connective tissues.
- Bone has a very hard matrix due to calcium salts in it
- Cartilage has slightly pliable matrix due to chondroitin salts.
- In human beings, skeletal system is made up of 206 bones and a few cartilages.

Grouped into two principal divisions –

**1. axial skeleton 2.appendicular skeleton.**

### **Axial skeleton**

- Comprises **80 bones** distributed along the main axis of the body
- 1.Skull,
- 2.Vertebrae column,
- 3.Sternum
- 4.Ribs

### **The skull**

- The **skull is composed of two sets of bones**
- Cranial bones (8)
- Facial bones (14)

- Total=22 bones
- **Cranial bones**
- Cranial bones form the hard protective outer covering, cranium for the brain.
- **Facial bones**
- The facial region is made up of 14 skeletal elements which form the front part of the skull
- **Hyoid bone**-U-shaped bone called hyoid is present at the base of the buccal cavity and it is also included in the skull
- **Ear Ossicles** -Each middle ear contains three tiny bones – Malleus, Incus and Stapes, collectively called **Ear Ossicles**
- **vertebral column**
- Formed by **26** serially arranged units called vertebrae and is dorsally placed
- Each has a central hollow portion (neural canal) through which the spinal cord passes.
- **occipital condyles**
- The skull region articulates with the superior region of the vertebral column with the help of two occipital condyles (dicondylic skull).
- First vertebra is the **atlas** and it articulates with the occipital condyles.
- The vertebral column is differentiated into
- Cervical (7),
- Thoracic (12),
- Lumbar (5),
- Sacral (1-fused) and
- Coccygeal (1-fused)

#### Functions of vertebral column

- Protects the spinal cord,



- Supports the head
- Serves as the point of attachment for the ribs and musculature of the back
- **Sternum**
- Flat bone on the ventral midline of thorax
- **Ribs**
- 12 pairs.
- **Each rib is a** thin flat bone connected dorsally to the vertebral column and ventrally to the sternum with the help of hyaline cartilage.
- **3 types**
  - 1. True ribs**
  - 2. false ribs**
  - 3. Floating ribs**
- **True ribs** :-First seven pairs of ribs are called true ribs.
- Dorsally, they are attached to the thoracic vertebrae and ventrally connected to the sternum
- **False ribs**
- The 8th, 9th and 10<sup>th</sup> pairs of ribs do not articulate directly with the sternum but join the seventh rib with the help of hyaline cartilage. These are called False ribs or vertebrochondral ribs.
- **Floating ribs**
- Last 2 pairs (11<sup>th</sup> and 12<sup>th</sup>) of ribs are not connected ventrally and are therefore, called floating ribs.
- **rib cage**-Thoracic vertebrae, ribs and sternum together form the rib cage.

### **Appendicular skeleton**

- The bones of the limbs along with their girdles constitute the **appendicular skeleton**.

### **Bones of hand (Fore limbs)**

- Humerus,
- Radius and Ulna,
- Carpals (wrist bones – 8 in number),
- Metacarpals (palm bones – 5 in number)
- Phalanges (digits – 14 in number)
- **Bones of the legs (Hind limb)**
- Femur (thigh bone – the longest bone)
- Tibia and Fibula
- Tarsals (ankle bones – 7 in number),
- Metatarsals (5 in number)
- Phalanges (digits – 14 in number)
- A cup shaped bone called patella cover the knee ventrally (knee cap).
- **Pectoral girdle**
- Pectoral girdle bones help in the articulation of the upper limbs with the axial skeleton
- Each girdle is formed of two halves. Each half of pectoral girdle consists of a **clavicle and a scapula**
- **Scapula** -A large triangular flat bone and has a slightly elevated ridge called the spine which projects as a process called the acromion. The clavicle articulates with acromion
- **glenoid cavity**:-Below the acromion is a depression called the glenoid cavity which articulates with the head of the humerus to form the shoulder joint
- **clavicle (collar bone)**-Each clavicle is a long slender bone with two curvatures
- **Pelvic girdle**
- Consists of two coxal bones ,Each is formed by the fusion of three bones
- **Ilium,**
- **Ischium**

- **Pubis**
- At the point of fusion of ilium, ischium and pubis is a cavity called acetabulum to which the thigh bone articulates
- **JOINTS**
- Joints are points of contact between bones, or between bones and cartilages.
- Classified into three major structural forms,
- **Fibrous,**
- **Cartilaginous**
- **Synovial**

#### **1Fibrous joints**

- Do not allow any movement.
- fuse end-to-end with the help of dense fibrous connective tissues
- This type of joint is shown by the flat skull bones

#### **2.cartilaginous joints**

- Joined together with the help of cartilages.
- Permits limited movements.
- The joint between the adjacent vertebrae in the vertebral column

#### **3.Synovial joints**

- A fluid filled synovial cavity between the articulating surfaces of the two bones
- These joints help in locomotion and many other movements.
- Ball and socket joint (between humerus and pectoral girdle, between femur and pelvic girdle)
- Hinge joint (knee joint, Elbow joint)
- Pivot joint (between atlas and axis)

- Gliding joint (between the carpals)
- Saddle joint (between carpal and metacarpal of thumb)
- **DISORDERS OF SKELETAL SYSTEM**
- **Arthritis**-Inflammation of joints.
- **Osteoporosis**
- Age-related disorder characterised by decreased bone mass and increased chances of fractures. Decreased levels of estrogen is a common cause.
- **Gout** Inflammation of joints due to accumulation of **uric acid crystals**.