BIOLOGY. Locomotion and Movement

➢ **Locomotion** : ***Locomotion is the process of voluntary change of position of an organism from one place to another.***
➢ **movement of Body parts** : Movement of body parts in relation to body axis is the other form of movement in animals.
***Ciliary's** movements are seen in the upper portion of the respiratory tract, fallopian tubes and vasa efferentia.
*Mammalian sperms in the female reproductive tract move with the help of flagellar movements.
*Cilia help in locomotion in paramecium; flagella help in locomotion in Euglena whereas Amoeba moves with the help of pseudopodia.
*In vertebrates, locomotion and limb movements depend on muscles and skeletal system.
*Muscle contraction moves bones of the skeleton like levers. This results in the movement of limbs and appendages.
*Among invertebrates like Hydra, leeches, earthworms and jelly fishes, skeletal system is absent.
➢ **Movements in invertebrates**:
1) Movements in Hydra: Locomotion in Hydra is carried by looping, somersaulting, gliding and climbing.
2) Movements in Annelids: Longitudinal and circular muscles by their alternate contraction and relaxation bring a wave of thinning and thickening. Setae present in the body wall play only an accessory role in locomotion.
3) Movements in starfish: In starfish, water vascular system helps in locomotion. Water enters the tube feet and their ampullae's. Muscular contractions force water into them from the water canals of the body.
In vertebrates, locomotion depends on the association of skeletal or striated muscles with the skeletal system formed of bones or cartilages or both.
➢ **Remember** : Human skeleton consists of total 206 bones. These are of various sizes ranging from the **tiny bony ossicles of the middle ear** (i.e. stapes) to ***the long thing bone or femur.***
➢ ***Skeletal Muscles***: Classification of muscles based on function:
1. Flexors: These muscles decrease the angle of a joint between anterior surfaces of bones i.e., contraction of these muscles brings the two bones closer. E.g. Bicep.
2. Extensors: These muscles return the parts from flexon to normal position i.e., these increase the angle of a joint, e.g. Tricep.
3. Abductors: contraction of these muscles moves bone away from the middle line.
4. Adductors: Contraction of these muscles moves the bone or part towards middle line.
5. Rotators: Contraction of these muscles causes a part to rotate or pivot on its axis.
6. Levators: These muscles raise a part.
7. Depressors: These muscles lower a part.
8. Tensors: These make a part tense or more rigid.
9. Supinators: Their contraction rotates the forearm and turns hand/palm upward.
10. Pronators: Turn the hand or palm downward.
➢ **Antagonistic Muscles**: The muscles which contract to produce opposite movements at the same joint are called antagonistic muscles.
➢ **Structure of striated muscles:** Each muscle fibre is a long, cylindrical, straight, unbranched and has blunt ends.
*A striated muscle fibre is externally covered by a special membrane, called **sarcolemma**.
*Sarcolemma invaginates to form a system of **T-tubules** along the **Z-lines**. Sarcoplasm is equipped with numerous large sized oval shaped mitochondria and glycogen granules as these muscle fibres have high energy requirements. It also has a network of ER called sarcoplasmic reticulum.
*It is multinucleate (syncytial). Nuclei are spindle shaped, peripheral in position and lie near the sarcolemma.
*Under light microscope, each myofibril of striated muscle fibre appears to be formed to alternate light and dark cross bands.

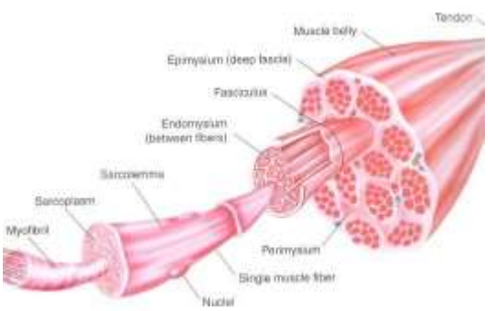

Figure 1: Muscle belly split into various component parts (from Essentials of Strength Training & Conditioning, National Strength & Conditioning Association)

*A **dark band**, also called anisotropic (having different refractive index in different planes) or **A-band**, has a light zone at the centre, called **Hensen's line** or **H-zone**.
*A light band, also called isotropic (having same refractive index in all planes) or **I-band**, has a dark membrane at the centre, called **Krause membrane** or **Z-**(Zwischenscheibe)line. Z- line is connected with sarcolemma on either side.
a) Actin protein: It forms the backbone of fibrous or F-actin and is formed of two polypeptide chains intercoiled upon each other to form a double helix. Each strand of F-actin is formed by polymerization of globular or G-actin molecules. Each helix of F-actin is formed of 13 G-actin molecules.
*Each G-actin molecule has active sites having ADP molecules which act as binding sites for heads of myosin.
b) Tropomyosin: It is about 40nm long and 20 A^0 in diameter. It is also formed of two polypeptide chains and is spirally coiled around F-actin. It lies in the groove of F-actin in such a way that each tropomyosin molecule covers seven active sites of actin molecule during the relaxed state.
c) Troponin: It is an oval-shaped globular protein lying at the end of tropomyosin protein. It has affinity for calcium ions.
➢ **Physiology of Muscle Contraction:**

Physical Change during Muscle Contraction: The process of muscle contraction is intimately associated with protein filaments of the myofibrils.

*The sarcomere is the unit of contractility and is represented by the region between successive Z-discs.

*During muscle contraction, the thin actin filament slide past among thick myosin filaments and result in shortening of the sarcomere.

*The contraction of sarcomeres causes the muscle to shorten in length.

* ***During contraction, I-bands shorten and Z-discs disappear, but the length of A-bands remains constant throughout the process.***

➢ **Sliding filament theory of Muscle contraction**:

a) Polarization of sarcolemma: When a nerve impulse arrives at the junction of nerve ending in the muscle, the sarcolemma of that muscle fibre is depolarized.

b) Release of Ca^{++} ions: The depolarization of sarcolemma is transmitted to the sarcoplasmic reticulum and causes release of Ca^{++} from the sarcoplasmic reticulum.

c) Conformational changes in actin: The released Ca^{++} binds to TpC subunit of troponin. This produces conformational changes in tropomyosin and then in actin filament, preparing it to interact with myosin-A TP.

d) Formation of actomyosin complex: The cross bridge of myosin binds to a globular submit G-actin of the actin filament forming actomyosin complex in presence of ATP and Ca^{++} ions.

e) Break of actin-myosin bridge: ATP binds to the myosin bridge, breaking the actin-myosin bridge to allow the movement of cross bridges leading to the sliding of thick and thin filaments past each other.

➢ **Chemical Events during Muscular contraction**: The various chemical events during a muscular contraction and relaxation were first given by Albert Szent Gyorgyi – a Russian scientist.

*The enzyme myosin ATPase is activated in the presence of Ca^{++} ions.

*This breaks down ATP to ADP with the release of inorganic phosphate and energy. Magnesium ions (Mg^{++}) are also essential in this process. The energy released is used up in muscular contraction.

*Body muscles have also got another compound called creatine phosphate (CP). This is also an energy rich compound. It helps in the conversion of ADP to ATP again almost immediately. This happens at the end of a muscular contraction.

ATP + CP **ATP + Creatine**

Muscular relaxation: During this period, actomyosin is again split into actin and myosin. This requires the utilization of energy.

Actomyosin $\xrightarrow{ATP \rightarrow ADP}$ *Actin* **+** *Myo* ***sin***

*This ATP is utilized by sarcoplasmic reticulum to trap free calcium ions.

*There is an active transport of calcium ions into the reticulum against the concentration gradient involving utilization of energy. This inhibits the myosin ATPase activity due to the non-availability of Ca^{++}ions. It takes about 0.1 second for a muscle to contract and then relax. This is known as muscle twitch.

➢ **Cori Cycle**: The release of energy from muscle glycogen involves a number of steps. These are grouped together under **Cori Cycle** described by CORI.

➢ **Characteristics of muscles: 1. Threshold Stimulus:** A muscle fibre would contract only when it receives stimulation of Certain intensity called threshold or liminal stimulus.

* The value differs from fibre to fibre. Intensity of stimulus below the threshold value which does not produce contraction in muscle fibre is called **subliminal/sublimited stimulus**.

* Stimulus stronger than the threshold one is called **Supraliminal/supra limited stimulus.**

2. Muscle twitch: It is a single isolated contraction of a muscle fibre in response to a single stimulus and relaxation. Latent period is the interval between the application of appropriate stimulus and initiation of contraction.

*It is 0.01 Second in skeletal muscle and up to 3 seconds in a visceral muscle.

*During latent period the stimulus is converted into Chemical excitation which is spread to all parts and chemicals required for contraction are liberated.

*Contraction period/phase is the duration for which the muscle remains in the contracted state. It is 0.04 second in a skeletal muscle and up to 20 seconds in a visceral muscle.

*Relaxation period is the interval required for the contracted muscle to regain its original relaxed/elongated state.

* Relaxation period is 0.05 second for a skeletal muscle and 2-3 seconds for visceral muscle.

3. Refractory Period: It is the interval during which a muscle fibre fails to respond to a second stimulus.

* Refractory period is 0.002-0.005 seconds in a skeletal muscle fibres and 0.1-0.2 seconds in a cardiac muscle fibre.

4. Summation of Stimuli: two or more subliminal stimuli applied simultaneously or successively get added up and evoke a response if the added up value becomes equal to or exceeds threshold one.

5. Tonicity: In a relaxed muscle, a few fibres are always undergoing contraction alternately so as to maintain health of the muscle.

6. All or None Law (Bowditch's Law): Response of a muscle fibre to a stimulus is not proportionate to its intensity. It is absent when the intensity is subliminal.

*Muscle fibre contracts to the maximum whether the stimulus has threshold value or supraliminal value.

*However, a muscle consists of a large number of fibres with different threshold values, some lower and some higher.

*Therefore, increase in intensity of stimulus increases contraction of the muscle though individual fibres obey all-or-none law. Force of muscle contraction also changes with change in pH, temperature, relaxation etc.

7. Tetanus: It is the phenomenon of sustained contraction of a muscle due to succession of nerve impulses stimuli being received by it.

*In muscle tetanus, though the whole muscle is contracted, all the muscle fibres are not contracted but different motor units are stimulated in rotation. Most of our daily activities are due to titanic contraction of muscles.

8. Muscle Tension: The force produced during contraction of a muscle is known as **muscle tension**.

*Isometric contraction is the development of muscle tension without actual shortening due to non-accomplishment of a job like pushing against an immovable object.

9. Isotonic Contraction: The contraction in which tension on muscle remains the same but length of muscle changes.

10. Isometric contraction: When during muscle contraction, muscle length remains same but tension increases e.g.

holding of some weight.

11. Muscle Fatigue: failure of muscle to respond to a fresh stimulus after a prolonged previous activity is called muscle fatigue. It is due to accumulation of lactic acid, consumption of stored glycogen, ATP and GTP, and change in neuromuscular junction which is sensitive to lactic acid.

12. Rigor Mortis: It is the state of body stiffening after death due to non-separation to actin myosin filaments caused by Non-availability of ATP/GTP.

13. Treppe (Staircase Phenomenon): A stimulus of constant strength applied regularly at close intervals to a muscle products a series of contractions, the first few of which are of increasing amplitude.

➢ **Red and White Muscle fibers** :

1. Red muscle fibres: These are thinner, darker muscle fibres having comparatively slow contraction rate.

*These contain the red heme-protein called **myoglobin.** It can bind oxygen to form oxymyoglobin that can be stored in red muscle fibres.

*These are rich in mitochondria. Red muscles carry out aerobic contractions; these fibres can contract for prolonged durations without fatigue.

*These are found in muscles which perform sustained work at a slow rate over a prolonged period. Extensor muscles on the back and some flight muscles in birds are examples of red muscles.

2. White muscle fibres: These are also called fast muscle fibres. These fibres are much thicker, lighter in color, free of Myoglobin and poorer in mitochondria.

*Their contraction rate is faster. These receive energy from anaerobic glycolysis.

*These accumulate lactic acid in considerable amount during strenuous work and soon get fatigued.

*White muscles are adapted for fast and strenuous work for short intervals and are made up mostly or exclusively of white muscle fibres.

Skeletal system:

➢ **Functions of Endoskeleton**: 1. It functions as a well organized **framework**, and imparts definite shape to the body.

➢ it provides **support** to the whole body.

➢ The striped muscles lie under the skin and in the limbs, surrounding the skeletal framework.

*The endoskeleton provides attachment to these muscles. When muscles contract, the skeletal elements move at their joints like levers moving at fulcra.

*It **protects** all internal organs from injuries and other hazards.* It helps in breathing.* It aids in hearing.

➢ The long bones of limbs are hollow and contain a soft tissue, the bone marrow, in their cavities.

* The bone marrow is mostly ***haemopoietic***.

➢ **Mineral storage**: the bulk of body's calcium remains in the bones.* marrow cavity of long bones contains **adipose tissue.**

➢**Axial Skeleton**: It occupies the longitudinal central axis of the body. **Skull** : It is present on the top of the vertebral column.**Cranium**: It encloses the brain. The ***cranium is also called the brain box.***

➢ ***The cranium is formed of 8 bones***. ***These include 1 frontal, 2 parietals, 1 occipital, 2 temporals, 1 sphenoid and 1 ethmoid.***

➢ The cranial bones fit together by wavy, immovable boundaries called **sutures**.

*The sutures help dissipate the shock of a blow to the head. A hole, called **foramen magnum**, at the base of the skull allows the brain to continue into the spinal cord located in the occipital bone.

➢ The occipital bone is at the back and is the lower part of the cranial cavity. It is pierced by the foramen magnum, through which the medulla oblongata passes to join the spinal cord.

➢ On each side of the foramen magnum are masses of bone which form the **condyles**. the skull of man is **dicondylic**.

➢ On either side of the cranium is an auditory capsule that contains 3 small bones called ear ossicles, individually named malleus, incus and stapes.

ii) Face: It is composed of 14 bones. These include 2 nasals, 2 maxillae, 2 palatines, 2 zygomatic or cheek bones, 2 lacrymal, 2 inferior nasal conchae, I vomer and 1 mandible. Mandible is movable so as to allow mastication and speech. One bone, ***called hyoid, lies at the base of the tongue also*** called **tongue bone**.

2. Vertebral Column: It consists of a row of 33 (in children) movably articulated ring-like bones, the vertebrae. The vertebrae are grouped into 5 categories: i) **Cervical vertebra**, 7 in number, present in the neck. The first cervical vertebra is called **atlas**. It provides up-and-down or nodding movement to the skull on it.

➢ The second cervical vertebra is ***termed axis***. It allows side –to-side or turning movement to the atlas and skull on it.

➢ The **cervical vertebrae are the smallest of the bones** and except the first and second, which are peculiar in shape, the cervical vertebrae posses many characters in common.

Special Cervical Vertebrae: **The first cervical vertebrae or atlas** support the head and consists of a complete ring of bone composed of two lateral masses united by an anterior and a posterior arch.

* **The second cervical vertebra or axis** is the pivot on which the atlas turns in the rotary movements of the head.

*From the body of the axis, a process of bone arises which is called the **odontoid peg**; this peg articulates with the back of the anterior arch of the atlas and is held in position by the transverse ligament of the atlas.

ii) **Thoracic vertebra**, 12 in number

iii) **Lumbar vertebra**, 5 in number, located in the abdomen. They are largest and strongest to bear the weight of abdominal viscera that hang from their region of the back.

iv) **Sacral**, 5 in number, placed in the pelvis. They fuse in childhood to form a single bone, ***the sacrum in the adult.***

v) **Coccygeal**, 4 in number, occur in the vestigial tail. They are very small, rudimentary and fused to form a curved, triangular bone, the **coccyx**, or **tail bone**.

Curves: In the vertebral column of human beings four curves are formed, **cervical, thoracic, lumbar and sacral**.

Vertebral formula: The vertebral formula for humans is $C_7, T_{12}, S_{(4)}, C_{(3.5)} = 33(children)$

*A vertebra is typically a bony ring. Its hole is called the **vertebral foramen**. The front border of the vertebral foramen is very thick. It is known as the **body**, or **Centrum**. It is flat on the upper as well as the lower side.

* The vertebral arch gives off process to which the muscles are attached. The processes include a median **spinous process and paired articular processes and transverse processes.**

*The upper **superior articular processes** (prezygapophysis) project upward and have articular facets directed backward.

*The lower **inferior articular processes** (prezygapophysis) project downward and their articular facets are directed forward. They provide limited movement between vertebrae.

*The vertebral foramina of all the vertebrae when in contact form a **vertebral canal** that encloses the spinal cord.

*Between the centre of adjacent vertebrae, ***there are elastic pads of fibro cartilage***, the **inter-vertebral discs**.

- **Vertebral Centra**: i) **Procoelous** – concavity on anterior facet, posteriorly convex, e.g. frog, lizards.
  ii) Amphicoelous – concavities on both sides, e.g. VIII vertebra of frog.
  iii) Opisthocoelous – concavity on posterior facet and convexity anteriorly e.g. Urodeles.
  iv) **Heterocoelous** – anterior face concave from side to side, convex above downwards; posterior face reverse e.g. birds.
  v) **Acoelous** – without concavity e.g. IX vertebra of frog, vertebrae of mammals.
  vi) **Amphiplatyan** – flat on both facets, e.g. mammals.

3. Ribs: There are 12 pairs of ribs.

- The upper seven pairs of ribs are attached in front directly to the sternum. These are called **true ribs** or **vertebrosternal ribs**.
- The next three pairs of ribs are joined to the rib above each. They are termed **false ribs or vertebrochondral ribs**.
- The lower two pairs of ribs are free in front. They ***are known as floating ribs or vertebral ribs*** transversely.
  *The first pair of rib is attached ***transversely*** whereas the remaining pair of ribs are ***attached obliquely***. They help in breathing movement.

4. Sternum: It is a long, narrow, flat, vertical bone in the middle of the front wall of the chest. It is shaped like a dagger with a handle called **manubrium**, a blade termed **body**, and a tip known as **xiphoid process**.

- **2. Appendicular Skeleton**: It comprises girdles and limb bones.

1. Girdles: These give articulation to the limb bones. There are 2 girdles on each side:

i) Pectoral (Shoulder) Girdle : It consists of 2 bones; ***scapula and clavicle.***

*The scapula, also called **shoulder blade**, is a large, flat, triangular born placed at the back of the shoulder. It has at its at its lateral angle, a shallow concavity, the **glenoid cavity**, for the articulation of the head of the humerus.

*The clavicle, also called **collar bone**, is a rod-like bone, curved like the letter ***f***.

It is attached to the sternum through the sternal process and also attached to the scapular through acromion process.

ii) Pelvic (Hip) Girdle :

- The pelvis is formed by 2 innominate bones (hip bones). The sacrum and the coccyx also take part in the formation of the pelvis.
- Each innominate bone consists of three separate bones, the ilium, the ischium and the pubis.
- On the outer surfaces, it has a depression named ***acetabulum***, where the head of the femur articulates.

* It is formed by the union of three bones, the **pubis** forms the front part, the ***ilium*** forms the upper part and the **ischium** the back part.

- The **ischium** is the thickest and ***the strongest portion of*** the in nominate bone.

***Tuberosity of the ischium lies at its lowest point, and on this, the trunk rests while sitting.**

- The **obturator foramen** is a large oval foramen lying below the acetabulum and is bounded by pubis and ischium.

* It is filled with membrane and at its upper part the obturator vessels and nerves pass from the pelvis with the thigh.

2. Limb Bones: **i) For limbs**: ➢Each arm contains 30 bones, namely, **humerus** in the upper arm, radius and **ulna** in the forearm, 8 **carpals** in the wrist, 5 **metacarpals** in the palm, and 14 **phalanges** in the fingers.

- Supporting the upper arm is a long bone, called **humerus**.
- The forearm is composed of two bones, the ***ulna and radius***. The ulna is a long bone having a shaft and two extremities.
- **The trochlear notch** of the ulna is formed by these two processes; it articulates with the trochlear surface of the humerus in the formation of the elbow joint.
- Distally the ulna and radius articulate with eight small bone called **carpals** which form the wrist.
- Proximal row is with 4 carpals – ***scaphoid, lunate, triquetrum and pisiform***, while distal row is also with 4 carpals – ***Trapezium, trapezoid, capitate and hamate.***
- The thumb is ***composed to two phalanges*** whereas **all other fingers contain three phalanges**.
- Thumb of hand is called pollex.

ii) Hind limbs: ➢ Each leg also contains 30 bones, namely, ***femur in the thigh, patella in the knee, tibia and fibula in the lower leg, 7 tarsals in the ankle 5 metatarals in the sole and 14 phalanges in the toes.***

- The lower end of the femur possesses two curved convex surfaces, called **condyles**, which articulate with the tibia to from a hinge joint at the knee. A patella groove separates the two condyles.
- A flat triangular piece of bone, called ***the patella*** is found in the gap between the two projections of the femur.

****The tibia and fibula bones form the shank of the lower li***mb. The tibia, which lies on the inner side, is the thicker of the two.

- The tibia or shin bone forms the main skeleton of the leg and lies medial to the fibula; it is a long bone with shaft and 2 extremities. The ankle region consists of seven bones called **tarsals**.
- Proximal row has two bones, outer-calcaneus (heel bone) and inner talus. Middle row has single bone navicular. Distal row has four bones-cuboid, lateral cuneiform, intermediate cuneiform and medial cuneiform. These are adapted for supporting body weight.
- The tarsal articulate distally with long metatarsal bones to form the foot, while in turn the metatarsals articulate with digits composed of phalanges forming the toes.
- Thumb of foot is called hallux.
- **Types of Bones** : i) **Long bones**, e.g., humorous of upper arm, radius and ulna of forearm, femur of thigh.
  ii) **Short bone**, e.g. metacarpals of palm and metatarsals of feet, phalanges of fingers and toes.
  iii) **Flat bones**, e.g. scapula of shoulder girdle, sternum, cranial bones.
  iv) **Irregular bones**, e.g. vertebrae, carpals of the wrist.

Joints: **There are 3 main types of joints**: 1. Fibrous, fixed, or immovable.

2. Cartilaginous, or slightly movable. 3. Synovial, or freely movable.

1. **Fibrous or Immovable Joints (Synarthroses)**: The immovable joints occur between the bones of the cranium and in the tooth sockets. They do not allow movement because the bones are held firmly together ***by collagen fibres***.

2. Cartilaginous or Slightly Movable Joints (Amphiarthroses) : The slightly movable joints are found between the centre of vertebrae, at the public symphysis and between the ribs and sternum. This allows limited movements at the joint.

3. **Synovial or Freely Movable Joints (Diarthroses)**: The freely movable joints mostly exist between the limb bones. They permit a great deal of movement. A space called the **synovial cavity** is lined by a fibrous synovial membrane.

*The joint is held intact by l***_igaments_**. Ligaments may be stretched by exercise, thus loosening the joints and allowing free movement.

*The synovial joint is further supported by tendons and muscles that work the joint. If synovial fluid is under secreted, inflammation occurs in the joint and it becomes painful. This condition is called **osteoarthritis.**

➢ **The synovial joints are further of six types**:

i) Ball-and-socket Joint: One bone forms a ball-like head that fits into a socket formed in the other bone. The bone with a head can move nearly in all directions. Shoulder joint and hip joint are of this type.

ii) Hinge Joint: This joint allows movements in one plane only. The knee joint, ankle joint and joints between the phalanges are of this type.

iii) **Angular, Ellipsoid, or Condyloid Joint**: This allows movement in two directions; side to side and back and forth. Wrist and metacarpophalangeal joints are of this type.

iv) Gliding Joint: This joint permits sliding movements of two bones over each other. The joints between zygapophyses of the vertebrae, between the carpals in the wrist and tarsals in the ankle, between sternum and clavicles are of this type.

v) **Pivot Joint**: This joint allows only a rotary movement of the bone between the atlas and axis vertebrae in man is of this type.

vi) **Saddle Joint**: This joint resembles the ball-and-socket joint but both the ball and the socket joint but both the ball and the socket are poorly developed. The joint between the metacarpal of the human thumb and the corresponding carpal is of this type.

➢ **Disorders of Skeleton and Joints**: The injury can be of ***5 types***: dislocation, fracture, arthritis and slipped disc.

1. Sprain: Sprain refers to injury to a joint capsule, typically involving a stretching or tearing of tendons or ligaments.

2. Arthritis: It is inflammation of the joints.

3. Dislocation: It is displacement of bones from their normal positions at a joint; for instance, slipping out of the ball of one bone from the socket of another bone into which it is fitted.

4. **Slipped Disc**: It is a displacement of vertebrae and the intervertebral fibro cartilage disc from their normal position.

5. Fracture: When bones break, it is known as fracture. Fracture occurs rarely in children. The bones of children have a large quantity of organic matter and are, therefore, very flexible and less likely to break. With advancing age, mineral matter is deposited in the bones. This decreases the organic matter, making the bones. This decreases the organic matter, making the bones hard and brittle. Thus, old people are more liable to fracture of bones.

➢ **Types of fracture**: **i) Green stick fracture**: It is a simple crack in the bone and the two parts of the bone are still holding together.

ii) Simple fracture : When a bone is fully broken into two separate portions, but the two portions are not much displaced from their position.

iii) **Avulsion fracture**: When a small part of the bone is broken away from the main bone but remains suspended to the ligament.

iv) Comminuted fracture: In this fracture, a bone is broken into more than two pieces.

v) Compound fracture: It is the most serious type of fracture in which a bone gets broken into several pieces, and some of the fragments protrude out through the injured skin.