Revision Notes

Class 11 Biology

Chapter 20 – Locomotion and Movement

Locomotion and Movement

Movement is defined as the movement of living organisms from one place to another; if the movement causes a change in location or position, it is called locomotion; such as walking, climbing, running, etc.

Kinds of Movement

There are three kinds of movement which are ciliary, amoeboid, and muscular.

Ciliary Movement

This type of movement occurs in those organs which are covered with ciliated epithelium. It helps to capture dust particles that are inhaled during breathing and also helps to move the egg from the fallopian tube into the uterus.

Amoeboid Movement

This type of movement can be seen in some immune cells, such as macrophages and white blood cells. It can also be seen in amoeba moving through pseudopods.

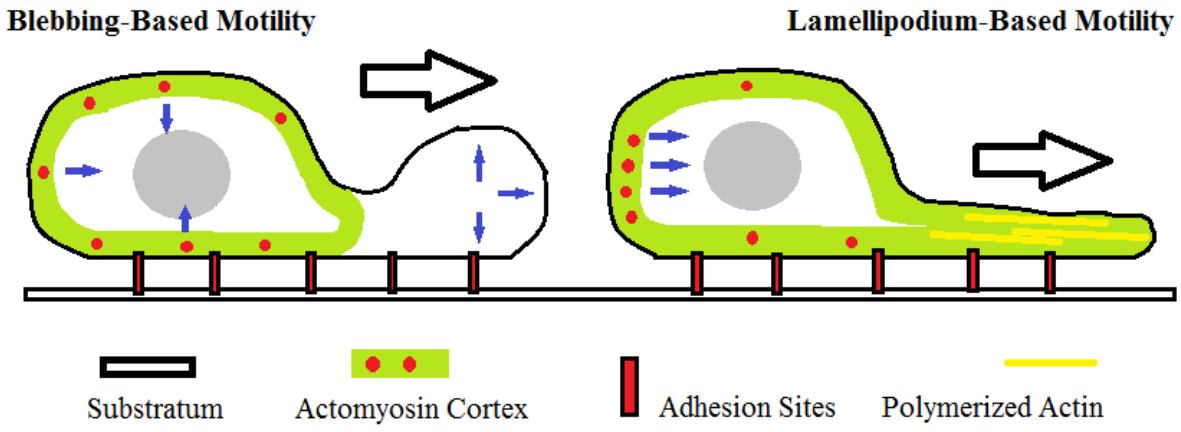


Fig. 2. Amoeboid movement in Amoeba

Muscular Movement

Muscle movement is seen in the tongue, chin, limbs, etc. The muscles, bones, and nervous system are all involved in locomotion.

Muscle

Muscle or muscle tissue is essentially mesoderm. It is an organization of cells that is involved in body movement. Skeletal muscle, smooth muscle and cardiac muscle are the three main muscle types.

Skeletal muscles are voluntary muscles that mean these muscles are under the control of our will and under the control of the somatic nervous system. They are striated muscles because of the characteristic striations present on them. These muscles are attached to the bones through tendons and are involved in keeping the body in a particular posture and performing different body movements.

Smooth muscles lack striations and are also called visceral muscles. These muscles control involuntary body movements. They are located in the walls of both the digestive tract and reproductive tract.

Cardiac muscles are the heart muscles that help the heart to contract and relax rhythmically. These muscles are involuntary in nature and also have cross stripes with branching patterns.

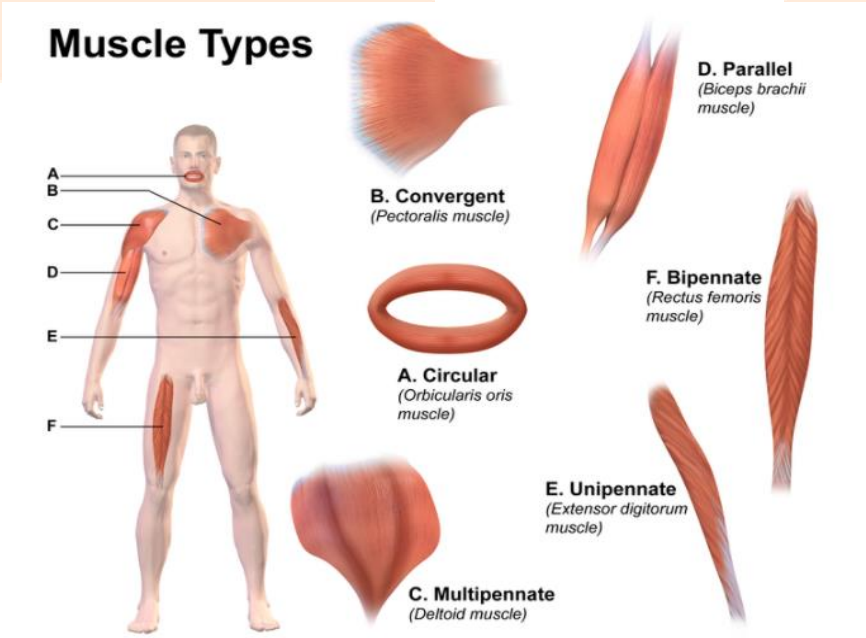


Fig. 3. Types of muscles

Structure of muscle

Several muscle bundles in skeletal muscle form a fascicle. Each muscle bundle is composed of several muscle fibers. The plasma membrane arranged on the muscle fibers is called sarcolemma. The muscle membrane or sarcolemma surrounds the sarcoplasm. There are several nuclei in muscle fibers which are called syncytium. The endoplasmic reticulum present in the muscle fibers is called the sarcoplasmic reticulum. The calcium ions stored in the sarcoplasmic reticulum participate in the contraction of muscles. Muscle fibers contain parallel strands called myofibrils of myofilaments. The epimysium is the fibrous tissue that is present around the skeletal muscle.

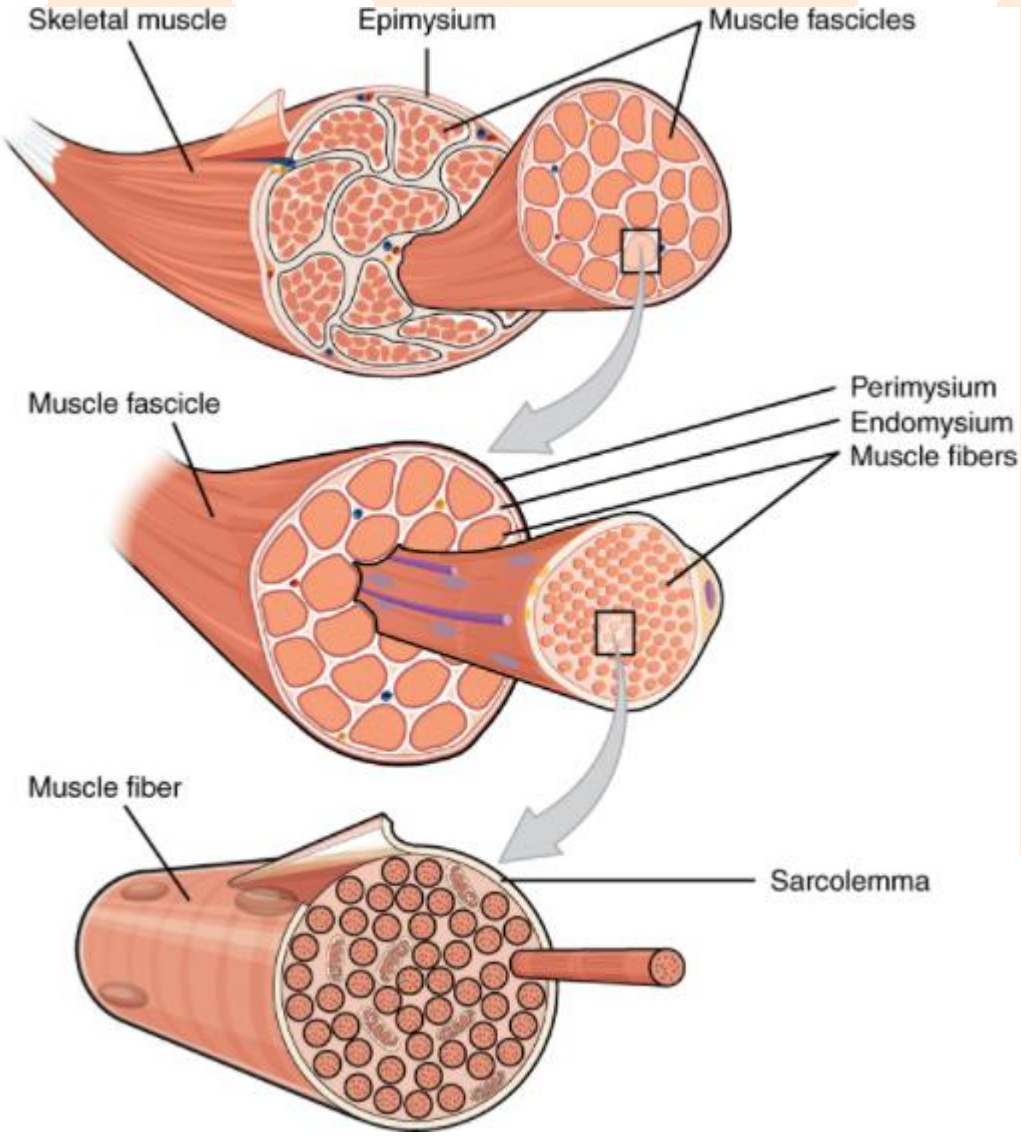


Fig. 4. Structure of the muscle

The characteristic stripes of skeletal muscle are due to the presence of two kinds of proteins which are actin and myosin. The light stripes are also called isotropic bands and have action. But the dark stripes are called anisotropic bands that have myosin protein. Filaments that are thin are called actin filaments, and thick filaments are called myosin filaments.

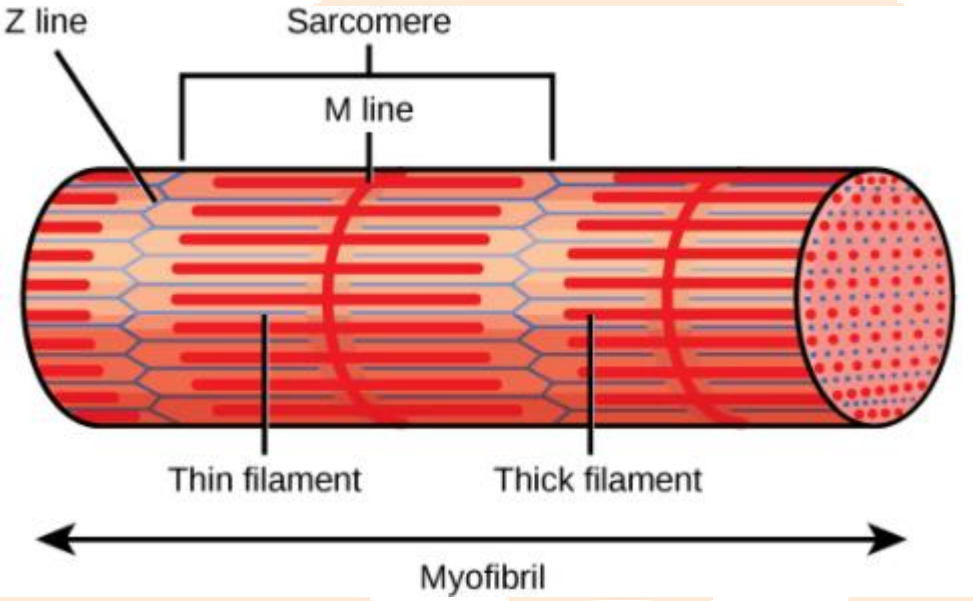


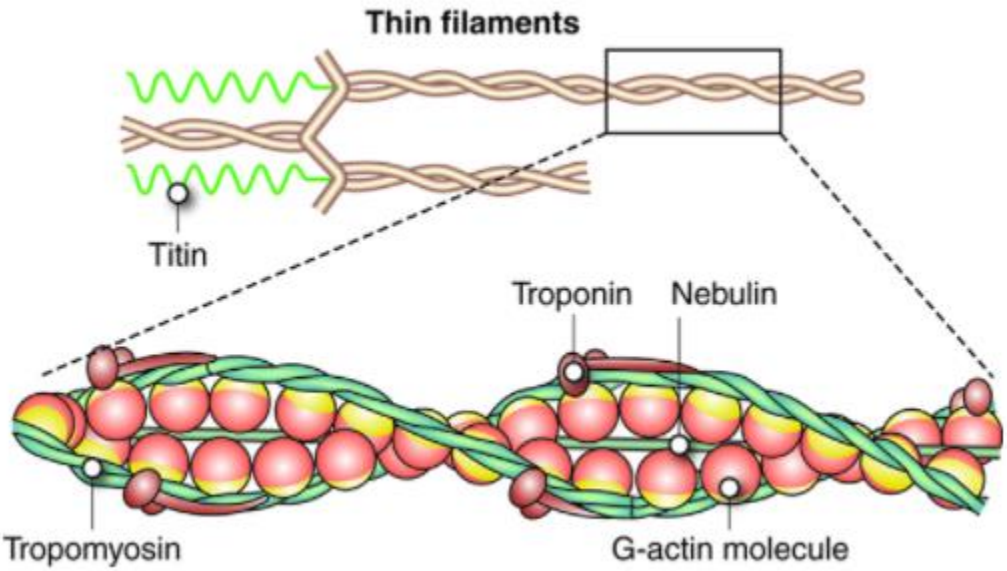
Fig. 5. Structure of sarcomere

There is an elastic fiber called the Z-line present in the center of each actin stripe. The part of myofibrils between two consecutive Z-lines is called a sarcomere. The sarcomere is called the functional unit of muscle contraction.

Structure of contractile protein

The two main contractile proteins are actin and myosin. The monomer unit of actin is called G-actin or globular actin. The polymer of G-actin forms F-actin or F-filament. Two of the F-filaments twist around each other to form actin molecules. The protein tropomyosin surrounds the F-actin. Another protein named troponin is evenly distributed in tropomyosin.

The monomeric unit of myosin is called meromyosin. Each of the meromyosins is composed of two parts: a spherical head and a long tail. The spherical head has ATPase activity and actin binding sites.



Muscle contraction mechanism

The muscle contraction is explained with the help of the sliding filament theory. During the contraction of muscles, the fine fibers slide over the thick fibers. When the signal is transmitted from the central nervous system to the motor neurons, muscle contraction begins. The neuromuscular junction is where motor neurons and muscle fibres come together. The release of neurotransmitters such as acetylcholine at the neuromuscular junction will generate action potentials in the muscle plasma membrane.

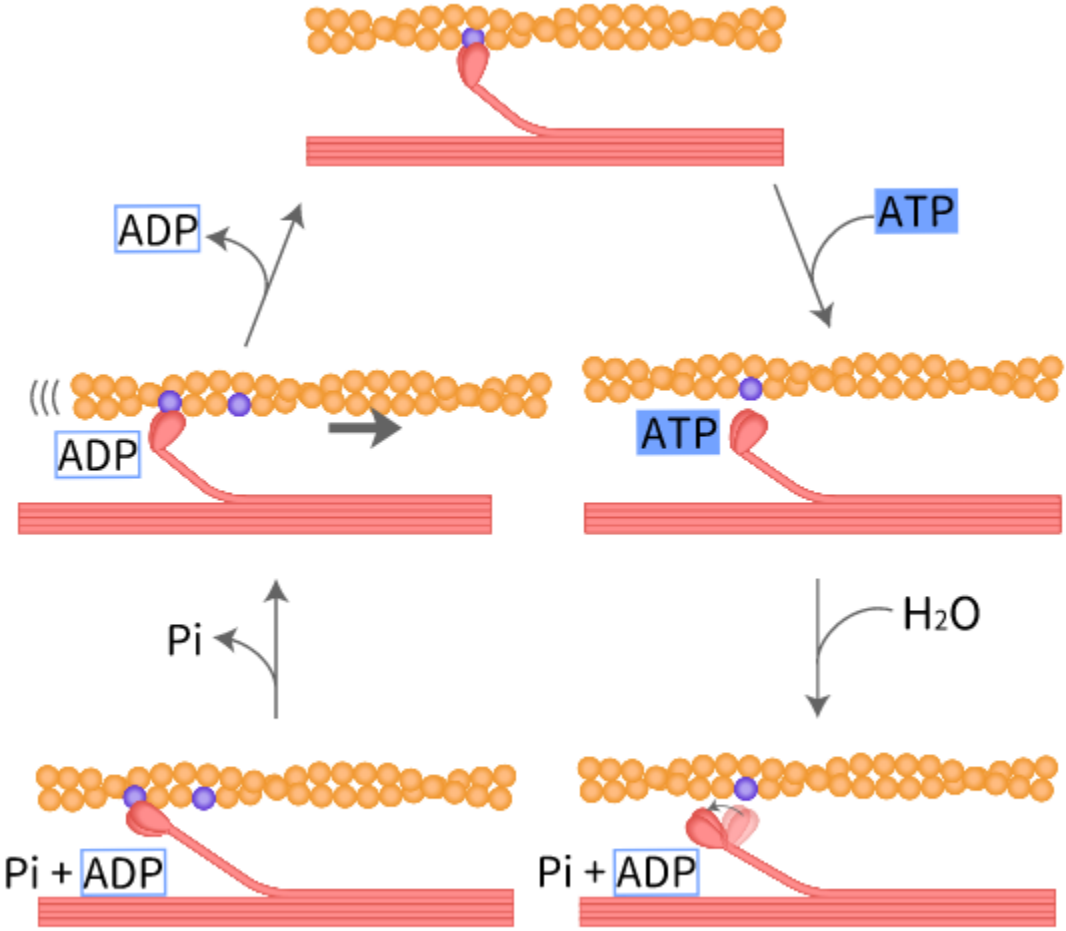


Fig.8. Sliding filament theory

The action potential causes the release of calcium ions from the sarcoplasmic reticulum into the sarcoplasm. The increase in calcium levels causes the binding of calcium ions to troponin present on actin filaments. This shows the active myosin binding sites. The ATPase activity of myosin exposes sites that allow cross-bridging between actin and myosin. It causes sarcomere shortening that leads to muscle contraction. Then the calcium ions are pumped back to the sarcoplasmic reticulum. This process hides the actin filaments by returning the muscle to its original position.

Formation of lactic acid in muscles

When the muscles are reactivated, such as during exercise or running, the anaerobic breakdown of glycogen in the muscles leads to the accumulation of lactic acid in the muscles, which leads to muscle pain and fatigue.

Skeletal System

The skeletal system comprises bones and cartilage. It helps the body to move. Due to the presence of calcium salts, bones are hard, and due to the presence of chondroitin sulfate, cartilage is flexible. A person consists of 206 bones and a small amount of cartilage. The skeletal system consists of two parts: the axial skeletal system and the appendicular skeletal system.

1. Axial Skeletal System

There are a total of 80 bones present in the axial skeletal system including the skull, sternum, vertebral column, and ribs.

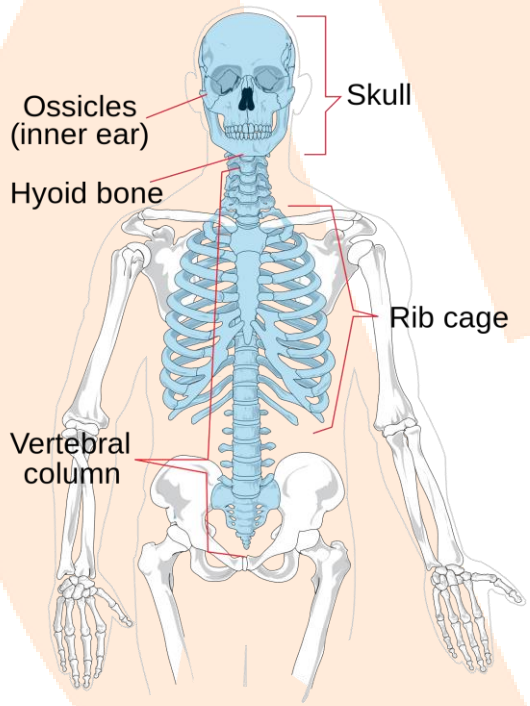


Fig.9. Axial Skeletal System

Skull is composed of 22 facial and cranial bones. The cranial bones are a total of 8 in number which protects the brain. The facial area is composed of 14 bones, forming the front part of the skull. The U-shaped hyoid bone is located at the bottom of the mouth. Each middle ear is composed of three small bones: the malleus, incus, and stapes. These are collectively called ear ossicles.

The Vertical column or spine is made up of 33 vertebrae. The vertebral column extends from the skull base and makes the basic structure of the trunk. Each of the vertebrae has a hollow central part called the neural tube through which the spinal cord passes.

The first vertebra is called the atlas and is connected to the occipital condyle. The spine or vertebral column is divided into 7 cervicals, 12 thoracic, 5 lumbar, 1 sacral, and 1 coccyx beginning from the skull. The number of cervical vertebrae in mammals is preserved.

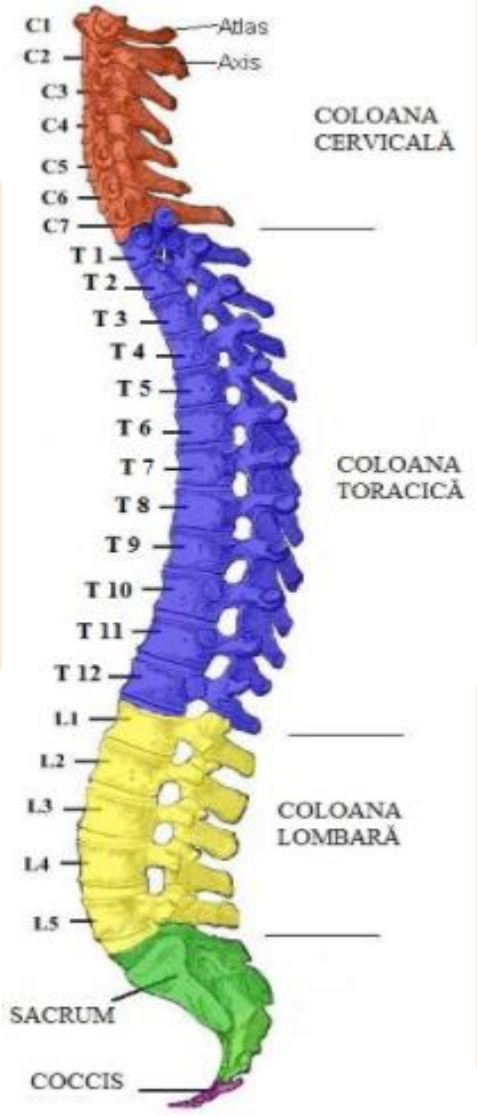


Fig.10. Vertebral column

Ribs: True ribs include the first seven pairs of ribs. They are called true ribs because they are attached to the sternum directly. The eighth, ninth, and tenth ribs pairs are connected to the seventh pair of ribs instead of directly connected to the sternum. Therefore, these are called false ribs. The eleventh and twelfth pairs are the last two pairs of ribs that are not directly connected to the sternum, they are called floating ribs. The thoracic vertebrae, ribs, and sternum together make up the rib cage.

Sternum is a flat bone located at the midline of the chest. Twelve pairs of ribs are connected to the breastbone or sternum.

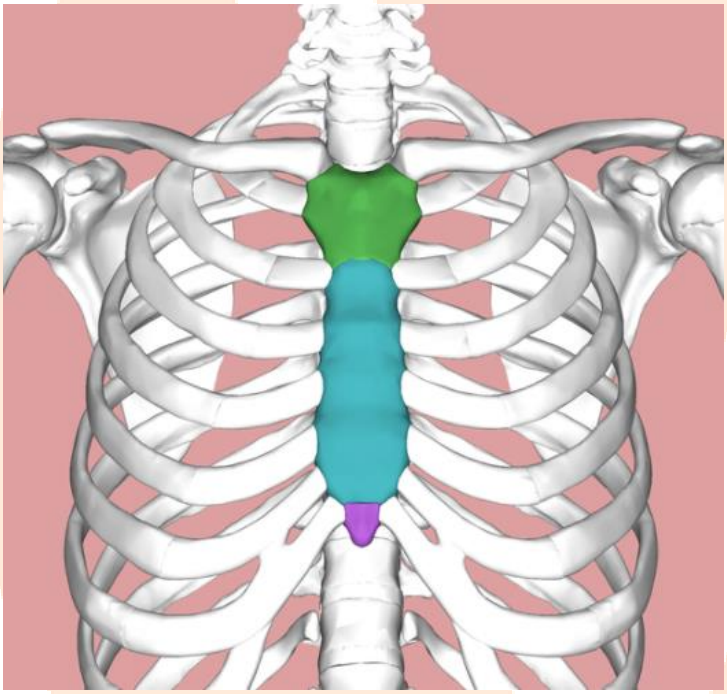


Fig.11. Sternum

2. Appendicular Skeletal System

The Appendicular Skeletal System is made up of limb bones and girdles. Each limb has 30 bones.

Forelimb bones: The bones of the front leg or arm or forelimb are the humerus, radius and ulna, wrist (8 carpal bones), and metacarpal bone (5 palm bones), and phalanges (14 digit bones).

Fig.12. Forelimb bones

Hindlimb bones: There are several bones present in the hind leg or limb which are the femur, the thigh bone (the longest bone), tibia and fibula, and 7 tarsals (the ankle bones), 5 metatarsals, and 14 phalanges. The cup-shaped bones present on the knees are called the patella.

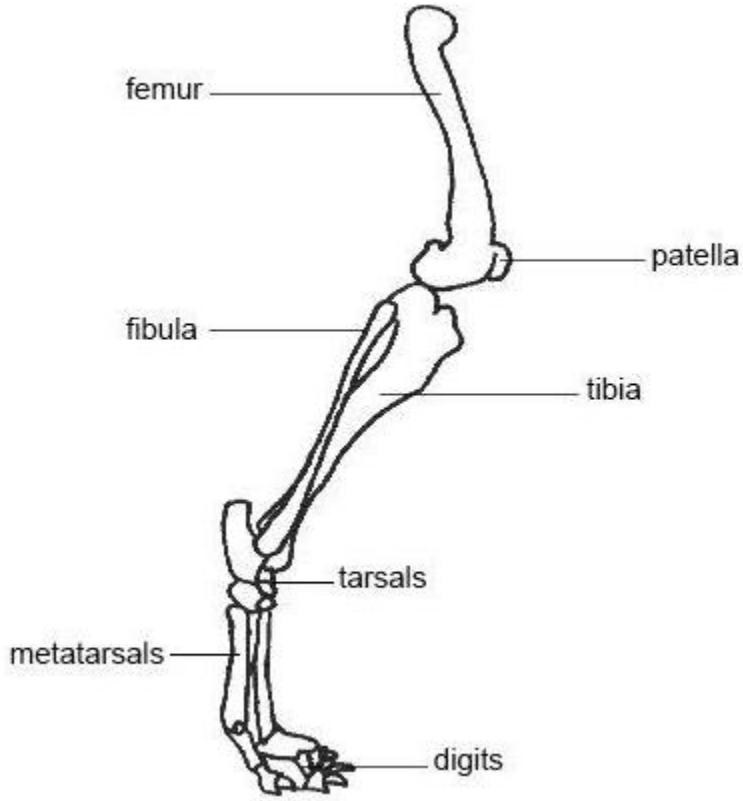


Fig.13. Hindlimb bones

Pectoral girdle has two bones, the collarbone/clavicle, and the scapula. The scapula has a cavity called the glenoid, which forms a hinge in the form of a ball and socket joint with the humerus and is connected to the bones of the forelimbs.

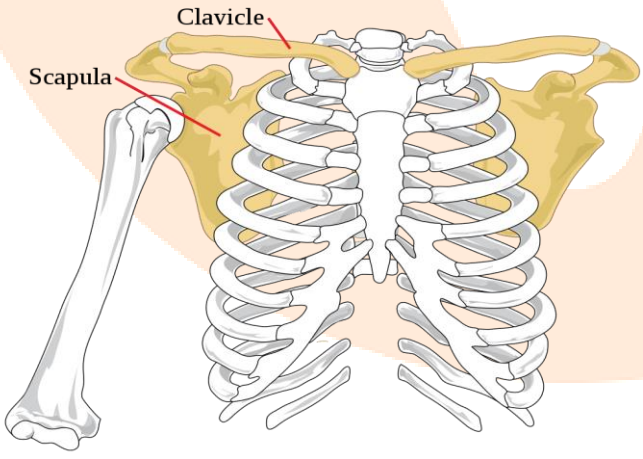


Fig.14. Bones of Pectoral girdle

Pelvic girdle has a cup-shaped cavity called the acetabulum, which forms a spherical connection as a ball and socket joint with the femur that is connected with the bones of the hind leg, and the thigh muscles are connected with the pelvic girdle.

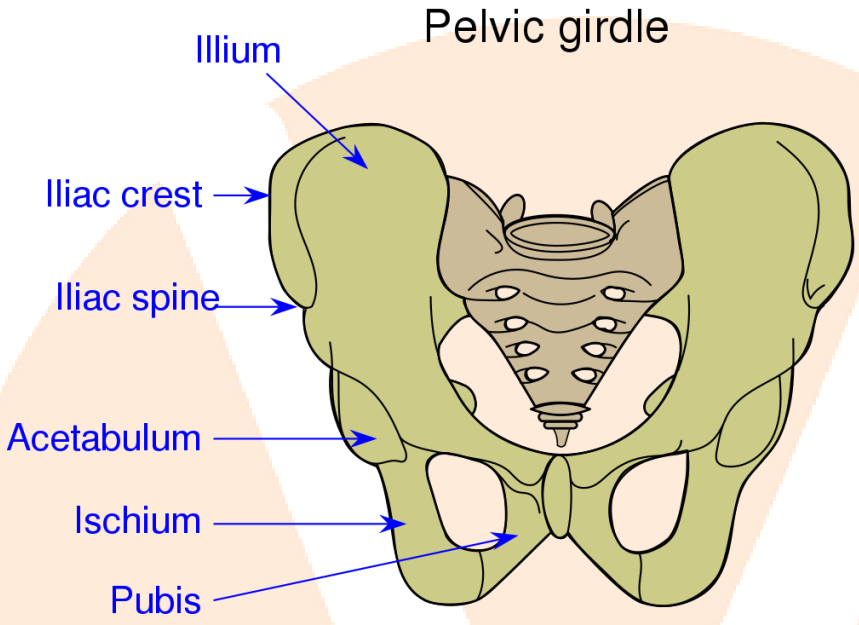


Fig.15. Bones of Pelvic girdle

Joints

Joints are connections between bones or between bones and cartilage. They are important for locomotion because they act as fulcrums for the force exerted by muscles to induce movement. There exists three important types of joints:

1. **Synovial joints:** There is a characteristic fluid-filled synovial cavity between the two bones, which allows more flexibility and more movement. For example- hinge joints (knee and elbow joints), ball and socket joints (hip and shoulder joints), pivot joints (neck), etc.

2. **Fibrous joints:** The bones are connected by dense fibrous tissue forming sutures. They are motionless and can be seen in the joints between the flat bones of the skull.

3. **Cartilaginous joints:** Cartilage exists and helps to connect two bones. Such joints are partially movable and located between the vertebrae.

Disorders related to muscular and skeletal systems

Myasthenia gravis: This disease affects neuromuscular nodes, causing skeletal muscle fatigue, weak and paralyzed. Myasthenia gravis is an autoimmune disease.

Muscular dystrophy: It is a genetic disease that causes progressive destruction of skeletal muscles.

Tetany: This leads to low levels of calcium ions in body fluids, which leads to rapid muscle spasms.

Arthritis: Arthritis is the inflammation of joints.

Gout: This condition is caused by the accumulation of uric acid crystals in the joints, which can cause inflammation of the joints.

Osteoporosis: The bone mass is reduced, which increases the risk of fractures. It is related to age, and is usually related to decreased estrogen levels.