SUPPORT AND MOVEMENT IN PLANTS AND ANIMALS

- ✓ **Support-**It's the ability of organisms to bear their weight and maintain their body forms
  Movement- It's the displacement of parts of the body of an organism e.g. growth Movements of plants and limbs of animals.
- ✓ **Locomotion-** It's Movement of the whole organism.
- ✓ **Necessity for support and Movement in plants**
- ✓ Movement enables plants to adjust to the environment e.g. growth of pollen tube to bring about fertilization.
- ✓ Enables the plants to obtain resources from the environment like light, water and nutrients-Tropic and nastic Movements.
- ✓ Enables plants to escape or avoid harmful stimuli such as high temperature.
- ✓ Supportive tissues enable a plant to hold delicate organs like leaves and flowers where they can most efficiently carry out their functions.
- ✓ Supportive tissues enable a plant to maintain its correct posture.
- ✓ Enables plants to withstand external forces such as strong winds and animals climbing on them

Arrangement of tissues in stems

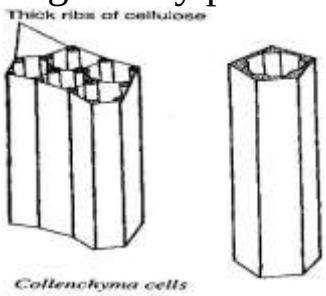
- ✓ A stem plays an important role in support in a plant. This is due to the presence of support tissues which provide mechanical support. These tissues are;

(i) Parenchyma

- ✓ They are spherical or elongated. They form the major component of the cortex and pith.
- ✓ When turgid they become tightly packed and rigid, thus enable a plant to attain an erect posture.
- ✓ They provide the main support in many herbaceous plants such as tomatoes and Irish potatoes. However when such plants lose water on a hot dry day, the cells become flaccid and loosely packed. This causes the

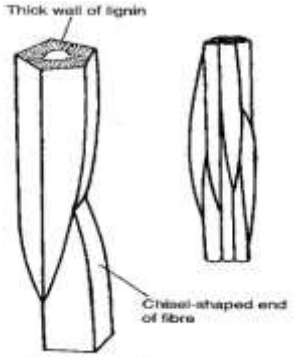
plants to droop a phenomenon called wilting.

- ✓ **(ii) Collenchyma cells**
- ✓ Not all stems develop collenchyma.It always occur towards the outside beneath the epidermis.
- ✓ Their walls are thickened with cellulose especially at the corners to provide mechanical support.
- ✓ Collenchyma cells contain living protoplasm and their walls are not lignified.
- ✓ Collenchyma tissue is important in providing mechanical support in leaves, herbaceous plants and young woody plants.



- ○ *Collenchyma cells*

- ✓ **(iii) Sclerenchyma**
- ✓ Their walls are thick and lignified. The Sclerenchyma cells are often long fibres in stems such as hibiscus.
- ✓ Sclerenchyma consists of dead cells thickened by lignin. Lignin.is a complex polysaccharide.
- ✓ It's the main constituent of wood.

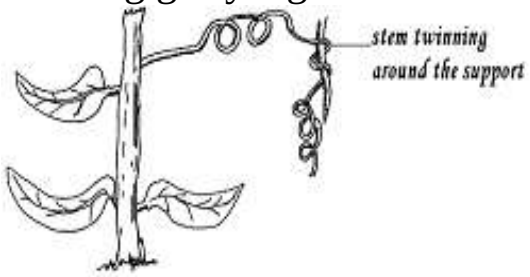


- ○ *Sclerenchyma fibres*
- ○ **Xylem vessels**

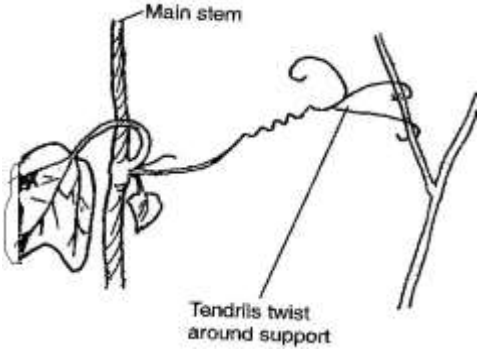
- ✓ They are thick walled tubes with lignin deposited unevenly in rings, spirals or patches on their walls.
- ✓ Their main function is transport but because their walls are thick and lignified, they give strength and support to the stem.
- ✓ They are found in angiosperms.
  - ○ **Xylem tracheids**

- ✓ These are long cells with tapered ends .They are dead cells with thick unevenly lignified walls and help to strengthen and support the stem.
- ✓ Based on the nature and distribution of the strengthening tissues, there are two types of stems i.e.
  - ○ **Herbaceous stems**

- ✓ The tissue is relatively soft and easily crushed. Plants with this kind of stem are usually small and do not grow very tall.
- ✓ Mechanical strength in such stems is directly related to the turgor pressure of the living cells of which it is composed.
- ✓ Some herbaceous plants are known to obtain support by twinning round other plants e.g. passion fruit stems and morning glory e.g.



- ✓
- ✓ Others support themselves by use of tendrils e.g. Pumpkins



- ✓ **(ii) Woody stems**
- ✓ They have support tissues whose cells have stiff, thickened or lignified walls. Therefore they are referred to as strengthening tissues. These tissues are; collenchyma, sclerenchyma, xylem vessels and tracheids. Even when completely dry, these cells remain strong and maintain their shape.
- ✓ They develop thick, strong trunks and branches and those plants live for many years.
- ✓ Stems of woody plants grow in height and in diameter from year to year.
- ✓ Stems of woody plants when young exhibit herbaceous characteristics in terms of support but as they mature they undergo secondary growth that leads to development of elaborate tissues e.g. bark covering their trunks.
- ✓ **Activity1; To observe wilting in plants**
    - **Materials**
- ✓ -Herbaceous plant-Irish potatoes/Sonchus
- ✓ -Woody shrub-Sodom apple/Mexican marigold
    - **Procedure**

- ✓ Uproot a young herbaceous plant and a woody shrub within the same span of time.
- ✓ Lace the two plants on the laboratory bench for 30 minutes.
- ✓ Observe the appearance of stem and leaves of;
- ✓ herbaceous plant
- ✓ Woody shrub
- ✓ Account for the appearance of the shoot in the two plants above.
- ✓ **Support and Movement in Animals**
- ✓ Animals have a firm and rigid framework for support known as a skeleton.
- ✓ **Functions of skeleton**.
- ✓ Supports the weight of the animal's body.
- ✓ Gives the body its shape.
- ✓ Provides surface for attachment of body muscles to facilitate movement
- ✓ Internal organs are attached onto the framework or suspended from it.
- ✓ -Animals move from place to place to;
- ✓ Search for food.
- ✓ Escape from predators or hostile environment.
- ✓ Look for mates and breeding grounds.

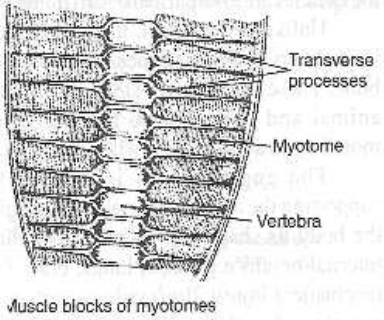
Types of skeleton

- ✓ Hydrostatic skeleton.
- ✓ Exoskeleton
- ✓ Endoskeleton

Exoskeleton

- ✓ It's a characteristic of members of the phylum Arthropoda and is made up of a substance called chitin. Chitin is secreted by epidermal cells and hardens on secretion.
- ✓ This Exoskeleton supports and protects inner delicate tissues.
- ✓ It's waterproof and therefore prevents excessive loss of water from the body tissues.
- ✓ Exoskeleton provides a surface for attachment of body muscles which is essential for movement.
- ✓ Chitin is not evenly distributed i.e. it is thin at the joints to allow for efficient movement.
- ✓ **NB** Exoskeleton limits growth. To overcome this limitation it is therefore periodically shed, a process called moulting (ecdysis).

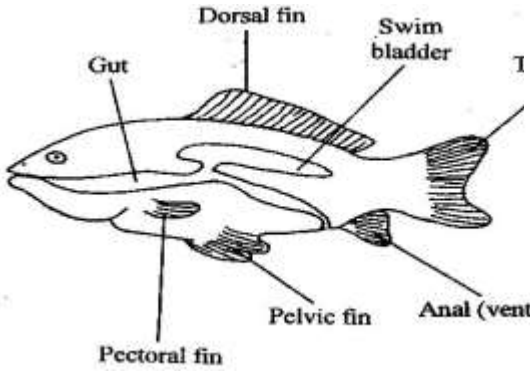
- ✓ **Endoskeleton**
- ✓ It is a characteristic feature of all vertebrates.
- ✓ It's made up of living tissues i.e. cartilage or bones, hence these tissues grow steadily within the animal.
    - **Functions**
- ✓ Supports the animal's body weight.
- ✓ Gives the body its shape.
- ✓ Protects inner delicate organs e.g. heart, lungs, brain from mechanical injury.
- ✓ It provides surface for attachment of body muscles when they contract or relax to bring about movement.
- ✓ The long and the short bones of the skeleton produce the blood cells.
- ✓ Calcium and phosphate deposits on the bones cause hardening of bone tissue therefore bone acts as a reservoir of Calcium and phosphate ions in the body.
    - **Locomotion in a finned fish –Tilapia**
- ✓ -The finned fish are adapted for movement. In the water in the following ways;
- ✓ They have a streamlined body which reduces resistance against movement and enables it to cut through the water easily.
- ✓ It has an inflexible head that enables it to maintain forward thrust.
- ✓ The scales of the fish overlap and are pointed backwards to allow the water to pass over the fish easily without any obstructions.
- ✓ The fish also secretes mucus which covers the body and this reduces friction during movement.
- ✓ The fish has a flexible backbone on which segments of muscle blocks (myotomes) are attached.



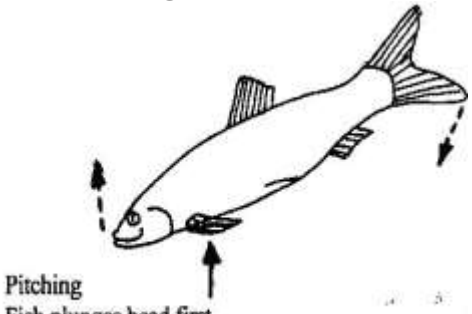
Muscle blocks of myotomes

- ✓ The fish has strong tail muscles which contract and relax to bring about undulating movements.

- ✓ Some fish posses a swim bladder between the vertebral column and the gut. It provides fish with the buoyancy and also helps the fish to adjust its vertical position in relation to depth in water.
- ✓ The fish posses a lateral line system along the length of their body that enables it to detect vibrations and changes of pressure in water thus enabling the fish to respond suitably.
- ✓ The tail has a large surface area which increases the amount of water that is displaced resulting in an increase in the forward thrust.
- ✓ They have two types of fins i.e.;
- ✓ Paired fins-Pectoral and pelvic fins
- ✓ (ii)Unpaired fins-Dorsal, ventral and caudal fins
- ✓

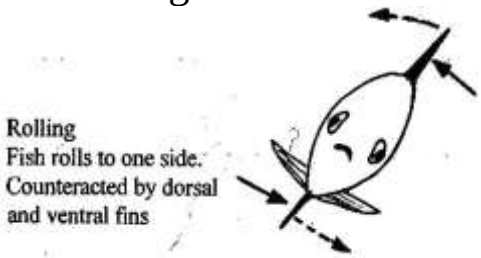


  - **Paired fins- Pectoral and pelvic fins**
- ✓ -They have the following functions;
  - Maintaining balance
  - **Braking**-When the Paired fins are extended rapidly forward at right angles to the body.
  - **Changing direction**-Each Pectoral fin can be used independently of its opposite member hence act as pivots around which the fish can turn rapidly.
- ✓ **Control pitching** of the fish i.e. the tendency of the fish to plunge down head first e.g.



  - **Unpaired fins-caudal, Dorsal ,and ventral (anal)fins**
- ✓ -They have the following functions;

- ✓ Reduce rolling i.e. fish rolling to one side.



- ✓ Reduce yawing i.e. lateral deflection of the body.

- ✓ **NB** Caudal fin propels the fish forward and steers fish while in motion.
    - **Activity 1; To examine external features of a finned fish**
    - **Requirements**
- ✓ Freshly killed finned fish in a tray.
- ✓ A pair of forceps

    - **Procedure**
- ✓ -Examine the fish provided and identify the following features;
- ✓ Scales
- ✓ Fins-caudal, ventral, Dorsal, pelvic and Pectoral fins
- ✓ Note the shape of the fish's body.
- ✓ Place the fish to lie on its side on the bench. Stroke the fish from the head to the tail using your fingers and from the tail to the head. Record your observation in relation to the arrangement of the scales.
- ✓ Draw and label the fish.
    - **Activity 2; To calculate the tail power of fish**
- ✓ **Requirements**
- ✓ Freshly killed finned fish in a tray
- ✓ Means of measuring(in millimeters)
- ✓ **Procedure**
- ✓ Obtain a Freshly killed finned fish.
- ✓ Measure its body length from the mouth to the tail tip.
- ✓ Measure the length from the tail tip to the anus.
- ✓ Calculate the percentage length of the tail to the rest of the body.
- ✓ Tail power is given by;

Tail power=<u>Length from the tail tip to the anus</u> ×100

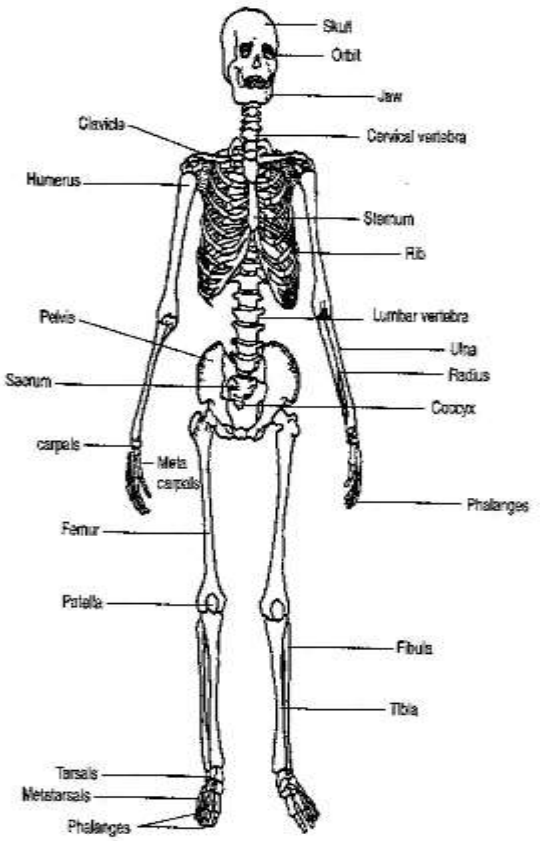
Length from the mouth to the tail tip

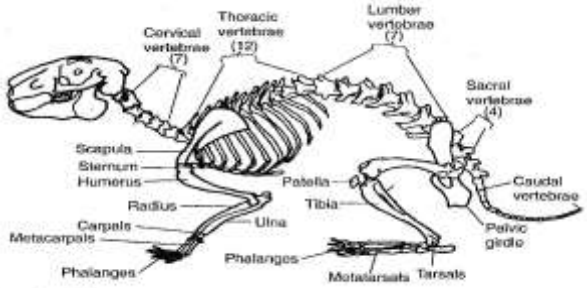
- **Support and Movement in mammals**

✓ In mammals the bones and muscle work together to bring support and movement.

✓ The skeleton system in mammals is divided into two parts i.e.;

- Axial skeleton
- Appendicular skeleton





Skeleton of a rabbit

(1) Axial skeleton

✓ This consists of the following;

(a) Skull

✓ It consists;

(i) Cranium

✓ It encloses and protects the brain. There are perforations on the cranium to allow blood vessels and

nerves to pass to and from the brain.

(ii) Lower jaw (mandible) and upper jaw (maxilla)

- ✓ It articulates (forms a joint) with the upper jaw (maxilla) through a hinge joint.
- ✓ At the posterior end of the cranium are two smooth rounded protuberances, the occipital condyles, which articulate with the atlas vertebra to form a joint which permits the nodding of the head.
- ✓ X

(b) Ribcage

- ✓ It encloses the thoracic cavity protecting delicate organs e.g. heart and lungs.
- ✓ The cage is made of ribs articulating with vertebral column to the back and the sternum to the front. At the articulating points, the ribs have cartilage.

(c)Sternum

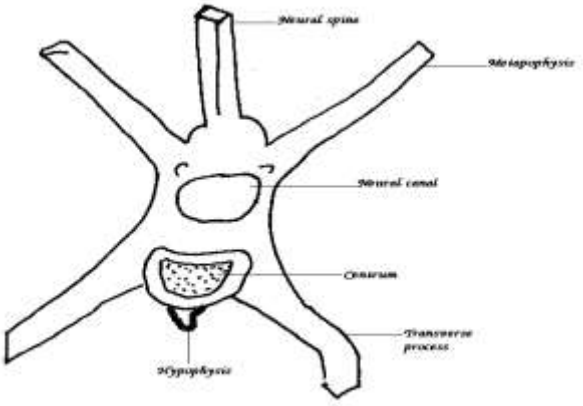
- ✓ It supports the ribs and protects the organs in the thoracic cavity.
- ✓ In flying vertebrates the sternum is very prominent and often modified to form a keel which gives a large surface area for attachment of pectoral muscle (flight muscle)
- ✓ **NB** At the lower end, the sternum and ribcage offer surfaces for attachment of muscles of the back and the abdomen.

(d) Vertebral column

- ✓ The Vertebral column consists of bones called vertebrae. The number of vertebrae varies from species to species e.g. in human there are 33 vertebrae.
- ✓ The vertebrae are separated from each other by cartilage called intervertebral disc which has various functions i.e.
- ✓ Acts as cushion that absorbs shock and reduces friction.
- ✓ It makes Vertebral column flexible by allowing for a certain degree of movement between the vertebrae.
- ✓ The Vertebral column has 5 types of vertebrae
  - -Cervical vertebrae
  - -Thoracic vertebrae
  - -Lumbar vertebrae
  - -Sacral vertebrae

-Caudal vertebrae

The vertebrae have got common basic plan e.g.



- ✓ The parts of a vertebra are;
  Centrum-It's a solid structure of the vertebra. It supports the weight of the vertebrae'
  Transverse process-Are lateral in relation to Centrum while the **neural spine** is dorsal to the Centrum.
- ✓ These two are projections which offer surfaces for muscle and ligament attachment.
  Neural canal-It's a centrally running passage for the spinal cord.
  Neural arch-It's an arch of bones which arises from the Centrum. Together with Centrum they protect the spinal cord.
- ✓ The vertebrae articulate with each other anteriorly and posteriorly by facets called zygapophysis.
- ✓ At the anterior (front) and posterior (back) of each vertebra is a pair of smooth facets for articulation of successive vertebrae.
- ✓ Facets at the anterior parts are called prezygapophyses. They face upwards and inwards.
- ✓ Facets at the posterior part are called postzygapophyses. They face downwards and outwards.

Cervical vertebrae

- ✓ They are found in the neck region. There are 7 cervical vertebrae.
- ✓ All Cervical vertebrae have vertebraterial canals in the transverse process for the passage of vertebral artery and vertebral nerves.
- ✓ The first t**wo** cervical vertebrae called atlas and axis are different from other cervical vertebrae.

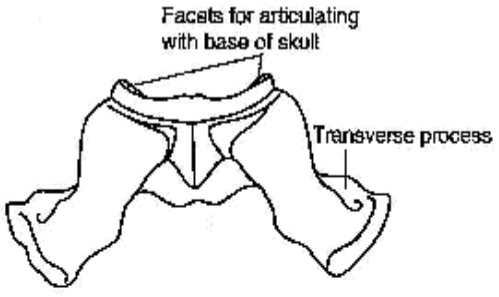
Atlas

- ✓ Has a small neural spine.
- ✓ It has no Centrum.

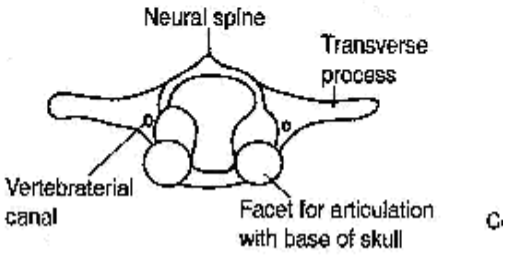
- ✓ Neural canal is wide for the passage of the large spinal cord in the neck region.
- ✓ Their transverse processes are broad and wing-like offering a large surface area for attachment of neck muscles.
- ✓ It has broad facets for articulation with condyles of the skull. This forms a joint which allows for up and down movement of the head (nodding).

Axis

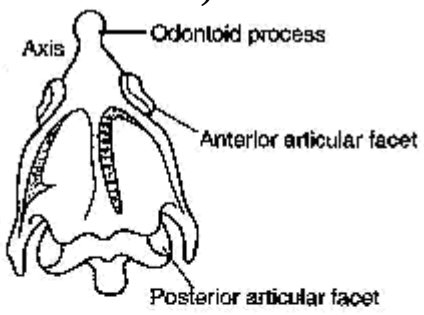
- ✓ It's the second cervical vertebra on the neck region.
- ✓ The Centrum is broad and projects in front to form an odontoid process/peg. This forms a peg which fits into the ventral side of the neural canal of the atlas.
- ✓ The joint between the atlas and axis allows turning movement of the head (rotatory movements).



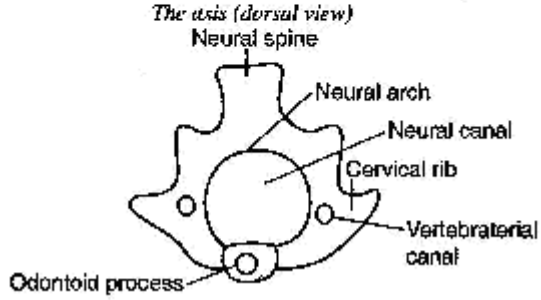
The atlas (Ventral view)



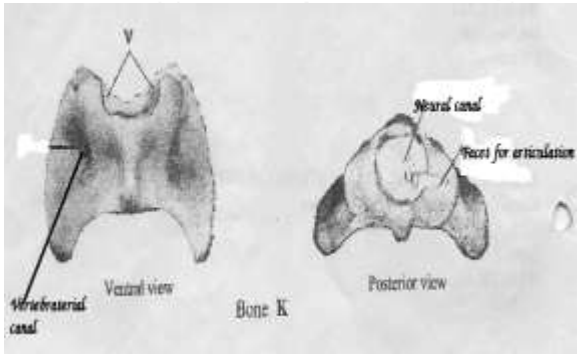
The atlas (anterior view)

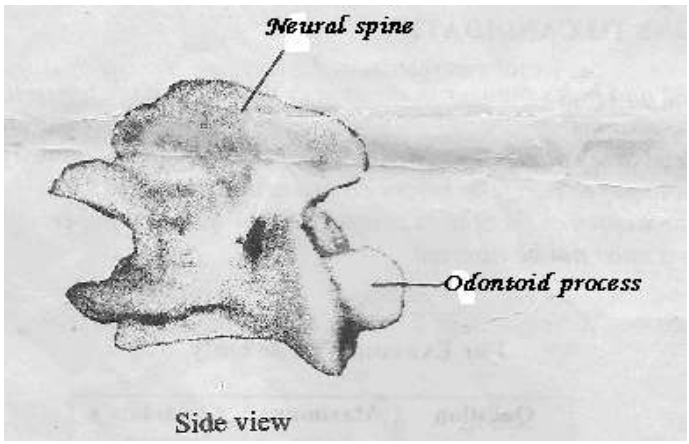


The axis (dorsal view)

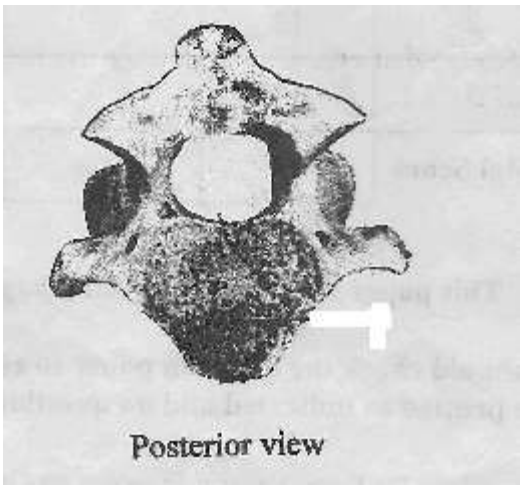


The axis (anterior view)

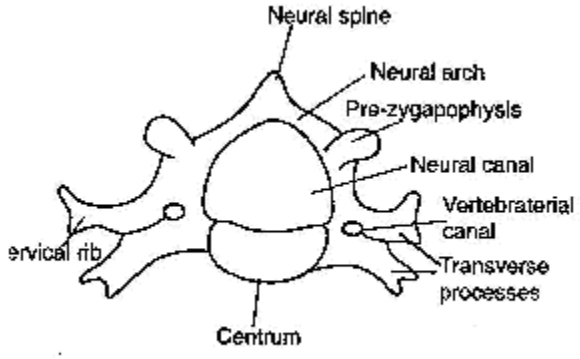




Side view


Posterior view

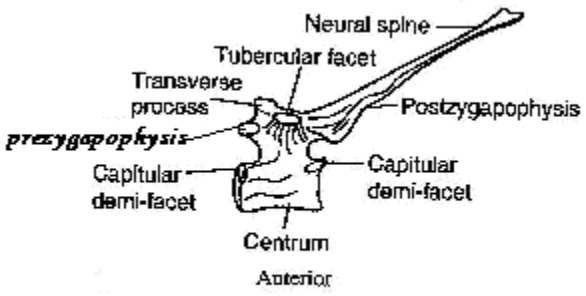
- ✓ It has broad neural spine.
- ✓ Has wide neural canal.
- ✓ Has wing-like transverse process.
  -The other 5 cervical vertebrae posses;
- ✓ Broad and branched transverse process. These offer a large surface area for attachment of neck muscles
- ✓ Short neural spine
- ✓ Wide neural canals and wide Centrum.
- ✓ They posses the prezygapophyses and postzygapophyses.



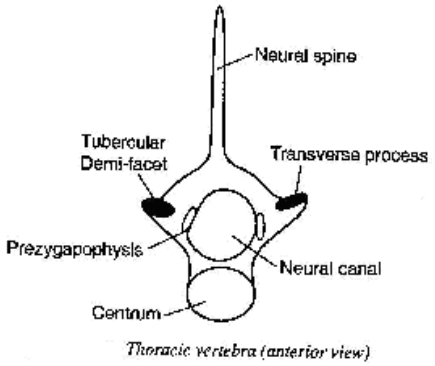
The cervical vertebra (anterior view)

(b) Thoracic vertebrae

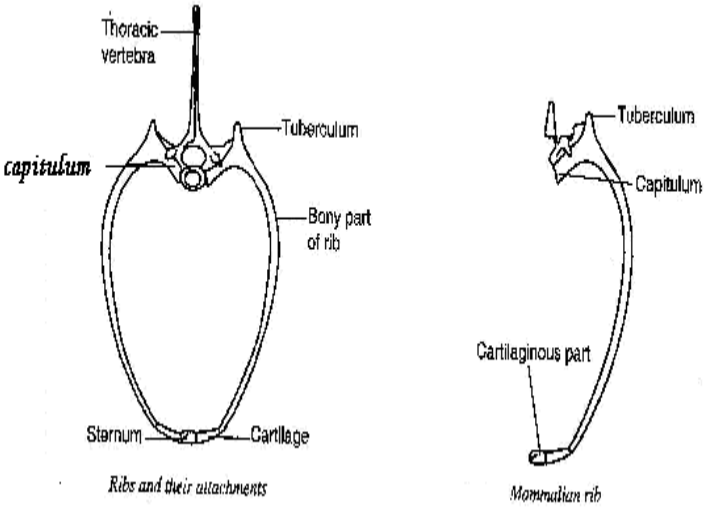
- ✓ They are found in the thoracic region articulating with the ribs. In man they are 12 in number
- ✓ They have a long neural spine which offers a large surface area for attachment of back muscles.
- ✓ Centrum is large.
- ✓ Short transverse process.



Thoracic vertebra (lateral view)



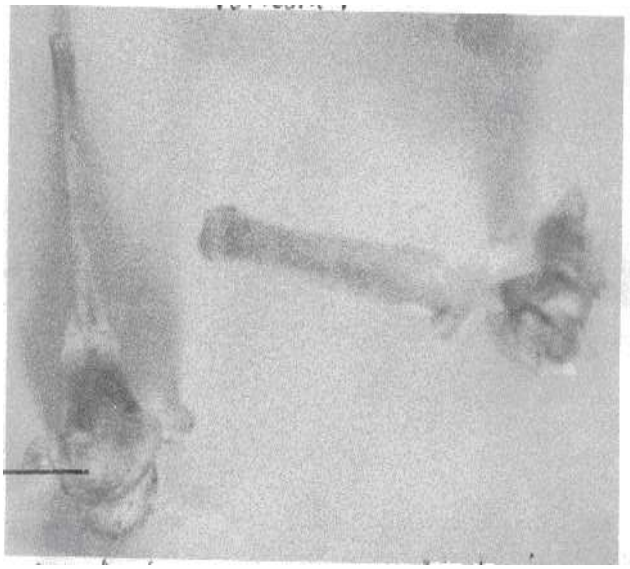
Thoracic vertebra (anterior view)



Ribs and their attachments

Mammalian rib

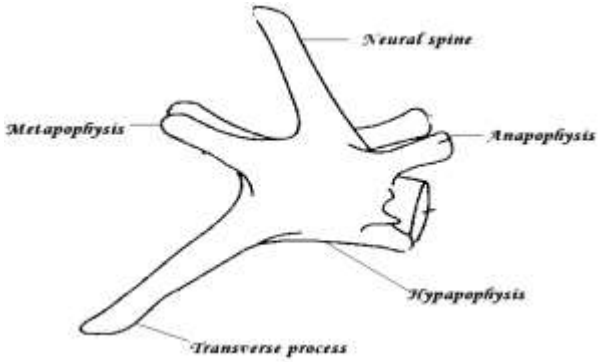
- ✓ The ribs articulate with the vertebrae at two points i.e. capitulum and tuberculum.The tuberculum facet on each transverse process articulates with tuberculum of the rib while the capitular demi-facets on the Centrum articulate on the capitulum of the rib.

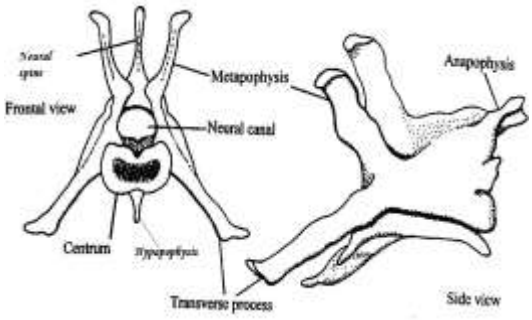


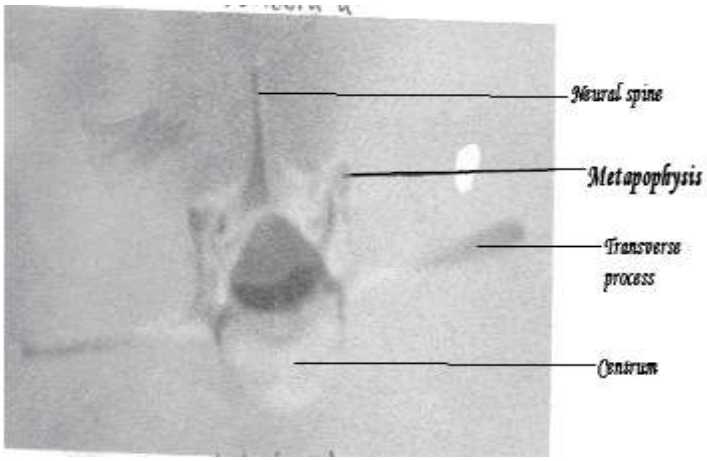
Lumbar vertebrae

- ✓ They are found in the lumbar region of the body. In man there are 5 vertebrae.
- ✓ They have large and broad Centrum to offer support.
- ✓ They have broad and long transverse process projecting forwards and downwards from the Centrum for muscle attachment.
- ✓ Have broad neural spine for muscle attachment.
- ✓ Infront and on either side of the neural spine are two projections called metapophyses.
- ✓ Also projecting dorsally near the transverse process are anapophyses.

- ✓ In some animals e.g. rabbits another projection the hypapophysis arises ventrally to the Centrum. All these projections offer additional surfaces for the attachment of abdominal muscles.

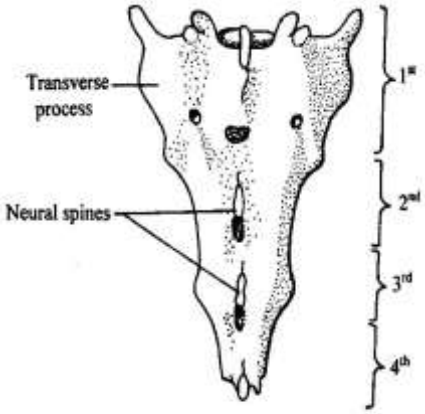






- ✓ **NB** The vertebrae in the lumbar region are adapted to support the weight of the body and to withstand strains of movement.
- ✓ **Sacral vertebrae**
- ✓ They are situated in the sacral region. Man has 5 while rabbits have 4.
- ✓ They have large and broad Centrum to offer support.
- ✓ Neural canal is narrow.
- ✓ Neural spine is short.
- ✓ The first anterior sacral vertebra is large with wing-like transverse process which is fused to the pelvic girdle.
- ✓ The transverse processes of the remaining vertebrae are not attached. They all offer a large surface area for attachment of back muscles.
- ✓ All the sacral vertebrae are fused to form a rigid

structure the sacrum. This makes sacrum strong and firm to bear the body weight and spread it to the legs through the pelvic girdle.

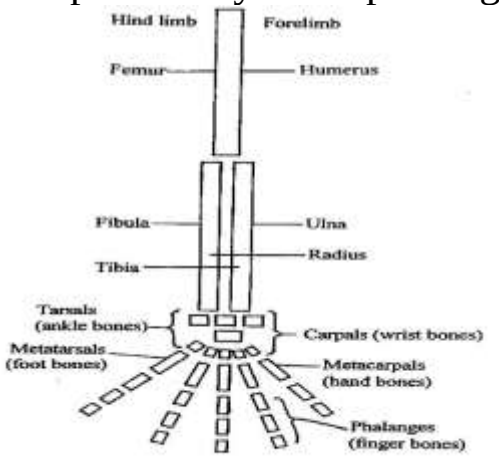


Sacrum of rabbit (1st, 2nd, 3rd, and 4th, refer to the position of the individual sacral vertebra)

- ✓ **Caudal vertebrae**.
- ✓ They are found in the tail region. The number depends on the size of the tail. In man where the tail is vestigial they are 4 and are fused to form a coccyx.
- ✓ Neural spines and zygapophyses are short.
- ✓ Neural canal and neural arch are absent hence the entire bone is Centrum.

Appendicular Skeleton

- ✓ It consists of the girdles and limbs attached to them. The girdles are the pectoral girdle on the anterior side and pelvic girdle to the posterior.
- ✓ The limbs to the anterior part of the body are fore-limbs and those to the posterior are hind-limbs.
- ✓ The limbs of all mammals are constructed in the same basic plan with 5 digits (fingers and toes) in each limb. This is called pentadactyl limb plan e.g.

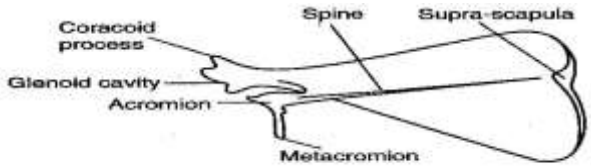


Plan of the pentadactyl limb.

- **Bones of fore-limbs**
- **Pectoral girdle**

- ✓ This is made up of two halves each of which consists of 3 bones i.e.
- ✓ -Scapula
- ✓ -Coracoid process
- ✓ -Clavicle
- ✓ These bones are attached to the upper part of the vertebral column. The two halves are not fused but are attached firmly by muscles.

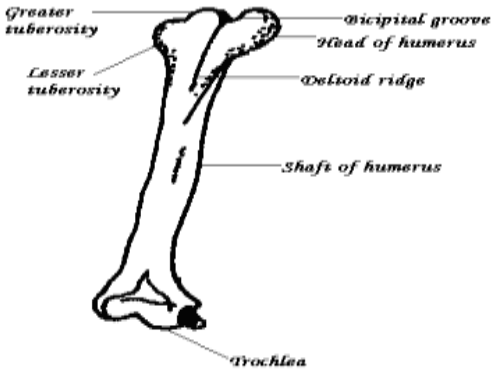
- ✓ **Scapula (Shoulder blade)**
- ✓ It's a flat, triangular-shaped bone. At its apex is a concave cavity or depression, called glenoid cavity which articulates with the head of humerus to form the ball and socket joint.
- ✓ A spine runs along the outer surface of the scapula and at its free end, there are two projections i.e. acromion and metacromion which are both for muscle attachment.



Left scapula of a rabbit

Clavicle (collar bone)

- ✓ It articulates on one end with acromion process and the other with sternum. It's for muscle attachment and aids in movement of arms.
- ✓ **Humerus**
- ✓ This is the bone found in the upper arm. Its head articulates with scapula at the glenoid cavity of the pectoral girdle where it forms ball and socket joint.
- ✓ Near the head are two roughened projections i.e. the greater and lesser tuberosities. These extend into a shaft which provides surface for muscle attachment.
- ✓ Between the tuberosities, is a groove called bicipital groove. It is along this groove that the tendons of the biceps muscles pass.
- ✓ At the lower end is the trochlea which articulates with the forearm to form a hinge joint at the elbow.



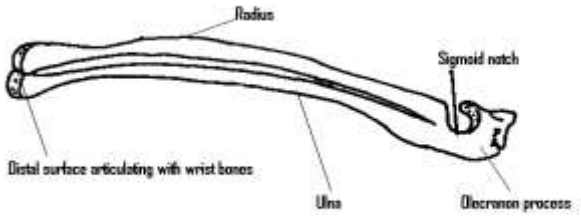
- **Ulna and Radius**

- ✓ These are two bones found in the forearm. The radius is found on the side of the thumb.
- ✓ The ulna is on the side of the small finger and has a projection called **olecranon process**. This has a sigmoid notch which articulates

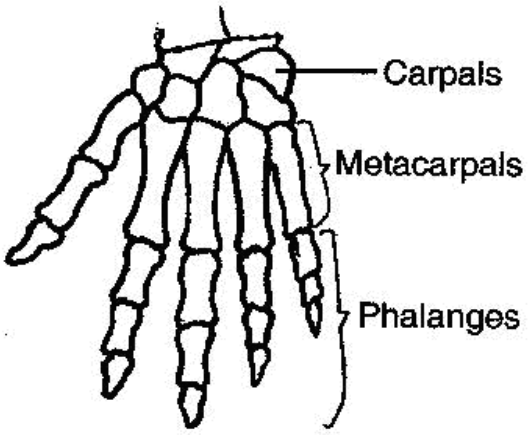
with the humerus forming a hinge joint.

Functions of olecranon process

- ✓ Offers a large surface for attachment of tendons, ligaments and muscles
- ✓ Prevents overstretching of the lower arm
- ✓ Limits movement at the joint (acts as stopper).
- ✓ Limits movement of radius and ulna+
- ✓



- **Carpals, metacarpals and phalanges**
  - **Carpals-** They are small bones found in the wrist (wrist bones). They are nine (9) in the number.
  - **Metacarpals (Hand bones) -** They form the skeleton of the hand and are 5 in number.
  - **Phalanges (Finger bones) –**Each digit has 3 bones called phalanges singular phalanx except the thumb that has two.



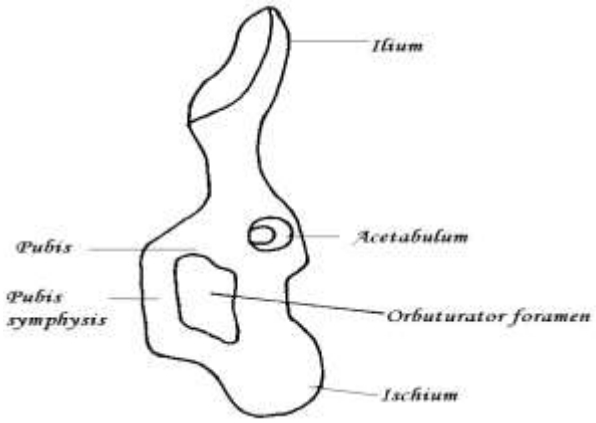
  - **NB** In cattle and goats the fore limbs has two digits while in the horse there is only one digit.

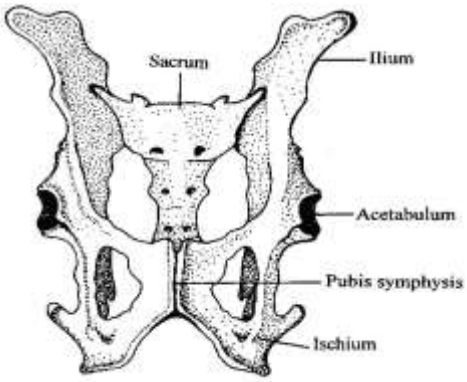
Bones of Hind limb

- ✓ These are;
- ✓ **The pelvic girdle**
- ✓ It consists of two halves fused at the pubic symphysis. Each half is made of 3 fused bones i.e.
  - -Ilium
  - -Ischium
  - -Pubis
- ✓ Each half has a cup-shaped cavity, the acetabulum. This articulates with the head of the femur to form a

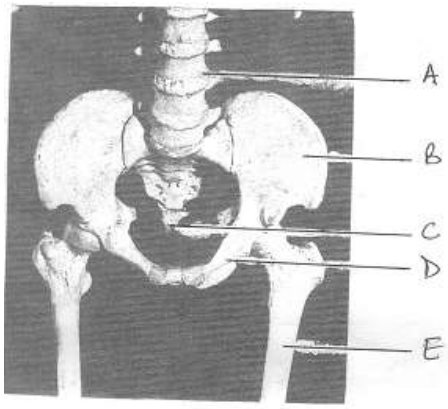
ball and socket joint. Dorsally, the ilium articulates with the sacrum.

- ✓ The ilium provides a large surface to which thigh muscles are attached.
- ✓ *Has sacral facet that attaches it to the transverse process of the 1st sacral vertebra
- ✓ Between Ischium and pubis is a hole called orbiturator foramen. This is an aperture through which blood vessels, nerves and muscles pass. This design is an adaptation to reduce the weight of the pelvic girdle and hence lighten the load to be supported by the hind limb.
- ✓ The pubic symphysis is composed of flexible cartilage which permits the widening of the females girdles when giving birth.
- ✓ The ilium, Ischium and pubis are fused to form the innominate bone.





Pelvic girdle of rabbit



- **NB** The size of the pubic cavity is important in females in regard to childbirth. A hormone called

relaxin causes the relaxation of the pubis symphysis during birth thus expanding the size of the pelvic cavity.

- **Femur**

✓ It's a long bone found between the hip and the knee. The head of femur fits into the acetabulum forming the hip joint.

✓ At the tip of the shaft are the greater and lesser trochanters which are extensions for muscle attachment.

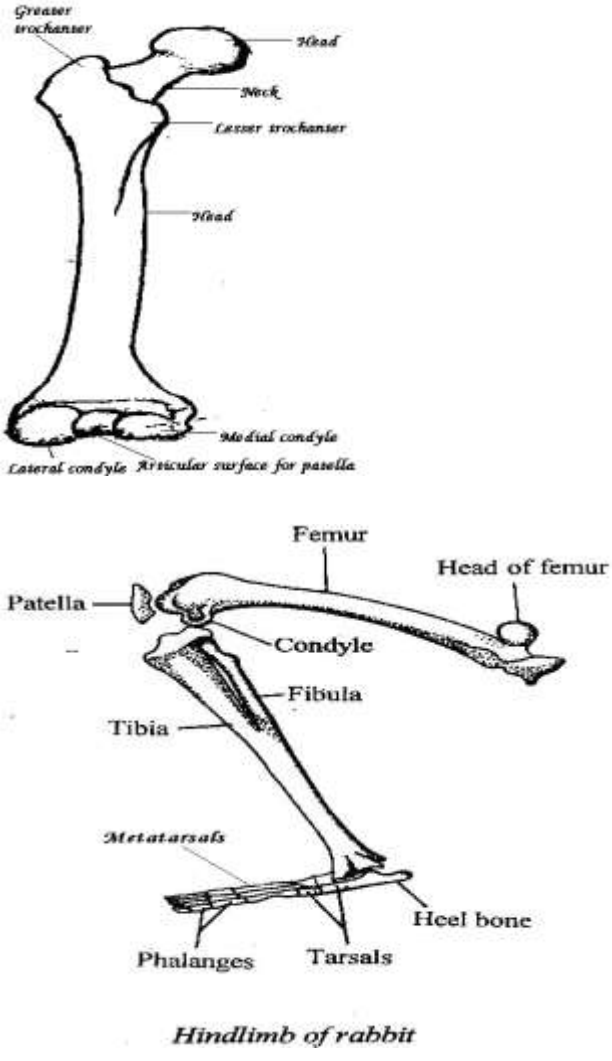
✓ The shaft of the femur leads to the lower end with expanded and rounded knobs called condyles.

✓ The condyles articulate with the patella (knee cap). They also articulate with tibia to form hinge joint at the knee.

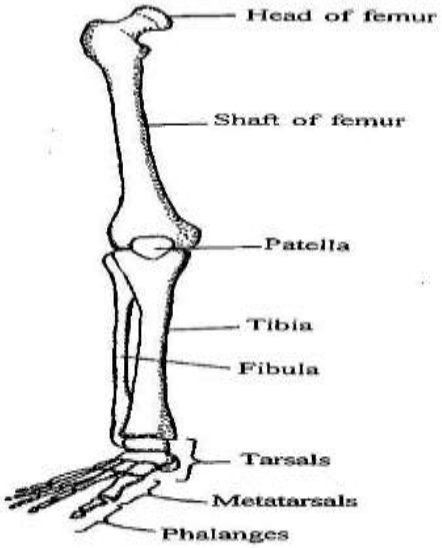
✓ The **tibia** and **fibula** form the skeleton of the lower hind limb.

✓ The heel has 7 small bones in man called **tarsals (ankle bones**). These articulate with the tibia and fibula on the upper end and with the **metatarsals (foot bones**) on the lower end.

✓ The metatarsals are 5 in number and form the skeleton of the foot. In man, there are 5 digits (toes) on the foot, 4 in rabbits, 2 in the cow and 1 in the horse. Each digit has 3 **phalanges (toe bones**) except the big toe that has two.



Hindlimb of rabbit



Human hindlimb

- **JOINTS**

✓ A joint is a connection between two or more bones. There are various types of joints e.g.

- **Immovable joints**

✓ **e.g.** Fused bones in the skull and the pelvic girdle.

✓ Gliding joints e.g. at the wrist, ankle and between vertebrae in the vertebral column.

- **Movable joints**

✓ They are found at various points of the appendages. These joints are characterized by bones covered with cartilages at the ends and bones being held together by tough ligaments.

✓ The joint area is filled with a lubricating synovial fluid and is also called synovial joints.

✓ Synovial joints are of two types.

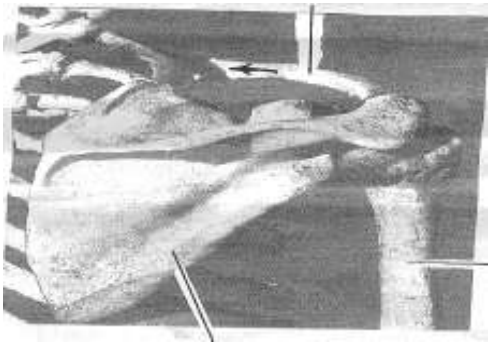
- **Ball and socket joints**

✓ This is a type of joint with two bones, one with a round head and the other one with a depression or a cavity into which the head of the first bone fits and moves freely.

✓ In this joint, movement is possible in all directions.

- Examples; **Hip and shoulder joints**

✓ This joint allow the limbs to rotate through 360°, however, they cannot bear very heavy loads.

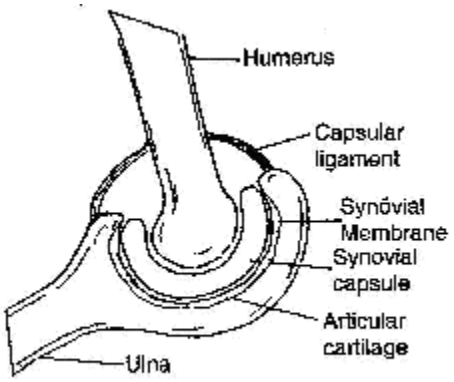
✓ 

- **Hinge joint**

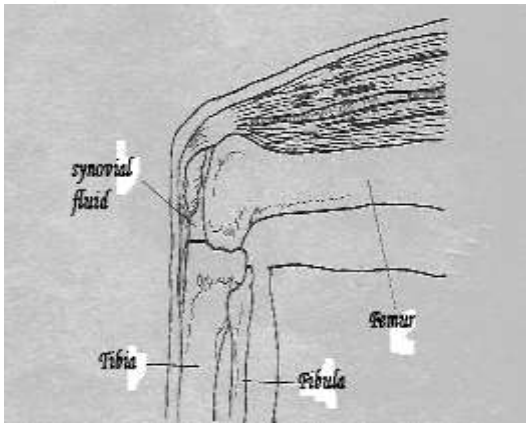
✓ The depressions in one bone allow the smooth condyles of another bone to fit and articulate to allow movement in one direction.

- ✓ The maximum stretch of the limb at this joint is 180º. They are found at the elbow, knee and phalanges.

Ulna – humerus hinge joint

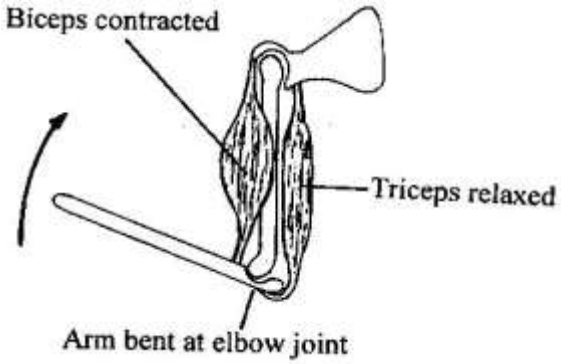


- ✓ *Ulna-humerus hinge joint*



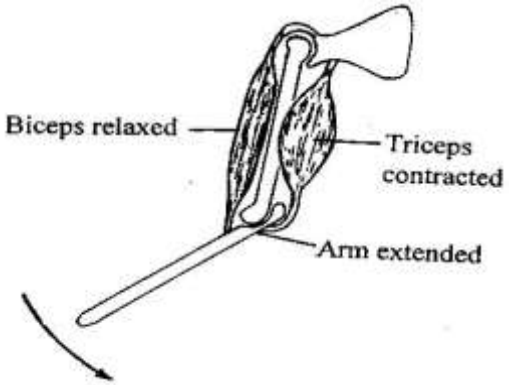
Movement of a joint

- ✓ At a movable joint the bones are held together by an inelastic tissue called **ligament.** Ligaments restrain movement of the bones thus preventing dislocation.
- ✓ At the joint, muscles are attached to the bones by an inelastic tissue called **tendon.**
- ✓ A muscle is attached to two points, the origin on an immovable bone and **insertion** on a movable bone.
- ✓ Muscles which operate joints are in pairs and are antagonistic.
- ✓ A muscle may bring about bending at a joint. This type of a muscle is called **flexor muscle** while the other which straightens the limb is the **extensor muscle**.
    - **Movement at the hinge joint of the elbow**
- ✓ In the arm there are two antagonistic muscles i.e. biceps and triceps.
- ✓ The biceps (flexor muscles) flex the arm while the contraction of triceps (extensor muscles) extends the arm. The biceps contract and triceps relax. This pulls the ulna – radius upwards hence bending the arm.



✓

✓ While the triceps contract the biceps relax thus straightening ulna – radius leading to extension of the arm. e.g.

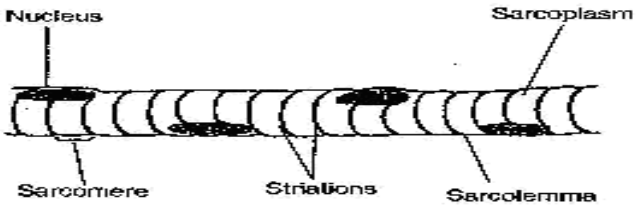


✓

✓ During this movement of the arm, the hinge joint at the elbow serves as the fulcrum with the biceps muscles providing the effort to lift the load at forearm.

✓ **Structure and function of muscles**

✓ Muscles are tissues specialized for contraction.



✓

✓ There are 3 types of muscles i.e.
- Skeletal muscle
- Smooth muscle
- Cardiac muscle
- **Skeletal/striated muscle**

✓ They are attached to the bones/skeleton and are responsible for locomotion and other voluntary movements.

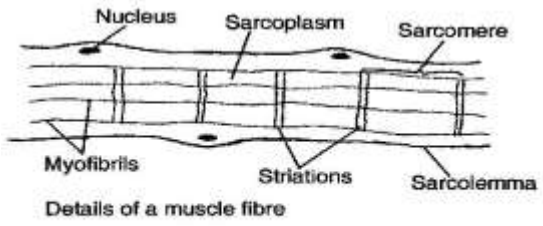
✓ They are innervated by the voluntary part of the nervous system therefore known as voluntary muscles.

✓ Its fibres have stripes running across them hence they are also known as striated or striped muscle.

They contract and fatigue rapidly.

- ✓ They are made up of long cylindrical cells with multiple nuclei (multinucleated).
- ✓ Each fibre contains many myofibrils running parallel to each other.
- ✓ A skeleton muscle is made up of a bundle of long fibres running the whole length of the muscle. The covering of a muscle fibre is called a sarcolemma.
- ✓ The myofibrils are composed of two proteins strands i.e. actin and myosin.

✓ Structure of striated muscle



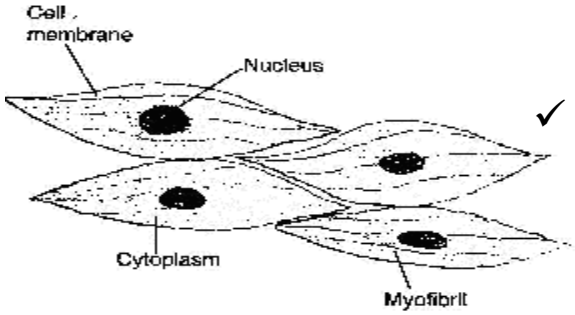
✓ *Structure of a striated muscle*

- ✓ The functional unit of the muscle is the myofibril which has the ability to contract. Muscles require large amounts of energy to contract this energy is provided by the numerous mitochondria present in the sarcoplasm.
- ✓ Sodium ions and calcium ions are also necessary for muscle contraction.
- ✓ The force created by contraction is transmitted onto the skeleton in the same magnitude by the tendon. This brings about the appropriate movement of the skeleton.

▪ **Smooth/visceral muscles**

- ✓ They are found in the walls of tubular body structures e.g. digestive tract, blood vessels, urinary tract, reproductive tract, respiratory tract etc.
- ✓ They are made of long spindle – shaped cells with a single nucleus.
- ✓ They contain myofibrils enclosed by plasma membrane.
- ✓ They lack cross striations hence referred to as smooth muscles.
- ✓ They are innervated by the autonomic nervous system and can therefore not be contracted at will, hence they are also called involuntary muscles. They

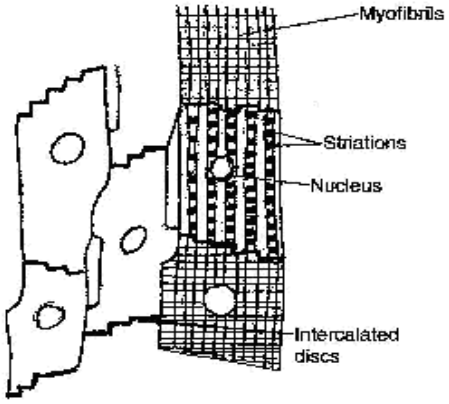
are capable of contracting slowly and fatigue slowly unlike skeletal muscles.



Fibres of smooth muscles

- **(c) Cardiac muscle**

- ✓ This is the heart muscle. Each muscle fibre consists of short cells with centrally placed nuclei and numerous striated myofibrils.
- ✓ The ends of the cells are marked by thickened region called intercalated discs. These form bridges between fibres hence transmit impulses rapidly throughout the heart.
- ✓ The contractions of the heart muscle are generated from within the heart itself without nervous stimulation. Therefore heart muscle is said to be myogenic.
- ✓ Cardiac muscle is capable of continuous rhythmic contractions without fatigue throughout the life of the mammal.
- ✓ They have more mitochondria than skeletal muscle to sustain the energy demands.



Cardiac muscle

- ✓

(d) .