SUPPORT AND MOVEMENT

Organisms need rigid framework to support their bodies/ weight off the ground and maintain their shape. In animal this function is performed by skeleton while in plants is by variety of supportive tissues.

Movement is displacement of part of organism

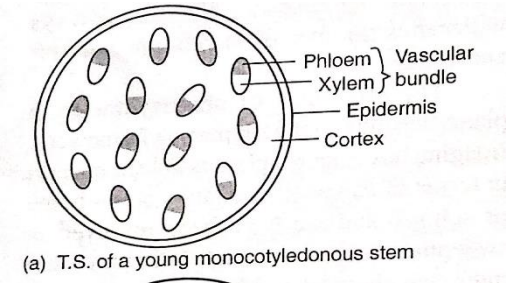
Locomotion is displacement of whole organism's body.

Necessity for movement &support in plants

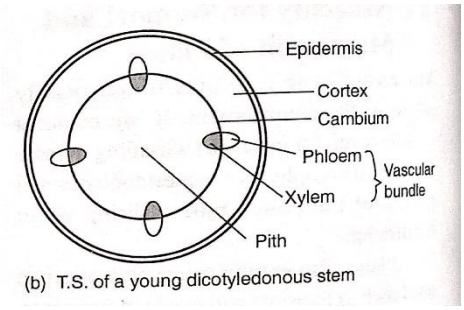
- Facilitate fertilization as male gamete swim to ovum as in Bryophya and Pteritophyta, alas growth of pollen tube down the style to embryo sac.
- Enable plants obtain resources from the environment such as light, water and nutrients through tropic and nastic movements.
- Help plants withstand the forces in environment e.g. gravity, wind, animals tied to them and storms.
- It enables plant parts to be held upright e.g. leaves to absorb maximum light energy for photosynthesis, flower and fruits for pollination and dispersal respectively.

Tissues in stem

Stems plays major role in plant support. There are several tissues which provide mechanical support.



(a) T.S. of a young monocotyledonous stem



(b) T.S. of a young dicotyledonous stem

a) Ground tissues i.e. parenchyma, collenchymas, sclerenchyma

b) Xylem vessels and tracheids.

A. Ground tissues

i) Parenchyma tissues

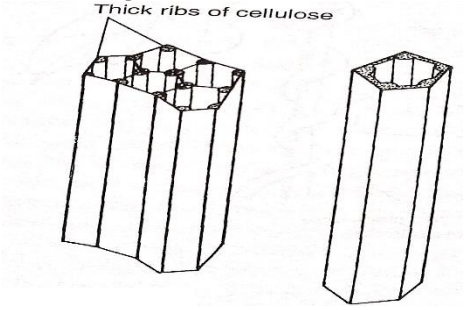
These are cells located in cortex and pith. Their main function is packing i.e. storage of water and food. Its made of spherical or elongated cells.

Also provide support to herbaceous plants when turgid (turgidity).

ii) Collenchyma tissues

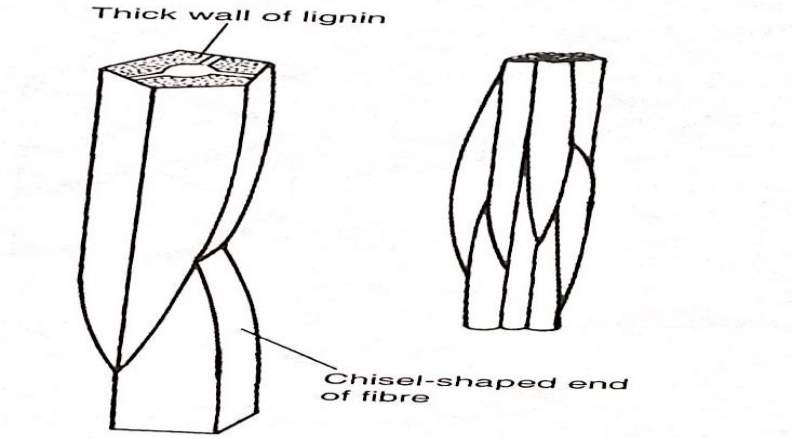
Found beneath epidermis, almost like parenchyma only that their corners are thickened with cellulose to provide mechanical support.

It has living protoplasm; its walls are not lignified.



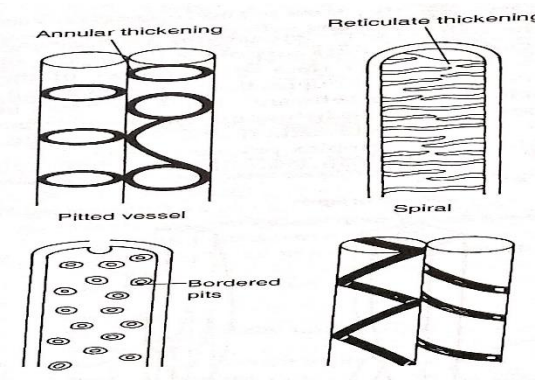
iii) Sclerenchyma tissues

The walls are thick and lignified; made of dead cells thickened cells.

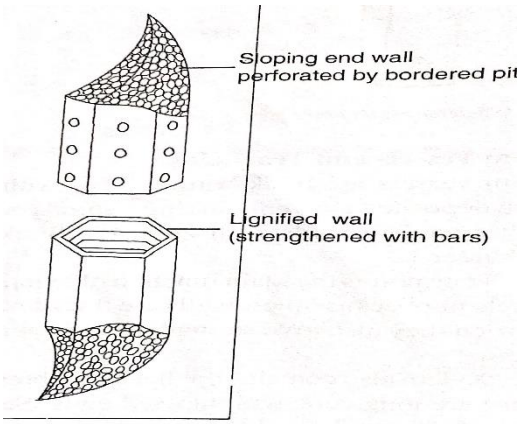


B. Xylem vessel and tracheids

Xylem vessels and tracheids have thick walls with deposits of lignin which are uneven in rings which provide support in stems



a)Xylem vessels



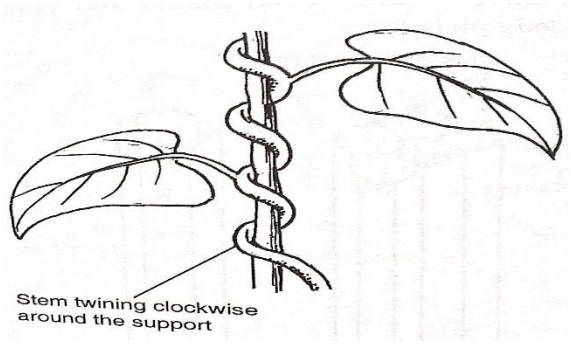
b) tracheids

Types of Stems

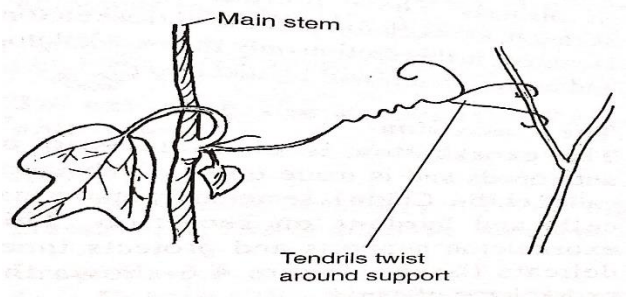
Stems can be classified into two depending on nature and distribution of strengthening tissues.

a) Herbaceous stems

- Soft and usually small and grow short
- Made of parenchyma cells which provide support only through turgidity; only that it wilts when water becomes limited in supply.
    - Because turgidity is not enough for some plants, they opt to twin round other plants e.g. morning glory, lianas



- Others use tendrils to support themselves on other plants e.g. pumpkin



b) Woody stem type

Have support tissues whose cells are stiff, thickened or lignified i.e. strengthening tissues such as collenchymas, sclerenchyma, xylem vessels and tracheids; remain in shape even when completely dry. Plants with woody stem grow in height and girth.

Necessity for movement &support in animals

Why to animals move?

- ✓ In search for food
- ✓ In search for mates
- ✓ To escape from predators
- ✓ To escape from unfavorable environment

Importance of support in animals:

- ❖ Support the weight of animals
- ❖ Provide surface for muscle attachment
- ❖ Protect internal organs against mechanical damage
- ❖ Enable organisms move
- ❖ Gives body shape to the organism
- ❖ Formation of some tissues e.g. blood formed in bone marrow.

Rigid framework in animals is called skeleton.

Types of skeleton

a) **Hydroskeleton**/ hydrostatic as in earthworms

b) **Exoskeleton** e.g. in arthropods

It's made of chitin.

- ➢ Tough and hardened to protect delicate tissues
- ➢ Waterproof to protect against desiccation.

Exoskeleton is thin in limbs to allow movement.

c) Endoskeleton

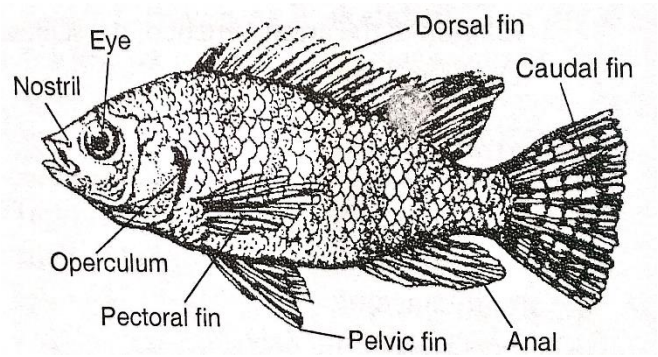
Found in vertebrates made of rigid structures called bones; also cartilage plays major role in vertebrate support.

Locomotion in finned fish

Adaptations of fish for locomotion

- Stream lined to reduce resistance against movement as it cuts through water.
- Head being inflexible enables it to maintain forward thrush.
- Scale overlap and face backwards to allow water to pass over the fish without obstruction.
- Fish also secrete mucus which covers the body and this reduces friction during movement.
- Has flexible backbone with segments of muscle blocks called myotomes; which contract and relax bringing about undulating movement.
- Presence of swim bladder between vertebral column and gut which provides buoyancy and helps the fish adjust its vertical position in relation to depth of water.
- Has lateral line which enables the fish detect vibrations and change in pressure in water, thus enabling the fish to respond suitably.

- Have fins which help in movement in water i.e. maintaining balance, steer the fish and bring about swimming.



Types of fins

a) Paired fins e.g. pelvic and pectoral

Used for:

- Maintaining balance
- Braking
- Changing direction
- Control pitching i.e. upward and downward movements

b) Unpaired fins e.g. dorsal, anal and caudal

- Reduce rolling as it rock from side to side and lateral deflection of the body (yawing)
- Caudal fin propels the fish forward and steers the fish while in motion.

NB lateral flattening of fish body increases surface area and thus prevent yawing and rolling and keep the fish upright.

Tail power = $\frac{\text{Length of tail tip to anus}}{\text{length of tail tip to mouth}}$ X 100

Support & Movement in mammals

Bones and muscles work together to bring about movement and support.

Skeleton is divided into two:

i) Axial

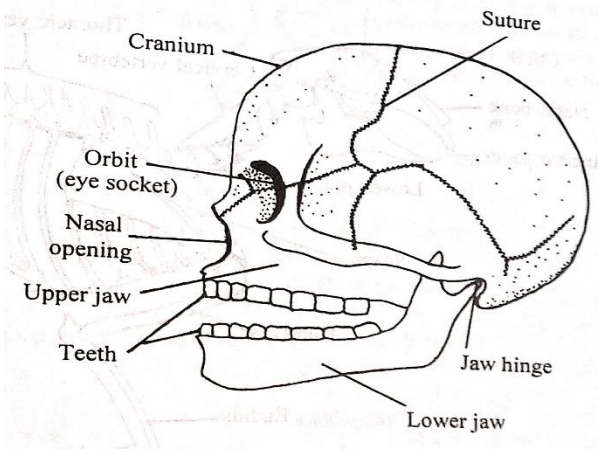
ii) Appenducular

A. Axial skeleton

Consist of skull, sternum, ribcage and the vertebral column

i) Skull

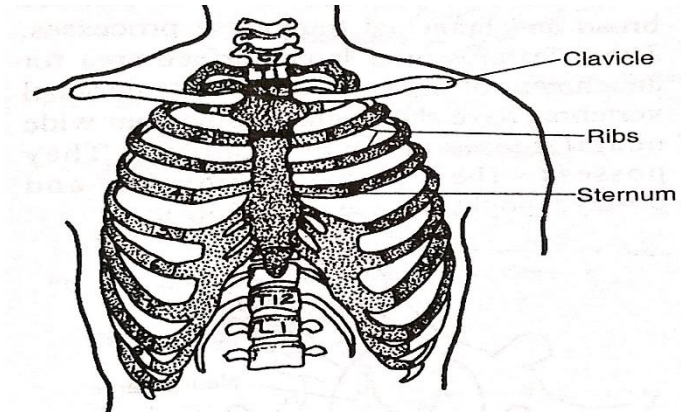
Many bones join to form cranium and immovable joints. Its main purpose is to protect the brain, alfactory organs, middle and inner ear. There are perforations that allow passage of blood vessels to and from the brain. Facial skeleton consist of upper jaw which is fixed and lower jaw which is articulates forming movable hinge joint.



At posterior end it has smooth rounded protuberances and occipital condyles which articulate with atlas vertebra to form a joint that allow nodding of the head.

ii) Ribcage

Enclose thoracic cavity protecting lings and heart. Ribs articulate with vertebral column to the back and sternum to the front.



In birds sternum is prominent modified to keel which gives large surface area for attachment off pectoral muscles (flight muscles).

On lower side of rib cage and sternum offers surface for attachment of back and abdominal muscles.

iii) Vertebral column

Consist of five regions, made of several vertebrae; each vertebra is separated by cartilage called **inter-vertebral discs** which:

- Act as cushion and absorb shock

- ❖ Reduce friction between the vertebrae
- ❖ Brings about flexibility by allowing movement of vertebrae

The five regions are:

i) Cervical vertebrae

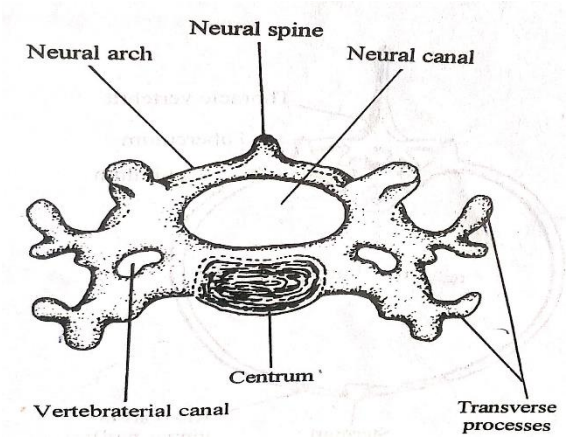
ii) Thoracic vertebrae

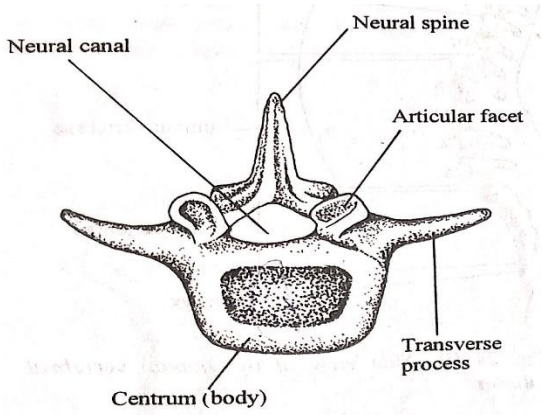
iii) Lumbar vertebrae

iv) Sacral vertebrae

v) Caudal vertebrae

Basic plan of vertebrae





a) Centrum- Solid structure which supports the weight of the vertebra.

b) Transverse processes- Lateral to the centrum; projections which offer surface for muscle and ligament attachment.

c) Neural spine- Dorsal projection to centrum which offer surface for muscle and ligament attachment.

d) Neural canal- Centrally positioned canal which allow passage of spinal cord.

e) Neural arch- Is a arch which arises from centrum and together with centrum protect the spinal cord.

f) Articulating facets- Vertebrae articulates with each other i.e. anteriorly and posteriorly by facets (sygapophysis)

Facets to anterior are prezygophyses (face upwards and inward)

Facets to posterior are postzygophyses (face downwards and outwards)

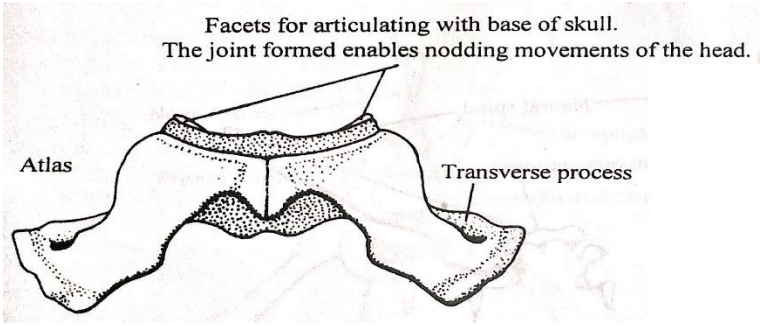
1. The cervical vertebrae

Found on the neck region. They are seven in humans. All have **vertebraterial canals** for passage of vertebral artery.

First two are atlas and axis which are distinct from the rest.

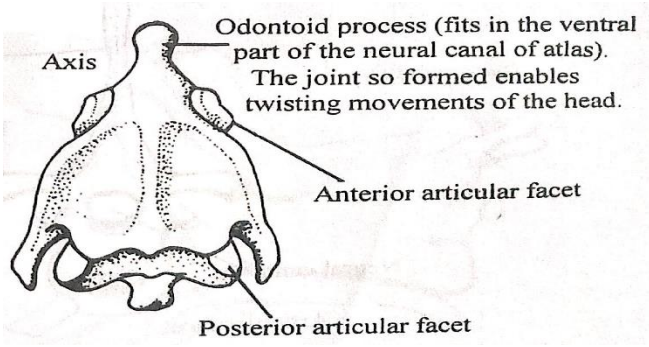
Features of atlas

- Small neural spine and centrum.
- Wide neural canal for passage of large spinal cord at the neck.
- Broad transverse processes which is wing-like to offer large surface area for attachment of neck muscles.
- Broad facets for articulation with condyles of the skull (forms joint which allow nodding of the head)



Features of axis

- Broad centrum and projects in front forming an **odontoid** process that fits into the ventral side of neural canal of atlas (forms joint which allow turning of the head).
- Has broad neural spine
- Wide neural canal
- Wing-like transverse processes.

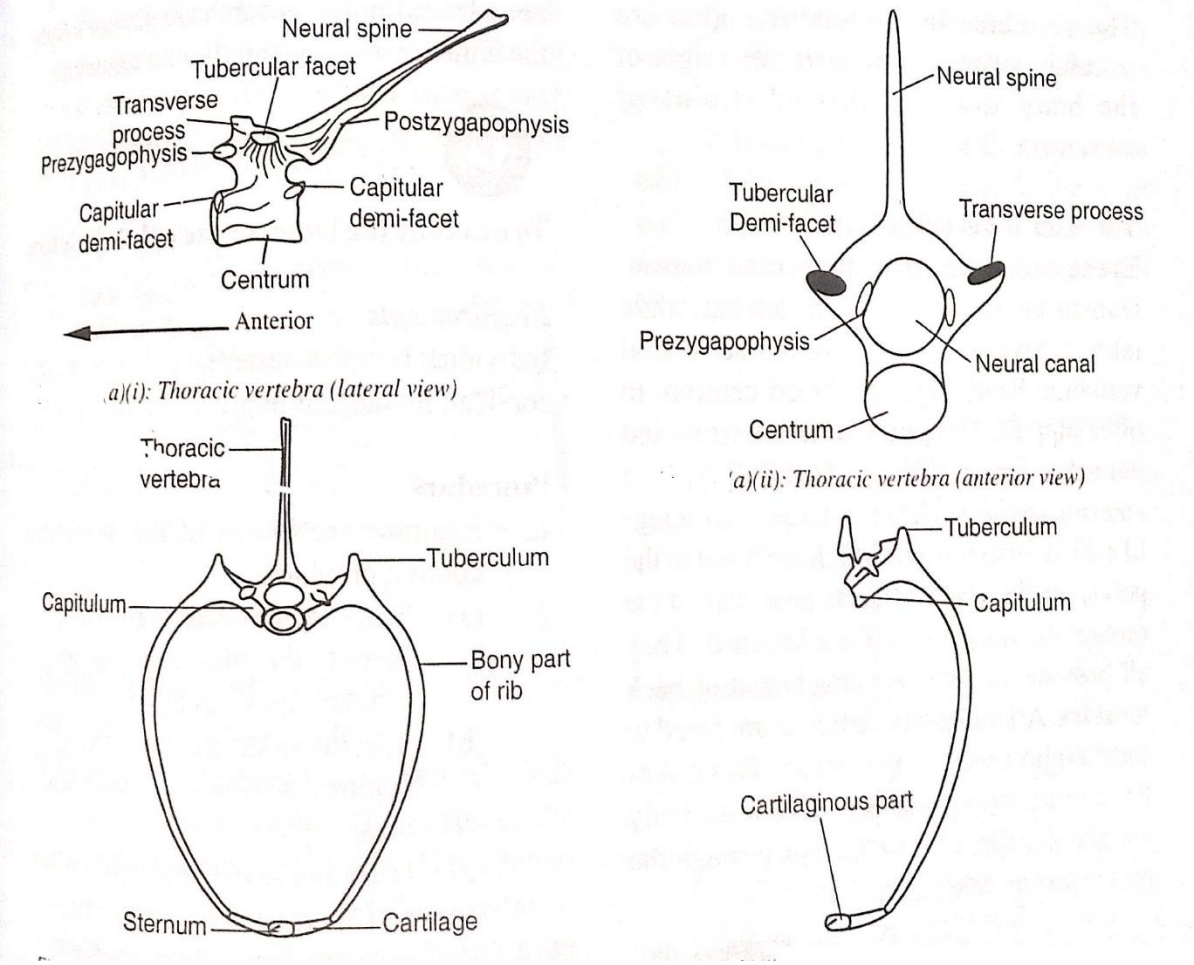


The other five cervical vertebra e features have:

- ✓ Broad branched transverse process which large surface area for attachment of neck muscles.
- ✓ Short neural spine
- ✓ Wide neural canal and wide centrum

2. Thoracic vertebrae

Found at thoracic region. They are twelve in humans



a)(i): Thoracic vertebra (lateral view)

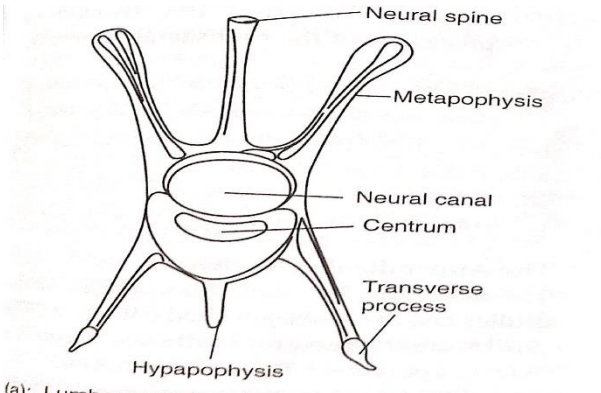
a)(ii): Thoracic vertebra (anterior view)

Features

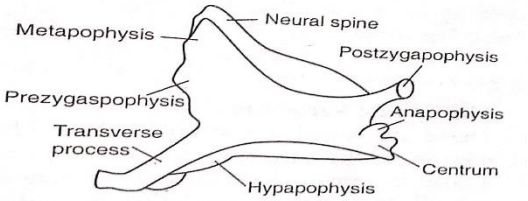
- Long neural spine to offer large surface area for attachment of back muscles.
- Large centrum
- Short transverse processes
- Neural arch is small
- Has two articulating facets for articulating with ribs i.e. tuberculum facets on each transverse process articulating with tuberculum of ribs. While capiltular demifacets on the centrum is articulating with capitulum.

3. Lumbar vertebrae

Found at lumbar region. In humans they are five.



(a): Lumbar vertebra (anterior view)



(b): Lumbar vertebra (lateral view)

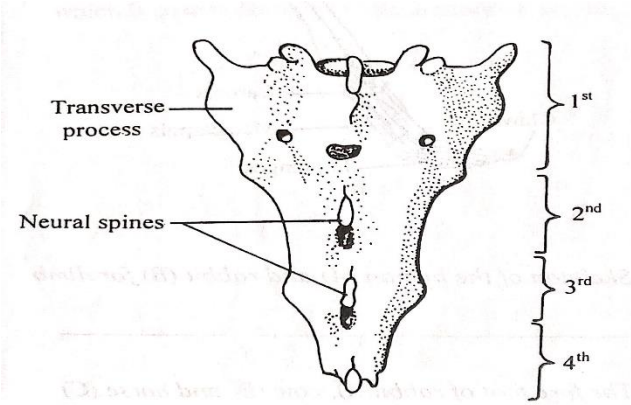
Features

- Large and broad centrum to offer support
- Long and broad transverse processes projections forwards and downwards from centrum to offer large surface area for attachment of abdominal muscles.
- Has broads neural spine to over offer large surface area for attachment of abdominal muscles.
- On both sides of neural spine are projections called metapophyses and projections on dorsally of transverse processes called anapophyses; in rabbits is projection ventrally of centrum called hypapophysis. All offer additional surface for muscle attachment.

Generally lumbar vertebrae are adapted to support weight and withstand strains of movement.

4. Sacral vertebrae

Found at sacral region. In humans are 5 in number.



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

Features

- Large and broad centrum to offer support.

- Neural canal is narrow and neural spine much reduced.
- First anterior sacral vertebrae have wing-like transverse processes which are fused to the pelvic girdle.

They all offer surface for attachment of back muscles. All sacral vertebrae are fused to form a rigid **sacrum** which makes it strong and firm to bear body weight and spread it to legs through pelvic girdles.

5. Caudal vertebrae

Found in tail region. Vary in number depending on tail size. In human they are only four which are fused to form coccyx.

Features

- Neural spine, all processes are much reduced.
- Neural canal and neural canals are absent.
- **The vertebrae are mainly centrum.**

B. Appendicular skeleton

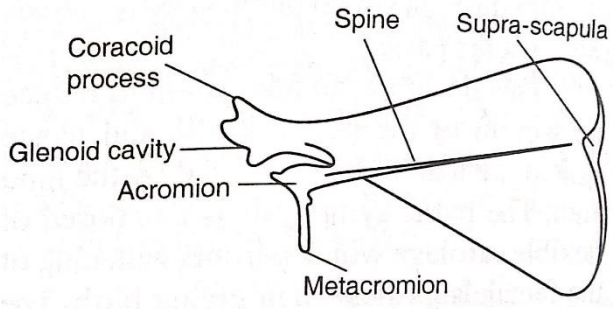
Consist of girdles and limbs attached to them. There are fore limbs and hind limbs. In mammals limbs has the same plan i.e. pentadactyl (terminate with five digits).

1. Bones of the fore limbs

i) Pectoral girdle

Made of two half's, each consist of scapula, coracoids process and clavicle. The halves are not fused but held firmly by muscle.

- **scapula**



– Flattened and triangular in shape

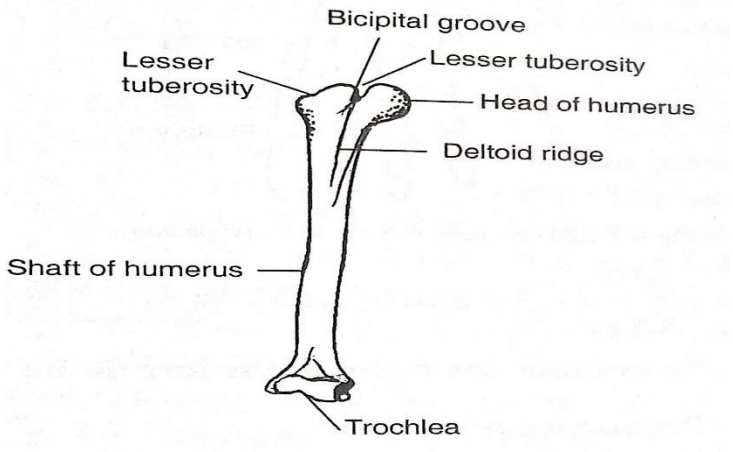
- has depression called glenoid cavity which articulate with humerus forming ball and socket joint.

- spine runs along oute surface and close to glenoid cavity are projections called acromion and metacromion which are both for muscle attachment.

- **Clavicle** – articulate on one end with acromion process and other with sternum.

ii) Humerous

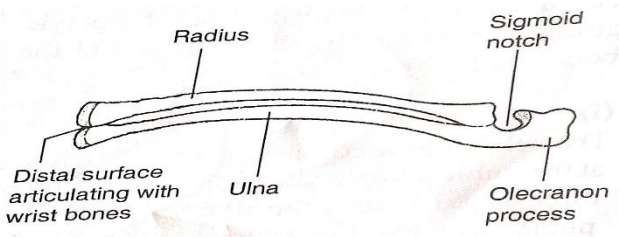
Articulates with scapula at glenoid cavity forming ball and socket joint at shoulder; and at elbow articulate with ulna and radius at sigmoid notch forming hinge joint.



- Near the head are two rough projections which run along the shaft; greater and lesser tuberosity for muscle attachment.
- Between tuberosity is bicipital groove that tendon of the biceps muscle passes.
- Lower end is trochlea that articulates with forearm at elbow.

iii) Ulna and radius

Found at forearm. Radius is to the side of thumb, ulna is to the side of small finger.

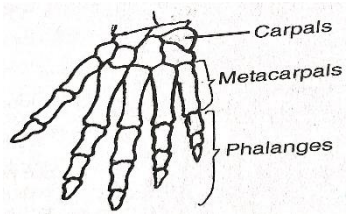


Ulna

- Has projection called olecranon process which offer surface area for attachment of tendons and prevent overstretching of the forearm at the joint.
- Has sigmoid notch which articulate with humerus to form hinge joint.

iv) Carpals, metacarpals and phalanges

Carpals are small bones at wrist.

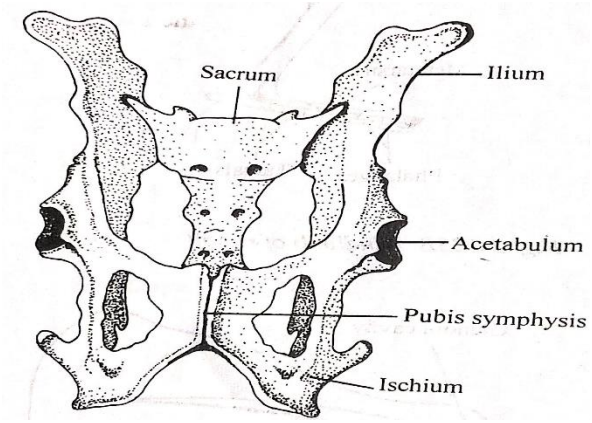


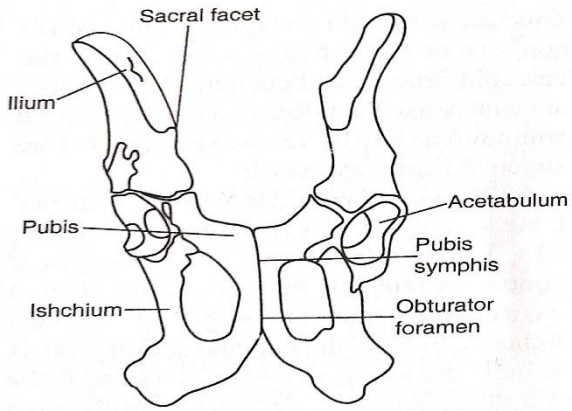
2. Bones of the hind limbs

i) Pelvic girdle

Consist of two halves fused at pubic symphysis

- ✓ Each half is made of fused bones i.e. ilium, ischium, and pubis.
- ✓ Each half has cup-shaped cavity acetabulum which articulates with head of femur to form ball and socket joint.
- ✓ Dorsally ilium articulates with sacrum.
- ✓ Ilium is above acetabulum and provides large surface for attachment of thigh muscles.
- ✓ Between ischium and pubis is a hole called obturator foramen; an aperture which blood vessels, nerves and muscle fibres pass.





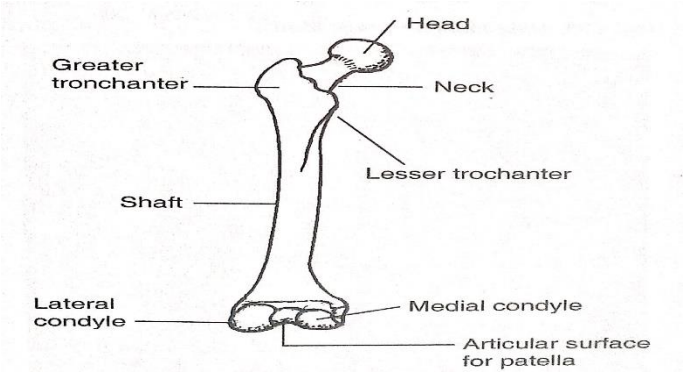
This design helps reduce weight of the girdle and hence reduce the load supported by hind limbs.

In females pubic symphysis is made of flexible cartilage which permits widening of the girdle during birth.

ii) Femur

Long bone between the knee and hip.

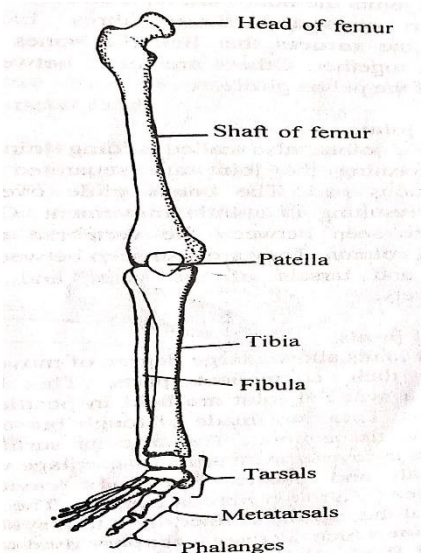
- o Has head which fits in acetabulum forming ball and socket joint at hip.
- o Has lesser and grater trochanter, extensions for muscle attachment.



- At lower end are expanded and rounded knob called condyles which articulates with patella.
- Articulates with tibia to form hinge joint at the knee.

iii) Tibia and fibula

Its lower section of the limb



Joints

Joint is connection between two or more bones.

Types of joints

- Immovable – found in skull and pelvic girdle
- Gliding – found in writs, ankle and between vertebrae
- Movable – found in shoulder, knee, elbow and hip.

Movable joints

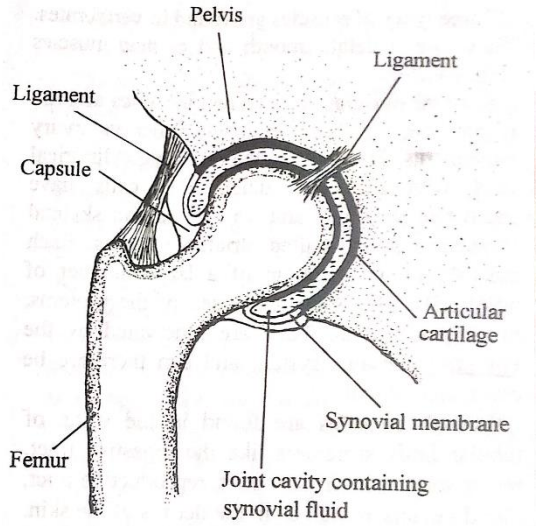
Made of bones covered with cartilage at one end and bones are held by tough tissue called ligaments. The joint area is found with lubricating fluid called synovial. Such joints are called synovial joints.

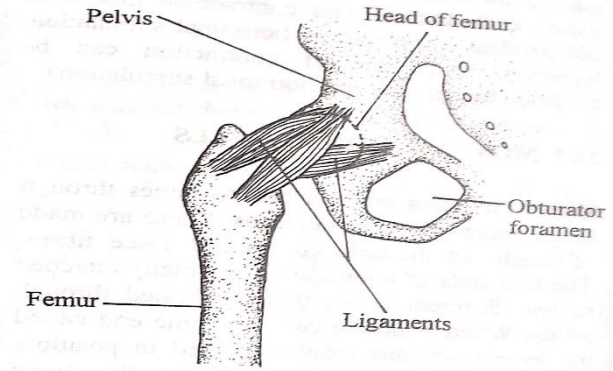
Synovial joints are of two types:

- Ball and socket joint
- Hinge joint

A. Ball and socket joint

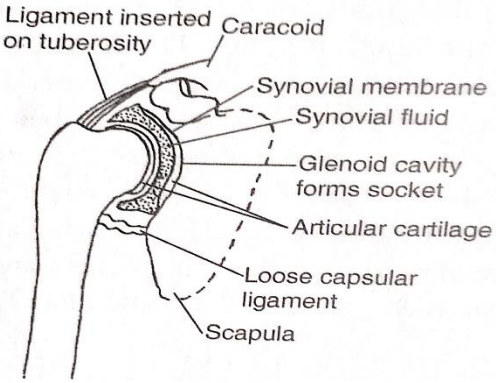
- Joint type with two bones, one with a round head and other with a cavity which head fit and move freely in all directions
- Found at shoulder and hips
- Can move 360^{θ}c





External structure of a hip joint (a ball and socket joint)

Inner view of hip joint

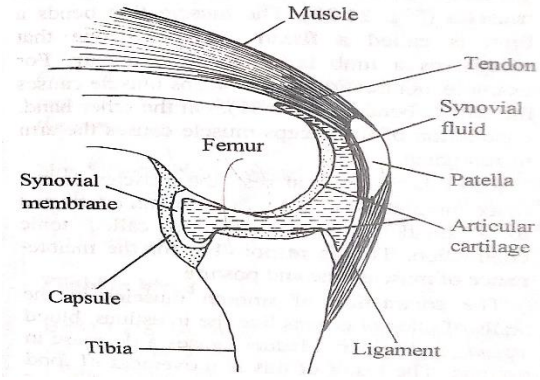


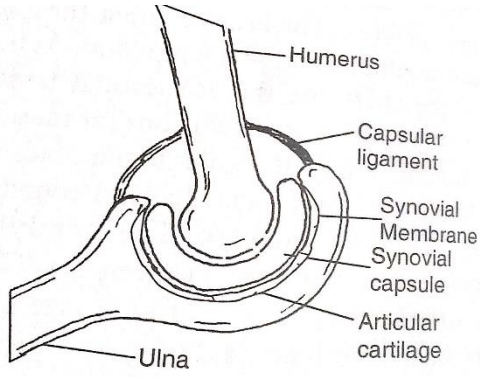
Ball and socket joint at pectoral girdle

B. Hinge joint

One bone allows smooth condyles of another bone to fit and articulate –

- Allow movenet in only one direction i.e. 180 $^{\theta}$c
- Found at knee, elbow and phalanges.





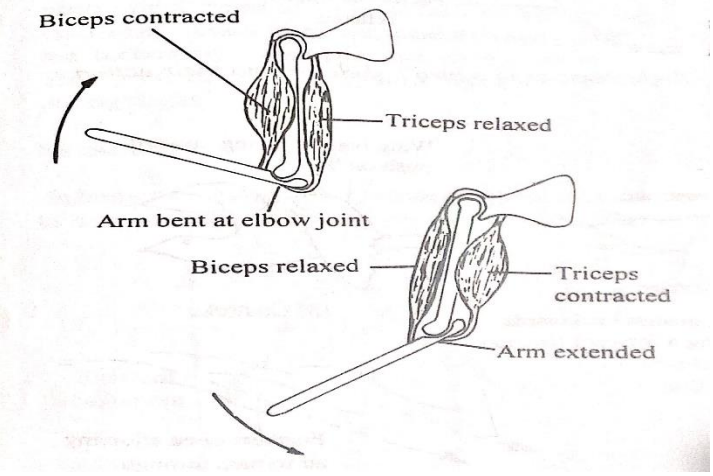
a) Knee joint ***b) elbow joint***

Movement at a joint

At joint bones are held together by inelastic tissue called **ligament**. Muscle is attached to the bone by inelastic tissue called **tendon**.

Antagonistic muscles operate the joints, bringing about movements i.e:

- Bending at the joint is brought about by **flexo**r muscle (bicep)
- Straightening at the joint is brought about by **extenso**r muscle (triceps)



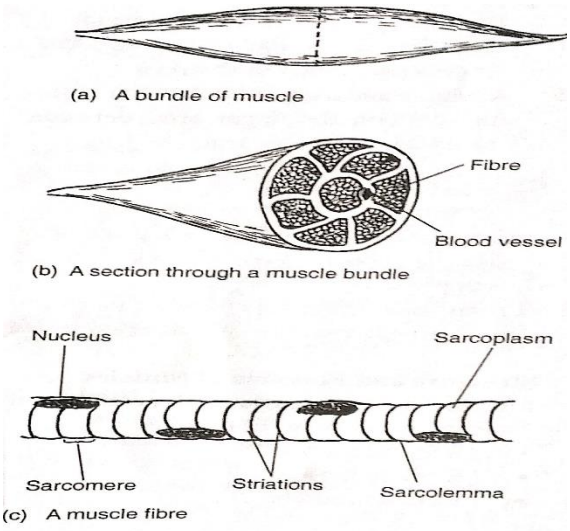
Structure and function of muscle

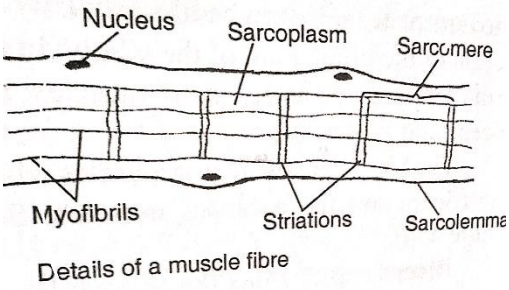
Muscle is a tissue specialized in contraction.

Types of muscles

1. **Skeletal muscles**

They play major role in locomotion.



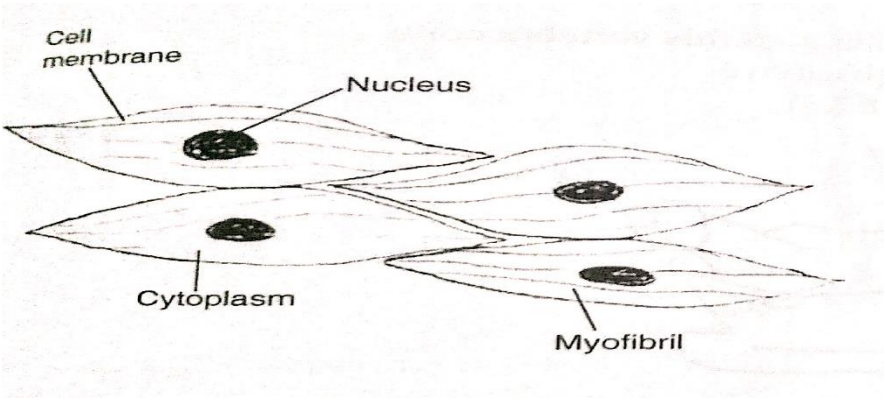


- They are striated and innervated by voluntary nervous system thus known as **voluntary muscles**.
- Muscle is made of multinucleated fibres, each fibre has several myofibrils. Each muscle fibre is covered by scrolemma.

- Myofibril is the functional unit which can contract and relaxes.
- Energy is from mitochondria in sacroplasm.
- Sodium and calcium ions are needed in muscle contraction.

2. Smooth muscles

Spindle shaped cells with single nucleus.

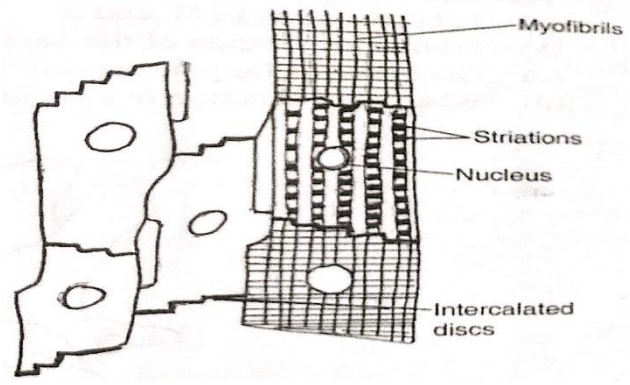


- Found in visceral organs e.g. blood vessels, gut, urinary tract, reproductive tract and respiratory tract.
- Myofibrils are enclosed by plasma membrane and are not striated.
- They are innervated by the autonomic part of nervous system thus called **involuntary muscles**.

3. Cardiac muscle

This is heart muscles. Each muscle fibre is made of short cells with centrally placed nuclei and several striated myofibrils.

End of each cell have thick regions called **intercalated discs** which help to transmit impulses rapidly throughout the heart tissues.



- Heart muscle is myogenic i.e. not controlled by nervous of hormonal stimulations
- Cannot fatique.
- Has more mitochondria than skeletal muscles to sustain energy demands.