CHAPTER-3

MEDICAL PARASITOLOGY

Parasitology is the science that deals with parasites and their pathogenic effects. Parasites of animal kingdom are divided into three main groups, namely, Protozoa, Helminthes and Arthropods. Parasitology may be divided into three sections.

1. Proto zoology - the study of protozoan parasites.
2. Helminthological - the study of Platyhelminthes and Aschelminthes parasites.
3. Entomology - the study of Arthropod parasites.

Parasites - An organism which receives nourishment and shelter from another organism where it lives is called a parasite. Parasites have also been divided into two major groups, the Ectoparasites and the Endoparasites.

Ectoparasites - Those parasites that live outside or on the surface of their host.e.g, Mosquitoes, Fleas, Bed-bug, Lice.

Endoparasites - Those parasites that live inside the body of their host, in blood, tissues, body cavities, digestive tract and other organs, e.g, ***Plasmodium vivax, Ascaris lumbricoides, Entameba histolytica.***

Host - An organism which harbours the parasite or the organism at the expense of which the parasite lives. There are two classes of host, the intermediate host and the definitive host.

Intermediate Host - The host in which the larval or juvenile stage of the parasites develop or the host in which asexual cycle of a parasites.

Definitive Host - The host in which harbours the mature adult stage of the parasites develop or the host in which sexual cycle of parasites.

The relation that exit between the parasites and their hosts are

Mutualism - An association in which both the organisms are deriving benefit from one another.

Symbiosis - The permanent association of the two organisms so dependent upon each other that one cannot live without the help of other e.g. Termites and certain species of flagellate protozoa.

Commensalisms - An association in which the parasite only is deriving benefit without causing injury to the host e.g, Man and ***Entamoeba coli.***

Parasitism - An association in which the parasite derives benefit and the host is always suffers some injury, however slight injury may be e.g,
Man and ***Entamoeba histolytica***.

Carrier - Infected individual which without showing evidence of infection thus serving as potential source of infection to other.

Vector - Arthopods, viz mosquitoes, flies, etc, which harbours parasites and transmits these diseases germs. In insect or any living carrier which transports a pathogenic micro-organism from the sick to the well.

The transmission of parasite diseases involves three factors.

(1) The source of the infection, e.g, Food. Water.

(2) The mode of transmission and portal entry. (swallowing, penetrating through mouth or skin)

(3) The presence of susceptible host.

Ascaris lumbricoides

(The Common Round Worm)

Classification

Phylum - Nemathelminthes

Class - Nematoda

Order - Rhabditia

Genus - ***Ascaris***

Species - ***A. lumbricoides***

eg. ***Ascaris lumbricoides***

Geographical Distribution - It is cosmopolitan, having a world -wide.

Habitat- The adult worm lives in the small intestine of man.

Morphology - They are the largest intestinal nematodes. The fresh from the intestine, it is light cream or pink in colour, but gradually changes to white. In shape it is cylindrical, tapering at both ends, the anterior end being thinner than the posterior. The mouth opens at the anterior end and possesses three finely toothed lips, one dorsal and two ventral. The digestive and reproductive organs float inside the body cavity containing an irritating fluid. The irritant active is due to the presence of a toxin ascaron. The life span of the adult worm in the human host is less than a year.

Male - The male is smaller than the female, and measures about 15 cm to 25 cm in length with a maximum diameter of 3 to 4 mm. The tail end of the male is curved ventrally in the form of a hook having a conical tip. The genital pore opens into the cloaca from which two curved copulatory spicules protrude. The anus opens with the ejaculatory duct into the cloaca.

Female - It is longer and stouter than the male and measures 25 to 40 cm. In length with a maximum diameter of 5mm. The posterior extremity is neither curved nor pointed but is conical and straight. The anus is subterminal and opens directly on the ventral aspect in the form a transverse slit. The vulva opens at the junction of the anterior and the

middle thirds of the body on the midventral aspect, this section of the worm is narrower and is called the vulvar waist.

Eggs -The eggs liberated by a fertilized female pass out of the human host with the faeces.

The characteristics of a fertilized egg are as follows:

(1) Round or oval in shape.

(2) Always bile stained and brownish in colour

(3) Surrounded by a thick smooth translucent shell with an outer albuminous coat which is mammillated.

(4) Contains a very large conspicuous, unsegemented ovum (the nucleus is concealed by a larger amount of yolk granules) there is a clear crescentic area at each pole.

(5) Floats in saturated solution of common salt.

The characteristics of this unfertilized eggs are as follows:

(1) Narrower, longer and more elliptical in shape.

(2) Brownish colour (bile-stained)

(3) Has a thinner shell with an irregular coating of albumin.

(4) Contains a small atrophied ovum with a mass of disorganized, highly refractile granules of various sizes.

(5) Does not float in salt solution.

Life Cycle

The worm passes its life cycle in one host, and no intermediate host is required. Man is the only known definitive host of ***A.Lumbricoides***. The various stages in the life cycle are described below.

Stage 1. Eggs in Faeces. Fertilized eggs containing the unsegmented ovum are passed with the faeces. They are not infective to man when freshly passed.

Stage 2. Development in soil- A rhabditiform larva is developed from the unsegmented ovum within the eggs-shell in 10 to 40 days time, depending on the atmospheric temperature and humidity. This takes place in the soil. The ripe egg containing the coiled up embryo is infective to man. Before hatching the larva undergoes a moulting.

Stage 3. Infection by Ingestion and liberation of larvae – When ingested with food, drink or raw vegetables, the embryonated eggs pass down to the duodenum where the digestive juices weaken the eggs shells and stimulate the enclosed larvae into activity. Splitting of egg-shell occurs and the rhabditiform larvae are liberated in the upper part of the small intestine.

Stage 4. Migration through the lungs – The larvae liberated in the small intestine do not directly develop into mature worms. The newly hatched larvae borrow their way through the mucous membrane of the small intestine and are carried by the portal circulation to the liver, here they live for a period of 3 to 4 days. Finally they pass out of the liver and via right heart enter the pulmonary circulation. While in the lungs they grow much bigger and increase in length and moult twice. Breaking through the capillary wall they reach the lung alveoli. The time taken for such migration is on an average 10 to 15 days.

Stage 5. Re-entry into the stomach and the small intestine-From the lung alveoli the larvae crawl up the bronchi and trachea, they are then propelled into the larynx and pharynx and are once more swallowed. The larvae pass down the oesophagus to the stomach and localize in the upper part of the small intestine, their normal abode. Another moulting occurs between the twenty-fifth the twenty-ninth day of infection.

Stage 6. Sexual Maturity and egg liberation – The larvae on reaching their habitat grow into worms become sexually mature in abouts 6 to 10 weeks times. The gravid females begin to discharge eggs in the stool within about two months from the time of infection. The cycle is again repeated.

CHAPTER-4

MEDICAL ENTOMOLOGY

Insect Vector

Vector:

A vector is an invertebrate host which is a carrier of pathogenic organisms. It is an agent which can transmit a parasite to another host.

Insect vector:

It is an insect which carries and transmits a pathogenic parasite to man and other vertebrate host. E.g; mosquitoes, flies, fleas and lice.

Mosquitoes:

Mosquitoes belong to the order Diptera. They posses short elongated and slender body, long many segmented antennae, long slender leg and an elongated proboscis with piercing and sucking mouth parts. The important genera of mosquitoes are ***Culex, Aedes,*** and ***Anopheles.***

CLASSIFICATION

Phylum	-	Arthropoda
Class	-	Insecta
Order	-	Diptera
Family	-	Culicidae
Genus	-	***Culex***, ***Aedes*** and ***Anopheles.***

Life Cycle of Anopheles

EGGS:

Following fertilization and blood meal, the female ***Anopheles***lay 50 to 150 eggs at night time the eggs are laid singly and horizontally on water. The eggs which is about 1 mm long, is white when laid but later changes to brown or black colour. After 2 or 3 days, the larva hatchs from the egg.

LARVA

The larva are called wrigglers. They are active and swim about in water. The first instar larva feeds and grow and moults three times. The four instar larva when full grown is

about one centimeter long. The larval stages last from 2 to 4 weeks according to temperature. The larva has a large chitinous head with a pair of compound eyes. The thorax is globular and its segments are fused together. The abdomen is slender and has nine segments. The larva hangs horizontally to the water surface by means of when the fourth instar larva casts it skin it becomes a pupa.

PUPA

The pupa is comma shaped and is called the tumbler. It has a large cephalothorax, a pair of respiratory trumpets and a pair of palmate hairs. By means of the trumpets and palmate hairs, the hangs from the water surface and takes in air. The abdomen ends in pair of paddles. The pupa is incapable of feeding and the pupal stage lasts from 2 to 7 days.

METAMORPHOSIS:

The larva feeds, moults and grow and then it passes into a pupa by complete metamorphosis. Most of the larval organs are broken down by histolysis and then reorganized into adult organs within the pupa by histogenesis. Finally the pupal covering splits and a perfectly formed imago emerges.

The mosquito rests on the water surface or on the pupal case, expands its wings and when harden about an hour, it takes flight.

Copulation between the sexes usually takes place shortly after emergence. Female ***Anopheles*** require blood meal to mature the eggs. Once to ovaries have ripened, following the blood meals, the ovigerous female searches a suitable collection of water on which to lay her eggs. The length of life of ***Anopheles*** is four to six months, longer in the temperature zones and shorter in the tropic.

CHAPTER -5

Comparative Anatomy and Physiology of Vertebrate

5.1THE INTEGUMENTARY SYSTEM

The integument or skin forms the external covering of a vertebrate. The skin comes in contact with the environment, and the type of environment, whether terrestrial or aquatic influences the character of the skin.

The skin of all vertebrates is built in accordance with a basic pattern. It consists of an outer epidermis and inner dermis, the relative amount of the two layers varies with the environment.

Modifications of the epidermis and dermis involve (1) The relative number and complexity of skin gland, (2) the extent of differentation and specialization of the mosts superficial layer (stratum corneum) of the epidermis, and (3) the extent to which bone develops in the dermis.

The epidermis is made of stratified epithelium of several layers of columnar epithelial cells which are held together lightly. The innermost layer of the epidermis is the ***Stratum Malpighii*** or ***Stratum Germinativum*** which divideds constantly to produce new cells these cells move upwards and tend to becomes flatten and their protoplasm becomes horny, this is called keratinization.

In aquatic fishes and amphibians the keratinized layer forms a cuticle, but in other vertebrates the outermost keratinized layer forms a layer of cells called *stratum corneum* of hard, horny, flat, and cornified cells made largely of keratin which is tough, waterproof and insoluble protein, it efforts protection and prevents desiccation. The dead ***stratum corneum*** is shed periodically in pieces or all at once. In aquatic vertebrates the epidermis bas mucous glands, the mucous keeps the skin slimy and protects it from bacteria. There are no blood vessels in the epidermis. The epidermis rests on a thin basement membrane, which separates it from the Dermis.

The dermis below the Epidermis has an outer loose layer and an inner dense layer. The dermis is made of dense connective tissue having cells, muscles, blood vessels, Lymph vessels, collagen, elastic fibers and nerves.

The skin also contained pigment. If the pigment is present in the epidermis, then it occurs as a diffuse substance or as granules. If the pigment is found in the dermis, then it is located as granules in special branching cell called ***chromatophores***.

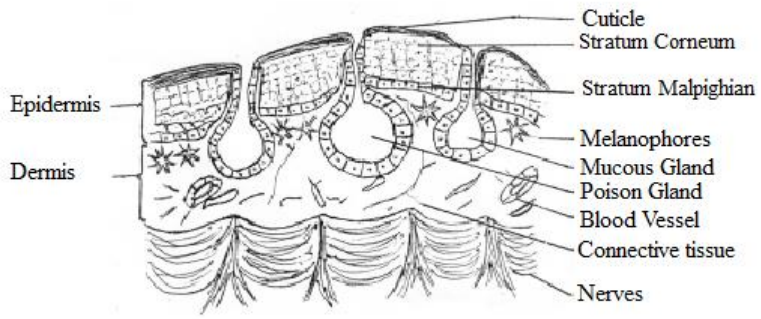
Under the dermis the skin has loose subcutaneous areolar tissue which separates the skin from the underlying muscles, it may also contain fat and muscles, especially in manmals.

Derivatives of the integument

Both layers of integument have given rise to various types of derivatives. The epidermis gives to integumentary glands, such as mammary glands, sebaceous glands, sweat glands, scent glands, mucous glands, Epidermal scales, horns, hoofs, nails, feathers and hairs. The dermis forms dermal scales of fishes and of some reptiles, turtles and crocodiles.

Integument in vertebrates

Amphibians



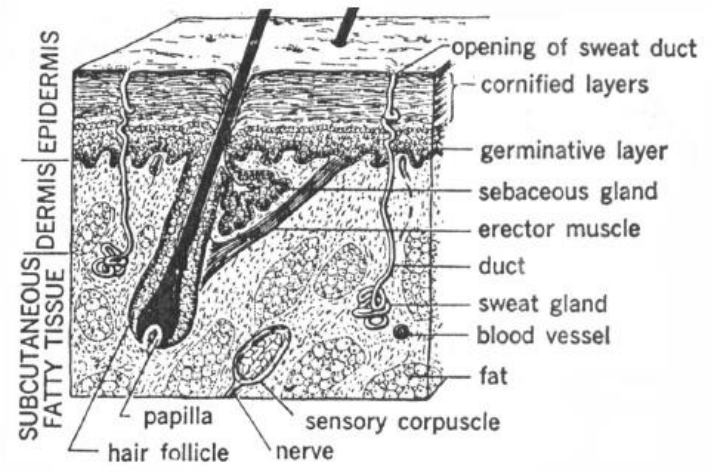
The epidermis has several layers of cells, the outer most layer is a stratum corneum made of flattened, highly keratinized cells, such a dead layer appears first in amphibians, and is best formed in this which spend a considerable time on land.

The stratum corneum is a adaptation to terrestrial life, it not only protects the body but prevents any excessive loss of moisture. In ecdysis, the stratum corneum is cast off in fragments of as a whole in some. Below the epidermis is a thin basement membrane. The dermis is relatively thin, it is made of two layers, an upper loose **stratum spongiosum** and a lower dense and compact **stratum compactum.** Connective tissue fibres run both vertically and horizontally. There are two kinds of glands, they are mucous glands and poison glands in the dermis, but they are derivatives of the epidermis. Mucous glands produce mucus which

not only forms a slimy protective covering but also helps in respiration. The poison glands produce a mild but unpleasant poison which is protective. In the upper part of the dermis are **chromatophores**. The ability of the skin for changing colour to blend with the environment is well developed, though the colour change is very slow.

The skin is sensitive to light in amphibians, especially in cave dwelling forms. It is an important organ of respiration, even more important than the lungs, it also enables the frog to respire under water for long periods, during hibernation. The skin is loose being attached to muscles only at certain places by connective tissue. There are no scales, except in caecilians.

Mammals



The skin is water-proof and elastic. It is much thicker than in other animals, especially the dermis is thick and tough and is used for making leather. The epidermis has an outer layer of **stratum corneum** containing keratin. Keratin is hard, tough water-proof and insoluble protein. In places of friction, such as soles and plams. The stratum corneum is very thick.

Below the stratum corneum is a refractive **stratum lucidum** in certain regions only. Stratum lucidum contains a chemical which produces keratin. Below stratum lucidum is **stratum granulosum** and below the stratum granulosum is a **stratum spinosum** whose cells are held together by spiny intercellular bridges , each bridge has two arms in close contact, one arm arising from each cell.Lastly there is a **stratum germinativum** or **malpighian** layer which rests on a thin basement membrane. The malpighian layer forms new cells continuously which move towards the surface and become flat and keratinized till the stratum corneum has flat cornified cells made of keratin, this layer is sloughed off continuously and replaced by new cells. There is no mucous glands in the epidermis

of mammals. The keratin from the epidermis at ends of digits forms claws, nails or hoofs.

The dermis is best developed in mammals. The dermis is made of elastic and collagen fibres. In the dermis layer there are blood vessels, nerves, smooth muscles, certain glands, tactile corpuscles, and connective tissue fibres extending in all directions. Below the dermis the subcutaneous tissue has a layer of fat cells forming adipose tissue which helps to maintain body heat.

In the lowest layer of the epidermis are pigment granules. In connection with the skin the epidermis forms hairs, sudorific glands, sebaceous glands and mammary glands. Hairs form an epidermal covering shafts or hairs project above the skin and their roots are embedded in hair follicles into each of which opens a branching sebaceous gland. The hair prevents a loss of body heat thus keep up the body temperature. Sebaceous gland are out pushing of the hair follicle wall, they produce an oily substance which keeps the hair supple and prevents it wetting in water, it also lubricates the skin. In the dermis are coiled sudorific or sweat glands, they are long tubes, their lower ends form a coiled mass and the upper end of the tube opens on the surface, the openings are called “pores”. Sweat glands get rid of metabolic waste and they maintain a constant body temperature, evaporation of sweat brings about cooling. Mammaryglandsoccur in both sexes but are functional only in females for producing milk for young.

5.2 Muscular System

The ability to move is an essential activity of living organism, which is made possible by the unit function of contractibility in muscles. These muscles allow organism to move a whole as well as move individual parts of the body.

They help the body stay erect and determine posture while producing most of the body heat. Muscles also participate in the less obvious movements of the internal organs. All muscles, whether they are skeletal, smooth and cardiac, have three characteristics in common contractibility, extensibility and elasticity.

Muscles are attached to the bones of skeletal by non-elastic cords called tendons. Bones are attached by joints. Skeletal muscles are attached in such way to bridge these joints so when a skeletal muscles contracts, the bone to which it is attached will move, similarly at the site of the attachment of the tendon to the skeletal,

the collagenous bundles of tendon continue into and contribute to perichondrium or periosteum of the skeletal part to which they are attached.

Strusture of a muslce

Muscles (skeletal) consist of musclar and tendonous protions. The muscular portion or fleshy mass of muscle is called belly. Muscles with two belies in sequence with an intervening tendon are termed as digastric. A muscle with multiple heads may be termed as bicipital, tricipital and so on.

The muscles as a whole is surround by a tough glistening fibrous shealth, the epimysium. The major bundles of muscle fibres (fascicles)within the muscles are surround by another sheath the perimysium. Each individual muscle fibre is surrounded or wrapped by another sheath, endomysium which lies superficial to the sarcolemma.

Tendons are constitution of the muscles beyond the site where the muscle fascicles end, the perimysium and epimysium containing into and becoming part of tendon. So tendon is entirely of connective tissue fibre. Some tendons form thin and flat sheets called aponeurosis.

MUSCLE ORIGIN AND INSERTION

Muscles are attached at both ends to bones cartilages, ligaments, tendons, skin and sometimes to each other. The origin is attached to a fixed structure or bone, it moves least during muscle contraction. The insertion is the other end, attached to a movblepart, it is the part that moves most during muscle contraction. The belly is the central body of muscle.

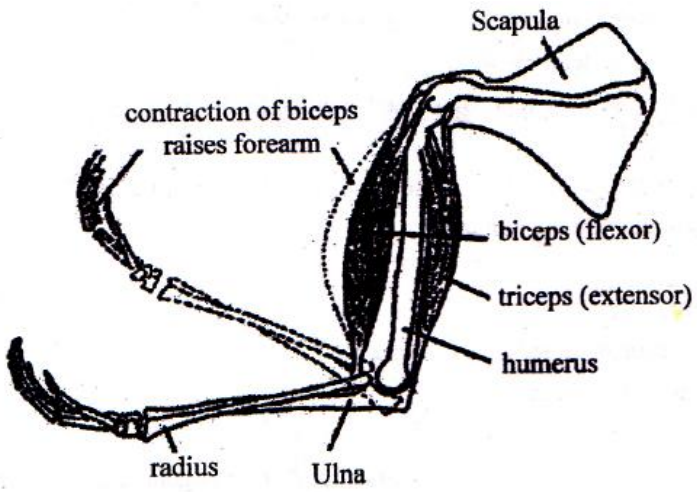
By example, upper arm muscles are arranged in antagonist pair, the muscle located on the front part of the upper arm is the biceps. One end of the biceps is attached to the scapula and humerus (its origin) when the biceps contracts, these two bones remain stationary. The opposite end of the biceps is attached to the radius of the lower arm (it insertion); this bone moves upon contraction of the biceps.

Action of muscle

The muscles of the body are arranged in pairs. One produces movement in a single direction, the other does so in the opposite direction. This arrangement of muscles with opposite is known as an antagonist pair.

Extensor muscle is the one which acts to open out a joint or to straighten two segments of a limb.

Flexors	-	tend to draw one segment towards another or to close a joint.
Adductors	-	draw a part towards middle of the body
Abductors	-	causes displacement away from the midline
Protractors	-	draw parts forward or outward (such as tongue)
Retractors	-	pull the parts back or inward
Levators	-	raise a part
Depressors	-	lower the part
Rotators	-	cause rotation of a part on its axis.
Supinators	-	are rotators that turn the palm upward
Pronators	-	Make it prone (turn it down ward)
Dilators	-	have the opposite effect (dilate or widen the opening)
Sphincters	-	are also constrictor that make an opening smaller or narrow



Antagonistic muscles of the forearm

5.3 SKELETAL SYSTEM

Skeleton

In vertebrates the skeleton forms a framework of the body. The skeleton is made of cartilage or bone or both cartilage and bone.

There are main types of skeleton exoskeleton and endoskeleton.

(1) Exoskeleton

Exoskeleton found in both invertebrates and vertebrates. The outer shells of the Molluses.Exoskeleton of arthropods eg, Crab scorpion and insect and etc.

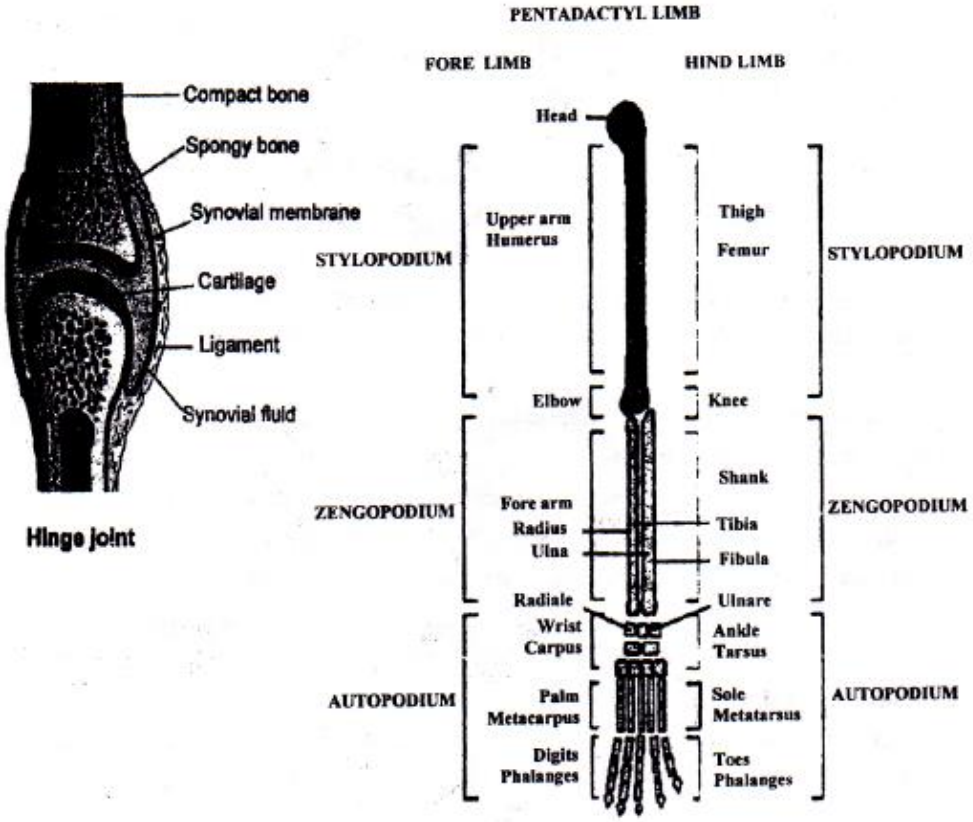
The exoskeleton of vertebrates consists of dermal scales and fin rays in fishes, the bony armour of turtle, crocodilians and some mammals (armadillos).

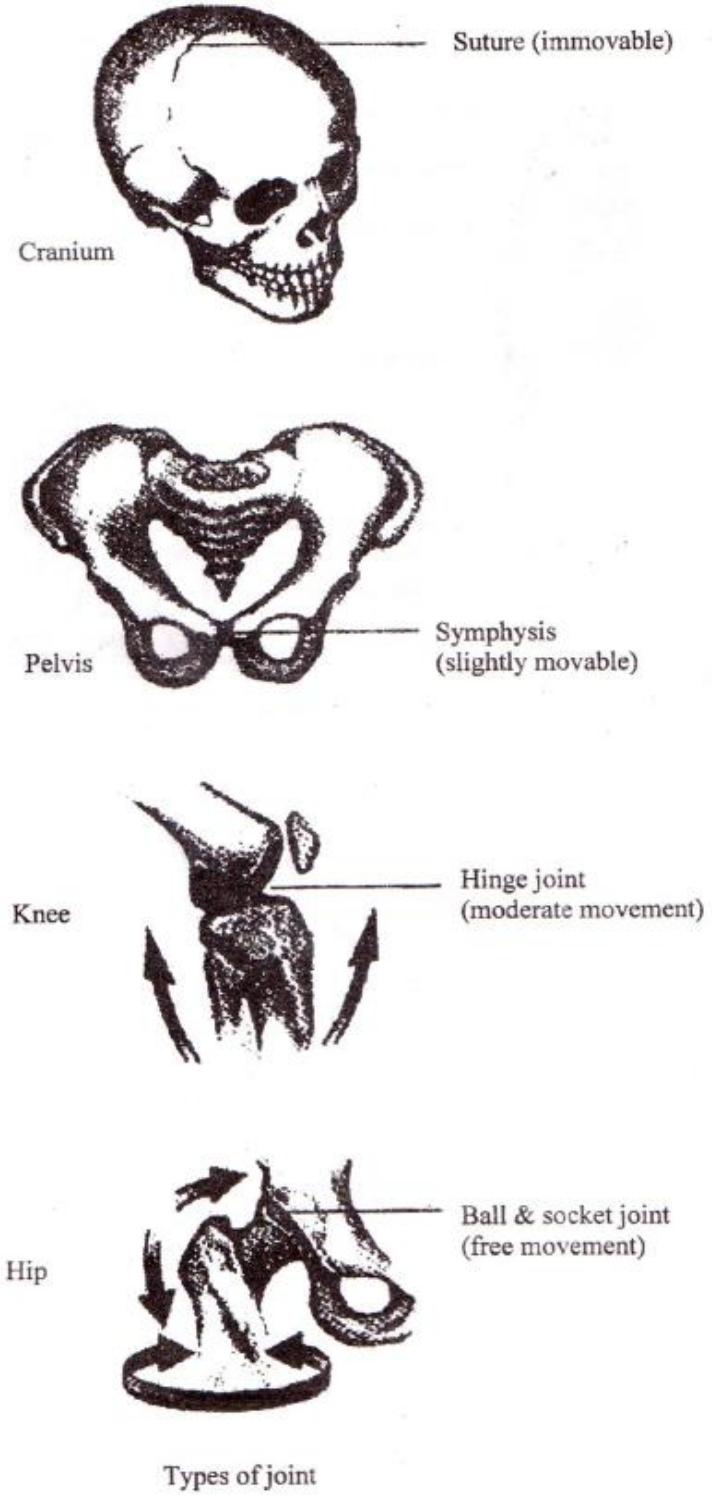
(2) Endoskeleton

The endoskeleton only found in the vertebrates. The presence of an endoskeleton is a characteristic of vertebrates. The notochord forms the endoskeleton in *Amphioxus.* But in higher vertebrates the notochord is only embryonic and in adult replaced by a vertebral column.

An axial skeleton is made of skull, vertebra column ribs and sternum.

An appendicular skeleton consists of pectoral girdle, pelvic girdle and the skeleton of paired limbs and unpaired appendages.


Compact bone
Spongy bone
Synovial membrane
Cartilage
Ligament
Synovial fluid
Hinge joint
PENTADACTYL LIMB
FORE LIMB
HIND LIMB
Head
STYLOPODIUM
Upper arm
Humerus
Thigh
Femur
STYLOPODIUM
Elbow
Knee
ZENGOPODIUM
Fore arm
Radius
Ulna
Shank
Tibia
Fibula
ZENGOPODIUM
Radiale
Ulnare
Wrist
Carpus
Ankle
Tarsus
AUTOPODIUM
Palm
Metacarpus
Sole
Metatarsus
AUTOPODIUM
Digits
Phalanges
Toes
Phalanges



Types of joint

JOINT

A joint is defined as the sport where two or more bones meet. Bones of the mammalian skeleton are joined to one another in different parts of the body in order to allow movement of the body parts.

There are various types of joints which permit varying degrees of movement. However in some parts of the body such as the skull and the pectoral girdles, the bones are firmly attached to one another so that movement of this bones is not possible. Such joints are known as immovable joint or synarthrosis. Those of the skull are known as sutures. Most of the bones in the body are held by moveable joint. The vertebrae are joined by ligament and intervertebral discs which allow very little movement between them amphiarthrosis. The bones of the limbs have freely articulating moveable joint which is called diarthrosis. There are four main types of moveable joint.

Ball and socket joint

The shoulder joint and hip joint are ball and socket joint. The head of the humerus is the ball like structure which is into the cup-like glenoid cavity of the pectoral girdle. This allowed movement is several directions. Similarly the rounded head of the femur fit into the hollow acetabulum to form the freely articulating joint.

Hinge joint

The elbow joint and knee joint are hinge joint. The movement of the bone is limited to one direction only. Each set of bones making up this joint function one hail or a hinge.

Gilding joint or sliding joint

This type of joint allows the sliding of bones over one another. It occurs at the wrist and ankle. The hand and the foot to be moved up and down or rotate only slightly.

Pivot joint

This type of joint allows rotation of part of body and another. It is formed between the atlas and axis. The odontoid process of the axis acts as the pivot, which allows the rotation of the head on the vertebral column.

Structure of joint

The bone meeting at a joint are always held together by the strong ligament, present of which prevents dislocation of bones during movement.

Sometimes the whole joint is enclosed by a tube of ligament, called the capsular ligament, the articulation surfaces of the bone are covered by cartilage called articular cartilage. This prevents the articulation bones from being worn out by the friction due to movement. Between the surfaces of the articular cartilage, there is a sac. The lining, membrane of the sac is called the synovial membrane. The space in the sac synovial capsule is filled with a fluid known as synovial fluid. This fluid serves as a lubricant during movement.

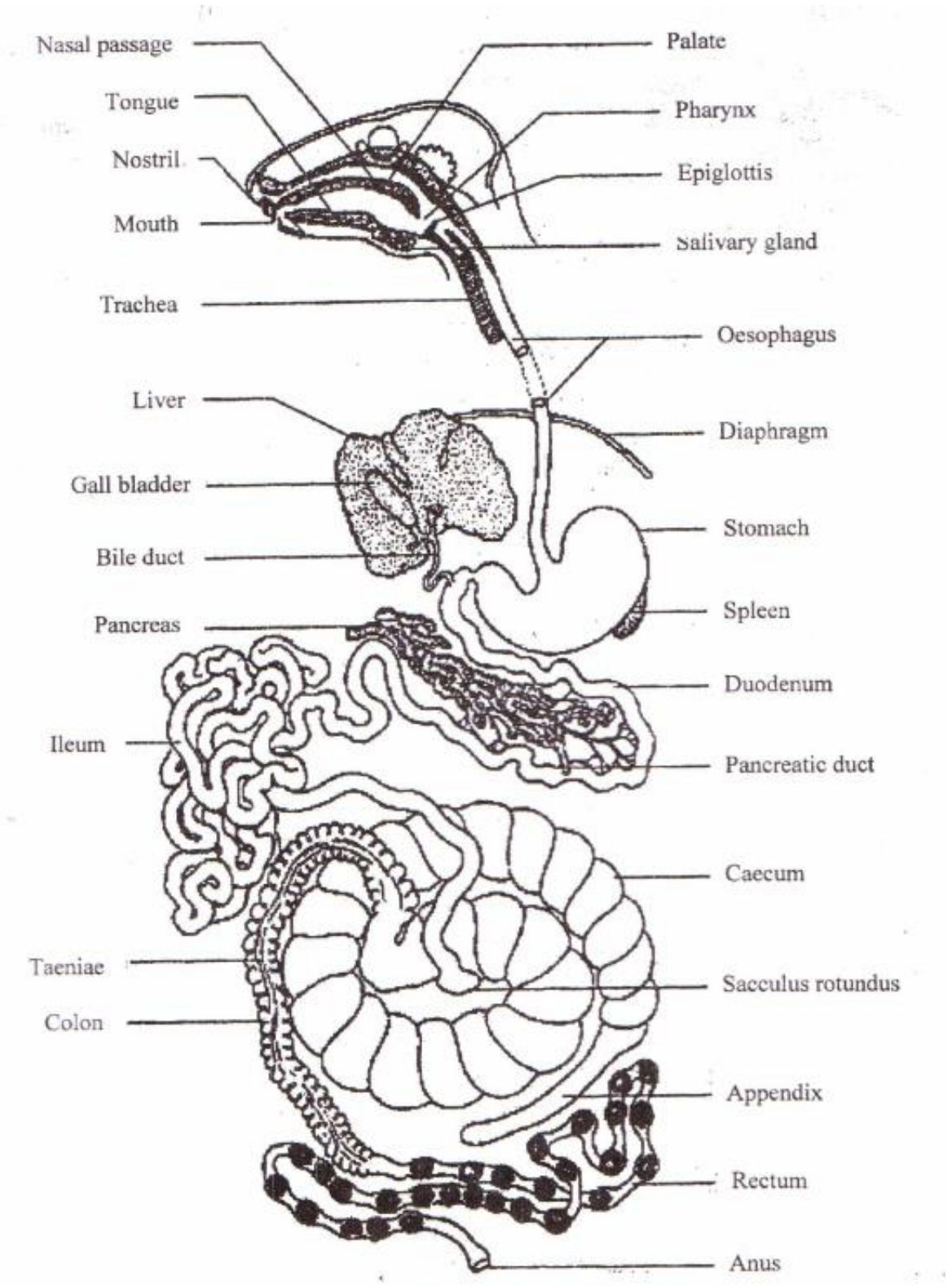
This structure allows free movement of the bone meeting at a joint.

5.4 DIGESTIVE SYSTEM

The digestive system of the mammal consists of two main components, (i) the alimentary canal and (ii) The digestive glands associated with the alimentary canal.

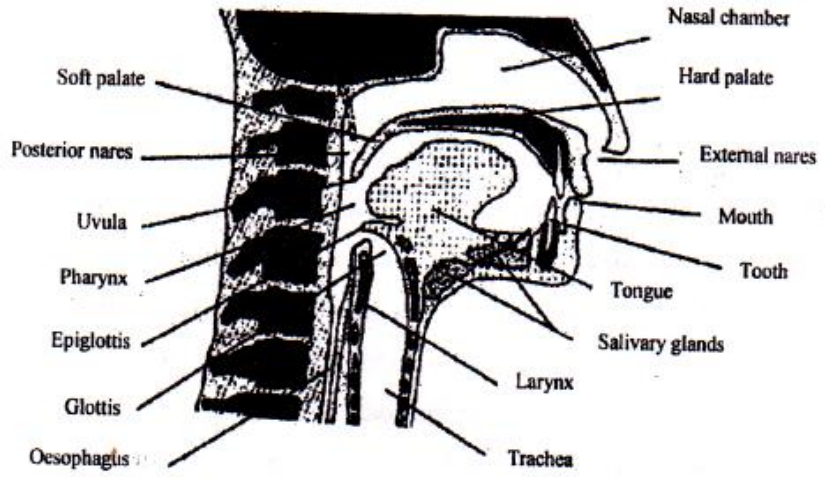
Alimentary Canal

The alimentary canal is a long coiled tube which consists of the bucco pharyngeal cavity, oesophagus, stomach and intestine.



Digestive system of rabbit

Bucco pharyngeal cavity



Buccal & Pharyngeal Regions

The mouth is bounded by two mobile and muscular lips. The mouth opens into a large spacious buccal cavity between the jaws. The buccal cavity is roofed with the palate sides are formed by the cheeks and the floor by throat. The anterior end of the palate is hard supported by the maxillae, premaxillae and palatine bones called hard palate. The posterior end of the palate is soft smooth, fleshy and formed of connective tissue called soft palate. The external nares open into the nasal passage and the internal nares have been pushed far back into the pharynx. There is no clear cut demarcation between the buccal cavity and the pharynx therefore both these structures are considered together as buccopharyngeal cavity.

Tongue: The tougue is situated on the floor of the mouth and attached along the greater part of its length to the floor of the buccal cavity with the free rounded tip infront. It is fleshy muscular, movable organ and helps in manipulating food and mixing it with saliva. The surface of the tongue bears four kinds of papillae. These papillae are (i) Fungiform, which are numerous mushroom shaped situated at the margins of the tongue, (ii) filiform, which are filamentous, numerous situated at the upper surface of the tongue, (iii) circumvallate, which are large sized few in number situated at the base of the tongue and (iv) foliate which are broad, leaf-like situated at the sides of the base of the tongue.

Teeth: Both the jaws of the mammal bear teeth which are situated on the premaxillae, maxillae and dentary bones. The teeth are situated in the sockets of the jaws, i.e.,

thecodont, and are of different shapes, i.e, heterodont. Two sets of teeth are seen during the life time of mammals. The first set is known as milk-teeth which are deciduous in the young conditions. The milk teeth are replaced by the other set of permanent teeth in the adults. This type of dentitions is known as diphyodont.

The teeth in mammals are four different types incisors, canines premolars and molars. All of these are with characteristic shape, definite position, and function, their number is also definite and fixed in every mammals. In rabbit only three of them are found because canines are absent.

Dentition is expressed by the dental formula. The dental formula is expressed as the different types of teeth in one half of the upper jaw and is writtern above a line while the number of teeth of one half of lower jaw is written below the line, e.g.

$$D.F = \frac{\text{Number of teeth in one half on the upper jaw}}{\text{Number of teeth in one half on the lower jaw}}$$

$$\text{Or} = \frac{\text{Insisor, Canine, Premolar, Molar}}{\text{Insisor, Canine, Premolar, Molar}}$$

$$\text{Or} = \frac{\text{I, C, P, M}}{\text{I, C, P, M}}$$

Thus, the dental formula of rabbit will be $= \frac{2}{1} = \frac{0}{0} = \frac{3}{2} = \frac{3}{3} = 28$

Man will be $= \frac{2}{2} = \frac{1}{1} = \frac{2}{2} = \frac{3}{3} = 32$

Structrue of teeth: A typical tooth can be divided into three parts the crown which is visible part of the tooth and projects out from the gum the neck lying below the crown in the gum and the root embedded in a socket of the jaw bones. A periodontal membrane is found between the root and the socket. The bulk of the tooth is formed by hard dentine. Inside the dentine a pulp cavity is found which contains connective tissue, blood vessels and nerves. The pulp cavity is lined by a layer of odontoblast or bone cells. The dentine is chemically bone-like and contains many fine canaliculi in which the processes of odontoblast run. The crown is covered by a hard, shiny white enamel, while the root is covered by the bony cement layer. Further the attachment of teeth on the jaw bones are strength by the gum.

The posterior free end of the soft palate forms a pendulum-like flap, the velum palati. On either side of the velum palati a pit is situated call tonsillar fossa which contain a papillae mass of lymphoid tissue known as palatine tonsil. The pharynx is

divided into two chambers due to the velum palati, the naso pharynx and the oro-pharynx. The internal nares open into the naso-pharynx and the opening of the Eustachian tubes also present at the sides of this chamber. Posterior to the velum palati, the pharynx remains undivided which leads into a dorsal glottis opening into the oesophagus and ventral glottis opening into the trachea. The glottis is guarded by the leaf-like cartilaginous flap called epiglottis. When the animal swallows the food, the soft palate closes the internal nares and the epiglottis closes the glottis, so that the food passes into the oesophagus and never into the trachea.

Oesophagus

The bucco-pharyngeal cavity through the gullet into a long narrow, distensible canal, the oesophagus. The oesophagus is joined by mucous secreting goblet cells. The secretion of which smoothens the oesophageal passage. The oesophagus passes through the neck and thoracic cavity, then pierces the diaphragm to open into a sac-like stomach. Oesophagus acts as an organ of conducting the foods and no digestion occurs here.

Stomach

The stomach is large, curved sac-like structure situated behind the diaphragm slightly towards the left side in the abdominal cavity. The stomach is differentiated into three regions a broad curved cardiac regions into which oesophagus opens, a narrow pyloric region which leads into the dudodenum and the third part is situated in between cardiac and pyloric regions called fundic region.

A muscular sphincter or cardiac valve is present at the opening of the oesophagus in cardiac region which region which prevent the backward passage of food from stomach to oesophagus. Similarly a pyloric sphincter prevents the opening of pyloric region into the duodenum. The gastric glands of the cardiac region called cardiac glands contain only muscous secreting cells. The gastric glands of the pyloric region called pyloric glands produce mucous only. The gastric glands of the fundic region called fundic glands contain mucous secreting cells zymogen cells or propepsin, prorenin secreting cells and oxyntic cells or hydrochloric acid producting cells. The pyloric region of the stomach opens in the intestine.

Intestine : The intestine can be divided into small and large intestine.

Small intestine : The first part of the small intestine is the duodenum which runs backwards then turns infront forming a U-shaped loop. In the loop of the duodenum a pinkish diffused structure is found which is known as pancreas. The pancreatic duct from the pancreas opens in the distal loop of the duodenum.

Brunner's glands of duodenum produce mucous protecting from acid. In the mucous membranes layer is crypts of Lieberkuhn.

Digestive Glands

In addition of the glands found in the wall of the alimentary canal, there are certain other glands outside in but in its close association the produce secretions essential for the process of digestion. These glands are the salivary glands pancreas and liver.

Salivary glands: Four pairs of salivary glands are found around the buccal cavity that open in it by long and small salivary ducts. In addition of the salivary glands, mucous glands are also found on the palate and tongue. The various salivary glands of rabbit are:

(i) **Parotid glands**

These glands are situated at the base of pinnae and their long fine ducts open behind the upper incisors.

(ii) **Submandibular or submaxillary glands:**

These glands are situated on the inner side of the angle of lower jaws and their long ducts open behind the lower incisors.

(iii) **Sublingual glands**

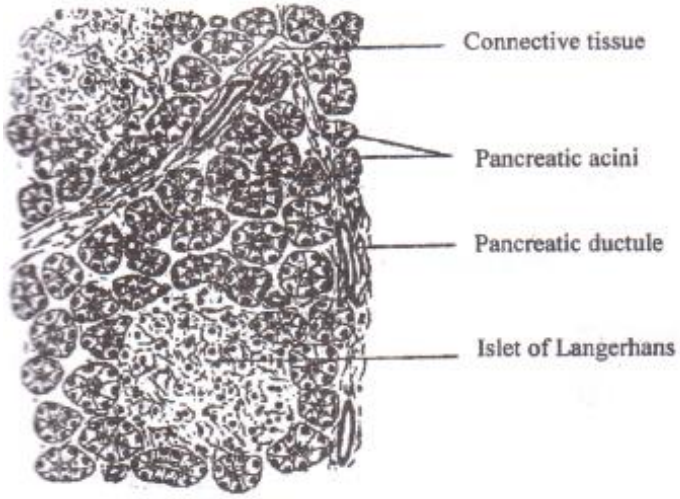
These glands are situated below the tongue and their short ducts open below the free part or tip of the tongue.

(iv) **Infraorbital glands**

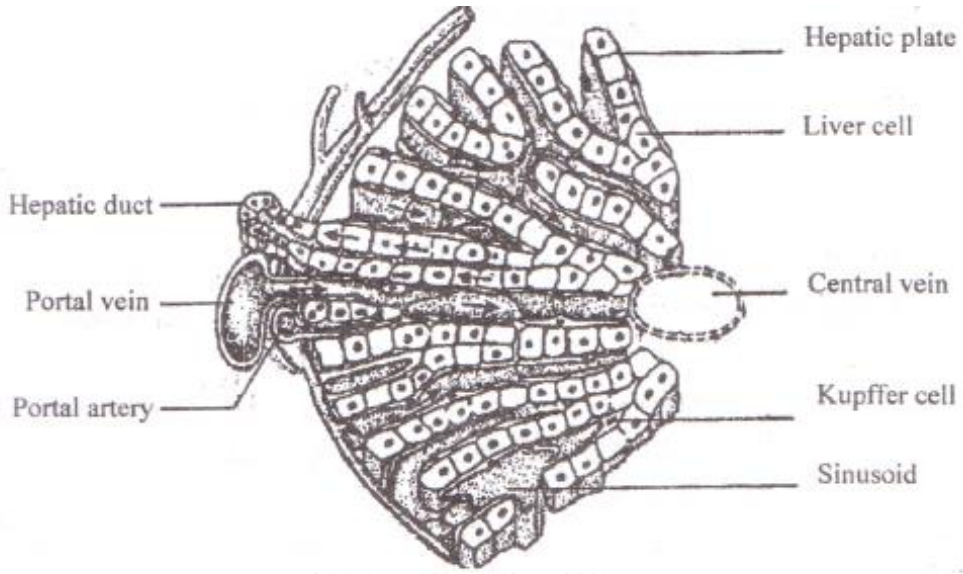
These glands are situated below the orbit and their ducts open near the upper molars.

Saliva is secreted by these salivary glands which contain slippery mucin and watery ptyalin. The mucin lubricates the food in the food passage while ptyalin helps in the digestion of starch. The salivary glands are stimulated to produced saliva by action due to the presence of food in the buccal cavity.

Pancrease: It is an irregular pinkish glands situated in "U" Shape by the duodenum and ileum. Histological it consists of a large number of branching tubules called acini embedded in connective tissue containing blood and lymph vessels, nerves and pancreatic ducts. The acini formed of cubical epithelial cells which secrete the pancreatic juices consisting of special enzymes, like trypsinogen, amylase and lipase. A number of small ducts from the acini unite together to form a common pancreatic duct which opens at the distal end of duodenum. Several groups of cells called islets of Langerhans are situated in between the acini of pancreas constituting an endocrine gland. The secretion of islets of Langerhans is a hormone called insulin which plays an important role in the metabolism of carbohydrate. The deficiency of insulin causes a disease called diabetes.



Portion of a Pancreas

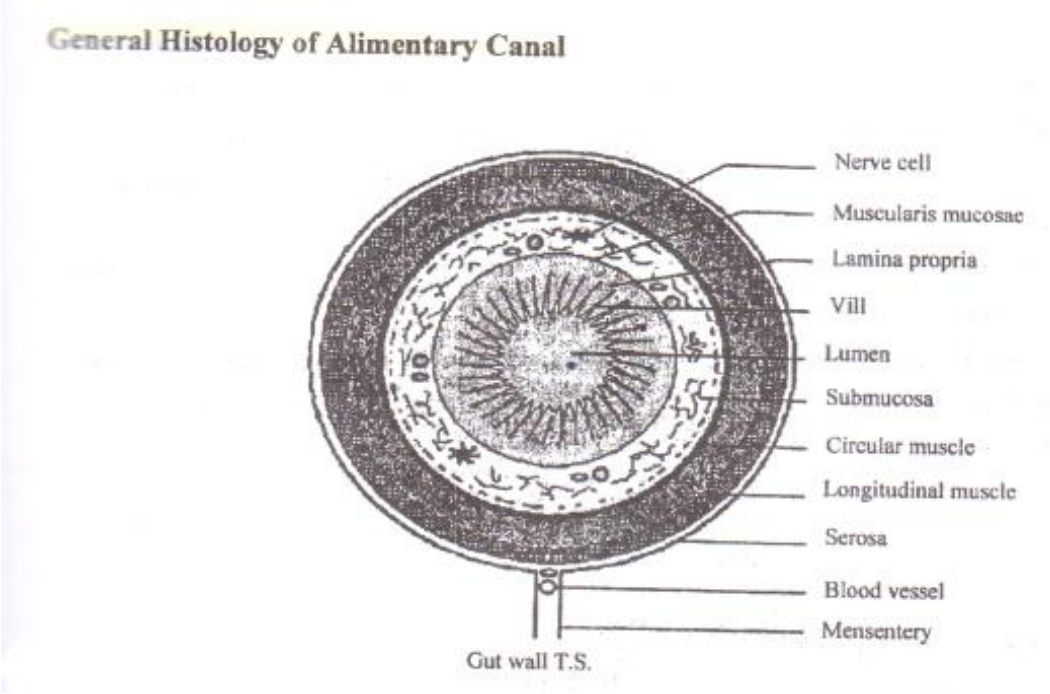


Portion of a section of liver

Liver: The liver is the largest gland of the body consisting of five lobes of which three are on the left and two on the right sides. The left lobes are left lateral, left central and a spigelian lobe while the right lobes are right central and caudated lobe. The liver presents a convex anterior surface fitting against the posterior wall of the diaphragm and a concave posterior surface fitting over the stomach and first part ofthe small intestine. The gall bladder is a large saccular structure, situated more or less between the right and left lobes. A large cystic duct arises from the gall bladder which receive several small hepatic duct from the different lobes of the liver carrying bile. Thus a large common bile-duct is formed which opens in the proximal part of the duodenum.

Generalized cross-section of a gut

Although highly variable from region the gut is generally formed (from inside outward) by four successive layers.



1. Mucous or tunic mucous

It is internal layer of the gut that lies the cavity of lumen and rest upon the connective tissue, lamina propria, surrounding this is thin smooth muscle layer, muscularis mucous. The lining of cavity of lumen is called the gastric epithelium. It is provided with villi. The villi are densy covered by minute finger like projections called microvilli. The mucous of anterior and posterior part of Oesophagus and rectum may be stratified squamous epithelium while that of the greater part ofthe gut is

simple columnar epithelium. The cells of this epithelium may have varied glandular structure, as secretory cells or posteriorly absorptive cells. In the mucous, the pocket like structure (Crypts of Liberkuhn) are present between the villi.

2. Submucosa

Usually thick layer mainly founded by loose connective tissue but containing numerous blood vessels, nerve plexus, lymph vessels. Branching, Brunner's gland are also present in duodenum.

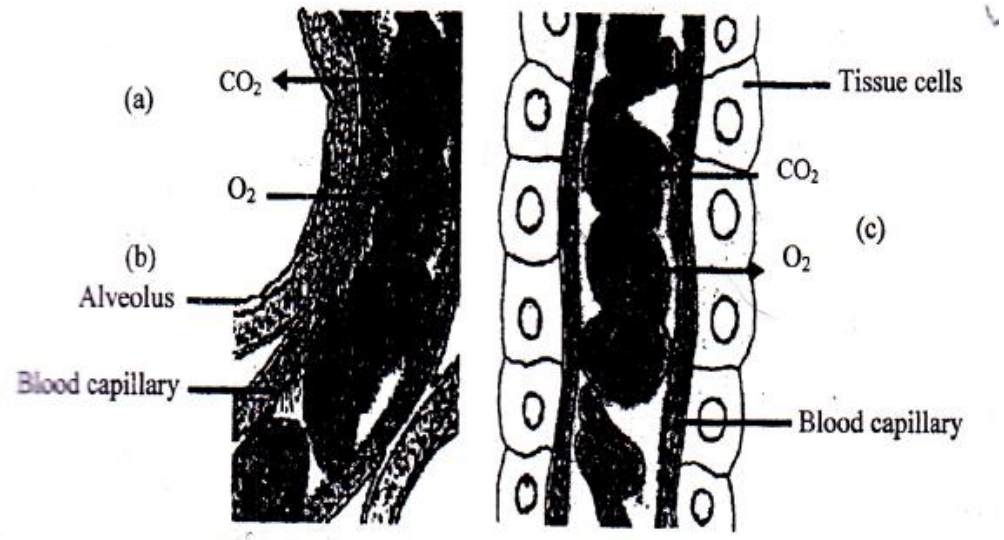
3. Muscularis externa (Muscularis layer muscle layer)

Generally include two prominent layers smooth muscles internally a circular muscle layer (capable of constricting gut). Externally a longitudinal muscle layer (enable of extending its length). These layers are especially developed in the stomach region. Between and adjacent two layers may have plexus of nerve cell, blood, lymph vessels and connective tissue. The orientation or circular and longitudinal muscle layer carry out the wave movement of muscles.

4. **Peritoneum or Serous tunic of Serosa**

Mostly the gut is surrounded externally by serosa or visceral peritoneum connective tissue. In oesophagus of mammals the portion below the diaphragm is covered with serosa while the portion before the diaphragm is only covered with adventitia.

5.5 RESPIRATORY SYSTEM



All animals need oxygen for the metabolism in their cells and must displace of the resulting carbon dioxide. The exchange of these gases is termed respiration.Some animals can exist for months on fat or other food stored in their bodies, many can live a shorter time without water, but few service long without oxygen, since little, is shorted in the body. Most animals obtain the oxygen from their environments.

Ordinary respiration in different animals is performed, by various respiration organs or system, such as the body covering, gills, lungs or trachea, These structures are unlike in appearance but fundamentally the same in function. Each comprises a moist permeable membrane through which molecules of oxygen and carbon dioxide diffuses readily. In accordance with the laws of gases each gas act independently of others. When a difference in diffusion pressure exists on the two sides of a membrane, more molecules pass towards the region of lesser pressure than in the opposite direction. The partial pressure of oxygen in the air or water is greater than within an animal body, where it is constantly being used up, so that oxygen tends to enter any suitable membrane surface. The arterial pressure of carbon dioxide is greater within the animal, so that it tends to pass outward. These exchanges occur simultaneously. In many small animals the exchange of gases is direct, from air or water through membrane to tissue cells, but it is more complex in larger species and those with dry or non-permeable exterior. In the latter, respiration consists of two stages.

1. **EXTERNAL RESPIRATION**

The exchange between environment and the respiratory organs.

2. **Internal respiration**

The exchange between the body fluids and the tissue cells. The term "respiration" is normally associated with free oxygen. But some intestinal parasites and invertebrates live where there is little or no oxygen in their environment. These anaerobic animals may obtain energy in the absence of free oxygen by the metabolism of foods in their bodies.

5.6 Circulatory System

In the circulatory system of vertebrates there are two systems, they are a blood vascular system and a lymphatic system. The blood vascular system is a closed system in vertebrates, it has contractile heart, arteries, veins and capillaries. The lymphatic system consists of lymph channels and lymph. The lymphatic system is an open system with lymph spaces.

The blood vessels which carry oxygenated blood away from the heart to the arteries. The arteries divided into thinner arterioles which branch into externally thin and small capillaries. The capillaries form a network in all body tissues. From the capillaries the blood passes into thin venules which combine to form veins. Veins are those blood vessels which carry deoxygenated blood towards the heart,

The arteries and their branches form an arterial system, while the veins and the their tributaries a venous system.

Frog Heart

The heart of frog is a conical muscular organ situated ventrally to the liver in the pericardial cavity. It is a triangular structure with broader anterior part and narrow posterior part. (The broader anterior part and narrow posterior part.) The broader part is known as atrium or auricle where as the posterior part is known as ventricle. Internally the atrium (auricle) is divided by an inte-auricular septum into a large right auricle and a small left auricle. The ventricle is conical in shape with thick muscular walls. Thus the ventricle and two auricles are three main chambers of the heart, From the ventral upper right side of the ventricle arise a cylindrical structure, the truncus arteriosus, which extends forward obliquely across the right auricle and finally divides

into two halves the so called branches or trunks. On the dorsal surface of the heart there is a thin walled somewhat triangular chamber, the sinus venosus into which the three caval veins (two anterior, precavals and one posterior postcaval) are opened, In front of the sinus venous there is pulmonary vein which opens into the left auricle.

Internally the heart is three chambered with two auricles and one ventricle. The two auricles are separated by interauricular septum. In the right auricle close to the septum there is a transverse oval opening called, sinus auricular aperture through which blood enters into the ventricle from the sinus venosus. It is guarded by two lip like sinus-auricular valves. These valves allow the free flow of blood only into the auricle but prevent the backward flow of the blood. In the left auricle slightly anterior to the sinus-auricular aperture but close to the septum there is a small opening of pulmonary vein which has no valve. The two auricles open into a single ventricle by an auriculo-ventricular aperture which is bounded by two pairs of auriculo -ventricular valves prevent the flow of blood to the auricles. The ventricle is a triangular chamber of the heart with muscular wall having ridges or columnae carnae. From the upper right side of the ventricle arise a tubular truncus arteriosus, the opening of which is guarded by three semilunar valves, on contraction of the ventricle these valves are pushed apart and make a free passage for the blood from the ventricle into the truncus arteriosus. The truncus arteriosus is formed of a basal thick conus arteriosus and a distal a thin wall ventral aorta.

The conus arteriosus is provided with a row of semilunar valves. One of these valves has been modified to form a large spirally twisted spiral valves, which completely divides the cavity of conus arteriosus into two passage, a dorsal and left cavum pulmocutaneum and ventral and right cavum aorticum. Both of which communicate with the ventral aorta. In front of the ventral aorta the truncus arteriosus is divides into two halves, each half having carotid arch, systemic arch and pulmocutaneous arch.

Heart of Rabbit

The heart is a muscular organ lying in the left side of the thoracic cavity in between the lungs. It is completely enclosed with a thin walled sac pericardium.

The heart is four chambered, with two auricles and two ventricles. The sinus-venosus and truncus arteriosus are not found.

Three venae cavae, the precavals and the postcaval, open directly into the right auricle and two pulmonary veins lead by a common opening in to the left auricle. The auricles are thin walled, separated from each other by an inter-auricular septum. The ventricles are also separated from each other.

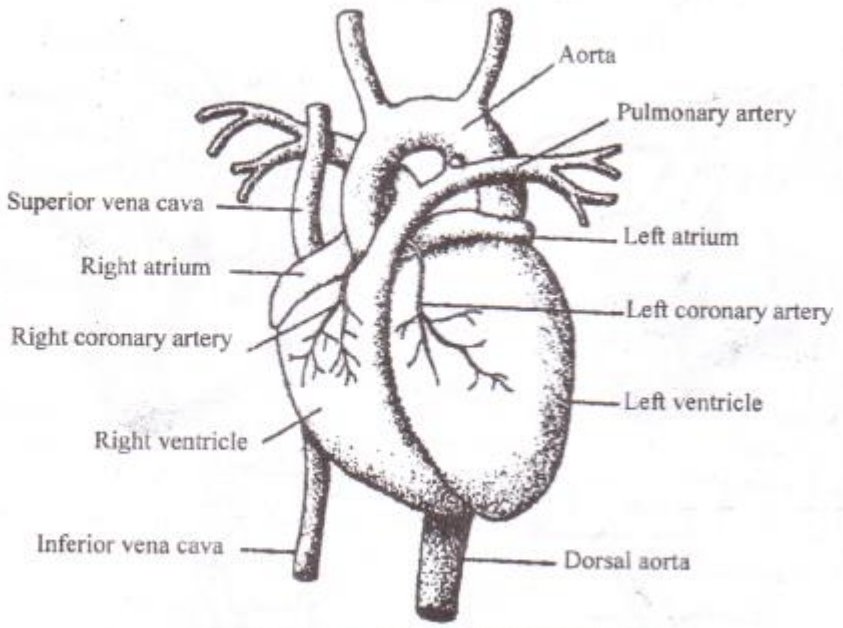
completely by an inter ventricular septum. The right and the left auricles open into the ventricles of their sides by auriculo-ventricular apertures respectively. The right auriculo-ventricular aperture is guarded by a tricuspid valve. While the left auriculo-ventricular aperture is guarded by a bicuspid or mitral valve. These valves are attached with the papillary muscles or columnae carnae of the ventricle through chordae tendinae. The two sides do not communicate with one another. From the front end of the right ventricle arises the pulmonary artery, and from the front of the left venticle arises the single aortic arch. The opening of each of these vessels is provided with three semilunar valves.

The venous blood from anterior part of the body is collected by the precavals while the postcaval collects blood from the posterior part of the body. The precavals and postcaval open in the right auricle though separate opening. The pulmonary veins which open in the left auricle by a common opening carry oxygenated blood from the lungs. The tricuspid and bicuspid valves between right and left auriculo-ventricular aperture respectively allow the passage of the blood only in one direction, i.e from the auricle into the ventricles only. The pulmonary artery of the aorta which arises from the right ventricles carries venous blood to the lungs for oxygenation. The aorta or aortic arch which arises from the left ventricle carries oxygenated blood to the different parts of the body. The semilunar valve allow the passage of blood only in one direction, i.e, from the left ventricle to the aorta and from the right ventricle to the pulmonary artery only and prevent the backward flow of blood into the ventricles.

The venous blood from various parts of the body, which returns by the cavals reaches the right auricles and is then driven by the auricular contraction into the right ventricle. It is then driven to the lungs through the pulmonary artery.

From the lungs the oxygenated blood returns to the left auricle. It is driven into the left ventricle and hence through the aorta to all parts of the body.

The Mammalian Heart



External structure of mammalian heart

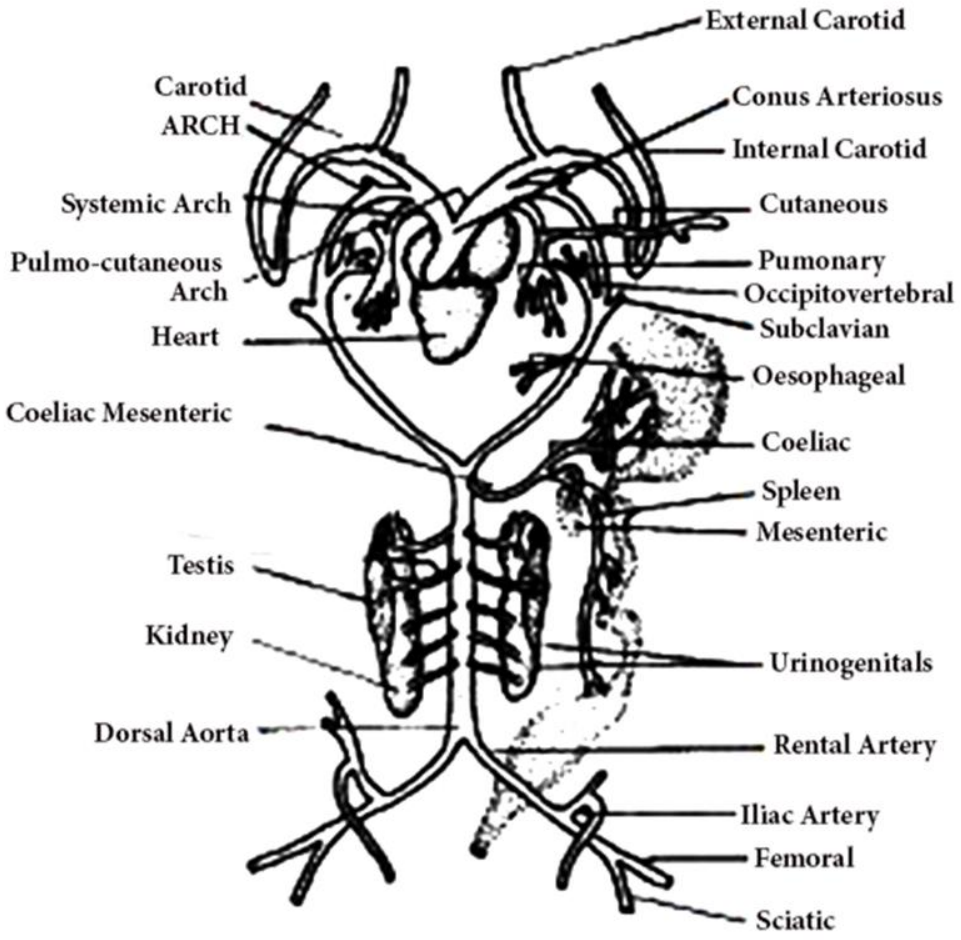
Arterial System of Frog

The blood vessels *which* carry the blood away from the heart to different parts of the body constitute the arterial system. In frog arterial system begins with the truncus arteriosus which divides into two large right and left branches. Each brach consist of three arteries, an anterior carotid arch, a middle systemic arch and a posterior pulmocutaneous arch. Each pulmocutaneous arch divides into two arteries a pulmonary artery going to a lung and a cutaneous artery to the skin and buccal cavity. The carotid arch of each side also divides into two an external carotid or lingual going to the lower jaw and tongue and an internal carotid to the orbit and brain. Each internal carotid its commencement bears a swollen carotid body or labyrinth. The two systemic arches pass outward and curve around the Oesophagus and join together to form a median dorsal aorta going backward beneath the vertebral column. Each systemic arch gives out three arteries, oesophageal artery to the oesphagus, occipital vertebral artery to the head, vertebral column and spinal cord and a large subclavian to the forelimb,

From the dorsal aorta arises a number of arteries. A large but unpaired coeliaco-mesenteric artery arises at the point where the dorsal aorta is formed by the union of the right and left systemic arches. Coeliaco-mesenteric divides into two main branches, small coeliac artery going to the stomach (gastric) and liver (hepatic) and large anterior mesenteric sending branches to the duodenum (duodenal) spleen (splenic) and ileum (intestinal). From the anterior mesenteric artery arises and unpaired posterior mesenteric artery going to the large intestine.

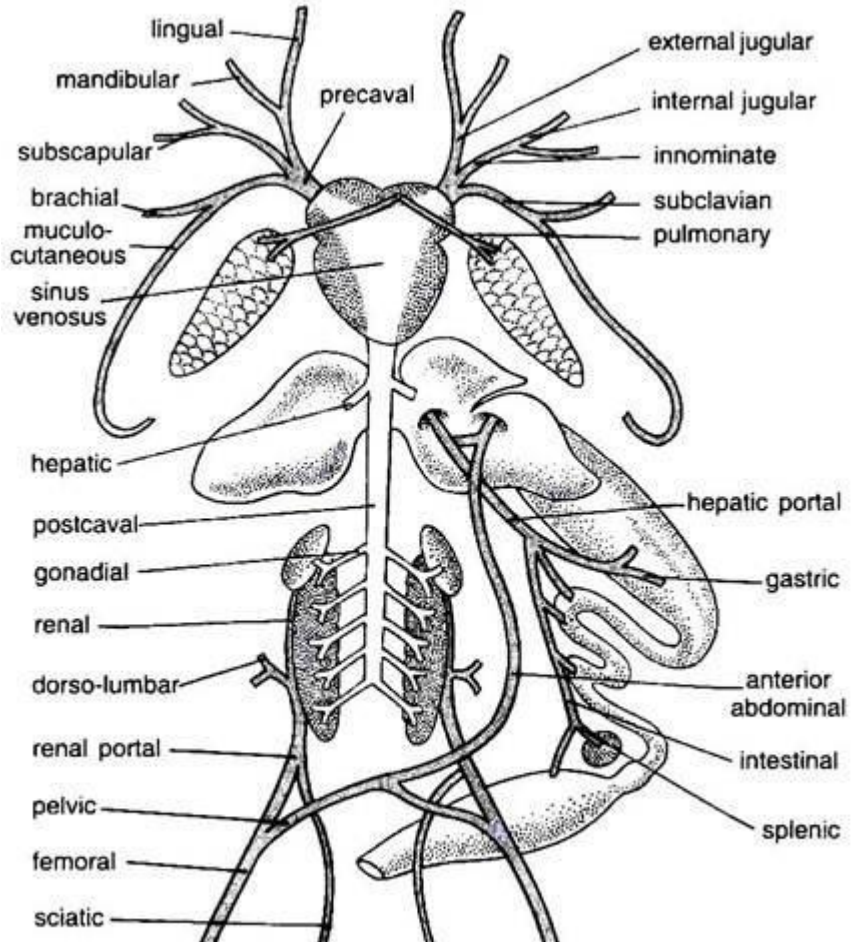
The dorsal aorta runs backwards between and beneath the kidneys along the mid-dorsal line give of the following arteries, four to eight pairs of renal arteries going to the kidneys, a pair of gonadial (ovarian or spermatic) to the gonads.

Posterior dorsal aorta divides into two large iliac arteries supplying the hind limbs. Each iliac enters the legs gives of the following arteries, an epigastirc artery going to the muscles of the thigh and the urinary bladder , a fermoral artery going to the skin and the muscle of the anterior part of the thigh and sciatic artery going to the shank.



Arterial System of Frog

Venous system of Frog



Venous System of Frog

The blood vessel which carry the blood towards the heart constitute the venous system, it means the blood from different parts of the body is returned into heart by veins. The blood from two lungs is returned by two pulmonary veins which open into the left auricle after uniting with each other. The blood from the rest of the body comes to the sinus venous which opens into the right auricle through sinus auricular aperture. The precavals vein (posterior vena cava veins) from the front posterior parts of the body being back the blood into three veins and external jugular receiving branches from the tongue (lingual) and floor of the mouth (mandibular), an innominate receiving branches from the brain and orbit (internal jugular) and from shoulder (subscapular) and a subclavian vein receiving braches from arm (brachial and from skin and muscles of the abdomen and also mucous membrane of mouth and head muscles (musculo-cutaneous). The postcaval vein.(posterior vena cava) receives

blood from the legs, kidneys, gonads and liver. It arises between the kidneys and runs forward ventral to the dorsal aorta in the mid-ventral line. Before it communicated with the sinus venous it receives hepatic veins from the liver five or six renal veins collect blood from each kidney and pour it into the posterior vena cava. The veins from the gonads open either directly into vena cava or to the anterior most renal vein. The veins which collect the blood from the posterior side of the body constitute renal portal system two large veins, the femoral and sciatic, return the blood from each leg. On entering the body cavity each femoral veins divides in front of the thigh into two, the pelvic and the external iliac veins and renal portal veins. The pelvic passes ventrally and meets the fellow from the opposite side forming the anterior abdominal vein. The external iliac passes which runs forward and joins the sciatic veins to from the renal portal veins which runs along the outer margin of the kidneys sending branches to it. The renal portal vein receives the blood from the body wall through dorso-lumbar vein. Hepatic caporal system collects the blood from the alimentary canal through many branches and carries it to the liver where the vein break up into capillaries and the blood is collected by hepatic veins to pour into the post cava.

5.7 NERVOUS SYSTEM OF RABBIT

The vertebrate nervous system has three divisions.

CNS : Central nervous system comprising the brain and spinal cord,

PNS : Peripheral nervous system consisting of cranial and spinal nerves arising from the brain and spinal cord respectively.

ANS : Autonomic nervous system made of two ganglionated sympathetic parasympathetic nerves, ganglia in the head and viscera, and their connecting nerves.

Stimulus and response

Any physical or chemical change capable of exciting an organism or its parts is stimulus. Common external stimuli derive from temperature moisture, light, gravity, contact, pressure, oxygen supply, salt concentrations and odours. Internal stimuli result from the quantity of food, water, oxygen or wastes in the body and form fatigue, pain disease or other conditions. Some stimuli act directly upon cells or tissues and elicit a direct response (e.g sun burn) but most animals have various kinds of receptors (sense organs) to receive stimuli.

A specialized receptors is a cell or organ having an special sensitivity to some particular kind of stimuli, as the eye to light and the ear to sound exteroreceptors receive stimuli from the external environment and interoreceptors from within the body, as with hunger or thirst. Receptors induce the transmission of nerve impulses through the nervous system; the impulses, inturn, excite terminal structures, or effectors (muscles, gland) to bring about responses.

The stimulus and response are accomplished by the nerves, spinal cord and brain in association with receptors and effectors.

The Neurone or Nerver Cells

The neurone performs the specific function of the system. The neurone transmits the nerve impulses. It exhibits many shapes, but all have a cells body and one or more processes. The longest process is the axon or nerve fibers. It transmits nerve impulses to a synapse or effector. The other processes of neurons are dendrites. They are short extensions of the cell body that provide an increased surface or receipt of incoming impulse from axons.

Sensory or afferent neurons are those which conduct impulses from receptors to or towards the central nervous system.

Motor or efferent neurons conduct impulses from the central nervous system To various effectors.

Mix nerves contain both sensory and motor fibers. Most vertebrate nerves are mixed.

Functional Divisions of the Nerrvous system

The body functions of the nervous system are somatic or visceral, somatic functions are those which are carried out by the voluntary muscles, skeleton and the skin and its derivatives. Visceral functions are those which are performed by the digestive, circulatory, excretory, endocrine, and the urogenital system. Both somatic and visceral functions are divided into two components each they are afferent or sensory and efferent or motor, thus the nervous system has four functional divisions.

1. The somatic sensory component fibres carry impulses from the skin, sense organs, voluntary muscles and joints to the central nervous system.
2. The somatic motor component carries impulses from the central nervous system to the voluntary muscles.
3. The visceral sensory component carries sensations from the viscera and organs of taste and smell to the central nervous system.
4. The visceral motor component carries impulses from the central nervous system to the involuntary muscles, brachial muscles and glands.

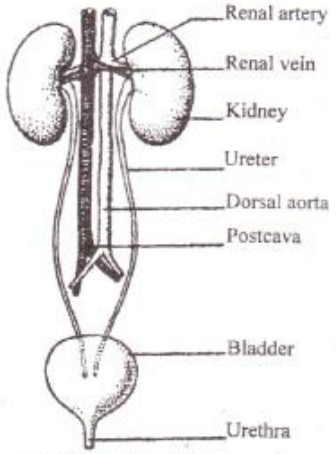
The dorsal half of the central nervous system is sensory an the ventral half is motor. This is especially marked in the medulla oblongata and the spinal cord. The four functional components are arranged from the dorsal to the ventral side in the order, somatic sensory, visceral sensory, visceral motor, and somatic motor. Typically each peripheral nerve is also made of all four functional components. This condition is typical of amniotes, but is anamiotes the visceral motor component has its fibres passing through both dorsal and ventral roots.

5.8 THE EXCRETORY SYSTEM

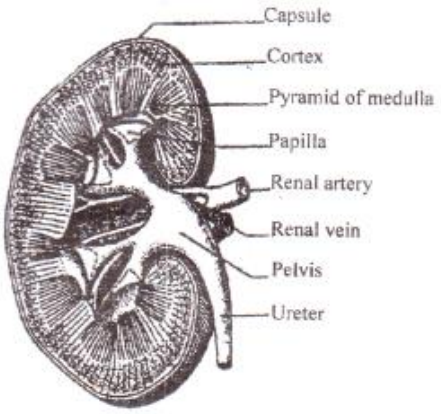
Excretion is the removal of waste products from the body of a living organisms. The common excretory products formed in the bodies of animals a are water, carbon dioxide, mineral salts and nitrogenous compounds such as urea, uric and ammonium compounds. These products may come either from every cell in the body or from certain part of the body only. Most of them are the products of the body metabolism and can be inferred to as metabolites. Sometimes materials that are taken into the body from outside may be in excess of what is required. If so, they will have to be removed as waste.

It is necessary that all unwanted products be removed from the body of the living organism. If they were allowed to remain in the body. They would soon become harmful and poisonous to the living cells. Hence, it is also extremely necessary that they are removed as quickly as possible. The removal of undigested food in animals through the anus is not known as excretion but egestion. Carbon dioxide is removed through skin and gills or lungs, but others are excreted through to the kidney.

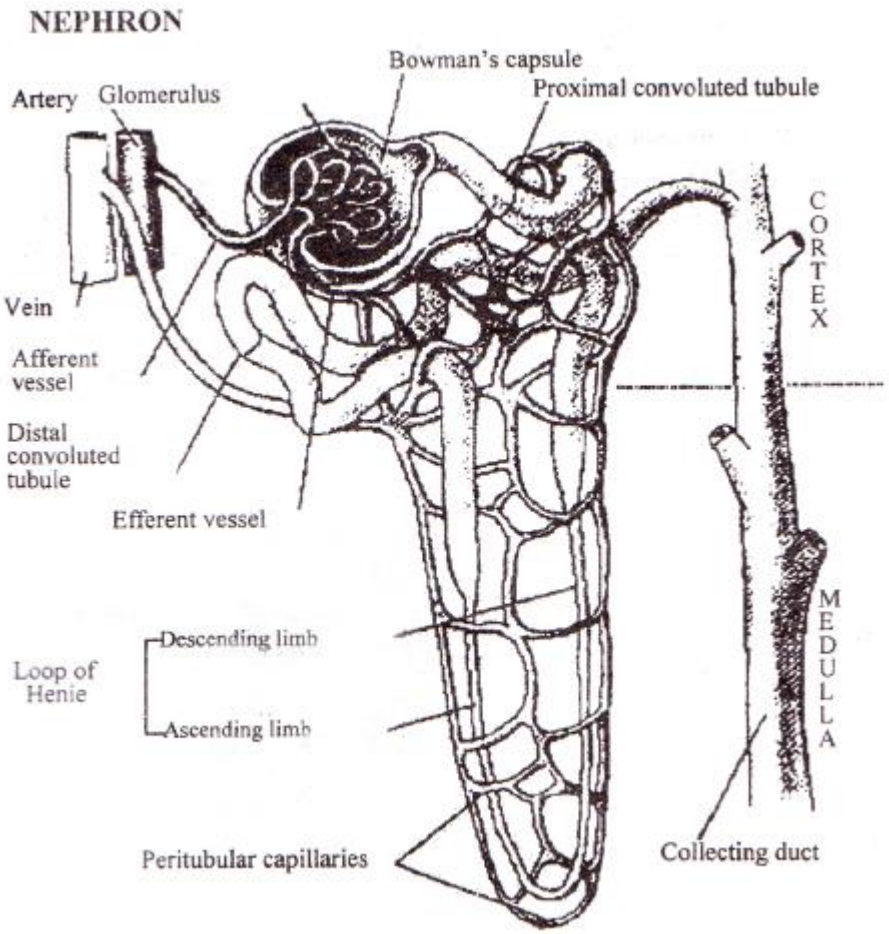
Most excretory substances are in solution in water, and any excess of water is also eliminated by kidneys. The excretory and reproductive systems are closely associated, particularly in the males, hence it is customary to consider the two systems together as urogenital system.



Excretory system of mammal



Kidney in median section



Vertebrate Kidney

There is a pair of compact kidneys lying dorsal to the coelom. Each mammalian kidney consists of an inner medulla and outer cortex, the latter containing about a million of minute excretory units or nephrons. A nephron is made up of (1) a malpighian or renal corpuscle composed of a globular double-walled Bowman's capsule around a clump of arterioles, or Glomerulus and (2) a tubule, both convoluted and straight, surrounded by blood capillaries. An afferent arteriole take blood into the glomerulus and an efferent arteriole takes blood away from it. All the tubules discharge into a central cavity (pelvis)of the kidney that connect to the ureter.

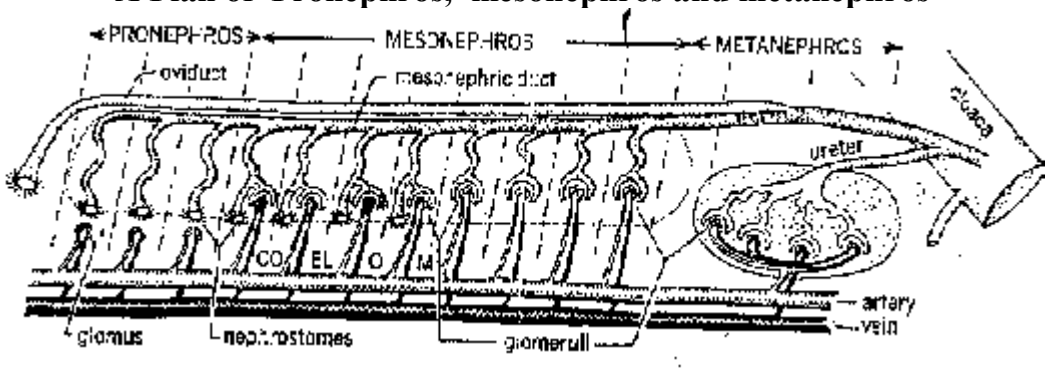
The ureter, a common collecting duct, carries the waste posteriorly. In amphibians, reptiles, and birds the two ureters discharge into the cloaca, to which a urinary bladder connects in amphibian and reptiles. The waste or urine is always fluid except in reptiles and birds, where the semisolid excretion(uric acid) are voided as a

white paste (guano) with the feces. In most mammals the ureters connect directly to the bladder, hence a median duct, the urethra, discharges to the exterior, passing through the penis in the male.

The early vertebrate or the ancestral vertebrate had pair of kidneys running through the entire length of the coelom, each had segmentally arranged tubules, one pair per body segment. Each tubule opened separately into the coelom by a peritoneal funnel and nephrostome, near each funnel was a glomerulus enclosed in the Bowman's capsule. This kidney is an archinephros.

In present day, vertebrates, the uriniferous tubules develop antero-posteriorly in three stages in succession, these are pronephros, nesonephros and metanephros.

A Plan of Pronephros, mesonephros and metanephros



Pronephros

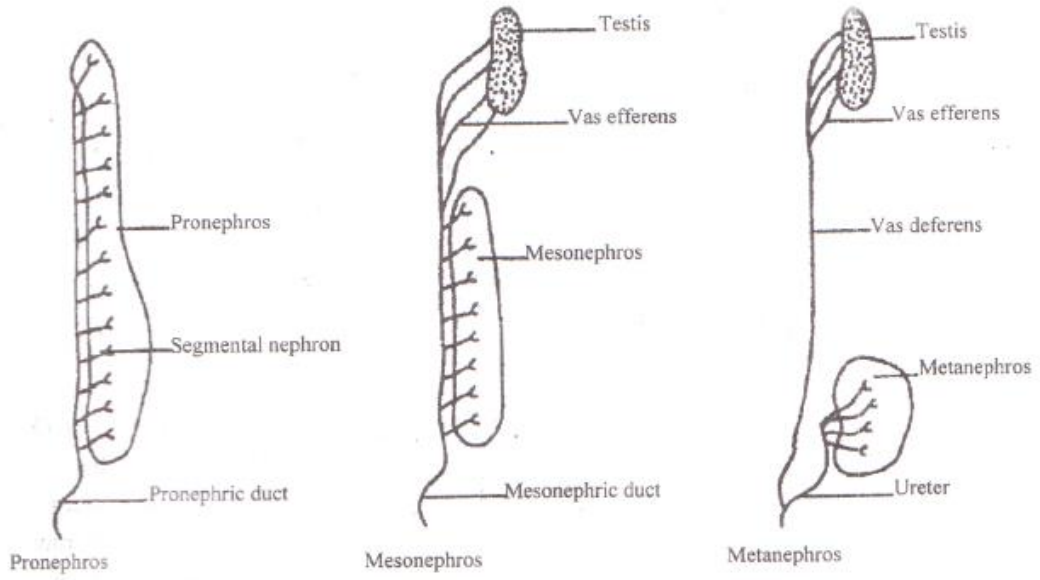
Pronephros develop in the anterior most part of the nephrostome. There are only 1 to 13 uriniferous tubules in each, one pair to each segment. Near each tubule is a glomerulus but Bowman's capsule and peritoneal funnel are lacking. These glomeruli are called external glomeruli. The uriniferous tubules of each pronephrosopen into a common pronephric duct which runs backward to enter the embryonic cloaca.

A pair of pronephros become functional only in some cyclostomes and embryos of all anamniotes. In other they degenerate during development.

Mesonephros

Mesonephros develops from that part of the nephrotome which lies behind the pronephros. At first it consists of paired segmental uriniferous tubules, each with a peritoneal funnel opening into the coelom, and a glomerulus enclosed in a Bowman's capsule. These mesonephricuriniferous tubules join the existing pronephric duct on

each side which is called mesonephric tubules or Wolffian duct. Later the mesonephric tubules undergo budding to form hundreds of tubules, so that their segmental arrangement is lost. The latter tubules have no peritoneal funnels. Mesonephros form the adult functional kidneys in some fishes and amphibians. They form the kidneys of embryo of amniotes which they degenerate in the adult.



Types of vertebrate kidney

Metanephros

Metanephros develops only in amniotes. It is formed from the posterior most part of the nephrotome behind the embryonic mesonephros. Metanephros has a double origin, a tubular outgrowth arises from the mesonephric duct near the clocas and itgrows into the nephrotome where it divides into branches which form collecting tubules and calyces, while the proximal part of the tubular outgrowth becomes the ureter or metanephric duct.

The nephrotome gives rise to metanephricuriniferous tubules of which there are thousands with no segmental arrangement. The metanephric tubules are long and much coiled with glomerulus enclosed in Bowman's capsule and lacking the peritoneal funnels. So these connection with the coelom is lost. Metanephros are the functional kidneys of adult amniotes.

STRUCTRUE OF THE MAMMALIAN KIDNEY

The mammalian kidney reveal that it is composed primarily of many tiny tubules. The kidney appears to consist of two regions, Thecortex region and medulla region. The outer cortical portion of the kidney consists of coiled tubules while the tubules in the medullar portion are straight giving a striated appearance. The outer part of the kidney appears granular due to the presence of numerous bodies called renal or malpighian corpuscles. A single urinary unit is composed of one of these renal corpuscles and its associated uriniferous tubule. There are approximately one million of these urinary unites in each human kidney. Each such unit begin with a renal corpuscles which is composed of an outer thin double-walled capsule, Bowman's capsule and this surrounds a tuft or knot of blood capillaries called a Glomerulus. The capsule extends away from the renal corpuscle as the uriniferous tubules. Each coiled uriniferous tubule joins a larger collecting tubule, that passes through the medulla of the kidney and empties into the pelvis. Each uriniferous tubule is differentiated into three regions; the proximal convoluted tubule, the loop of Henle (with descending and ascending limbs) and a distal convoluted part. A small arteriolar afferent blood vessel enters each glomerulus when efferent vessel leaves each one. The efferent vessel that leaves each glomerulus forms a capillary net around each uriniferous tubule. These capillaries form small veins which empty into the renal veins.

5.9 ENDOCRINE SYSTEM

Glands are cells or groups of cells specialized in structure and function to produce substance needed in bodily processes. There are two type of gland in the body. They are endocrine glands and exocrine glands. The exocrine glands liberate their secretions through the ducts such as salivary and sweat gland. The endocrine glands liberate their secretions directly into the blood (or) lymph without ducts. The secretions produced by these glands are called hormones. Hormones are important in the regulation of the functions of the body, regulation of metabolic activities and the control of the growth of the animal. Endocrine glands of vertebrates are

(1) Pituitary - lies at the base of brain.

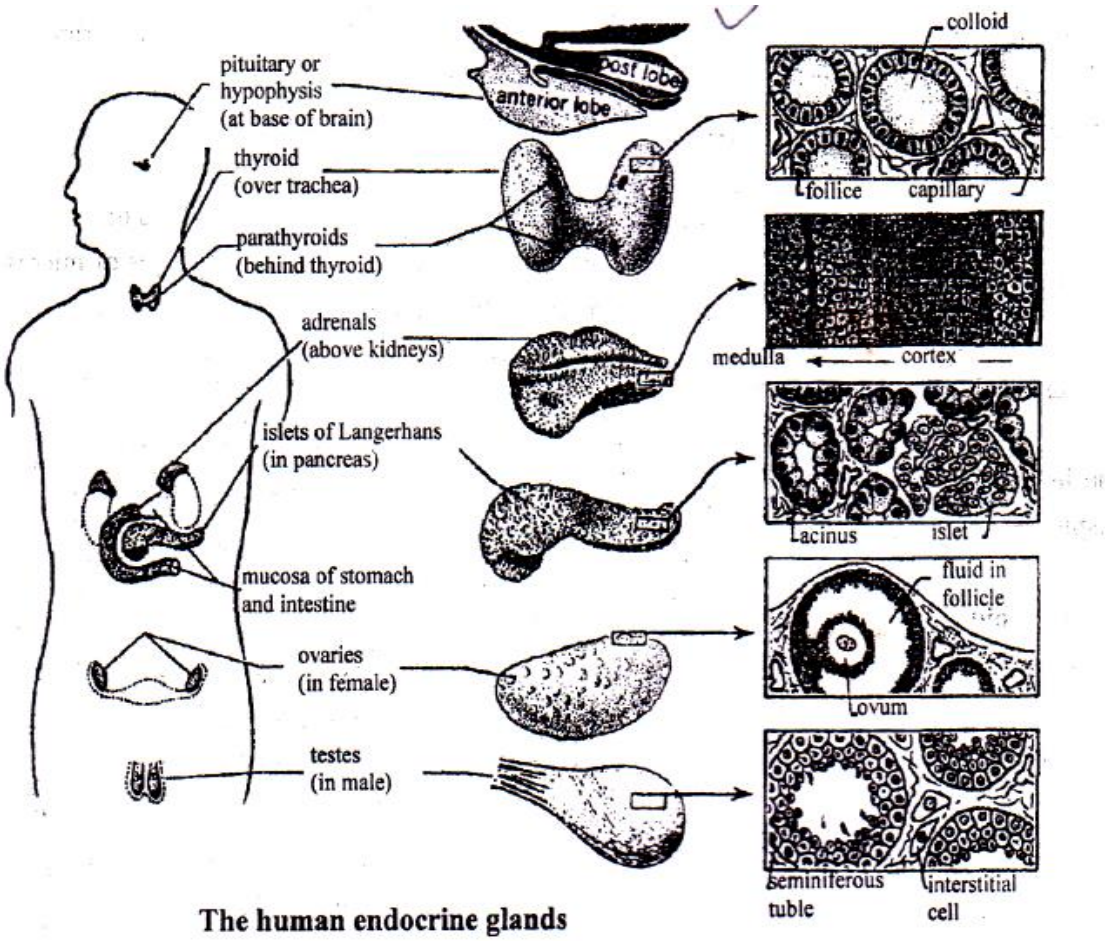
(2) Thyroid - lies on either side of the trachea, below the larynx.This gland of two lobes joined by an isthmus.

(3) Parathyroids - lie behind or partly embedded in the thyroid are two pairs of small oval parathyroids.

(4) Adrenals - these two small glands adjacent to the anterior or upper end of the kidneys.

(5) Islets of Langerhans - lies in pancreas or within pancreas.

(6) Gonads (Testis and ovaries) - Ovaries in female, testis in male.



The human endocrine glands