

# Detailed Study

## 1. Pigeon

Pigeon is a gentle bird. Hence it is considered as the *living symbol of peace*. There are more than 500 species of pigeons.

*Columba livia* is commonly called *blue rock pigeon*.

It is a wild pigeon.

It is slaty grey in colour with two dark bars on wings and a broad black bar across the tail end.

Pigeon is cosmopolitan in distribution. It exhibits *social behaviour*.

The pigeons fly in *flocks* and *roost* together.

It is *graminivorous* in habit. It is *monogamous* and partnership lasts for entire life.

Each clutch contains only *two eggs*. Both parents incubate the eggs alternately. The eggs are hatched on the *17<sup>th</sup> day*.

Nestlings are helpless, featherless and blind. The parents feed them for a month.

Pigeon is slaty grey in colour with dark bands on the wings and tail.

The body is *spindle-shaped*. The body is covered by *feathers*. It is divisible into four regions, namely *head, neck, trunk* and *tail*.

The head is spherical with a pointed anterior end. The jaws are elongated into a pointed *beak* or *bill*. It is formed of an *upper beak* and a *lower beak*.

The beak is covered by a horny sheath called *rhamphotheca*. There are no teeth in the beaks.

The mouth is located in between the beaks. The base of the upper beak contains a pair of *external nostrils*. Posterior to the nostrils there is a pair of whitish swollen skin called *cere*.

On the sides of the head two prominent *eyes* are located. Each eye is protected by three eyelids, namely an *upper eyelid*, a *lower eyelid* and a *third eyelid* or *nictitating membrane*. The nictitating membrane is transparent and movable.

Behind the eyes there are two *ear openings*, one on each side. The ear opening leads into a short tube called *external auditory meatus*.

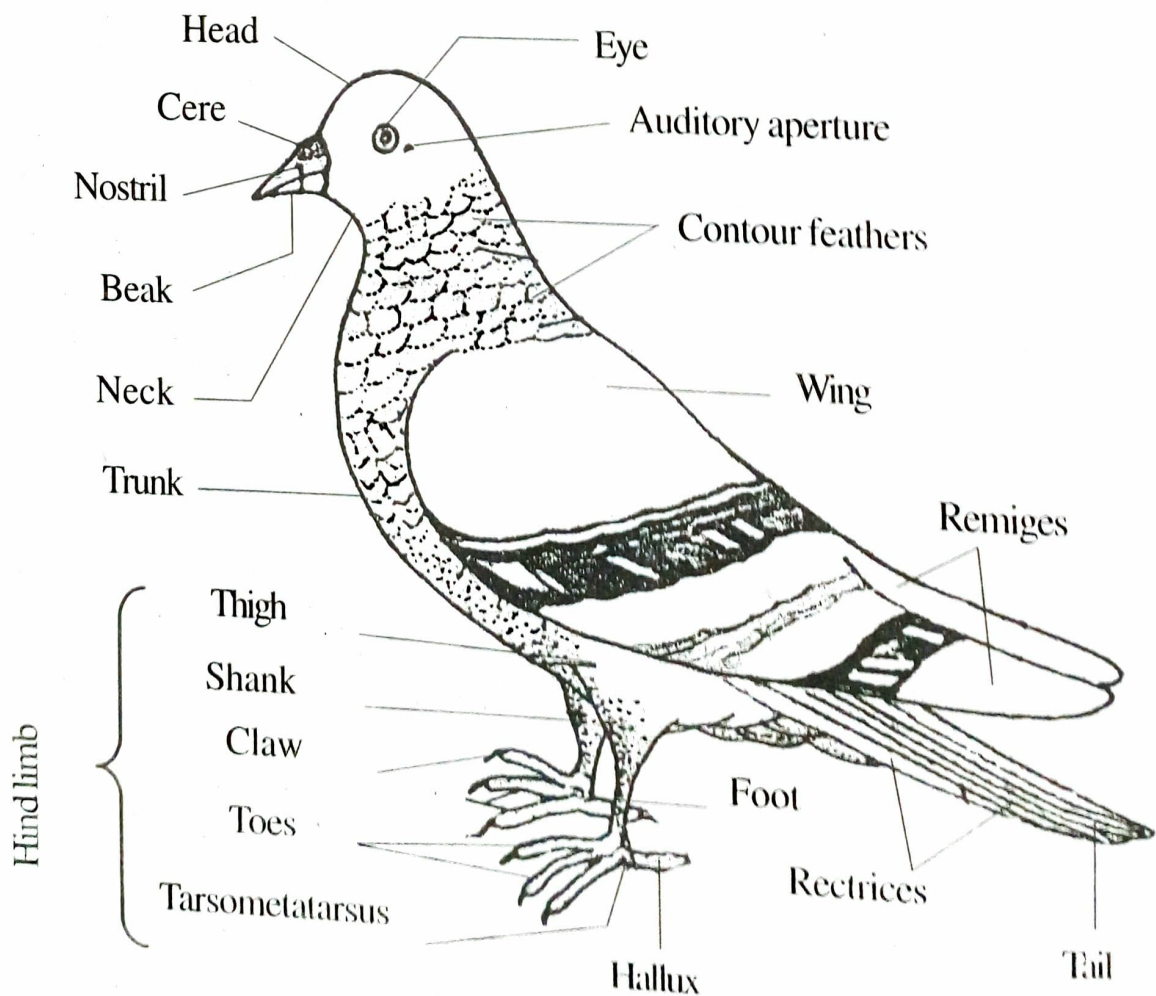


Fig.7.36: Pigeon - External features.



The *neck* is long, flexible and cylindrical. It links the head with the trunk. It helps to deal with the food materials.

The *trunk* is compact, stout immovable and spindle-shaped. The trunk bears a mid-ventral bony ridge called *keel* or *carina*, a pair of *wings*, a pair of *hind limbs* and a *cloacal aperture* at the posterior end.

The *wings* are the modified fore limbs. They are attached to the anterior region of the trunk. Each wing has three regions, namely *upper arm*, *fore arm* and *hand* with three clawless *digits*.

A fold of skin extends between the trunk and the upper arm. It is called *postpatagium*. Similarly there is another fold of skin between the upper arm and the fore arm. It is called *prepatagium* or *alar membrane*.

The wings bear large feathers called *remiges* at the posterior margins. The wings are used for flight.

*Hind limbs* are two in number and are used for walking and perching. Each hind limb has three regions, namely *thigh*, *shank* and *foot*.

The foot bears four long clawed toes. The first toe is called *hallux* and it is directed backwards.

The *tail* is a small stumpy, conical projection of the trunk beyond the cloacal aperture. It is also called *uroptygium*. It bears a tuft of tail feathers called *rectrices*.

On the mid region of the uropygium, there is an oil gland called *uroptygial gland* or *preen gland*. The oil secreted by the oil gland is picked up by the beak and is used to lubricate the feather.

The tail is used as an organ of *steering*, *balancing* and *brake*.

## Skin

The skin of pigeon is thin and dry. Skin glands are absent. The uropygial gland is the only skin gland.

The skin is formed of two main layers, namely an outer *epidermis* and an inner *dermis*.

The epidermis is formed of three layers, namely an outer *epitrichium*, a middle *stratum corneum* and an inner *stratum germinativum* or *stratum Malpighii*.

The dermis is formed of connective tissue and it contains *nerves*, *blood vessels* and *muscle fibres*.

## Exoskeleton

The exoskeleton in birds is *epidermal* in origin like that of reptiles.

Birds have the following exoskeletal structures:

1. *Beaks*
2. *Claws*
3. *Scales*
4. *Feathers*

### 1. Beaks

Beaks are *horny* structures covering the upper and lower jaws. They help in *feeding*, *preening* and *fighting*.

### 2. Claws

Claws are *horny* structures present on the tip of the toes. They are used for *perching* and *walking*.

### 3. Scales

The scales of birds are epidermal in origin. They cover the lower part of hind limbs. They are of the reptilian type.

### 4. Feathers

Feathers are the *epidermal exoskeleton* of birds.

The arrangement of feathers on the body is called *pterylosis*. The feathers are not arranged throughout the entire surface of the body. But they are arranged in tracts called *pterylae*. Between the pterylae, there are featherless areas called *apteria*.

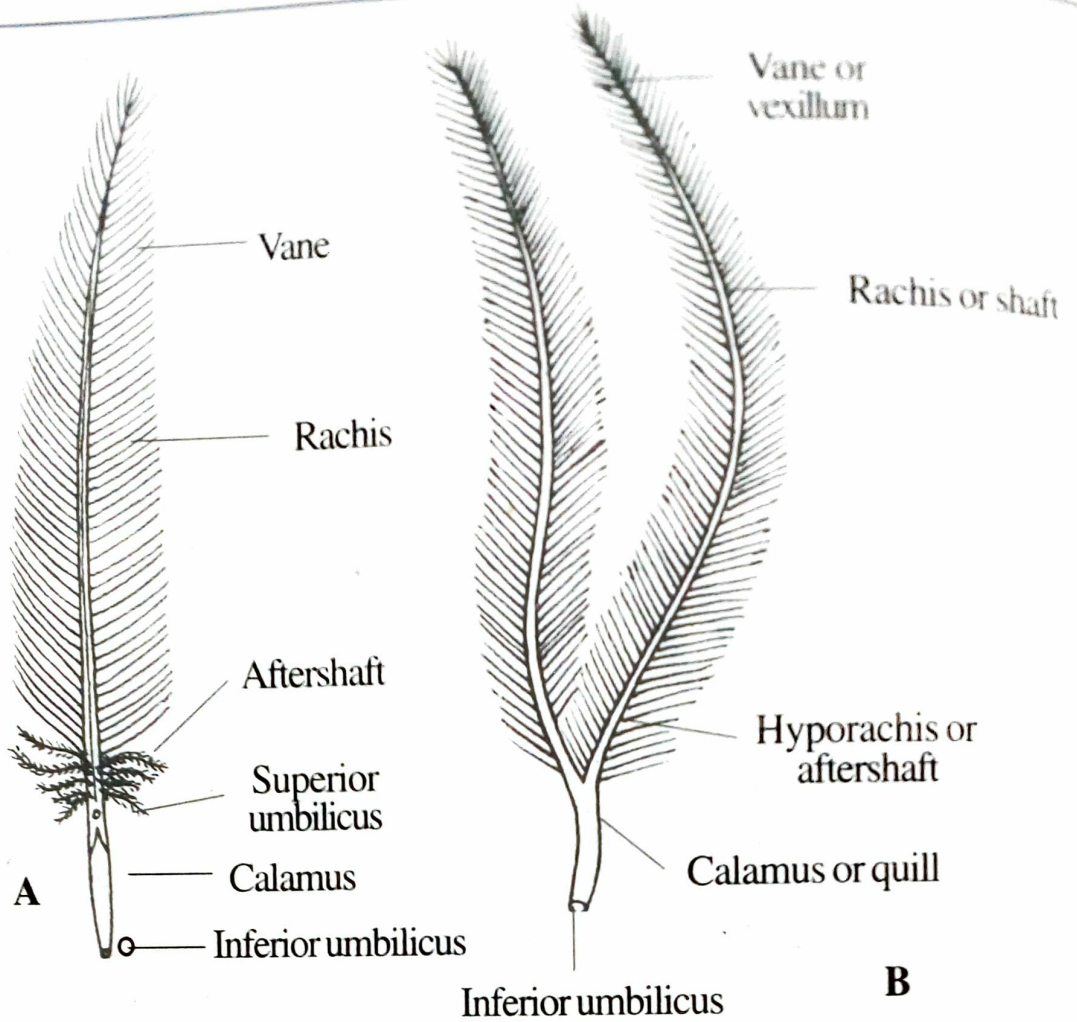


Fig.7.37: Pigeon - A. A typical quill feather, B. A quill feather.

A typical feather has a **central axis** and an expanded portion called **vane** or **vexillum**.

The central axis has a basal portion called **quill** or **calamus** and a distal portion called

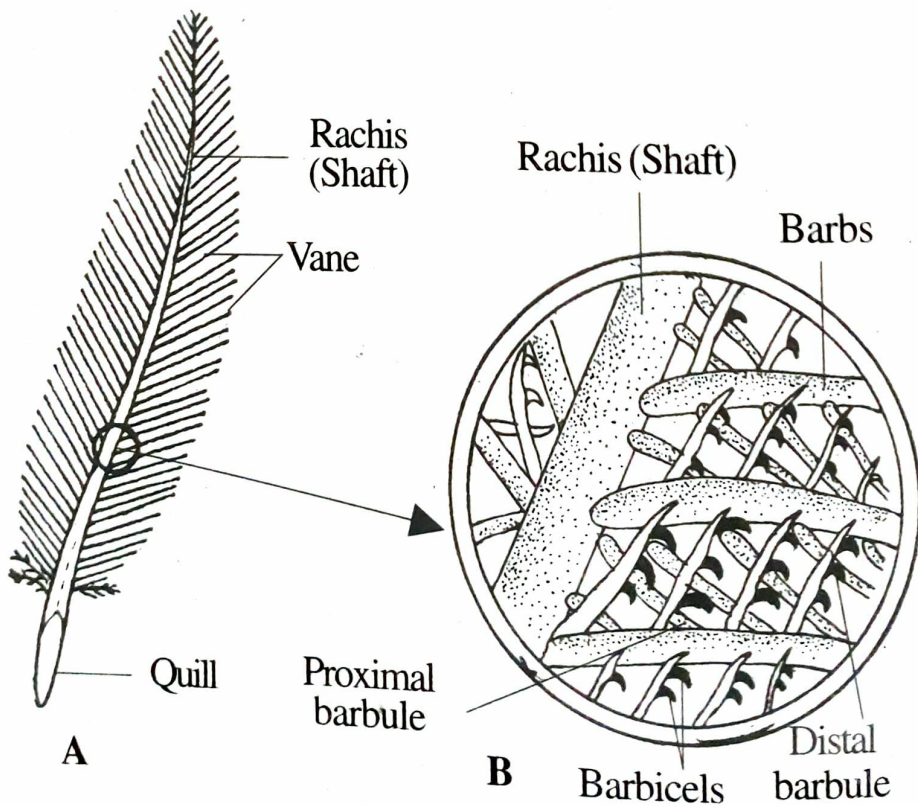


Fig.7.38: Pigeon - A. A typical feather. B. A portion of feather enlarged.



into capillaries.

## Respiratory System

Pigeon exhibits *pulmonary respiration*.

The respiratory system starts from *external nostrils*. The external nostrils are situated near the base of the upper beak, beneath the cere. They open into a pair of *olfactory sacs*.

The olfactory sacs open into the *buccopharyngeal cavity* by a pair of openings called *internal nostrils*.

The buccopharyngeal cavity contains a *slit-like* opening called *glottis*. The glottis opens into a tube called *trachea*.

The trachea is a long tube running the entire length of the neck.

The wall of the trachea is supported by bony rings called *tracheal rings*.

The anterior end of the trachea is enlarged into a chamber called *larynx*.

The larynx is supported by a *cricoid cartilage* and a pair of *arytenoid cartilages*. The larynx does not produce sound.

The trachea divides into two branches called *primary bronchi*.

The primary bronchi are supported by incomplete *cartilaginous rings*. The primary bronchus passes into the lung. The primary bronchus remaining inside the lung is called a *mesobronchus*. The mesobronchus runs upto the posterior end of the lung.

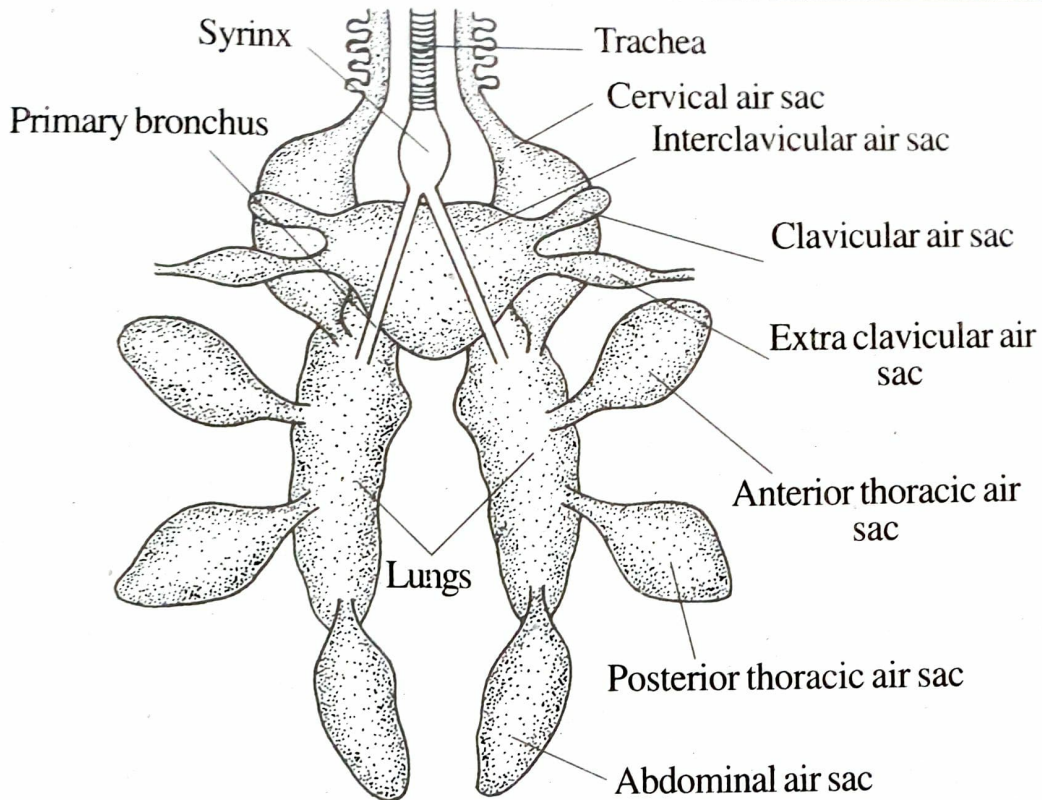


Fig.7.56: Pigeon - Respiratory system - Ventral view showing lungs and nine air sacs.

The mesobronchus gives a number of lateral branches called **secondary bronchi**.

The secondary bronchi of the anterior region are called **ventrobronchi** and the secondary bronchi of the posterior region are called **dorsobronchi**.

The secondary bronchi are connected with each other by numerous thin small tubes called **tertiary bronchi** or **parabronchi**.

The tertiary bronchi give out small branches called **bronchioles** or **air capillaries**. The air capillaries remain in close contact with **blood capillaries**.

Pigeon has a pair of lungs. The lungs are very small. They are not elastic. They are solid and spongy.

The main substance of the lung is formed of a network of **air capillaries**. The air capillaries are connected to the **bronchi**.

The lung of birds is beset with **air sacs**. The air sacs are formed by the expansions of the mucous membrane of the secondary bronchi.

The **air sacs** are thin walled membranous sacs. They are devoid of blood vessels. Pigeon has **nine air sacs**:

1. A pair of cervical air sacs.
  2. A median interclavicular air sac.
  3. A pair of anterior thoracic air sacs.
  4. A pair of posterior thoracic air sacs
- and
5. A pair of abdominal air sacs.

The air sacs communicate with the pneumatic cavities of the bones.

The interclavicular air sac gives out on either side a diverticulum called **clavicular air sac** into the armpit and **extraclavicular air sac** into the humerus.

All the air sacs are connected to the secondary bronchi. From the proximal end of each air sac, except the cervical air sacs, a small tube arises. It is called **recurrent bronchus** or **saccobronchus**.

The recurrent bronchus passes into the lungs and gets connected with the secondary bronchus.



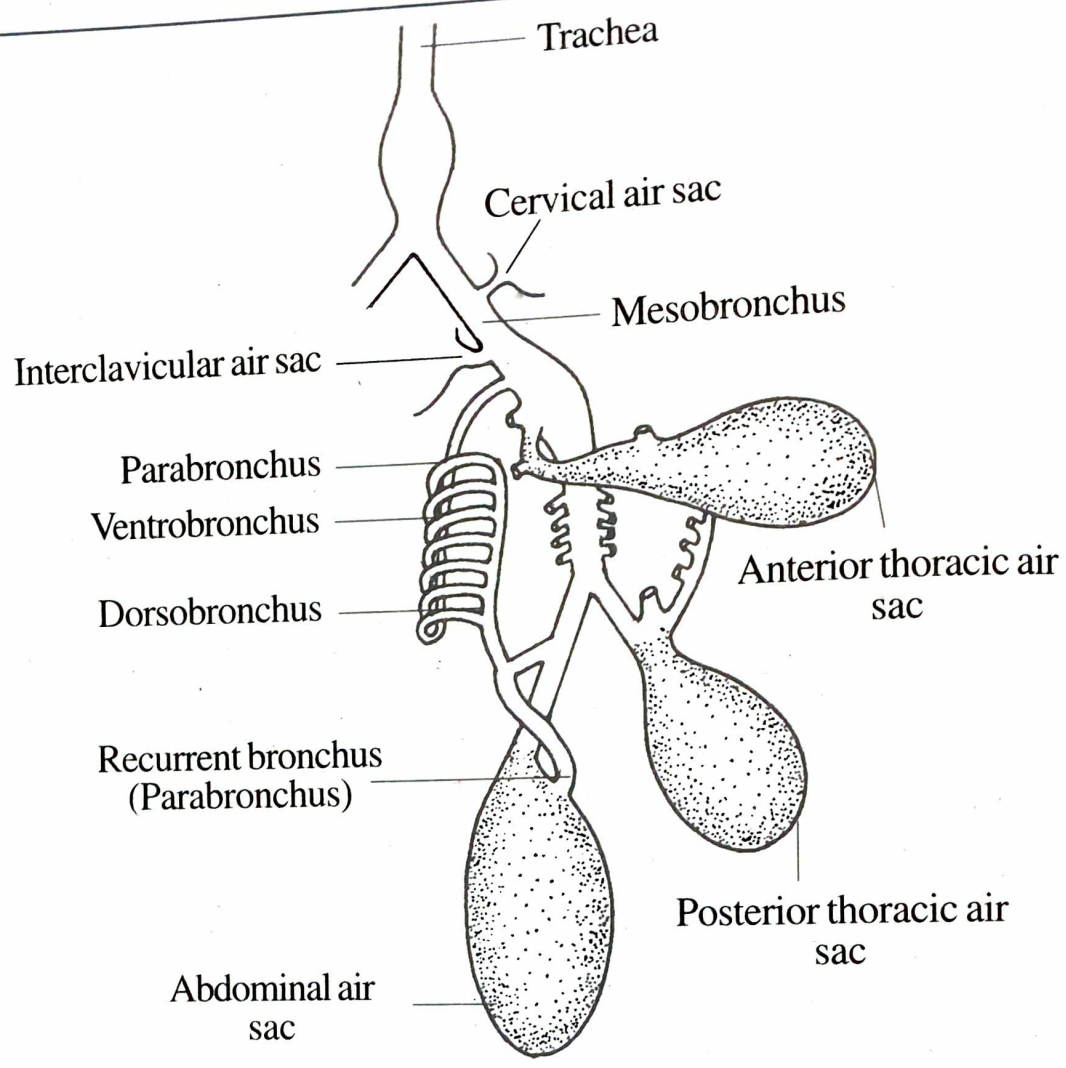


Fig.7.57: Pigeon - Internal structure of a lung showing parabronchus.

Air sacs do the following functions:

1. They act as **reservoirs of air**. They assist in **respiration**.
2. They are also helpful in **thermoregulation**. They help to remove the excess of temperature from the body.
3. They **reduce weight**.

**Mechanism of Respiration**

The mechanism of respiration is unique in birds. Birds exhibit **double respiration** where the lung is exposed to air two times for gaseous exchange.

There are two stages in respiration. They are, **inspiration** and **expiration**.

During inspiration air passes into the lungs. Some air enters the air capillaries and the remaining air passes directly into the air sacs.

In the air capillary, exchange of gases takes place.

During expiration, the deoxygenated air from the air capillaries rushes out through the respiratory tract. At the same time the air from the air sacs passes into the air capillaries through the recurrent bronchi and secondary bronchi. Thus during expiration also the air capillaries are provided with air for gaseous exchange. So birds have double respiration.

The respiratory movements are caused by **two sets of muscles**. One set of muscle operates during flight and the other set works at the time of rest.

During flight both inspiration and expiration are caused by the movements of the **pectoral muscles**.

At rest inspiration is caused by the activities of *intercostal muscles* and expiration is caused by *abdominal muscles*.

## **Sound Producing Organ**

In birds, the sound is produced by the *syrinx*.

It is the *sound box* in birds. It is a unique feature of birds and it is absent from other vertebrates.

It is a sac located at the posterior end of the trachea where the trachea divides into bronchi.

It consists of a cavity called *tympanum*. The wall of the tympanum is supported by *tracheal rings*.

At the junction of the bronchi there is a fold of mucous membrane. It is called *semilunar membrane*. It is supported by a bar of cartilage called *pessulus*.

The mucous membrane of each bronchus forms an *internal tympaniform membrane* associated with the inner wall and an *external tympaniform membrane* associated with the outer wall.

The sound is produced by the vibrations of the tympaniform membranes as the air is expelled from the lungs.

**Flight**



its feathers, birds are described as *glorified reptiles*.

## 5. Flight Adaptations

Birds are aptly described as the *masters of air*. Man constructed aeroplanes after seeing birds.

Birds are good fliers. They are the fastest animals. Their morphology, anatomy and physiology are highly modified for movement in the air.

The following are the flight adaptations of birds:

### 1. Shape

Birds have a *stream lined, boat-shaped* or *spindle-shaped* body. It gives very little resistance while flying.

### 2. Feathers

The body is fully covered by feathers. They have the following functions:

1. Reduce friction.
2. They reduce weight.
3. Wing feathers are used for striking the air.
4. Tail feathers are used for lifting up and steering.

5. Body feathers form a *blanket*. The blanket holds certain amount of air between the body and the feather covering. This air helps the birds to keep a *buoyancy*.

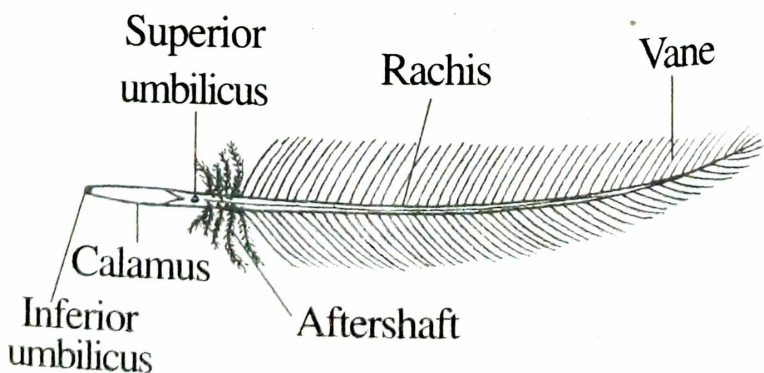


Fig.7.101: A quill feather-A portion of vane magnified.

### 3. Wings

Fore limbs are modified into wings which are used for striking the air.

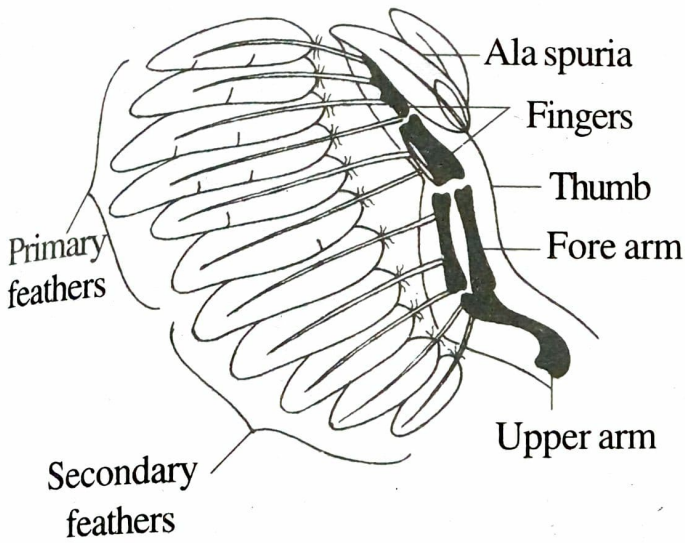


Fig.7.102: A wing.

### 4. Tail

Tail feathers help in lifting up and steering.

### 5. Loss of Weight

For flight, weight must be reduced. This is achieved by the following features:

1. Bones are **pneumatic** i.e. they are provided with air sacs.
2. Skull bones are thin and the sutures are obliterated.
3. Absence of ovary and oviduct from one side.
4. Absence of urinary bladder.
5. Production of solid excretory product in the form of **uric acid**.
6. Absence of teeth.
7. Presence of feathers.

### 6. Flight Muscles

The wing is operated by a set of muscles called **flight muscles**. The flight muscles are highly developed in flying birds and poorly developed in flightless birds.

There are four sets of flight muscles. They are

1. *Pectoralis major*
2. *Pectoralis minor*

### 3. *Coracobrachialis*

### 4. *Tensor muscles*

The *pectoralis major* and *coracobrachialis* bring about the downstroke of the wing.

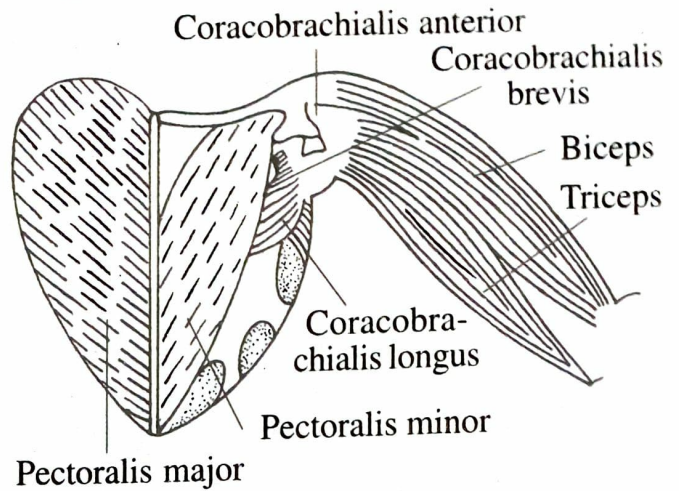


Fig.7.103: Flight muscles.

The *pectoralis minor* brings about the upstroke of the wing.

The *tensor muscles* keep the prepatagium tensely stretched when the wing is extended in flight.

### 7. Air Sacs

Air sacs are thin walled, non-muscular sacs connected to the lungs. There are **paired cervical air sacs, anterior thoracic air sacs, posterior thoracic air sacs** and an unpaired **inter clavicular air sac**. The air sacs serve as reservoirs for air.

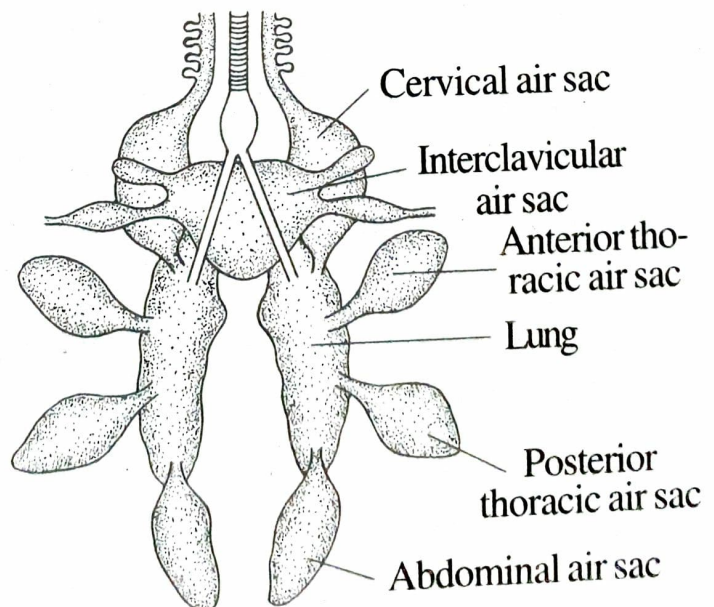


Fig.7.104: Air sacs of pigeon.



In other vertebrates, air is supplied to the lungs only once and that is during inspiration. But in birds, during expiration also air is supplied to the lungs from the air sacs. Thus in birds blood is oxygenated twice during a single breathing. This is called **double oxygenation** or **double ventilation**. Thus the respiratory system is highly adapted to supply more oxygen to the muscle.

**8. Warm Bloodedness**

Birds are warm blooded animals. This helps the perfect aeration of the blood and a great output of energy. The constant body temperature helps the birds to take flight at high altitudes and in all seasons.

**9. Efficient Circulatory System**

Active flight requires high output of energy. High output of energy requires more oxygen. The circulatory system is highly adapted for carrying more oxygen.

1. The blood contains large amount of haemoglobin.
2. Heart is large and divided into four chambers.

**10. Excretion**

The excretory system is highly modified to reduce weight.

1. Urinary bladder is absent.
2. Urine is in the form of **semi-solid uric acid**.

**11. Vision**

The power of eyes is very high. It has **pecten**. This helps birds to see objects from very high altitudes.

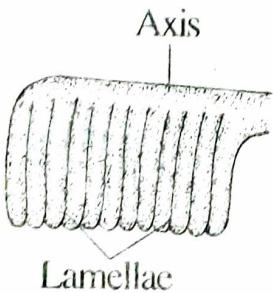


Fig.7.105: Pecten.



Fig.7.106: Foot of a bird.

**12. Perching**

The hind limbs and their muscles are well adapted for perching. Thus a bird sleeping on a perch cannot fall down.

**13. Pneumatic Bones**

The bones in birds are pneumatic containing air sacs. This renders their weight less.

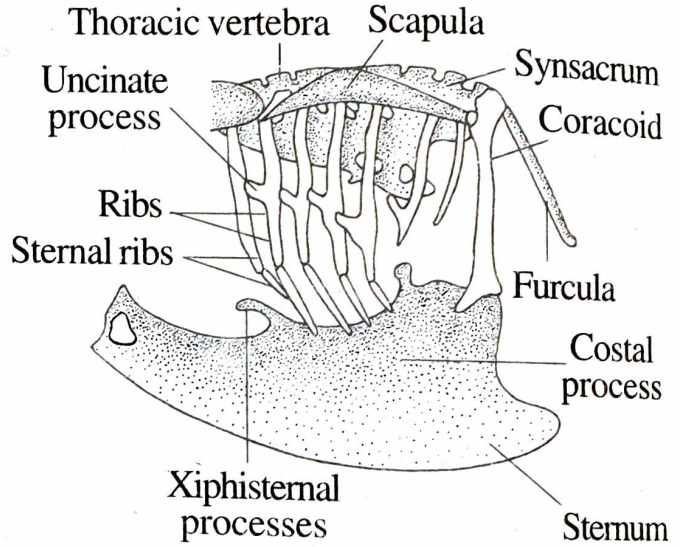


Fig.7.107: Thoracic framework of pigeon to show sternum, ribs with uncinates process, synsacrum and furcula.

**14. Synsacrum**

In the vertebral column about **fourteen vertebrae** are fused together to form a **plate-like structure** called **synsacrum**. It acts as a girder to support the entire weight of the bird. It is formed by the fusion of the following vertebrae:

Thoracic Vertebra	-	1 (last)
Lumbar Vertebra	-	6
Sacral Vertebra	-	2
Caudal Vertebra	-	5

**15. Keel**

The sternum bears a median ridge called **keel** or **carina**. The flight muscles are firmly attached to the keel.

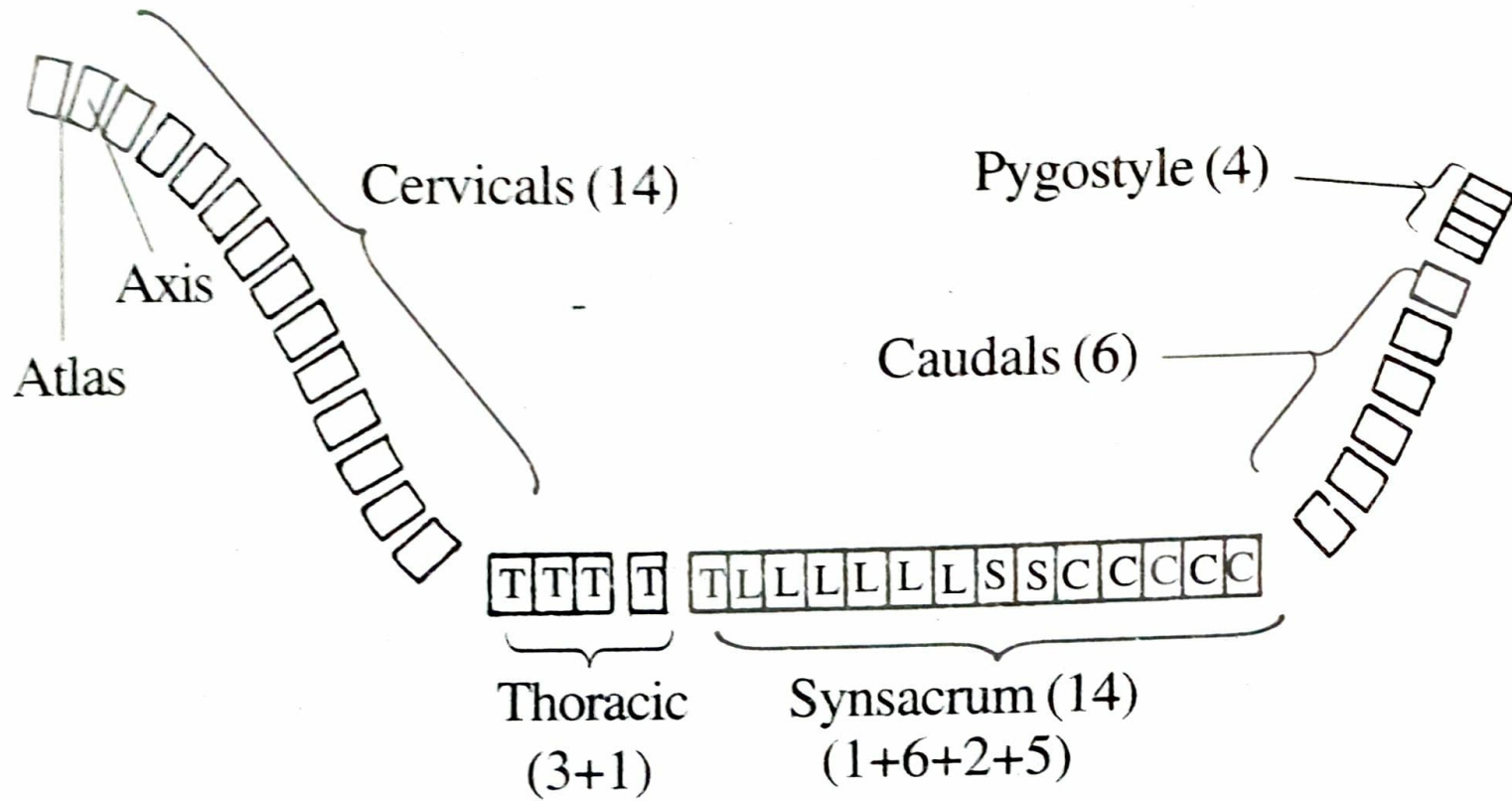


Fig.7.108: Components of the vertebral column of pigeon.

## 16. Furcula

The clavicles of the two pectoral girdles are fused ventrally to form a 'V'-shaped structure called *furcula* or *merry thought bone* or *wishbone*. It works like a spring between the two wings.

1. Breeding

2. Feeding

3. For getting suitable climatic conditions.

### Causes of Bird Migration

The migration of birds is caused by the

following factors:



# Rabbit

## (*Oryctolagus uniculus*)

Phylum	: Chordata
Subphylum	: Vertebrata
Class	: Mammalia
Subclass	: Eutheria
Order	: Lagomorpha

Rabbit is a **typical mammal** with **mammary glands**, a covering of hair and warm blood.

It gives birth to young ones and nourishes them with milk.

It is a **warm blooded** animal.

It enjoys **cosmopolitan** distribution. It lives in forests. It is **gregarious** i.e., it lives in groups.

It is a **burrowing** or **fossorial** animal. It is **herbivorous**. It is **domesticated** for flesh. It is used extensively for biological and medical researches.

Rabbit is **polygamous** and one male lives with many females.

It is usually **brown in colour**; but its colour varies in domesticated animals. It is about 16 inches long and it weighs 2 to 4 **pounds**.

The body is divisible into four regions, namely a **head**, a **neck**, a **trunk** and a **tail**.

The trunk is further subdivided into an anterior **thorax** and a posterior **abdomen**.

The **head** is elongated. Anteriorly the head is produced into a pointed **snout**.

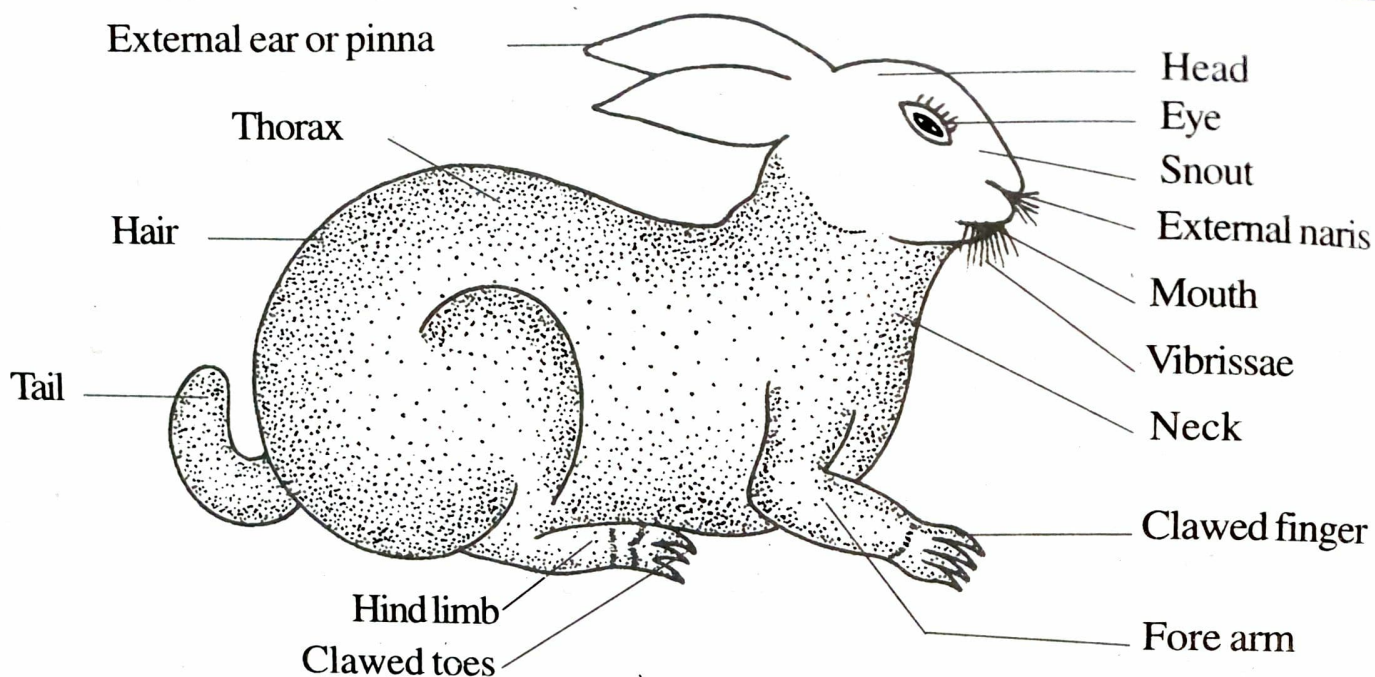


Fig.8.22: Rabbit.

The **mouth** is a transverse slit located at the anterior end, but on the ventral side of the snout. It is bounded by **two lips**, an **upper lip** and a **lower lip**.

The upper lip has a cleft in the middle through which the incisor teeth are clearly visible. Such a lip is called **hare lip**.

The sides of the upper lip produce stiff long thick hairs called **vibrissae** or **whiskers**. They are **tactile sensory organs** (organs of touch).

Just above the mouth, there are two oblique openings called **external nostrils** or **external nares**.

Two eyes are present on the sides of the head. They are protected by an **upper** and a **lower eyelid**.

A third eyelid called **nictitating membrane** is also present on the inner corner of the eye. It is also movable and used to clean the cornea.

The top of the head bears a pair of movable **pinnae**. They are used to direct the sound vibrations into the ear.

At the base of the pinna, there is an opening called **external auditory meatus**.

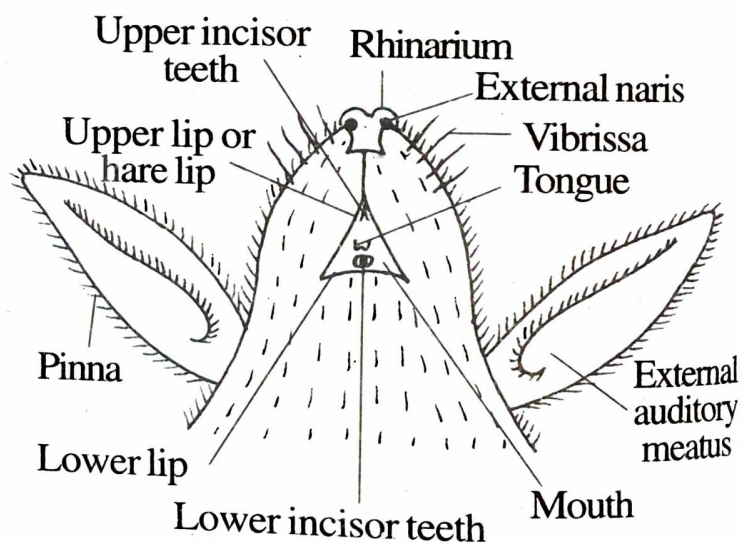


Fig.8.23: Rabbit - Head in ventral view.

The **neck** is short and it connects the head with the trunk. It helps in the free movement of the head.

The **trunk** is divisible into an anterior **thorax** and a posterior **abdomen**.

The thorax encloses a cavity called **thoracic cavity** and the cavity lying inside the abdomen is called **abdominal cavity**.

The two cavities are internally separated by a muscular partition called **diaphragm**.

The thoracic cavity is bounded by a skeletal framework formed of **ribs**.



The ventral side of the abdomen is provided with 4 or 5 pairs of **teats** or **nipples**. They are present in both sexes but well developed in females.

The ducts of the mammary glands open at the tip of teats.

The **anus** is present at the posterior end of the abdomen.

A pair of depressions are found on either side of the anus. These are called **perineal pouches**.

The **perineal glands**, lying inside open into these pouches. The secretions of these glands give the characteristic odour of the rabbit.

In male ventral to the anus, a **penis** is present. In female, in the same place a **slit-like vulva** is present.

The urinogenital opening is situated on the penis in the male and in the vulva in the female.

The male has a pair of **scrotal sacs**, one on either side of the penis. They enclose the testes.

The trunk bears two pairs of limbs, namely **fore limbs** and **hind limbs**.

Each fore limb is divided into three regions, namely a proximal **upper arm**

(brachium), a middle **fore arm** (antebrachium) and a distal **hand** (manus).

The hand is further divided into three regions, namely **wrist** (carpus), the **palm** (metacarpus) and the **digits** (5) with **claws**.

The hind limb is also divided into three regions, namely the **thigh**, the **shank** (crus) and the **foot** (pes).

The foot is further subdivided into an **ankle** (tarsus), an **instep** (metatarsus) and 4 **toes** with claws.

The tail is short and bushy and is located at the posterior end of the trunk.

### Integument (Skin)

The integument forms the covering of the body. It is formed of two layers, namely an outer **epidermis** and an inner **dermis**.

The integument also contains several structures derived from it. They include hairs, claws, nails and glands like **sweat glands**, **sebaceous glands**, **mammary glands**, **perineal glands** and **meibomian glands**.

**Epidermis:** It is the outermost covering of the integument. It is formed of four distinct layers of **stratified epithelial** cells. They are: 1. the **stratum corneum** (outer), 2. the **stratum lucidum** 3. the **stratum granulo-**

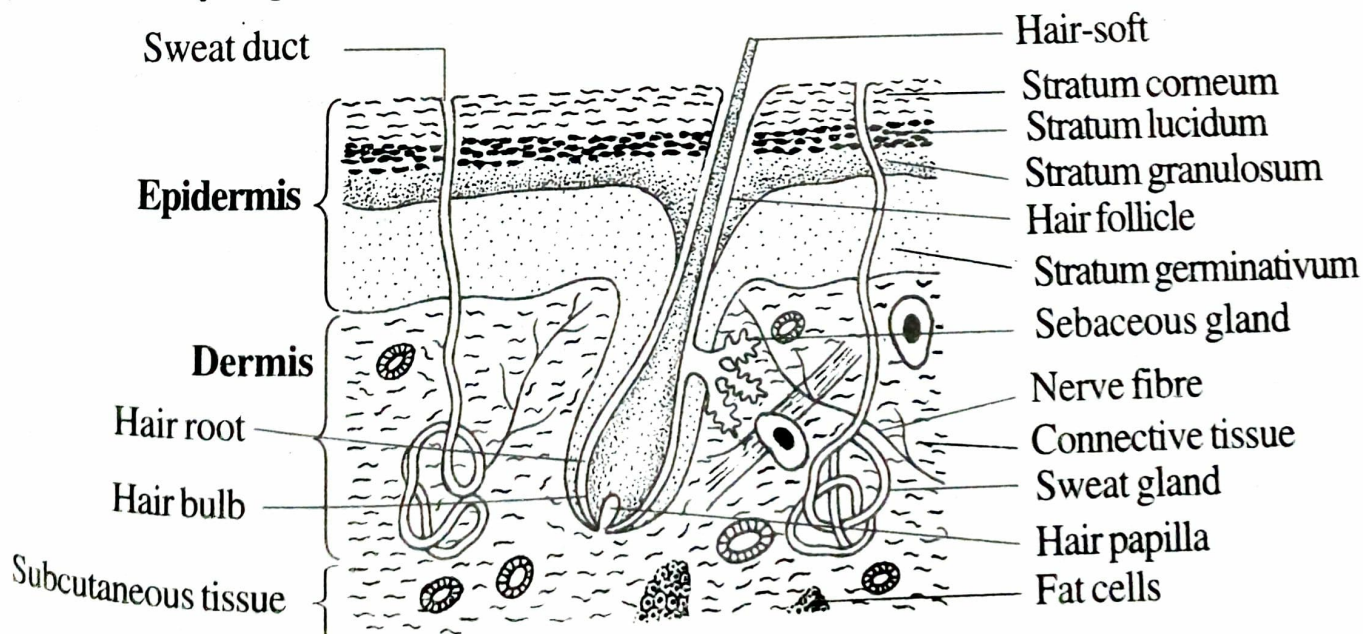


Fig.8.24: Rabbit - V.S. of skin.



*sum* and 4. the *stratum malpighi* or *stratum germinativum*.

The stratum corneum is the outermost layer. It is formed of dead cells. It is water proof because it contains *keratin*. This layer is peeled off periodically.

The second layer, stratum lucidum can replace the *stratum corneum*.

*Stratum granulosum* is formed of *granular cells*.

Stratum germinativum is the innermost layer and is formed of actively dividing cells. It receives the nutritive materials through blood vessels. This layer proliferates other layers of cells.

**Dermis:** The dermis is elastic in nature and is formed of *connective tissue fibres*.

In addition, it contains muscles, fat cells, nerves and blood capillaries.

The dermis also contains *integumental glands*. The root of the hair is embedded in the dermis.

**Hair:** The entire body is covered with hair. It develops from epidermis. It forms the exoskeleton.

Each hair has two parts, namely the *root* and the *shaft*.

The root is *bulb*-like and is embedded in the dermis.

The basal part of the root is enclosed in a *tube*-like structure called *hair follicle*. It is formed by the invagination of the stratum germinativum of epidermis.

The base of the hair follicle has a swelling of dermal tissues containing rich supply of blood capillaries. This is called *hair papilla*. It nourishes the hair.

The hair is covered throughout its entire length by the *cuticle*. Below the cuticle the hair is formed of two layers, namely an outer *cortex* and an inner *medulla*.

**Sebaceous Glands:** It is a branched *cutaneous gland* located by the side of *hair follicle*. It is derived by the out-pushing of hair follicle. Hence it is epidermal in origin. It opens into the hair follicle by a duct.

The secretion of this gland is called *sebum*. It keeps the hair only and water-proof.

**Sweat Gland:** It is an unbranched, long, tubular, much coiled cutaneous gland. It is derived from stratum germinativum; hence it is epidermal in origin. It opens to the outside on the surface of the skin.

It extracts *nitrogenous waste products* from the blood and disposes out in the form of sweat. It also helps to regulate the body temperature.

**Mammary Gland:** It is a modified sebaceous gland. It is formed of *alveoli* and *tubules*. It secretes *milk*.

**Perineal Gland:** It is a modified sebaceous gland. It is situated in the skin around the anus. It opens into the perineal pouches. The secretions are responsible for the characteristic odour of the rabbit.

**Meibomian Gland:** It is a modified sebaceous gland. It is located below the eyelids in the corner of the eye. It secretes an *oily secretion* which *lubricates the cornea*.

## Coelom

Rabbit is a *coelomate* animal. The trunk encloses the coelom. It is divided into two compartments. They are *thoracic cavity* and *abdominal cavity*. The two cavities are separated by a partition called *diaphragm*.



## Mesentery

Mesentery is a double fold of peritoneum which suspends an organ from the body wall. Eg. The *dorsal mesentery* suspends the alimentary canal from the dorsal body wall.

## Omentum

Omentum is a double fold of peritoneum which connects the stomach with some other internal organ. Eg. *Gastroduodenal omentum* connects the stomach with the duodenum.

## Ligament

Ligament is a double fold of peritoneum which joins any two internal organs other than the stomach. Eg. *Hepatoduodenal ligament* joins the liver and the duodenum.

## Diaphragm

Diaphragm is a characteristic feature of mammals. It is absent from other vertebrates.

It is a transverse partition lying between the thoracic cavity and the abdominal cavity.

The diaphragm is convex towards the thoracic cavity and concave towards the abdominal cavity.

Diaphragm assists in bringing breathing movements by altering its shape.

## Digestive System

The digestive system includes the organs concerned with food-grinding, swallowing, digestion, absorption and egestion.

It consists of two components, namely *alimentary canal* and *digestive glands*.

## Alimentary Canal

Alimentary canal is a coiled tube extending between mouth and anus and through which food passes. It includes mouth, vestibule, buccal cavity, pharynx, oesophagus, stomach, small intestine, caecum, large intestine and anus.

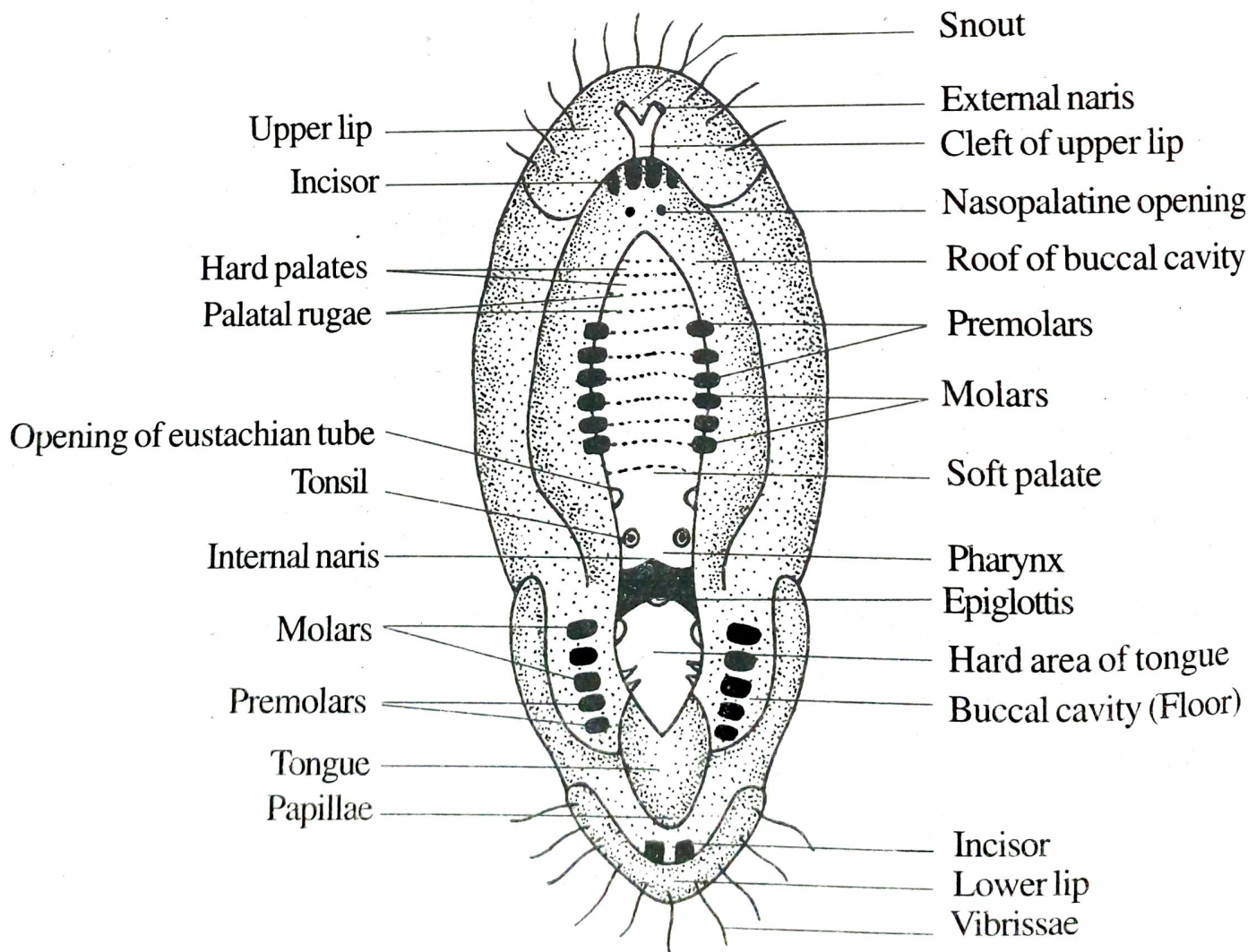


Fig.8.27: Rabbit - Buccopharyngeal cavity.



The alimentary canal starts from the **mouth**. It is bounded by two **lips**, an **upper lip** and a **lower lip**.

The upper lip is divided by a vertical cleft extending upto the nostrils. Through this cleft, the front teeth are exposed. This type of lip is called **hare lip**. Hare lip helps gnawing.

The mouth leads into the **buccal cavity**. It is bounded above by the **palate** and on the side by the **jaws**.

The jaws are **upper jaw** and **lower jaw**. They bear teeth. The floor of the buccal cavity contains a **tongue**.

Palate is the roof of the buccal cavity. It remains as a longitudinal partition between **food passage** and **nasal chamber**.

The anterior part of the palate is called **hard palate**. It is internally supported by the palatine processes of premaxilla, maxilla and palatine. The lower surface of the hard palate bears prominent transverse ridges called **palatal rugae**.

The floor of the buccal cavity is occupied by a muscular **tongue**. It is attached by most part of the posterior end and the anterior end is free.

The dorsal surface of the tongue bears numerous elevations called **papillae**. The papillae are of four types, namely **fungiform**, **filiform**, **circumvallate** and **foliate**. The papillae contain **taste buds**.

The tongue has three functions in rabbit:

1. The tongue manipulates the food.
2. It mixes the food with saliva.
3. It assists the teeth for grinding.

The human tongue, in addition, composes the words when speaking.

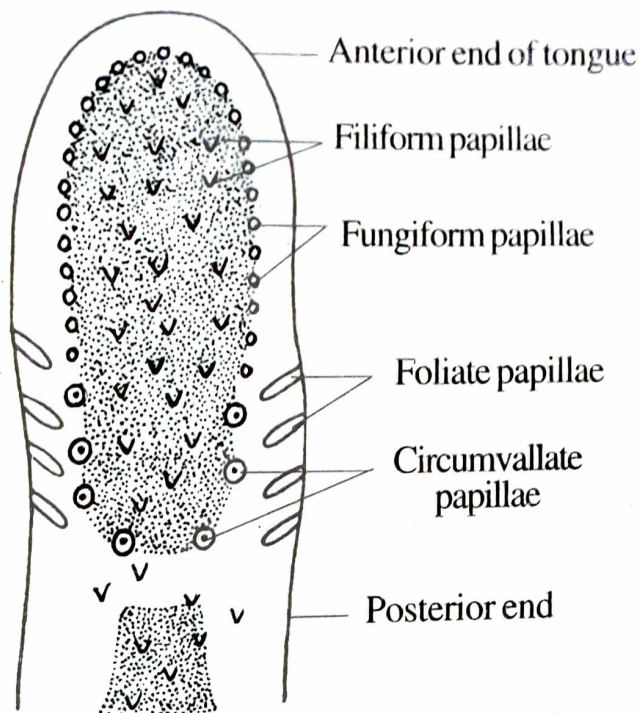


Fig.8.28: Rabbit - Tongue.

The buccal cavity leads into the **pharynx**. It lies beyond the soft palate. The pharynx can be divided into three regions, namely **nasopharynx**, **oropharynx** and **laryngopharynx**.

The **nasopharynx** lies dorsal to the soft palate. Anteriorly, it communicates with the nasal chamber through internal nares.

Laterally, it has a pair of **eustachian openings** leading into the middle ear through **eustachian tubes**. Behind the eustachian openings, a pair of lymphoid tissue, called **tonsils**, lies.

The **oropharynx** lies below the soft palate. It leads into a slit-like opening called **gullet**.

The **laryngopharynx** leads into the **glottis**. The glottis is guarded by a bilobed flap of skin called **epiglottis**.

The gullet leads into a narrow tube called **oesophagus**. It passes through the neck and in the thorax it pierces the **diaphragm** and reaches the abdomen. It serves to convey the food from the pharynx into the stomach.



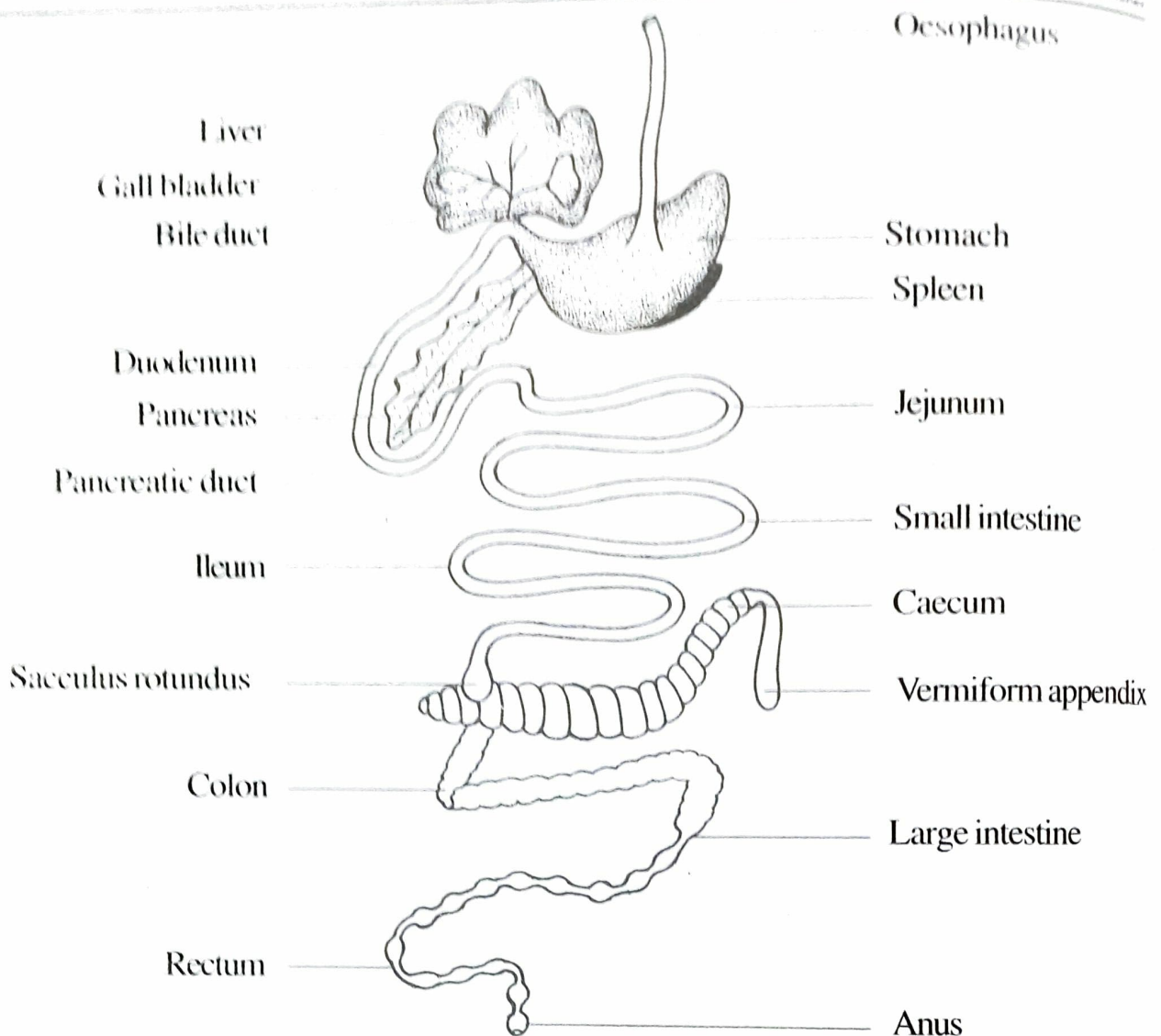


Fig.8.29: Rabbit - Digestive system.

The oesophagus opens into the stomach. It is a curved sac placed transversely at the anterior end of the abdomen. It has an anterior concave side called *lesser curvature* and posterior convex side called *greater curvature*. A *spleen* is attached to the greater curvature of the stomach.

The stomach has three regions, namely an anterior *cardiac stomach*, a middle *fundic region* and a posterior *pyloric stomach*.

The oesophagus opens into the cardiac stomach in the lesser curvature. This opening is called *cardiac aperture*. It is guarded by a valve called *cardiac sphincter* which prevents the passage of food back into the oesophagus.

The pyloric stomach opens into the small intestine by an opening called *pylorus* and is guarded by a valve called *pyloric sphincter*.

The stomach is followed by the *small intestine*. It is narrow coiled and much elongated. It comprises the longest part of the alimentary canal extending a length of 2 - 2.5 metres. It consists of three regions, namely *duodenum*, *ileum* and *sacculus rotundus*.

The stomach leads into the *duodenum*. It is *U*-shaped. It has a *descending limb* and an *ascending limb*. The descending limb receives the *bile duct* and the ascending limb receives a *pancreatic duct*.

The duodenum leads into **ileum**. It is very long and greatly coiled. The internal lining of ileum is raised into numerous **finger-like** processes called **villi**. Villi increase the surface area of the intestine.

The ileum leads into a spherical sac called **sacculus rotundus**.

**Caecum** is a thin walled sac. It is located between the small intestine and large intestine. It is about one foot long. It has a spiral valve inside. The spiral valve is externally marked by spiral constrictions. The caecum leads into a blind tube called **vermiform appendix**. It is about 10 cm long.

The caecum contains **bacteria** which **digest cellulose**.

The small intestine opens into the **large intestine**. The large intestine helps in the formation, storage and elimination of faeces. It also helps in digestion and absorption. It is about 1 m long. It consists of two regions, namely **colon** and **rectum**.

Colon is the anterior part of the large intestine. On one side it has a longitudinal band called **taenia**. The colon has a sacculated appearance owing to a series of constrictions. The constrictions form **pocket-like** pouches called **haustra**.

The colon leads into the **rectum**. It is about 75 cm long.

It has a beaded appearance owing to the presence of faecal pellets in it.

The rectum opens to the outside by the **anus**. It is guarded by an anal **sphincter**.

## Digestive Glands

The glands which help in digestion are called **digestive glands**. They have duct and are called **duct glands**. Their secretions are poured not into blood but into alimentary canal. Hence they are also called **exocrine glands**. Their secretions are called **enzymes**.

Rabbit has six types of digestive glands. They are mucous glands **salivary glands**, **liver**, **pancreas**, **gastric glands** and **intestinal glands**.

### 1. Mucous Glands

Mucous glands secrete **mucus**. It contains mucin which is **proteinaecious** in nature. The mucus glands present in the **digestive tract**. They are mainly found in the lining of the vestibule. The mucus helps in the moistening and swallowing of food in the buccal cavity. The mucous lining throughout the alimentary canal protects it from the action of enzymes.

### 2. Salivary Glands

Salivary glands secrete **saliva**. They are present in the head. Their secretions are poured into the buccal cavity by **salivary ducts**.

Rabbit has **four pairs** of salivary glands. They are named according to their locations. They are

1. **Parotid glands**, situated at the base of the pinna.
2. **Infra-orbital glands**, situated below the orbits,
3. **Submandibular** or **submaxillary glands**, located near the angles of the jaws.
4. **Sublingual glands**, situated below the tongue.

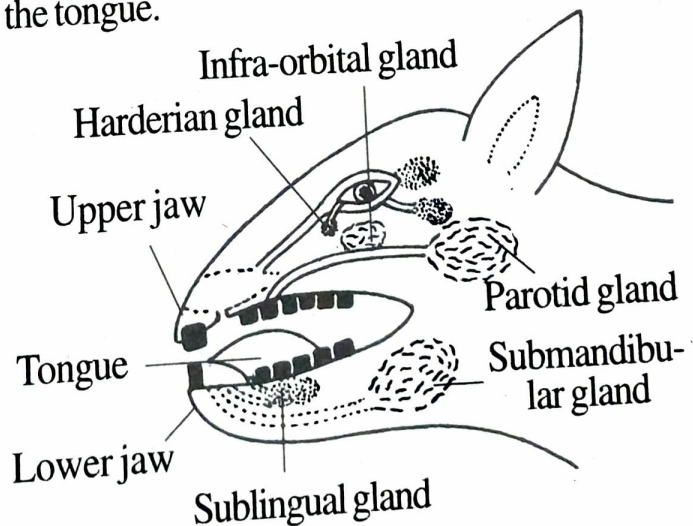


Fig.8.30: Rabbit - Salivary glands



The saliva mixes with the food in the buccal cavity. It functions as a lubricant for swallowing.

It also contain an enzyme called *ptyalin*.

### 3. Liver

Liver is the **largest digestive gland**. It is dark red in colour. It remains in the concavity of the diaphragm in the abdomen. It is attached to the diaphragm by a **suspensory ligament**.

The liver is formed of five lobes, namely a **caudate lobe**, a **right central** or **cystic lobe**, a dorsal **spigelian lobe**, a left **central lobe** and a left **lateral lobe**.

An elongated thin walled sac called **gall bladder** lies in the right central lobe. The liver cells secrete **bile**. It is stored in the gall bladder. Bile is a **greenish fluid**.

A duct arises from the gall bladder. It is called **cystic duct**. From each lobe arises a duct called **hepatic duct**. The hepatic ducts unite with the cystic duct and a common duct is formed. This common duct is called **bile duct**. The bile duct opens into the descending limb of duodenum near the pylorus.

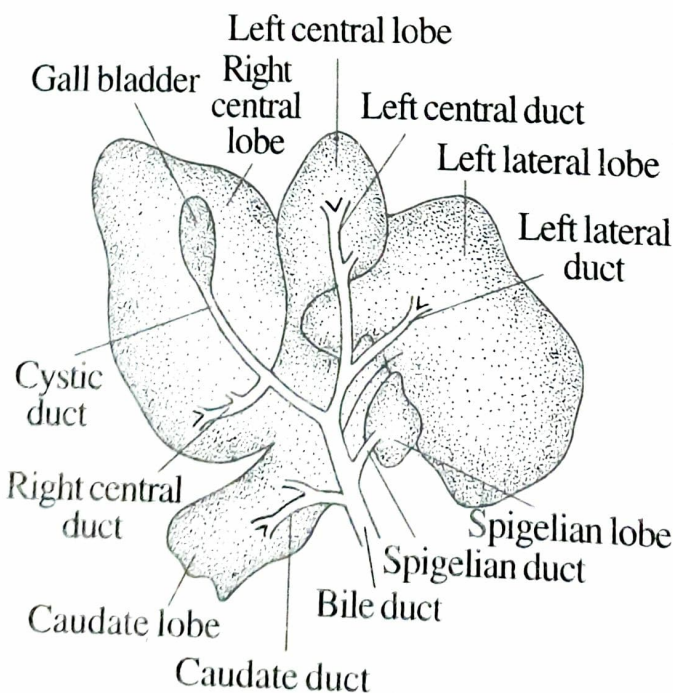


Fig.8.31: Rabbit - Liver.

### 4. Pancreas

Pancreas is an irregular **pinkish** gland located between the two limbs of the duodenum. It secretes **pancreatic juice** which is carried to the ascending limb of the duodenum by a **pancreatic duct**.

The pancreatic juice contains several enzymes like **trypsinogen**, **chymotrypsinogen**, **amylase**, **lipase**, **nucleases**, **nucleotidases** and **exopeptidases**.

The pancreas also contains an endocrine gland called **islets of Langerhans**. It secretes **insulin**.

### 5. Gastric Glands

The mucous membrane of the stomach contains numerous branched glands called **gastric glands**. They are of three types, namely **cardiac gastric glands**, **fundic gastric glands** and **pyloric gastric glands**. They secrete **gastric juice**.

The gastric juice contains, **pepsinogen**, **renin** and **hydrochloric acid**.

### 6. Intestinal Glands

The mucous membrane of the small intestine contains numerous, simple, tubular glands called **intestinal glands**. They secrete **intestinal juice** or **succus entericus**. It contains **mucous** and many enzymes such as **exopeptidases**, **nucleosidases** and **enterokinase**.

## Feeding

Rabbit is a **herbivorous** animal. It feeds on green leaves, vegetables, grasses, cereals, roots, barks, etc.

The incisors cut the food materials. Food pieces are taken in by the lips. The premolars and molars grind the food materials.

Mucous and saliva are added to the masticated food. In the buccal cavity, the tongue mixes well and makes the food into a ball called **bolus**. The bolus is swallowed



through the gullet. During swallowing, the epiglottis closes the glottis.

Digestion is a process where the complex food materials are broken into simple materials by mechanical and chemical means.

Digestion starts in the buccal cavity, continues in the stomach and it is completed in the small intestine.

Rabbit and other herbivorous animals cannot digest cellulose because they do not contain cellulase. The caecum of these animals contain large number of *symbiotic bacteria*. They digest cellulose into sugars.

The semi-digested food present in the stomach is called *chyme*.

In the intestine, the chyme is converted into a watery emulsion called *chyle*. Chyle is ready for absorption.

Absorption refers to the diffusion of digested food materials into the blood and lymph. It occurs mainly in the *ileum* and also in the *colon*.

The efficiency of absorption in the ileum is increased by the great length of ileum, slow movement of digested food in the ileum and the presence of *villi*.

The *amino acids* and *sugars* are absorbed through the capillaries. The *fatty acids* and *glycerol* are absorbed through the lacteal (lymph vessel).

The undigested materials pass into the colon. In the colon, most of the water is reabsorbed.

In the rectum, the faeces form small pellets which are eliminated through the anus. This process is called *defaecation* or *egestion*.

#### Coprophagy

Rabbit has the habit of eating its own faeces. This habit is called *coprophagy*. Faeces produced during night alone are eaten up which are soft and moist owing to incompletely digested cellulose. Faeces

produced during day are dry and hard and not at all eaten.

By eating the faeces rabbit is able to extract the entire nutrients lost in the faeces. If the rabbit is prevented from eating its own faeces, it will die.

### Teeth

Teeth are hard *bone*-like structures used to cut, tear and grind the food materials. The study of the structure, arrangement and function of teeth is called *dentition*.

They are present in a single row on the upper jaw and lower jaw. The basal portion of the teeth is embedded in sockets of the jaw bones. This type of teeth is called *thecodont* (L, *theca*-case of sheath; G, *odous*-teeth).

Rabbit has two set of teeth in its life time. The first set persists in the young rabbit and it is called *milk dentition* or *deciduous dentition*. It is lost in young and is replaced by another set in the adult. This second set of teeth is called *permanent dentition*.

The existence of two sets of teeth in the life of an animal is called *diphyodont dentition*.

In rabbit, the teeth are of different types. Hence the dentition is called *heterodont*.

### Structure of a Typical Tooth

The tooth is a derivative of epidermis and dermis. A tooth consists of three regions, namely *crown*, *neck* and *root*.

The crown is the exposed part. The neck is the middle portion of the tooth and is surrounded by a soft fleshy skin called *gum*. The root is embedded in a socket of the jaw bone.

The tooth is made up of a substance called *dentine*. The tooth encloses a cavity in the centre called *pulp cavity*. The pulp cavity contains *pulp*. The pulp consists of a gelatinous connective tissue with blood vessels, lymph vessels and nerve fibres. The pulp cavity has a



canal at the base called **pulp canal**. Through the pulp canal blood vessels, nerve fibres, etc. enter the pulp cavity. The pulp cavity is lined by dentine forming cells called **odontoblasts**.

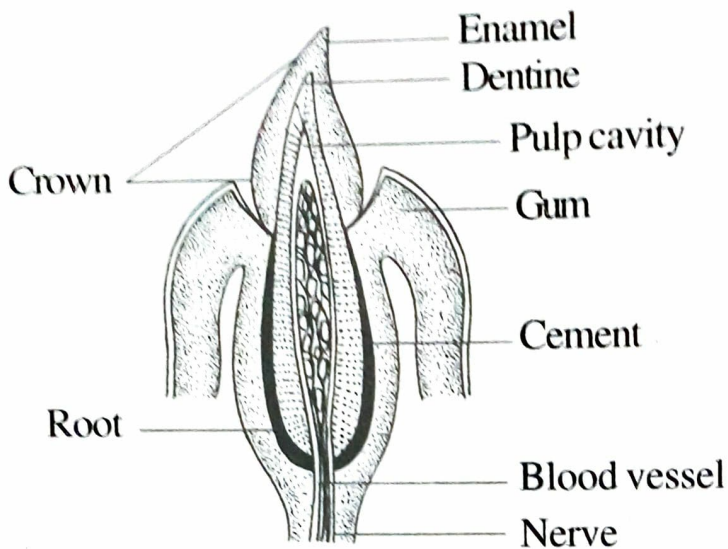


Fig.8.32: Rabbit - A typical tooth in vertical section.

The crown is coated with a white shining **calcareous** material called **enamel**. The root is coated with another substance called **cement**.

In rabbit, the pulp canal remains open permanently. This type of tooth is called **open rooted**. As the tooth receives blood throughout life, the tooth grows. But the size of the tooth remains constant as it wears when it is used.

In man, the pulp canal closes after the full growth of the tooth. Such a type of tooth is called **close rooted**. The close rooted tooth does not grow as the blood supply is denied.

### Types of Teeth

A typical mammal has four types of teeth. They are, **incisors**, **canines**, **premolars** and **molars**. But rabbit has only three types of teeth. The canines are absent.

Incisors are the **front teeth** and are **chisel-shaped**. They are used for cutting and hence they are also called **cutting teeth**. They are single rooted.

The premolars and molars are collectively called **cheek teeth**. They have broad surfaces used for grinding. Hence they are also called **grinding teeth**.

The premolar tooth has two roots and the molar has more than two roots.

There remains a gap between incisors and premolars in the upper jaw and lower jaw. This gap is called **diastema**. Diastema is due to the absence of canines.

Diastema is present in herbivorous animals only. In carnivorous animals, this place is occupied by the canines.

Diastema helps to identify a skull, whether it belongs to a herbivorous or carnivorous animal.

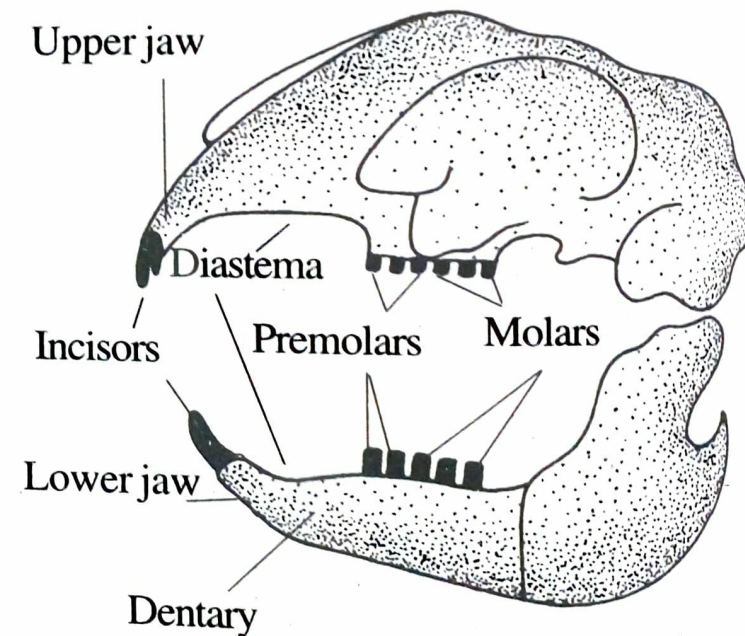


Fig.8.33: Rabbit - Dentition.

### Dental Formula

The number and arrangement of teeth in a species of mammal can be represented in the form of a formula called **dental formula**. In dental formula, the types of teeth are represented by their first letters **i**, **c**, **p** and **m**. The teeth on the upper and lower jaws are separated by a horizontal line. The teeth on one side of the upper jaw and lower jaw are recorded in dental formula because the teeth

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on both sides are identical. The dental formula for rabbit and a few mammals are given below:

### *Rabbit*

$$i \frac{2}{1}, c \frac{0}{0}, p \frac{3}{2}, m \frac{3}{3} = \frac{8}{6} \times 2 = 28$$

### *Man*

$$i \frac{2}{2}, c \frac{1}{1}, p \frac{2}{2}, m \frac{3}{3} = \frac{8}{8} \times 2 = 32$$

### *Opposum*

$$i \frac{5}{4}, c \frac{1}{1}, p \frac{3}{3}, m \frac{4}{4} = \frac{13}{12} \times 2 = 50$$

### *Horse*

$$i \frac{3}{3}, c \frac{1}{1}, p \frac{4}{4}, m \frac{3}{3} = \frac{11}{11} \times 2 = 44$$

### *Elephant*

$$i \frac{1}{0}, c \frac{0}{0}, p \frac{0}{0}, m \frac{3}{3} = \frac{4}{3} \times 2 = 14$$

### *Dog*

$$i \frac{3}{3}, c \frac{1}{1}, p \frac{4}{4}, m \frac{2}{3} = \frac{10}{11} \times 2 = 42$$