
UNIT 2 BODY SYSTEMS AND FUNCTIONS

Structure

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2.0 OBJECTIVES

After studying this unit, you will be able to:

- identify the different external and internal parts of birds;
- describe the different parts of digestive system of poultry; and
- discuss the different parts of reproductive system of poultry.

2.1 INTRODUCTION

Poultry is a warm blooded vertebrate; which means that their body temperature is relatively high and usually almost constant. They lay eggs that are incubated outside the body. During natural embryonic development, the eggs of the poultry are covered by the hen and they are maintained at a temperature close to her body temperature for the entire incubating period. An understanding of how various systems function within the body of the poultry makes it easier to know why certain practices are recommended time to time in different chapters related to poultry farming. From the structural standpoint, poultry is an interesting creature. It possesses feathers, has a breastbone and spur, but lacks teeth. Within poultry, chickens have a comb, which sets it apart from others birds. The comparison with most of the other domestic animals used for the production of food for mankind, the poultry is a short lived creature. It is a rapid breather, has a pulse rate of about 300 to 370 beats per minute and digests its food relatively quickly. The body temperature is higher than that of other domestic animals, averaging about 41°C or 106°F with variations between day and night temperatures.

2.2 EXTERNAL AND INTERNAL PARTS OF BIRDS

Before discussing the management of the poultry, it is necessary to have some basic knowledge of the physical feature of the poultry itself.

2.2.1 External Surface

The bird's body is covered with a combination of skin, feathers and localized scales, with the latter being a derivative of reptiles.

(i) **Feathers:** Birds are almost completely covered with feathers. During the evolutionary process of the poultry, most of the reptilian scales changed to feathers. Both scales and feathers are chiefly composed of the same protein and keratin. Feathers serve many purposes such as:

- Helps in flying
- Providing insulation from extremes of temperature (heat and cold)
- Protection from rain and snow

The condition of the feathers often serves to indicate whether a bird is sick or healthy. In certain breeds and varieties, the changes in the colour or colour pattern of the feathers serve as an index of certain nutritional deficiencies in the diet.

Since the feathers serve as insulation and the heat loss is roughly proportional to the surface area of the body, it is interesting to observe that the weight of feathers bears a closer relationship to body weight than does the number of feathers. The feathers in large sized birds tend to be larger than in small sized birds. Neither the weight nor the number of feathers serves as a satisfactory index of the insulating or thermoregulatory capacity of feathers. The weight of feathers apparently varies from about 4 to 8 per cent of live body weight with a difference being related to age, sex etc. Older male birds have a lower percentage of feathers than the females and younger birds. The number of feathers on birds in most of the breed varies from about 6,000 to 9,500. The order of the appearance of the various feather tracts is shoulder and thigh; rump and breast; neck, abdomen and leg; back, wing coverts and head.

(ii) **Head:** The head of the chicken includes the following parts:

- (a) **Comb:** There are several types of comb such as single, rose, pea, cushion, strawberry, walnut, V and butter cup. Out of this, single, rose and pea combs are common in commercial chicken. Comb type is the result of gene interaction, but comb size is associated with gonadal development and the intensity of light, either natural or artificial.
- (b) **Eyes:** Poultry have the ability to differentiate various colours and have superior ability to focus and to detect movements. The avian eye is the finest ocular organ in the animal kingdom.
- (c) **Eyelids:** The prominent laterally located eyes are provided with upper and lower lids.
- (d) **Eye rings:** Inner margin of eyelids.
- (e) **Eyelashes:** Bristle feathers composed of a straight shaft.

- (f) **Ears:** Avian species are known for their keen sense of hearing. Their voice production and ability to intimate sounds infers an exceptional degree of pitch discrimination.
 - (g) **Earlobes:** Fold of the skin just below the ears in fowls.
 - (h) **Wattles:** The two red pendulous muscles on either side of the eye or near the beak.
 - (i) **Beak:** The beak is a multi-functional organ of considerable importance. It is involved in procuring food, defence and aggression in social behaviour, courtship, nest making, grooming and communication. Its normal functions are often adversely affected by improper beak trimming.
- (iii) **Feet and shanks:** The shanks and most parts of the feet are covered with scales of various colours. Yellow is due to dietary carotenoid pigments in the epidermis when melanic pigment is absent. Varying shades of black are the result of melanic pigment in the dermis and the epidermis. When there is black in the dermis and yellow in the epidermis, the shanks have a greenish appearance. In the complete absence of both of this pigment, the shanks are white. Important parts of the shank and foot are:
- (a) **Hock:** The joint portion between thigh and shank.
 - (b) **Shank:** The lower portion of the leg.
 - (c) **Toes:** Most chickens have four toes on each foot, but there are a few breeds with five toes.
- (iv) **Skin:** Most of the chicken's body is covered with a thin skin. The absence of sweat glands makes it impossible for the bird to cool itself by evaporation from the surface of the body. The skin has a coarser texture in the areas of the comb, wattles, earlobes, beak, scales, spurs and claws.

In short, the external body parts of poultry can be divided into five different regions and their parts are as follows:

Sl. No	Name of the Region	Chicken	Duck	Turkey
1.	Head	i. Comb	i. Bill	i. Eye
		ii. Point of comb	ii. Eye	ii. Ear
		iii. Blade of comb	iii. Ear	iii. Beak
		iv. Base of comb	iv. Nostril	iv. Snood
		v. Beak		v. Nostrils
		vi. Eye		vi. Throat wattles
		vii. Ear		vii. Ear opening
		viii. Earlobe		
		ix. Wattle		
		x. Nostrils		
2	Neck	i. Hackle	i. Neck feather	i. Caruncle
3.	Trunk or body	i. Wing bow	i. Wing bow	i. Body coverts
		ii. Wing bar	ii. Wing bar	ii. Breast
		iii. Breast	iii. Breast	iii. Secondary and primary feathers

		iv. Primary feather	iv. Primary feather	
		v. Secondary feather	v. Secondary feather	
		vi. Axial feather	vi. Axial feather	
		vii. Fluff	vii. Fluff	
		viii. Back	viii. Back	
4.	Tail	i. Saddle feather	i. Tail feather	i. Tail
		ii. Sickle feather		
		iii. Lesser sickle feather		
		iv. Main tail feather		
5.	Limbs	i. Thigh	i. Thigh	i. Thigh
		ii. Drum stick	ii. Drum stick	ii. Hock
		iii. Hock	iii. Hock	iii. Shank
		iv. Shank	iv. Shank	iv. Spur
		v. Spur	v. Spur	v. Toe nail
		vi. Toes	vi. Toes	vi. Toes
		vii. Toe nail	vii. Toe nail	
		viii. Claws	viii. Claws	
			ix. Prominent web	

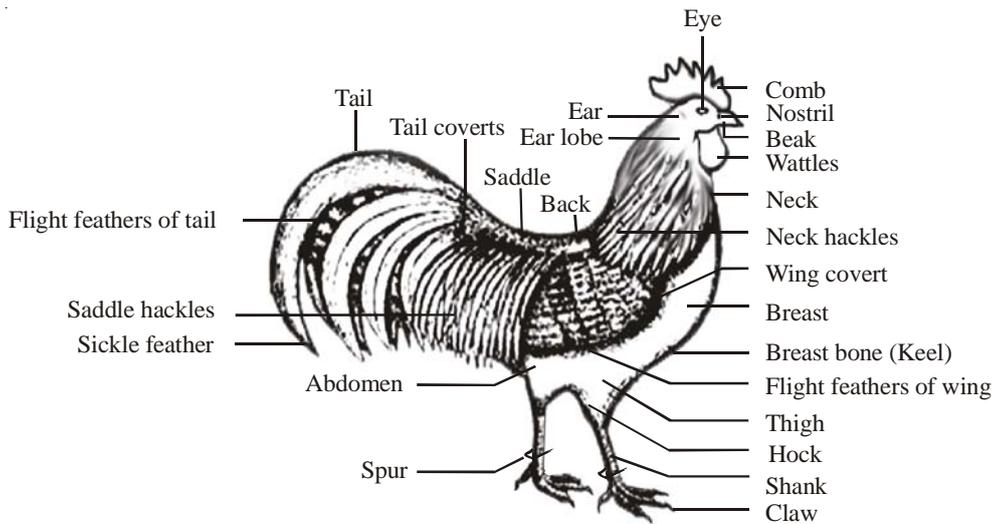


Fig. 2.1: Body parts of a chicken

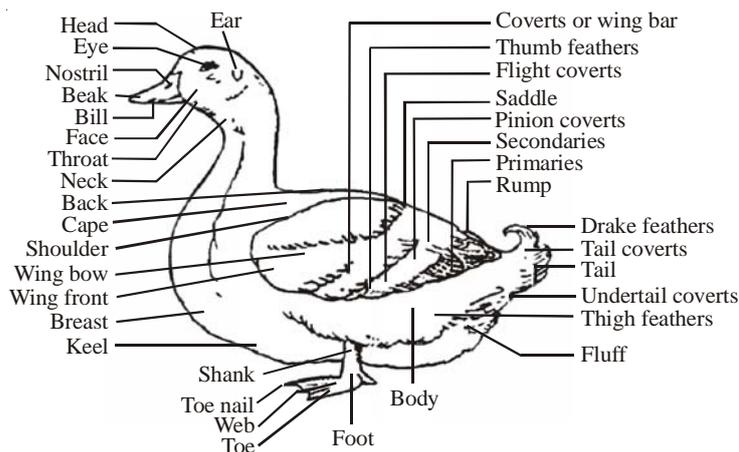


Fig. 2.2: Body parts of a duck

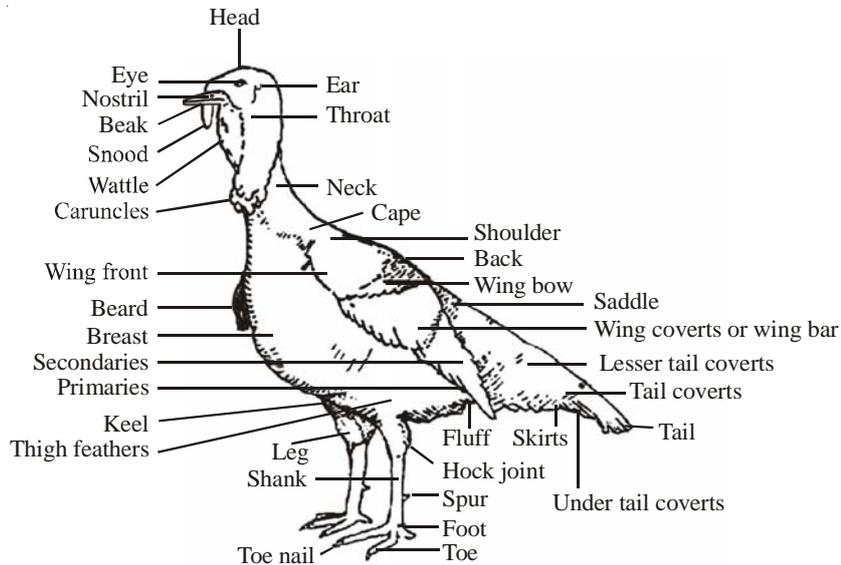


Fig. 2.3: Body parts of a turkey

Activity 1

Look at a chicken or duck or turkey available in your locality and try to identify different external body parts.

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2.2.2 Internal Surface

The internal surface of the bird’s body consists of various systems like skeletal, muscular, respiratory, urinary, circulatory, nervous, digestive and reproductive systems. The details of each system are detailed below:

(i) Skeleton (The Skeletal System)

The skeleton of the chicken is light in weight, but is very strong. The bones are especially rich in calcium salts and are thus very dense. There are 13 or 14 cervical vertebrae and 7 thoracic vertebrae in the vertebral column. Several of the coccygeal vertebrae are fused to form the last segment of the coccygeal group. This segment is called the “pygostyle”, the last bone being called the “urostilus”. The pygostyle forms the skeletal support for the feathers of the tail.

The chicken has seven pairs of ribs. The sternum is long and broad and support for viscera. The relative position of the two pubic bones to each other and the relative distance between the ends of the pubic bones and the posterior end of the sternum in hens that are in laying condition as compared with hens that are not in laying condition are important for judging of birds. When a hen is in laying condition, the pubic bones are spread far apart and there is a considerable space between the ends of the pubic bones and the end of the sternum. This factor is of practical importance in culling laying flock. Bones found in the skull, humerus, keel, clavicle and some vertebrae are hollow and connected to the respiratory system with air continually moving in and out of these specialized bones. There is also a soft, spongy bone material known as modularly bone present in varying amounts in the long leg bones (Femur and Tibia), and certain other bones of the skeleton of females. This meduallary is used to store calcium for later use in egg shell formation.

(ii) Muscles (The Muscular System)

The chicken has a very complex muscular system but there are only a few details of interest to students of poultry Husbandry. The breast or pectoral muscles are the largest of all the muscles and besides enabling the bird to raise and lower its wing, sometime provide the largest share of meat obtained from a chicken. Muscles are categorized by their function as voluntary or involuntary. Voluntary muscles are used for movement and flight while involuntary muscles (smooth muscles) are used in the functioning of organs such as the heart, intestines, blood vessels and others. Muscles that move the wings are attached to the keel (breastbone). These muscles also support the vital organ of the abdominal cavity. These muscles are well developed in most birds, but especially in meat type broiler strains, as genetic selection has produced birds with larger breasts.

(iii) Respiratory System

The respiratory system of poultry consists of nasal cavities, larynx, trachea, syrinx, bronchi, lungs, air sacs and air containing bones. Lungs of the poultry are small compared with those of mammals. They expand or contract only slightly and there is no true diaphragm. The lungs are supported by nine air sacs and a group of hollow, air containing bones. There are two pairs of thoracic and two pairs of abdominal air sacs and a single inter-clavicular air sac. While air freely moves in and out of the air sacs, only the lungs are responsible for the exchanging of oxygen and carbon dioxide occurring during respiration. Both the lungs and air sacs function as cooling mechanism as moisture evaporates from their surfaces and is exhaled as water vapour. The respiratory rate is governed by the carbon dioxide content of the blood; increased levels increase the rate, which ranges between 15 and 25 cycles per minute in the resting bird.

(iv) Urinary System

The urinary system consists of two kidneys that are located just behind the lungs. A single ureter connects each kidney with the cloaca. The urine of chickens is mainly uric acid, the end product of protein metabolism, which is mixed with the faeces in the cloaca and evacuated in the droppings as white pasty material.

(v) Circulatory System

The purpose of the circulatory system is to carry oxygen (O_2) from the lungs and nutrients that have passed through the intestinal walls in the cells. The venous system carries carbon dioxide (CO_2) back to the lungs and waste products from metabolism back to the kidneys for excretion from the body. The heart of the chicken has four chambers, two atria and two ventricles. It beats at a comparatively rapid rate of about 300 pulsations per minute. The smaller the bird, more rapid is the contraction. The main component of circulatory system is blood and lymph. Blood constitutes about 12 % of the weight of a newly hatched chick, and about 6 to 8 % of the mature chicken.

(vi) Nervous System

The nervous system of the chicken consists of the brain, spinal cord, sympathetic nerves controlling the viscera, and branches leading to the eyes and ears. The brain and spinal cord are quite similar in structure to those in mammals. A condition known as “Limber neck” in chicken is due to a paralysis of the nerves, and a common disease known as “fowl paralysis” or “neurolymphomatosis” is often associated with thickening of the sciatic nerve.

Check Your Progress 1

Note: a) Use the space given below for your answers.

b) Check your answers with those given at the end of the unit.

1) What are the different regions of external body parts of a bird?

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2) List the order of appearance of various feather tracts.

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3) What are the different systems found in the body of a bird?

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2.3 DIGESTIVE SYSTEM

A bird cannot be classified as a simple stomach animal, and yet its digestive system is somewhat similar. The organs related to digestion in poultry are described as under:

- i) **Mouth:** The digestive system starts with a part visible from outside namely beak by which feed is picked up. The teeth and lips are absent in mouth. These parts are replaced by a horny mandible on each jaw, forming the beak. The tongue is shaped like the barbed head of an arrow. Saliva, with its enzyme amylase which is used to convert starches to sugar during digestion, is secreted by the glands in the mouth. Another function of saliva is as a lubricant to help with the transport of food particles.
- ii) **Oesophagus:** It is characterized by enormous expansibility. Food passes from the mouth through the Oesophagus to the crop and onwards.
- iii) **Crop:** The crop is an enlargement of the Oesophagus and is used for storing and softening the food. Little or no digestion takes place here except for that involved with the salivary secretion of the mouth, which continues its activity in the crop.
- iv) **Proventriculus:** The Oesophagus ends in a small dumbbell shaped organ called Proventriculus, which has ample glands. It is here that gastric juices are produced and secreted. Pepsin, an enzyme needed for the digestion of protein, and hydrochloric acid are secreted by the glandular cell. Because the food passes quickly through the Proventriculus, there is little digestion of food material here, but the secretions pass into the gizzard where the enzymatic action occurs.
- v) **Gizzard:** The Oesophagus is connected with a bulged dish type structured organ called gizzard. It has strong muscle and functions chiefly in crushing and grinding of food. The gizzard, sometimes is called as ‘muscular stomach’. The gizzard is inactive when empty, but once food enters, the muscular contractions of its thick walls begin. The larger the particles of food, the more rapid the contraction.
- vi) **Small Intestine:** The small intestine is comprised of two major sections, the duodenal loop and the ileum. Within the duodenal loop lies the pancreas that

secretes pancreatic juices containing the enzymes amylase, lipase and trypsin. Other enzymes are produced by the walls of the small intestine, further aiding with the digestion of protein and sugars. The small intestine is the primary site of nutrient absorption.

- vii) **Caeca:** Between the small and large intestine lie two blind pouches known as caeca. The exact function of the Caeca is not well defined, but it has been concluded that they have little to do with digestion and only minor functions associated with water absorption. A small amount of carbohydrate and protein digestion and the microbial fermentation of dietary fibre also take place in the Caeca.

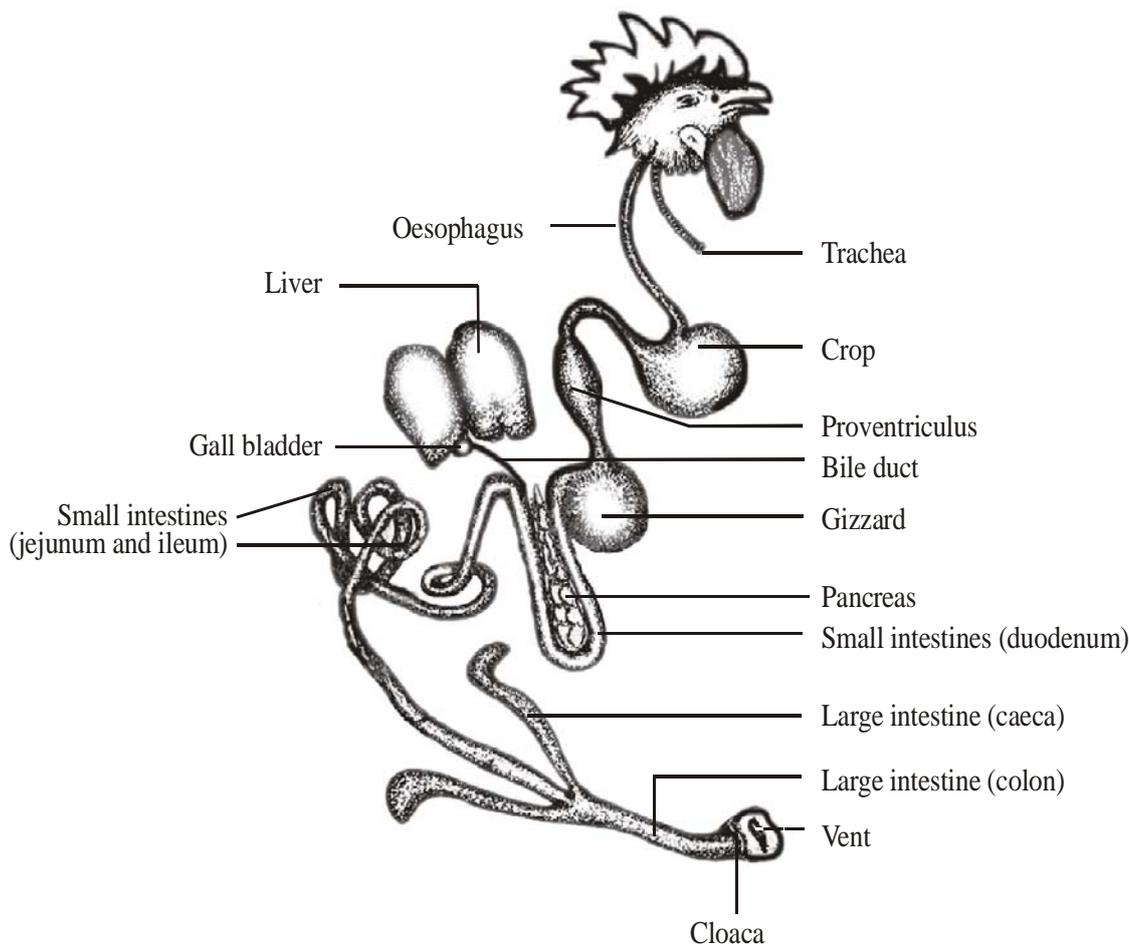


Fig. 2.4: Digestive System of fowl

- viii) **Large intestine:** The large intestine is a relatively short extension of the small intestine in the chicken. It is about twice the diameter of the small intestine. It extends from the end of the small intestine to the cloaca. The large intestine is involved in water resorption, and in doing so assists with maintaining the water balance in the bird.
- ix) **Cloaca:** The bulbous area at the end of the alimentary tract (from the mouth to the vent) is known as the cloaca. Cloaca means “common sewer”, and in the case of the chicken, the digestive, urinary and reproductive tracts all empty into the cloaca.
- x) **Vent:** The vent (anus) is the external opening of the cloaca. Its size varies greatly in the female depending on whether or not she is producing egg.
- xi) **Pancreas:** The pancreas lies within the duodenal loop of the small intestine. It is a gland that secretes enzymes into the duodenum by way of the pancreatic

ducts. These enzymes help in the digestion of starches, fats and protein. These enzymes, also known as pancreatic juices, neutralize the acid condition created in the Proventriculus.

xii) Liver: This is a large, several lobed, dark red organ. It is the largest gland in the body. The liver secretes bile. Bile is stored in the gall bladder and helps in the digestion of fat.

xiii) Gall bladder: While the chicken has a gall bladder, some bird's do not. The two bile ducts are used to transfer bile from the liver to the intestine. The right duct, through which most of the bile passes and is temporarily stored is enlarged forming the gall bladder. The left duct is smaller, therefore only a small amount of bile passes through it directly into the intestine.

Check Your Progress 2

Note: a) Use the space given below for your answers.

b) Check your answers with those given at the end of the unit.

1) Draw and label the Digestive system of chicken.



2) Describe the role of pancreas and liver.

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2.4 REPRODUCTIVE SYSTEM

The reproductive system of male and female birds varies significantly which are discussed below:

2.4.1 Male Reproductive System

The male chicken has two testes and two vas deferentia. The testes are bean shaped and yellowish white in colour. The testes are located in front of and near the kidneys about midway of the vertebral column. The sperm cells are formed in the testes. The spermatozoan is a long, slender, motile cell with a head, a neck and a tail. The testes are normally retained in abdomen unlike of the mammals.

Each testes give rise to a coiled duct called vas deference which starts from epididymis and ends in cloaca in the form of papilla, which is rudimentary copulatory organ in birds. The spermatozoa pass through epididymis to vas deference and then to cloaca and stored at distal ends of vas deference. The testes also produce a hormone which influences the sex characters.

2.4.2 Female Reproductive System

The female reproductive system consists of the following parts:

- i) **Ovary:** At the time of hatching, a female chick has two ovaries, two oviducts. But, towards sexual maturity, only the left one develops and became functional in the hen. The right ovary and oviduct degenerate and remain rudimentary (less developed). The hen's ovary is composed of 900-3600 ova (egg) or yolks in various stages of development.
- ii) **Oviduct:** The oviduct is a long tube through which the yolk passes and where the remaining portions of the egg are secreted. The segments of the oviduct and their purpose are summarized below:
 - a) **Infundibulum:** The funnel shaped upper portion of the oviduct is the Infundibulum. Normally inactive except immediately after ovulation, its purpose is to search out and engulf the yolk causing it to enter the oviduct. After ovulation, the yolk drops into the ovarian pocket or the body cavity, from which it is picked up by the Infundibulum. The yolk remains in this section for only a short period of about 15 minutes, and then is forced along the oviduct by multiple contraction. If the Infundibulum fails to engulf the yolk, then it falls into the abdominal cavity, where it is usually reabsorbed. Such birds are referred to as '**internal layers**'. The Infundibulum has no egg forming function.
 - b) **Magnum:** Next portion of the oviduct is magnum. This portion is the albumen secreting portion and is highly vascular. The yolk is tumbled in the magnum for uniform deposition of white (albumen) material. The duration of stay is 3 hours. Most of the proteins are secreted here.
 - c) **Isthmus:** The incomplete egg moves to a narrow, comparatively less vascular portion of the oviduct called isthmus. The duration of stay here is 1½ hours. Here, the inner and outer shell membranes are formed in such a manner as to represent the final shape of the egg.
 - d) **Uterus (Shell gland):** Uterus, the next part of the oviduct, is highly vascular. It is also referred to as shell gland since the shell is secreted here. The incomplete egg stays here for the longest duration of 16 to 18 hours. At the junction of isthmus and uterus, two chords like structure appear on either side of the yolk and they are called chalazae. The cuticle is laid down on the outside of the shell in the uterus. It also acts as a lubricant, while egg is being laid. The colour of the shell is due to ooporphyrin and is deposited 30 minutes before the laying of egg.
 - e) **Vagina:** The last part of the oviduct is vagina. The vagina has no role in egg formation and only serves to expel the egg once it leaves the shell gland.

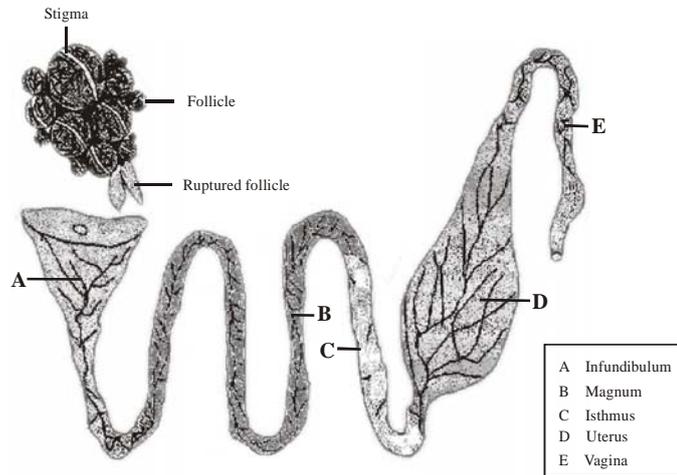


Fig. 2.5: Reproductive system of a hen

Check Your Progress 3

- Note:** a) Use the space given below for your answers.
b) Check your answers with those given at the end of the unit.
- 1) Draw and label the female reproductive system of chicken.

- 2) Which ovary and oviduct is functional in poultry?
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- 3) In which portion of the oviduct egg stays for longest duration?
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2.5 LET US SUM UP

The poultry's body is covered with a combination of skin, feathers and localized scales, with the latter being a derivative of reptiles. The most important internal structures are skeletal, muscular, respiratory, urinary, circulatory, nervous, digestive

and reproductive systems. A bird cannot be classified as a simple stomach animal, and yet its digestive system is somewhat similar. The digestive system consists of mouth, oesophagus, crop, proventriculus, gizzard, small intestine, caeca, large intestine, cloaca, vent, pancreas, liver and gall bladder. The male chicken has two testes and two vas deferentia. The testes are bean shaped and yellowish white in colour and are located in front of and near the kidneys about midway of the vertebral column. The sperm cells (spermatozoan) formed in the testes are long, slender, motile cell with a head, a neck and a tail. The female reproductive system consists of ovary and oviduct.

2.6 GLOSSARY

Artificial Insemination	: Ejaculation, collection and deposition of semen in female reproductive tract.
Clavicle	: Either of two slender bones that extend from the upper part of the sternum (breastbone) to the shoulder. Also called collarbone.
Culling	: Removing unproductive bird.
Debeaking	: Removal of beak.
Dubbing	: Removal of comb.
Keel	: A structure, such as the breastbone of a bird that resembles a ship's keel in function or shape.
Ovulation	: Ovulation is the process in the menstrual cycle by which a mature ovarian follicle ruptures and discharges an ovum or egg that participates in reproduction.
Pubic Bone	: One of the three sections of the hipbone; together these two bones form the front of the pelvis.
Selection	: Allowing certain individual to be parent in next generation.
Sexual Maturity	: is the duration between the date of hatch and date of first egg laid.
Skull	: The bony framework of the head, enclosing the brain and supporting the face; the skeleton of the head.
Sternum	: A long, flat bone located in the centre of the chest, serving as a support for the collarbone and ribs.

2.7 SUGGESTED FURTHER READING

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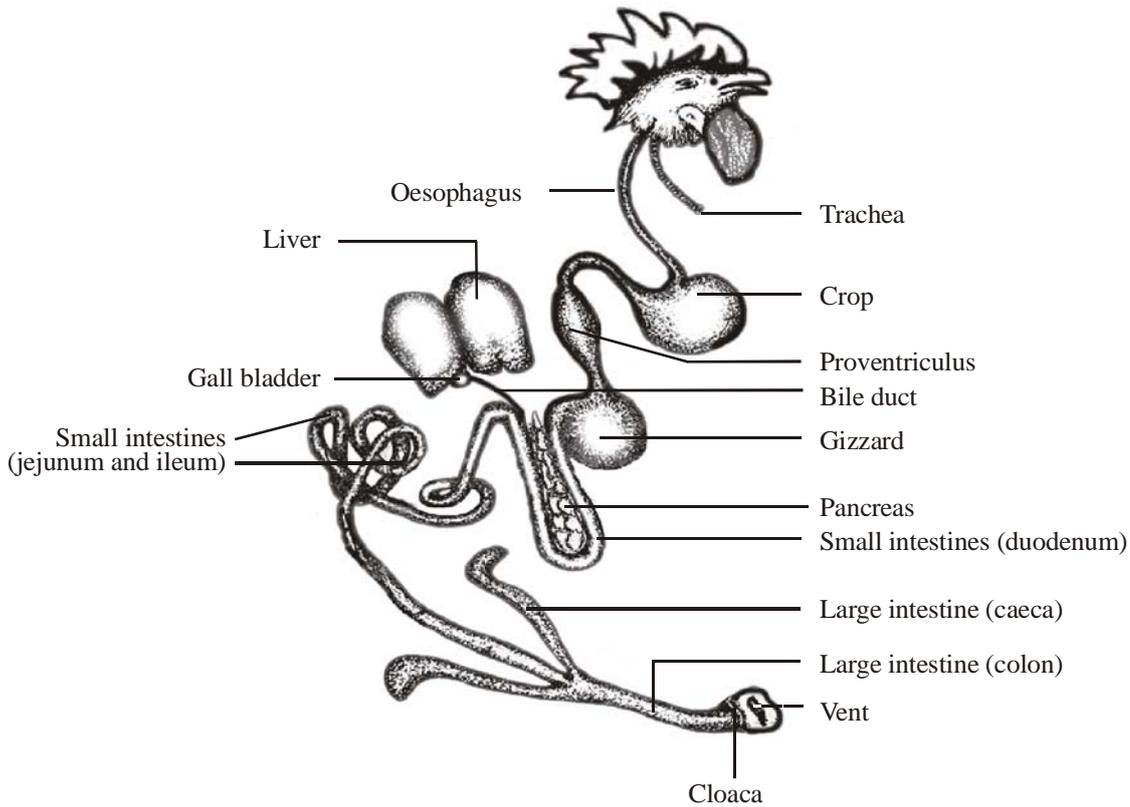
2.9 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

- 1) The external body parts of poultry can be divided into 5 different regions. They are head, neck, trunk, tail and limb.
- 2) The order of the appearance of the various feather tracts are: shoulder and thigh; rump and breast; neck, abdomen and leg; back, wing coverts and head.
- 3) The different systems found in the body of a bird are skeletal, muscular, respiratory, urinary, circulatory, nervous, digestive and reproductive systems.

Check Your Progress 2

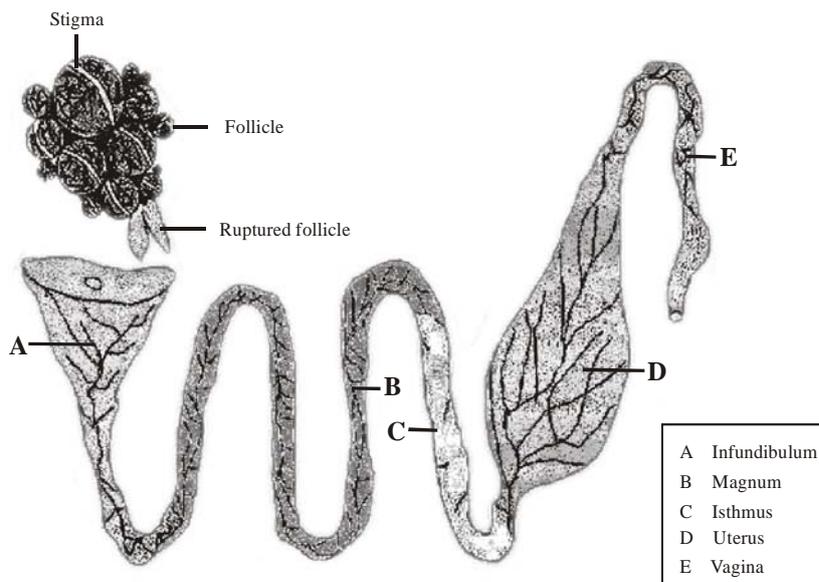
- 1) Digestive system of chicken:



- 2) Pancreas is a gland. It secretes enzyme which helps in digestion. Liver is the largest gland in the body and it secretes bile.

Check Your Progress 3

- 1) Female reproductive system of chicken:



- 2) The left ovary and oviduct is functional in poultry.
 3) The egg stay longest period in uterus of oviduct (16-18 hours).