

DENTITION, FEEDING AND DIGESTION IN MAMMALS

Specific Objectives

After completing this chapter, you will be able to:

- Identify the different types of teeth in mammals and relate them to their function.
- Enumerate various ways of preventing dental problems.
- Draw and label the digestive system of mammals.
- Describe the process of digestion, absorption and assimilation in mammals.
- Mention some diseases and disorders associated with the digestive system of humans.

The teeth play a major role in the digestion of food. They help to divide food into smaller pieces.

TYPES OF TEETH AND THEIR RELATION TO FOOD

The characteristics of teeth make up dentition. In mammals, for example, the teeth vary in size, shape and function – this is known as **heterodont dentition**.

Vertebrates such as fish, amphibians and reptiles have teeth of the same size, shape and function – this is described as **homodont dentition**.

INTRODUCTION - DENTITION IN MAMMALS

Dentition is the number, type and arrangement of teeth in an organism.

The diet of an animal, generally determines its dentition. For example, the dentition of a carnivore is different from that of a herbivore or omnivore.

Dentition of carnivores

Carnivores are flesh eating animals, e.g. lion, dog, cat. They have highly specialized teeth.

The characteristics of dentition in carnivore are:

1. Small, chisel-shaped incisors for seizing prey.

2. Long, conical, pointed and slightly inward-curved canines, used to hold and kill the prey and tear the flesh.
3. Small premolars and molars, except for the first lower molar and third upper molar which are very large. They are called **carnassial teeth**.
4. Smooth sides and sharp cups and edges that run along the jaw line, used for scraping flesh off bones.
5. Molars have blunt cusps for crushing bones.

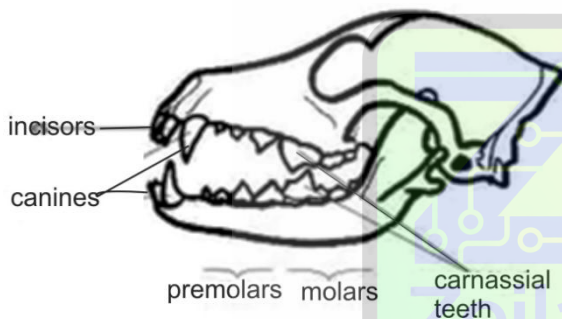


Fig. 9.5: Skull of a carnivore

Dentition of herbivore

Herbivores are animals that eat only plants, e.g. goat, cattle, rabbit.

Characteristics of carnivore dentition

1. Long, chisel shaped incisors for cutting and gnawing vegetation.
2. File-like premolars and molars with flat-ridged surfaces for grinding plant materials.
3. Absence of canine but instead, a large gap called a **diastema** between the incisors and premolars.

4. No canines in the upper jaw with poorly developed canines in the lower jaw.

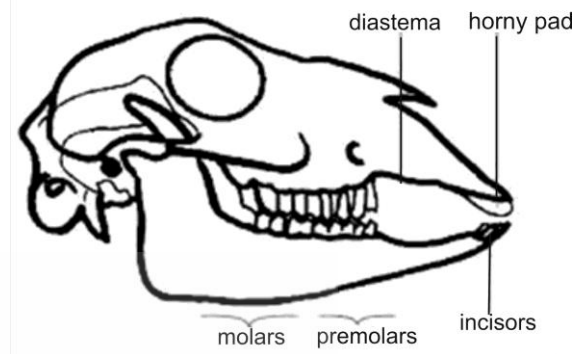


Fig. 9.6: Skull of a herbivore

Dentition of omnivores

Omnivores are animals that feed on both animals and plants. Their teeth are not highly specialised.

THE DENTAL FORMULA

Dental formula is the summary of the number, type and arrangement of teeth in the half of the lower and upper jaw of an animal.

The 32 teeth in an adult humans, for example, can be summarized as $i \frac{2}{2}, c \frac{1}{1}, pm \frac{2}{2}, m \frac{3}{3}$, where the initials are incisors (i), canines (c), premolars (pm), and molars (m) respectively. The figures on the lines represent the teeth in the upper jaw and those below the line are the teeth in the lower jaw. The total number of teeth in an adult human can therefore be obtained by multiplying the sum of the

figures indicated in the dental formula by 2, i.e. $2(4+2+4+6) = 32$.

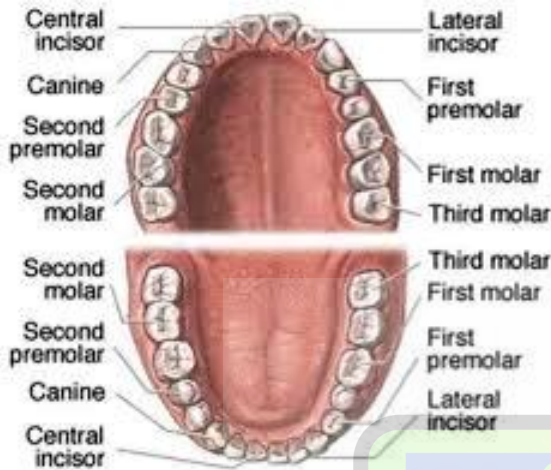


Fig. 9.7: Dental formula of man

STRUCTURE OF THE TOOTH

Teeth develop from a group of cells in the skin overlying the jawbones. Humans and other animals have different kinds of teeth. Although teeth differ in size and shape and perform different functions, their internal structure is similar.

Parts of the tooth

Crown: This is the part that projects above the gum.

Root: The part which is buried in a socket in the jawbone. Some teeth have a single root while others have two or three roots.

Enamel: This is a layer of thin, hard, shiny material composed mainly of calcium phosphate. It covers the crown.

Dentine: The dentine is located beneath the enamel and extended into the root. It makes up the greatest bulk of the tooth. Dentine is a very hard bone, but is not as hard as the enamel. Fine channels, containing living materials, pass through the dentine. The dentine encloses a central **pulp cavity**.

The pulp cavity: The pulp is made up of blood vessels, tooth-forming cells and nerve fibres with sensory nerve endings, which penetrates the dentine, making it sensitive to pain and temperature changes.

Cement: Teeth are fixed in the lower bone by the cement, which is a hard bony substance that covers the outside of the root.

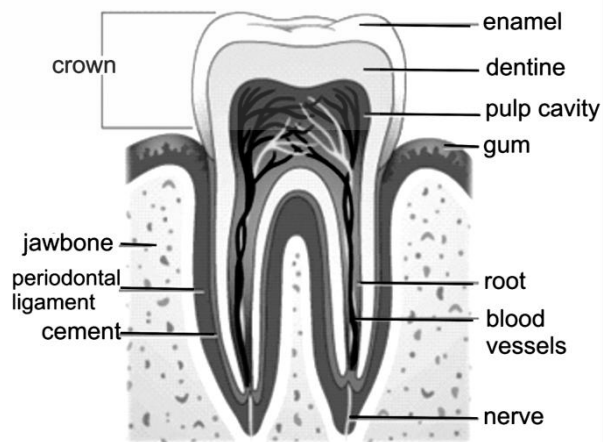


Fig. 9.8: Structure of a tooth (molar)

Periodontal fibres: Attached to the cement are tough periodontal fibres which run into the jaw bone. These fibres hold the tooth in its socket and permit slight tooth movements that cushion the tooth from excessive jarring when it hits a hard object.

Types of teeth and their functions in mammals

Teeth in mammals come in four different types – incisors, canines, premolars and molars.

Incisors

These are the two pairs of teeth found in the front part of each jaw.

Features of incisors

1. They are chisel shaped.
2. They have broad, flat cutting edge for biting and cutting food.
3. They have a single root.

Canines

There are two canines next to the incisors.

Features of canines

1. They are bluntly pointed.
2. They are used for cutting and biting solid foods.

Premolars

These are found in either half of the jaws.

Features of premolars

1. They have flat tops.

2. They have cusps (pointed ridges).
3. They have one or two roots.

Molars

They make the three final teeth on each half of each jaw.

Features of molars

1. They have flat tops.
2. They have four or five cusps.
3. They have three roots (upper molars) and two roots (lower molars).

The premolars and molars are collectively known as **cheek teeth**.

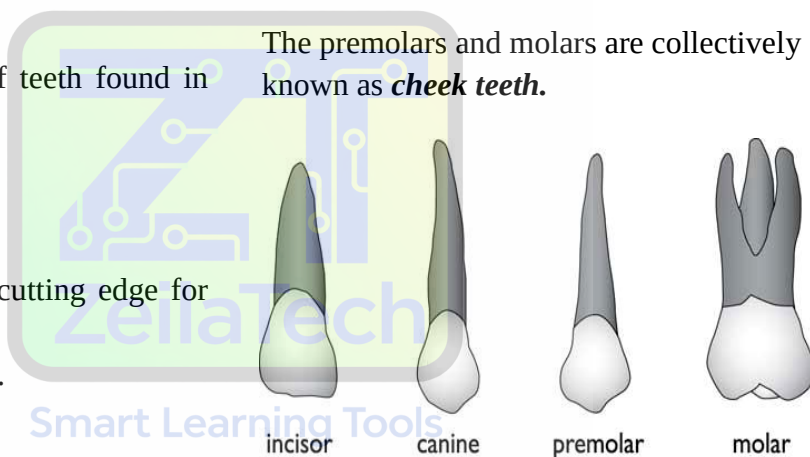


Fig. 9.9: Types of teeth in humans

Set of teeth in humans

Mammals have two sets of teeth in their lifetime. The first set of 20 teeth is called **milk teeth** and is found in young humans. They are made up of incisors, canines and premolars. These teeth fall out one by one in early life and are replaced by the **permanent teeth**. The last molar teeth in each jaw is called **wisdom teeth** because

they are the last to appear when the person is between 17 and 25 years old.

Care of the teeth in humans

In order to prevent and control dental problems, it is important for us to take good care of the teeth. Lack of proper care of the teeth results in dental caries (tooth decay) and periodontal disease.

Dental caries (tooth decay)

This is a dental condition caused when bacteria feed on sugar and starch in the mouth. Their enzymes react with the sugar and starch and produce acid.

The acid reacts with calcium in the enamel and dentine and breaks down the enamel and dentine creating a hole in the tooth. Bacteria move on to feed on the pulp and the sensitive nerve ending which causes toothache. At the early stages, the tooth can be repaired.

Causes of dental caries

1. Lack of hard food
2. Lack of vitamin D
3. Eating too much sugar
4. Lack of calcium
5. Improper cleaning of teeth

Periodontal disease:

This is caused by the accumulation of food debris, saliva and bacteria to form a hard thin coating on the surface of the teeth called **plaque**. The plaque spreads down to the gum causing the gum to swell, breed,

recede and give off bad breath. The recession of the gum causes the teeth to fall out.

Causes of periodontal disease

1. Lack of vitamin A and C
2. Improper cleaning of teeth
3. Lack of massage of the gum

Ways of preventing dental problems

The following are necessary measures to prevent the above diseases:

1. Cleaning the teeth regularly
2. Regular visit to the dentist
3. Eating food rich in minerals and vitamins
4. Using the teeth properly; for example, not using the teeth to open bottles or screws.

DIGESTIVE SYSTEM

Digestive system is a network of organs and enzymes which converts the complex food (i.e. carbohydrates, proteins, lipids etc) eaten into small and absorbable forms for the use of the body.

Or

Digestion is the breakdown of complex food substances into simple, soluble and absorbable forms.

Structure and functions of the digestive system of mammals

The digestive system of mammals is made up of the gut or alimentary canal and other organs and glands. The alimentary canal is a muscular tube made up of the following parts:

Mouth

Digestion starts from the mouth, where food is chewed with the teeth. Chewing (or mastication) breaks down solid food into smaller particles. Salivary glands produce saliva which:

- ❖ contains the an enzyme called **saliva amylase** that converts starch into **maltose**.
- ❖ is slightly alkaline and keeps the pH of the mouth approximately neutral which help in the action of saliva amylase.
- ❖ mixes with the food during chewing, making it soft and easier to swallow.

Oesophagus

A muscular tube that connects the mouth to the stomach. Food passes down the oesophagus through contraction and relaxation of the circular muscles of the gut. This action is called **peristalsis**.

The stomach

The stomach is a sac-like organ that produces **gastric juice** which contains:

- ❖ **hydrochloric** acid (sterilizes food, ends action of saliva amylase, provide acidic pH for action of the enzyme
- ❖ **pepsin** which converts proteins to **polypeptides**,
- ❖ **mucus** which forms a protective inner lining to the animal wall and
- ❖ **rennin** which solidifies liquid proteins so that they will remain in the stomach for pepsin to work on.

The contractions of the stomach wall muscles churn the food into **chyme** (a creamy-white mixture of food substance). At this stage glucose and alcohol are absorbed from the food into the blood stream.

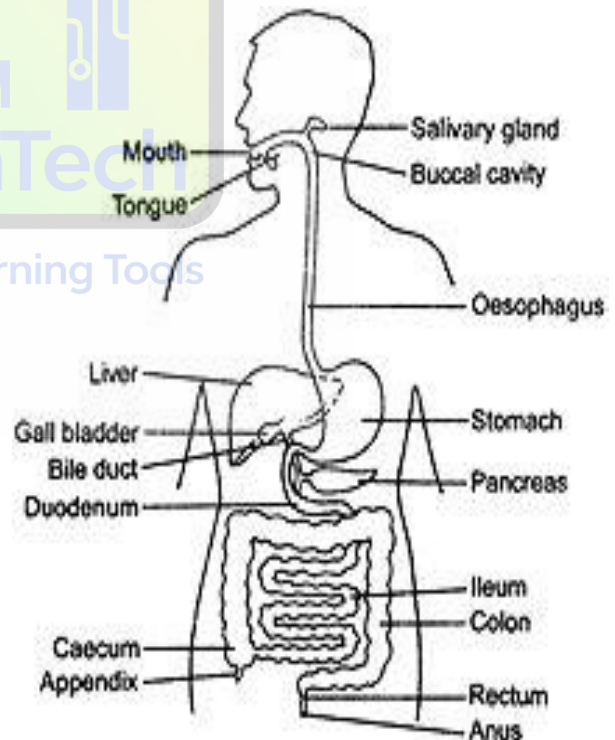


Fig. 10.0: Digestive system of man

Duodenum

The chyme from the stomach passes the pyloric sphincter into the duodenum where the hormone **secretin** is released into the bloodstream. Secretin then stimulates the gall bladder to release bile and the pancreas to release **pancreatic juice** into the duodenum.

Liver

The liver is one important organ which is responsible for most chemical activities in the body.

Functions of the liver

1. Production of bile which emulsifies or breaks down fats, converts glucose to glycogen, produces urea (the main substance of urine), makes certain amino acids (the building blocks of proteins).
2. Filtration of harmful substances from the blood (such as alcohol).
3. Storage of vitamins and minerals (vitamins A, D, K and B₁₂)
4. Maintaining the proper level of glucose in the blood.
5. Production of cholesterol; it produces about 80% of the cholesterol in the body
6. Production of heat to the body through chemical activities.
7. Production of some proteins such as fibrinogen in the blood plasma.

8. Destruction and stopping of hormones from unlimited action.
9. Conversion of excess fats into glycerol and fatty acids.
10. Excretion of excess cholesterol and old red blood cells from the body.

Bile

Bile is alkaline and raises the pH of the chyme. It emulsifies fat by changing large fat globules into small fat droplets. **Emulsification** increases the surface area of the fat making the digestion of fat by enzymes more efficient.

Pancreas

The pancreas secretes **pancreatic juice** which is alkaline and therefore raises the pH of the chyme. The pancreatic juice contains

- ❖ **amylase** which converts starch to maltose,
- ❖ **trypsin** which converts protein to peptides and polypeptides and
- ❖ **lipase** which converts fat to fatty acids and glycerol.

All these enzymes digest food as it passes through the duodenum into the ileum.

Ileum (small intestines)

The digestion process ends in the ileum. The walls of ileum secrete:

- ❖ **lipase** which converts all remaining fats into fatty acids and glycerol;
- ❖ **maltase** which converts maltose to glucose;

- ❖ ***lactase*** which converts lactose to glucose and galactose,
- ❖ ***sucrase*** which converts sucrose to glucose and fructose,
- ❖ ***erepsin*** which converts peptides to amino acids and
- ❖ ***enterokinase*** which converts trypsinogen to trypsin.

The small molecules of glucose, amino acids, fatty acids, and glycerol are the end products of digestion in mammals and are absorbed into the bloodstream by a process known as ***diffusion***.

The ileum contains thousands of microscopic projections called ***villi*** (singular, villus), which increases the surface area of the ileum and facilitates the absorption process. Undigested food passes into the colon.

Colon (large intestines)

The colon is responsible for the absorption of water from the undigested food. It contains some bacteria which digest the cellulose and produce vitamin B and K which are absorbed into the body. The remains of the undigested food pass on to become faeces.

Table 3.8: Organs and enzymes of digestion

Organ/ gland	Secreted enzyme	Enzyme action
Mouth (salivary glands)	• Salivary amylase	• Starch to maltose
Oesophagus	• Passage of food to stomach	
Stomach	• Pepsin • Rennin • Hydrochloric acid	• Polypeptides • Solidifies protein • sterilizes food; provide acidic pH for action of the enzyme
Duodenum	• Secretin	• Stimulates gall bladder to release bile and pancreas to release pancreatic juice
Liver	• Bile	• Emulsifies starch
Pancreas (pancreatic juice)	• Amylase • Trypsin • Lipase	• Starch to maltose • Protein to peptides and polypeptides • Fatty acids to glycerol
Ileum	• Lipase • Maltase • Lactase • Sucrose • Erepsin	• Fats into fatty acids and glycerol • Maltose to glucose • Lactose to glucose • Sucrose to glucose • Peptides to amino acids

Table 3.8: Organs and enzymes of digestion (continued)

	• Enterokinase	• Trypsinogen to trypsin
Colon		Absorption of water from undigested food
Rectum		Temporary storage for faeces

Rectum

The faeces move into the rectum, where they are stored and released periodically through the anus. The removal of food from the rectum is known as **egestion**. Not to be confused with **ingestion**, which is the act of putting food into the mouth?

DIGESTION IN MAMMALS

The term digestion refers to the breakdown of complex food into smaller form which can be absorbed by the body. Digestion occurs as a result of chemical or mechanical processes in the body. Digestion is very important because it allows the body to gain energy through ingested food.

Different food substances have different modes of digestion.

Digestion of carbohydrates

- ❖ Carbohydrate digestion starts in the mouth.
- ❖ Saliva contains ptyalin (salivary amylase) which converts starch to maltose.
- ❖ In the stomach, HCl in gastric juice sterilizes the food.

- ❖ The food is churned into liquid paste called chyme.
- ❖ In the duodenum, the bile secreted by the liver neutralizes the chime.
- ❖ Pancreatic amylase secreted by the pancreas converts starch into maltose sugar.
- ❖ In the ileum, the enzyme maltase converts maltose into glucose, which is the end-product of starch digestion.

Digestion of proteins

- ❖ Protein digestion starts in the stomach.
- ❖ Pepsin converts proteins to peptones.
- ❖ HCl sterilizes it; it is churned to chime and sent to duodenum where the bile neutralizes it.
- ❖ In the duodenum, the typsin which is secreted by the pancreas converts peptones into amino acids.

Digestion of fats

- ❖ The digestion of fat starts in the duodenum.
- ❖ Gall bladder releases bile into the duodenum.
- ❖ Bile neutralizes and emulsifies the fat.
- ❖ The enzyme lipase secreted by the pancreas and the wall of the small intestines converts emulsified fat into fatty acids and glycerol, which is the end-product of fat digestion.

Table 3.9: End-products of digestion

Food	End-product
Carbohydrates	Glucose
Proteins	Amino acids
Fats	Fatty acids and glycerol

DISEASES AND DISORDERS ASSOCIATED WITH THE DIGESTIVE SYSTEM OF HUMANS

Uses of Digested Food

The end-product of digestion is **assimilated** (taken up) by the cells in various parts of the body. Glucose and others move into the blood by **diffusion** and enter the liver through the hepatic portal vein. In the liver excess glucose is converted to **glycogen** and stored. Some of the monosaccharides enter body cells where they are respired.

Amino acids are also assimilated into the liver through the hepatic portal vein. Some enter the body cells where they are used to form protein for growth, repair of damaged and worn-out tissues and formation of enzymes and hormones. Excess amino acids are excreted out of the body as **urea**.

Fatty acids and glycerol come together again to form fats, which enters the lymph system before entering the bloodstream. They are stored as fat or respired to release energy.

Assimilation is the process whereby digested food substances are absorbed into the bloodstream.

Constipation

This is caused by not going to the toilet regularly. Faeces overstay in the rectum and more water is absorbed from them. This hardens and dries it making it difficult to pass out. Constipation is also caused by adequate chewing of food.

Prevention of constipation

Constipation can be prevented by including roughage in the diet, chewing food properly and visiting the toilet regularly.

Indigestion

Indigestion is caused by eating too quickly. This causes the gastric juice to produce excess acid. The acid climbs up the oesophagus, when a person belches. This gives a burning sensation in the heart (heartburns).

Prevention of indigestion

Slowing down the rate and speed of eating can prevent indigestion.

Diarrhoea

This occurs when faeces move through the colon too quickly before water can be absorbed from them. This causes the faeces to come out in a more liquid form. It is caused by bacteria in the gut.

Prevention of diarrhoea

Staying away from food for a short period will cause the bacteria to be driven away with the faeces. A lot of water should be drunk to prevent dehydration.

Stomach ulcer

This is caused by an attack on the stomach wall by excess hydrochloric acid in the stomach; this makes it sore.

Prevention of stomach ulcer

Eating at normal intervals can prevent stomach ulcer.

Jaundice

Jaundice, also known as **icterus**, is a yellowish discoloration of the skin, the conjunctival membranes over the sclerae (whites of the eyes), and other mucous membranes caused by increased levels of bilirubin in the blood.

Treatment

Infected persons must seek medical attention immediately.

Cirrhosis

Cirrhosis is a condition in which the liver slowly deteriorates and malfunctions due to chronic injury. Scar tissue replaces healthy liver tissue, partially blocking the flow of blood through the liver. Scarring also impairs the liver's ability to:

- ❖ control infections

- ❖ remove bacteria and toxins from the blood
- ❖ process nutrients, hormones, and drugs
- ❖ make proteins that regulate blood clotting
- ❖ produce bile to help absorb fats—including cholesterol—and fat-soluble vitamins

A healthy liver is able to regenerate most of its own cells when they become damaged. With end-stage cirrhosis, the liver can no longer effectively replace damaged cells. A healthy liver is necessary for survival.

Cirrhosis is caused by heavy alcohol consumption, obesity, hepatitis B, C and D, drug and toxins

Many people with cirrhosis have no symptoms at the early stages of the disease. However, as the disease progresses, a person may experience the following symptoms:

1. weakness
2. fatigue
3. loss of appetite
4. nausea
5. vomiting
6. weight loss
7. abdominal pain and bloating when fluid accumulates in the abdomen
8. itching
9. spiderlike blood vessels on the skin

Treatment and prevention

Medical attention is necessary if infected with cirrhosis. It is also advisable not to drink or engage in drugs. Nutritious food must be eaten always.

Hepatitis

Hepatitis (plural hepatitides) implies inflammation of the liver characterized by the presence of inflammatory cells in the tissue of the organ. A group of viruses known as the *hepatitis viruses* cause most cases of hepatitis worldwide, but it can also be due to toxins (notably alcohol, certain medications and plants), other infections and autoimmune diseases.

Treatment and prevention

Reducing the intake of alcohol, eating nutritious food and not doing drug may help prevent hepatitis. If infected by hepatitis, it is advisable to seek medical attention.

DIGESTIVE SYSTEM OF RUMINANTS

Ruminants are mammals which have a stomach system consisting of four chambers.

The stomach system are rumen, reticulum, omasum and abomasums.

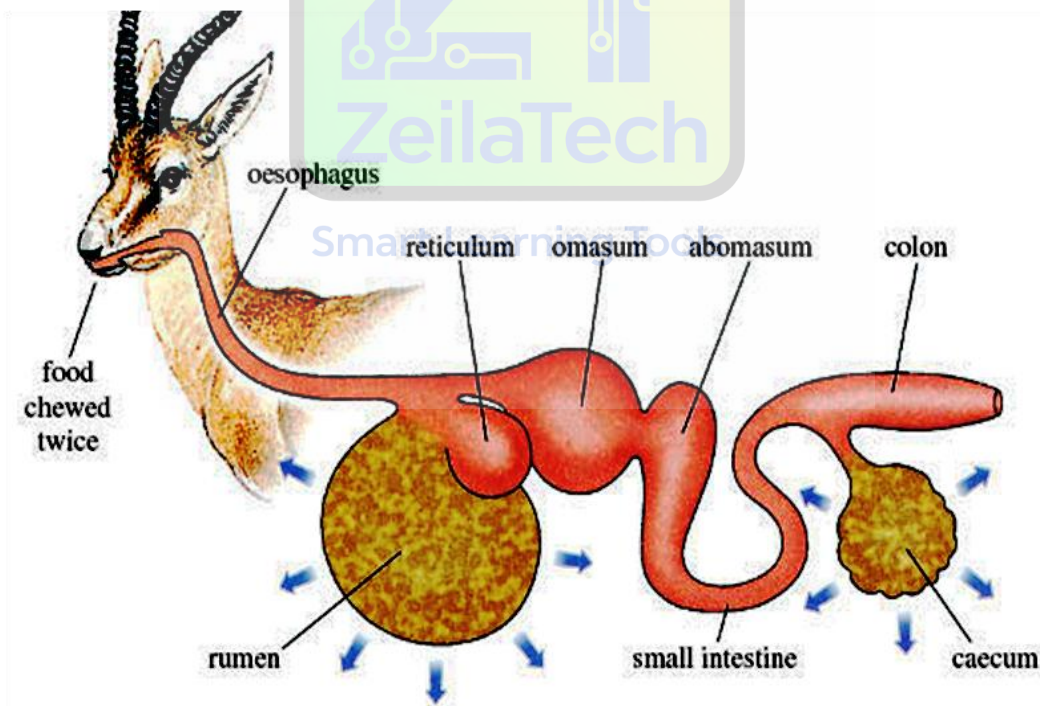


Fig. 10.1: Digestive system of a ruminant

Rumen

This is the first and largest chamber. Swallowed food enters this chamber where it is fermented by anaerobic bacteria which breakdown the cellulose.

Reticulum

When the food reaches the reticulum, it is regurgitated (brought back to the mouth) and chewed again. Food in the reticulum is known as *cud*.

Omasum

Much of the water in the cud is reabsorbed in the omasum.

Abomasum

This is also known as the true stomach of a ruminant. Gastric secretion in the abomasum digests the proteins in the food. Chyme is formed which moves on to the duodenum

Digestion in birds

The stomach of birds is divided into two – *crop* and *gizzard*. Food is stored in the crop and ground up in the gizzard with the aid of small stones, before it is passed into the intestines.

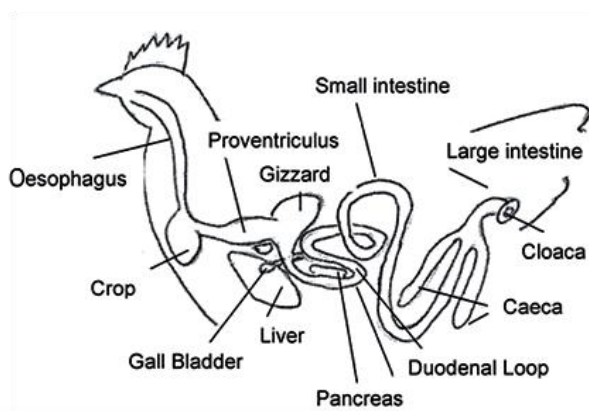
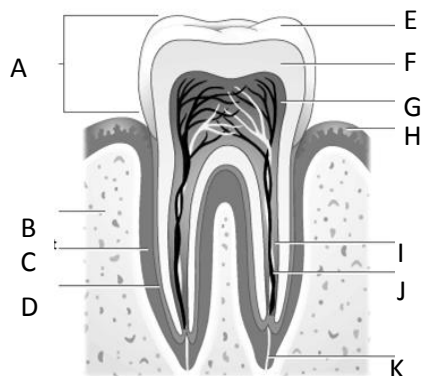


Fig. 10.2: Digestive system of a bird

TEST QUESTIONS

- (a) What is dentition?
(b) List three characteristics of the following types of dentition:
 - dentition of a carnivore.
 - dentition of a herbivore.
 - dentition of an omnivore.
- State three causes of dental problems and three ways of preventing them.
- Describe the digestive system of a mammal.
- The diagram below is a longitudinal section of through a molar tooth.



- i. Name the parts labeled A-K.
- ii. What is the function the tooth?
- iii. What is the function of the parts labeled E, G and H.

5. Explain three diseases associated with the digestive system of humans.

6. Fig. 5 is an illustration of the digestive system of a farm animal.

Study the figure carefully and answer the questions that follow.

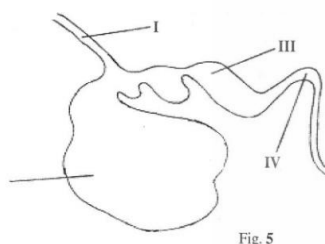


Fig. 5

- (a) (i) Name the parts labelled **I, II, III, IV, V** and **VI**.
- (ii) State one function each of the parts labelled **I, V** and **VI**.
- (b) (i) Name two farm animals that possess the digestive system illustrated.
- (ii) What is the general name given to the farm animal in (i)?
- (c) (i) Name one parasite that affect the part labelled **IV**.
- (ii) State two ways of controlling the parasite named in (i).

7. (a) State

- (i) two causes of tooth decay.

- (ii) two ways of preventin tooth decay.

8. **Fig. 3** below is an illustration of the human body.

Study the figure carefully and answer the questions that follow.

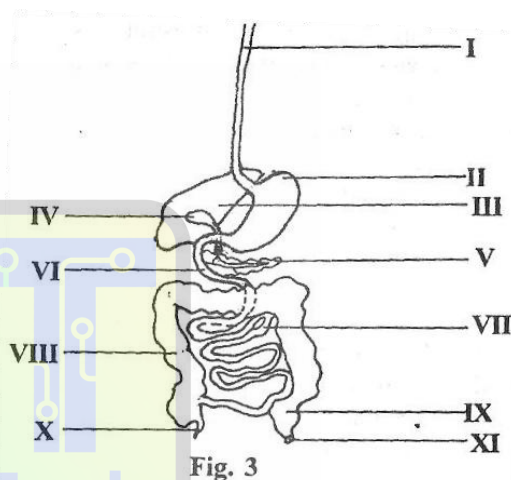


Fig. 3

- (a) (i) Identify the part of the human body illustrated.
- (ii) Name the parts labelled **I, II, III, IV, V, VI, VII, VIII, IX** and **X**.
- (c) Describe the digestive process that occurs in **VI**.
- (d) i) List two enzymes secreted by the part labelled **II**.
- ii) State one function of each of the two enzymes you have listed in (d)(i) above.

9. Figure 3 is an illustration of different types of teeth.

Study the figure carefully and answer the questions that follow.

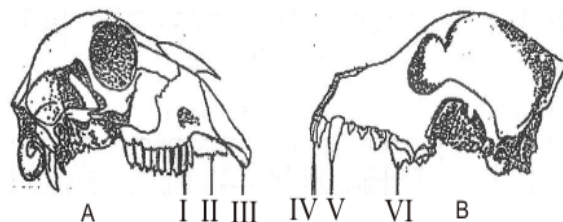
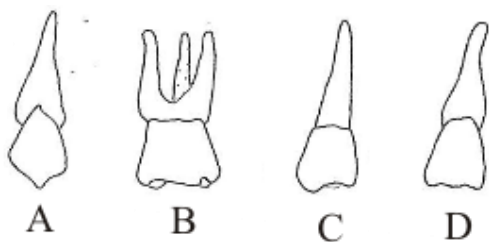


Fig. 2

- a) Identify each of the types of teeth illustrated.
 - b) Describe the structure of tooth C.
 - c) Give three structural differences between tooth A and tooth B.
 - d) State one function of each type of teeth.
 - e) i) Name the group of animals which possess all the types of teeth illustrated in figure 3.
ii) Support your answer with reasons.
10. a) State two functions of each of the following organs associated with digestion:
- i) liver;
 - ii) pancreas.
- (b) Describe the process of fat digestion in humans.
- a) Name the group of mammals which possess upper jaw type **A** and upper jaw type **B** respectively.
 - b) Give two examples each of mammals which possess upper jaw type **A** and upper jaw type **B**.
 - c) Name the parts labelled I, II, III, IV, V and VI.
 - d) State one function of each of the parts labelled II, IV and VI.
 - e) Tabulate four differences between upper jaw A and upper jaw **B**.

11. **Fig. 2** below is an illustration of two types of upper jaws, A and B of two group of mammals.

Study the figure carefully and answer the questions that follow.