



Sponsored by
The Science Foundation College
Uganda East Africa
Senior one to senior six
+256 778 633 682, 753 802709
Based On, best for science



Theme: Nutrition in plants and animals

S2 New Curriculum Biology-Chapter 5– Nutrition in Animals

Heterotrophic nutrition

Heterotrophic organisms are organisms that feed on complex ready-made organic food.

Uses of heterotrophic nutrition

- (i) energy for their vital activities,
- (ii) building materials, that is specific atoms and molecules for cell maintenance and repair and growth,
- (iii) vitamins (co-enzymes) that cannot be synthesised in organism but which are vital specific cellular processes.

The main forms of heterotrophic nutrition include

- (i) holozoic,
- (ii) saprotrophic (or saprophytic) e.g. mould, mushroom
- (iii) mutualistic
- (iv) parasitic, although some overlap between groups may occur.

Holozoic nutrition

It is a type of heterotrophic nutrition involves the following processes

- (i) **Ingestion:** is taking in of complex organic food(solid or liquid).
- (ii) **Digestion:** is the breakdown of large complex insoluble organic molecules into small, simple soluble diffusible molecules. This is achieved by mechanical break down and enzymatic hydrolysis. Digestion may be either extra or intra cellular.
- (iii) **Absorption:** is the uptake of the soluble molecules from the digestion region, across a membrane and into the body tissue proper. The food may pass into the blood stream to be transported to appropriate regions within the body of the

organism.

- (iv) **Assimilation** is the utilisation of the absorbed molecules by the body to provide either energy or materials to be incorporated into the body.
- (v) **Egestion** is the elimination from the body of undigested waste food materials.

Animals which feed on plants are called **herbivores**, those that feed on other animals **carnivores**, and those that eat a mixed diet of animal and vegetable matter are termed **omnivores**.

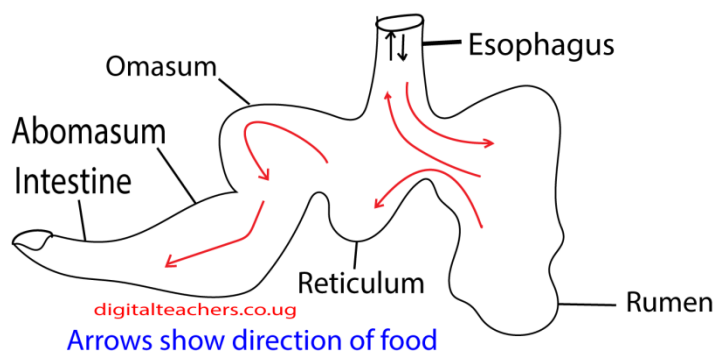
Herbivores



Challenges of herbivores while feeding on plant

- (i) Indigestible cellulose
This is overcome in two ways
 - (a) Ruminant e.g. cow and goat; developed a pouch at anterior end of the stomach called rumen that provides space for bacterial fermentation of ingested leaves.

Ruminant stomach



- (b) Other herbivores such as horse, zebra, rabbit, have well developed cecum inside which bacteria digest cellulose. Unfortunately, the cecum is at the end of the intestine that absorption of digested materials may not be efficient.

Actually, rabbit feed on their faeces to obtain enough nutrients from their food.

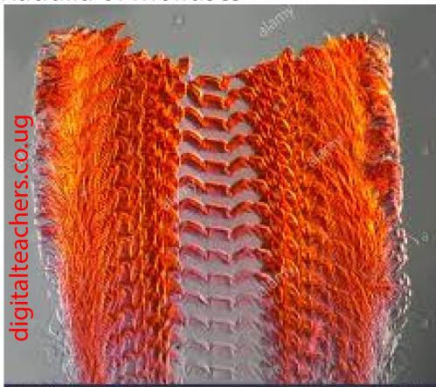
- (ii) Low nutrient value in plant materials: this is overcome by eating large volume of food.
- (iii) Cellulose in plant cell walls makes materials tough and difficult to digest, herbivores like cow and elephants have strong premolar and/or molar with ridges and large surface area to grind food. These molar and premolar grow throughout life.

Molar of cow



Herbivorous molluscs such as the snail possess a rasping organ, the **radula**. The radula is like a serrated conveyor belt, which by rubbing backwards and forwards against the hardened roof of the mouth can tear plant food

Radula of molluscs



Herbivorous insects like the locust have a pair of mandibles with a jagged edge for cutting through leaves of grass and other plants

Grasshopper mandibles



Sharp cutting edges

Carnivores

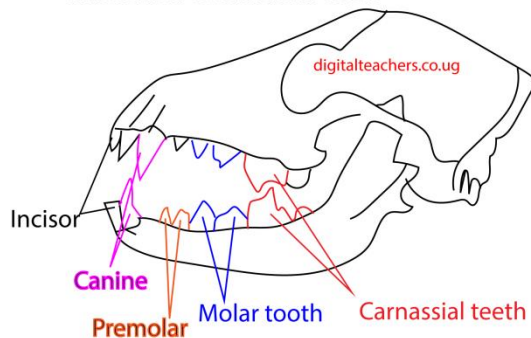


The challenge is not so much digesting the food as obtaining it.

Adaptation of carnivores to obtaining food

1. high speed locomotion,
2. sharp claws and dagger like **canine** teeth in the great cats,
3. sucker - **bearing tentacles** in octopus and squids
4. tentacles armed **with stinging cells** in sea anemones and jelly fishes.
5. teeth for tearing flesh for instance dog has strong canine and carnassial teeth for tearing meat.

Illustration of carnassial teeth



Insectivorous plants



These insectivorous plants live in nitrogen - deficient soils. All have green leaves and obtain their carbohydrates by photosynthesis; they obtain nitrogen from trapping and digestion of small animals, particularly insects.

Role of enzymes in nutrition

An enzyme is a biological catalyst. In nutrition, enzymes facilitate the breakdown of complex food substances (plants or animals) into simpler substances that can be utilized by the body during the process of digestion. Molecules acted on by enzymes are called substrate.

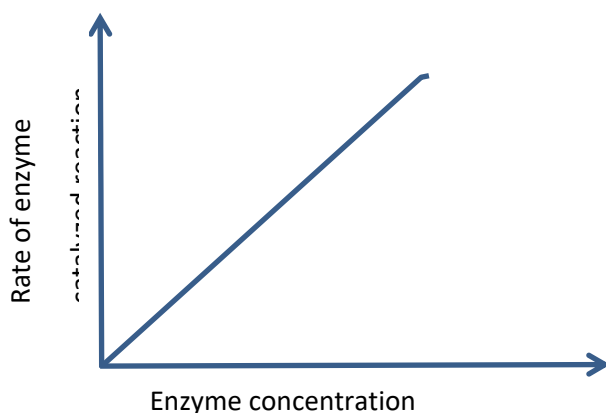
The properties of enzymes.

1. They catalyse the rate of biological reactions.
2. They are specific to particular reactions
3. They are not destroyed by the reaction in which they catalyse.
4. They work in either direction i.e., catalyse both forward and backward reaction.
5. They are inactivated by high temperatures
6. They are sensitive to pH changes

Factors affecting the rate of enzyme reaction

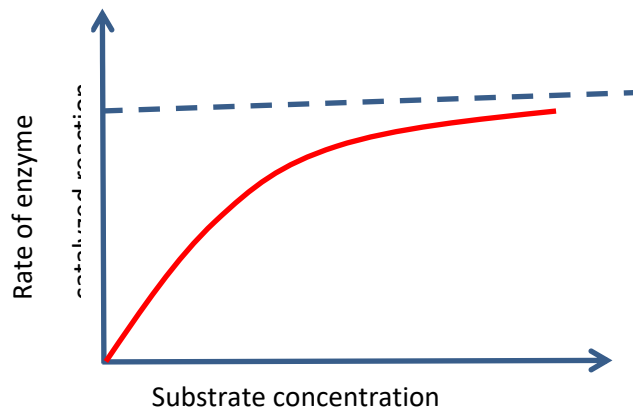
- (a) **Enzymes concentration;** provided that the substrate concentration is maintained at a high level, and other conditions such as pH and temperature are kept constant, the rate of reaction is proportional to enzyme concentration.

A graph showing relationship between enzyme concentration and the rate of enzyme- controlled reaction



(b) **Substrate concentration.**

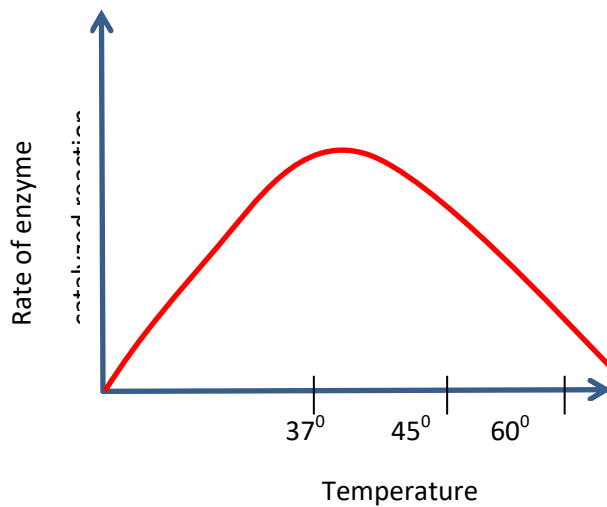
For a given enzyme concentration, the rate of an enzyme reaction increases with increasing substrate concentration. The theoretical maximum rate [V_{max}] is never quite obtained, but there comes a point when any further increase in substrate concentration produces no significant change in reaction rate. This is because at high substrate concentration the active sites of the enzyme molecules at any given moment are virtually saturated with substrate. Thus, any extra substrate has to wait until the enzyme/ substrate complex has dissociate into product and free enzyme before it may itself complex with the enzyme.



(c) Temperature

Up to 40°C, the rate of enzyme-controlled reaction increases smoothly with temperature, a ten degree rise in temperature being accompanied by approximately doubling the rate of reaction. Above that 40°C the rate begins to fall off and then declines rapidly, ceasing at about 60°C, because the enzyme is denatured.

Graph showing the effect of temperature on the activity of enzyme as salivary amylase.



(d) pH

Under conditions of constant temperature, every enzyme functions most efficiently over a narrow pH range e.g. pepsin at pH= 2, Amylase (salivary) at pH 6.8.

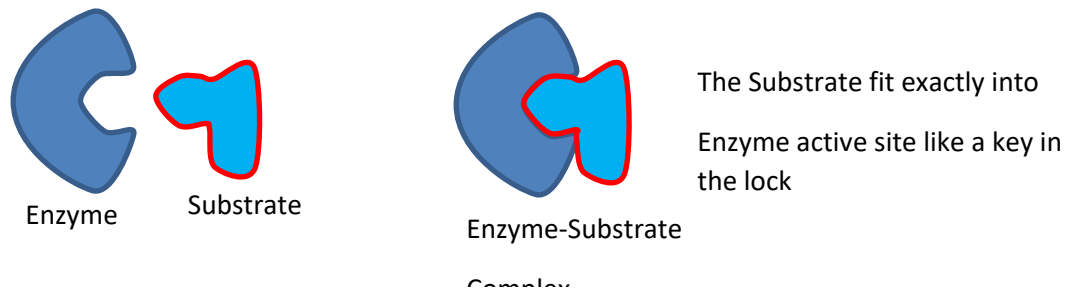
Mechanism of enzyme action.

The action of enzymes is specific to a given substrate and this specificity can be explained by two hypotheses.

(a) Lock and key hypothesis

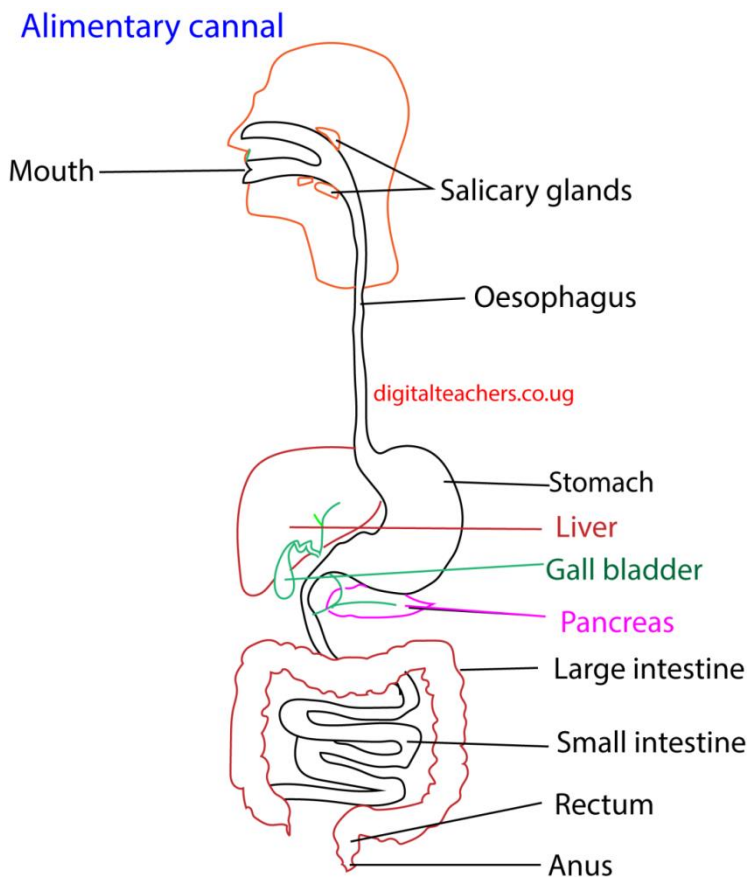
Enzyme are very specific to the substrate they act on because they have particular shape / configuration into which substrate with complementary shape fit in exactly as the key fit into the lock, thus the lock (enzyme) and key (substrate) hypothesis.

When an enzyme / substrate complex is formed, the substrate activated into forming the product of the reaction. Once formed, the product no longer fit into the active site and escape into the surrounding medium leaving the active site free to receive other substrate molecule.



(b) Induced fit hypothesis.

This hypothesis claim that enzyme and their active site are physically rather more flexible structure than this described by the lock and key hypothesis, and that the active site of the enzyme is **moulded into a precise** configuration in presence of a substrate to enable it perform its catalytic functions more effectively.



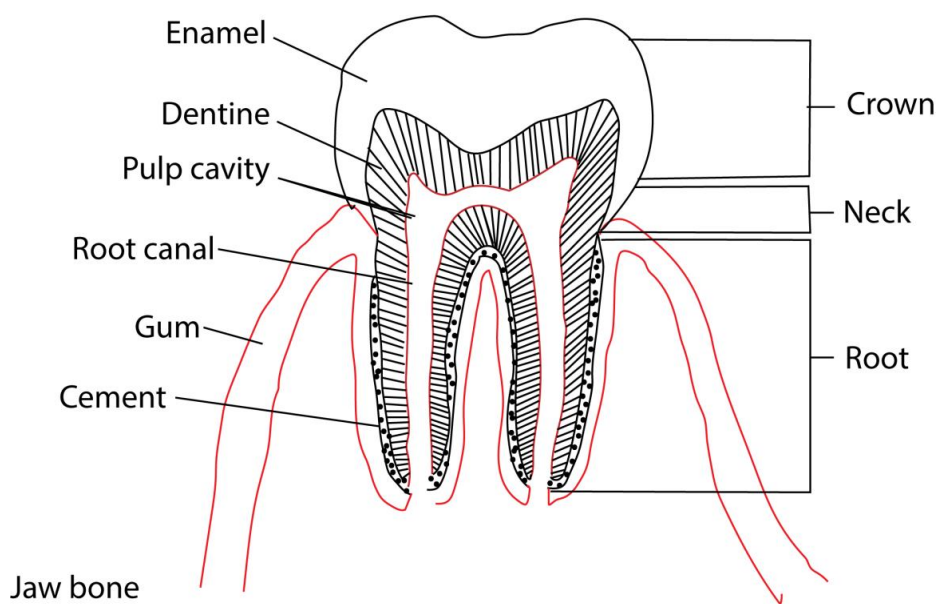
Summary of the functions of the different parts of the human digestive system.

SPECIALISED PART	FUNCTION
Buccal cavity	Ingestion, mastication.
Pharynx	Swallowing.
Oesophagus	Links pharynx to stomach
Stomach	Food storage and digestion of proteins.
Duodenum	Digestion and absorption.
Liver (bile)	Emulsification of fats.
Pancreas (pancreatic juice)	Digestion of starch, proteins and fats.
Iteum	Completion of digestion & absorption of food
Colon	Absorption of water.
Rectum	Formation and storage of faeces.
Anus	Egestion

Digestion in the buccal cavity

The food is broken up into smaller pieces by the chewing action of the teeth (**mastication**) and moistened by **saliva** from the salivary glands.

Cross section of a molar tooth



Dental formulae

It is written as an expression of the number of each type of **tooth** in one side of the upper jaw over the number of **teeth** in one side of the lower jaw. The letters correspond to the type of **teeth** (I = Incisor, C = Canine, P = Premolar, M = Molar).

Dental formula of human deciduous = $I \frac{2}{2}, C \frac{1}{1}, P \frac{2}{2}$, total 20

Dental formula of human permanent = $I \frac{2}{2}, C \frac{1}{1}, P \frac{2}{2}, M \frac{3}{3}$, total 32

Dental formula of sheep, goat, cow = $I \frac{0}{3}, C \frac{0}{1}, P \frac{3}{3}, M \frac{3}{3}$, total 32

Oral hygiene

Oral hygiene is all about keeping your mouth clean and healthy!

It involves regular practices like brushing your teeth at least twice a day, flossing to remove hidden debris between teeth, and visiting the dentist for check-ups.

Good oral hygiene helps prevent issues like cavities, gum disease, and bad breath, while also contributing to overall well-being—since oral health is connected to the rest of your body. A bright smile isn't just about looks; it's a sign of a healthy mouth.

Digestion in the stomach

The stomach is a dilated part of the gut where the food remains for two or more hours. Once in the stomach the food gastric gland in gastric wall secrete **gastric juice**

Gastric juice contains

- (i) **Hydrochloric acid** that kills germs and provide pH for the action of pepsin
- (ii) Enzyme **pepsin** which breaks down proteins into short polypeptide chains. Pepsin is secreted as an inactive precursor **pepsinogen** to prevent the gastric gland being destroyed by its own enzyme (auto-digestion).
- (iii) Enzyme **renin** coagulates casein, the soluble protein of milk, forming insoluble curd which is then attacked by pepsin.

Digestion in duodenum

Duodenum receives secretion from pancreas and gall bladder

- (a) Gall bladder produces bile that emulsifies fats.
- (b) Pancreas produces pancreatic juice that contains.
 - (i) **Pancreatic amylase**: breaks down starch to disaccharide maltose.
 - (ii) **Pancreatic lipase**: breaks down tri-glycerides in the emulsified fat into mono-glyceride and fatty acids.

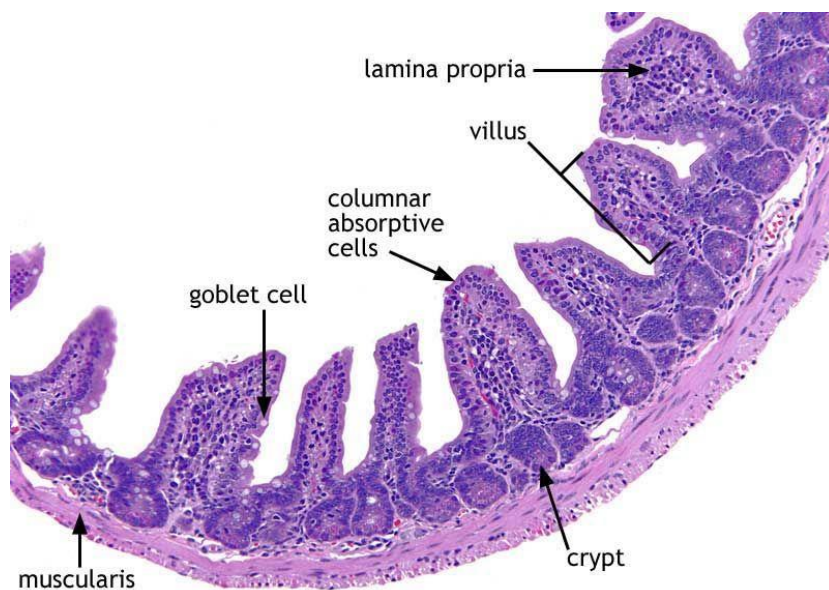
- (iii) **Protease:** (Protein - splitting enzymes) which include **trypsin, chymotripsin, carboxy-peptidare and elastase**).
- (iv) **Bicarbonate** neutralise acidic chime from the stomach

Digestion in small intestines

It is done by the following enzymes

- **Maltase:** hydrolyses maltose to glucose, thus completing digestion of starch.
- **Sucrase** hydrolyses sucrose (Sugar cane) to glucose & fructose.
- **Lactase** hydrolyses lactose (Milk sugar) to glucose & galactose.

Absorption of digested food

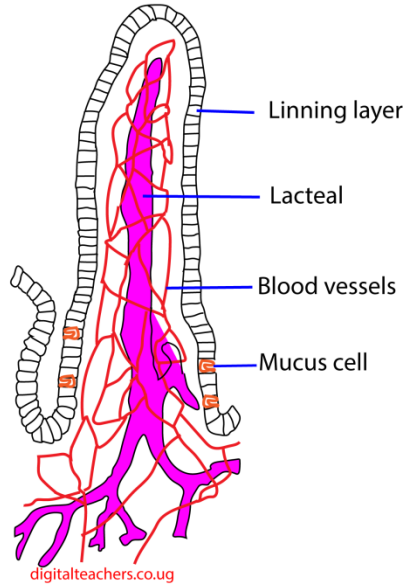


It occurs in small intestines

Adaptation of small intestine for absorption of food

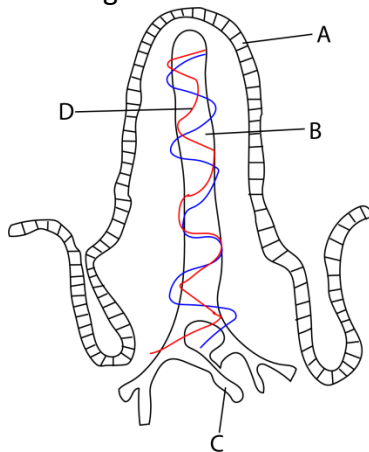
1. Long to allow food enough time for absorption
2. Villi and microvilli increase surface area for absorption
3. Well supplied by blood to carry away absorbed food so as to maintain diffusion gradient
4. The villi have thin membrane to reduce diffusion gradient
5. Villi have high concentration of mitochondria to provide energy for active transport.
6. **circular fold** increase surface area for absorption
7. Villi contain lacteal for absorption of fats

Vertical section through villus



Revision questions

1. The diagram below shows the structure of the villus



(a) Label parts marked A, B, C and D.

(b) What food substance enter

(i) A

(ii) B

(c) State two factors which make a villus an effective absorption structure.

(d) How does the absorbed food in B reach the general circulation?

(e) State two nutrients which are absorbed before reaching the villi.

2. (a) Describe the activities of digestion which occur in each of the following parts of alimentary canal

(i) Stomach (04 marks)

(ii) Ileum (06 marks)

- (b) How is the ileus adapted to food absorption (05marks)
3. (a) what is a balanced diet? (01)
 (b) in which ways is the ileum adapted to its function? (08marks)
 (c) Outline the fate of the food after absorption. (06marks)
 4. (a) Describe the digestion of proteins in a mammal. (06marks)
 (b) Explain how the ileum is suited for its functions. (09maks)
 5. What are benefits of brushing your teeth regularly.
 6. Complete the table below which illustrates the digestive process

Region of digestion	Active enzyme	Substrate	Product
Mouth	Amylase		
Stomach		Proteins	
Duodenum		Polypeptide	
		Fat	

Please obtain free notes, exams and marking guides of Physics, chemistry, biology, history, from digitalteachers.co.ug website.

Thanks

Dr. Bbosa Science