NUTRITION IN LIVING ORGANISMS

Nutrition is the act of providing nutrients to the body cells that they can carry our activities required to keep themalive. Cells obtain nutrients from the food taken by the organism.

There are two main modes of nutrition:

Autotrophic nutrition
Heterotrophic nutrition

1. Autotrophic nutrition (auto = self, troph = nutrition)

It is the mode of nutrition in which the organisms manufacture their own food by photosynthesis using inorganic raw materials like Carbon dioxide and water in the presence of light and chlorophyll. It also called halophytic nutrition. The organisms are called Autotrophs or producers e.g. Are green plants

Autotrophic nutrition may be by:

- Photosynthetic nutrition
- Chemosynthetic nutrition

Photosynthetic nutrition is a process where green plants s synthesis food using raw materials like water, Carbondioxide and mineral salts in the presence of sunlight, hence called producers.

Chemosynthetic nutrition is a process by which some non-green bacteria e.g sulphur bacteria use chemical energy to manufacture their food. Energy is derived from chemical reactions and light is not required.

1. Heterophic nutrition (hetero = different.troph = Nutrition)

It is a mode of nutrition in which organisms cannot manufacture their own food and depend on others for their food. It is called holozoic nutrition since the organisms feed on solid food.

The organisms are called heterotrophs or consumers e.g all animals and the non-green plants.

Types of heterotrophic nutrition

Heterotrophs that feed on plants directly are called HERBIVORES e.g. Cow, rabbits. Those that eat flesh of other animals by killing themare called CARNIVORES e.g. Lion.Those that feed on both plants and animals are called omnivores e.g. man, Bear, crow. These eat all kinds of food.

Depending upon the mode of living and the mode of intake of food,,

Heterotrophic organisms may be grouped as

- Saprophytic nutrition
- Parasitic nutrition
- Holozoic nutrition
- Insectivorous
- Epiphytes

Saprophytic nutrition (Sapro = rotten,phyto – plants

Saprophytic organisms obtain food from dead and decaying organic matter. e.g Fungi, molds, Mushrooms and many bacteria

Saprophytes secrete enzymes that are released on the substrate, which digests and breakdown complex food materials into simpler ones.

The soluble end product is absorbed back by the saprophyte.

Parasitic nutrition (Para = feeding, sites = gains)

Organism that lone on or inside other living organisms called hosts and obtain their food from them iscalled parasites. The mode of feeding depends upon the habit, habitat, and modifications of the parasites e.g.

An ectoparasite lives externally to the host; It may have certain devices which it uses to obtain from the host e.g. mosquito.

An endoparasite lives inside the body of a host and obtains nutrition from it e.g. tapeworm.

Semi parasite Depends for its nutrition on its host partially, when partially dependent. It owns carbohydrates; these normally have thick green leaves and attach to host branches by haustorial roots that connect up to the xylem stream of the host plant.

Total parasites lack chlorophylland depend totally on host plant for food and water. They also absorb food and water using **haustoria** roots.

Holozoic nutrition (hole= Whole, soon = animal)

This involves ingestion of complex organic which are broken down into smaller soluble molecules, which are assimilated in the body.

Holozoic nutrition (holo= whole, zoon- animal)
This involves ingestion of complex organic substances which are broken down into smaller soluble molecules which are assimilated in the body

Insectivorous feeding

Some green plant growing in Nitrogen deficient conditions are capable of preparing their own food,

Capture and digest insects to obtain nitrogenous substances e.g. Neponthes (pitcher plants) Drosera (sun dew), untricularia (bladder wort)

Epiphytes:

Plants which grow on trees for support are called epiphytes. They have green leaves and manufacture their own food by absorbing moisture from atmosphere through special aerial roots eg. Orchids.

Holozoic nutrition is characterized by

- Ingestion: the taking of complex organic food into the body.
- Digestion: The breaking down of complex organic food into smaller soluble diffusible molecules.
- Absorption: The taking up soluble diffusiblemolecules from digestive regions across a membrane into the body tissue.
- Assimilation: The utilization of absorbed food in the body.
- Egestion: The crimination of the undigested food materials from the body.

Symbiotic feeding:

It is modes of nutrition in which two types of organisms live together and are mutually organism live together and are mutually benefited e.g. lichens are a symbiotic relationship between fungi and algae.

Predators

These are carnivores which chase and kill their prey to eat it e.g. tiger.

Scavengers: are those carnivores which consumer dead and rotting meat e,g vulture and Jackals

Food and its components

Living organisms spend energy during various activities. This energy is obtained from food that they consume: Therefore food is necessary for proper growth, development and functioning of an organism.

The main components of our food are nutrients, roughages and water.

Nutrients are the elements present in food which provide energy to the body and enable it to grow, repair and mountain. It involves ingestion, digestion assimilation and egestion. Food can be classified according to their functions as follows:

- Energy rich foods:

These foods, when consumed are broken down to release energy. E.g carbohydrates.

- Body building foods: These provide nutrients to build mass and repair tissues e.g. proteins (milk, meat, eggs)

- Protective food:

These are vital for body functions and the absence of these nutrients resultin deficiencydisease, vitamins, and minerals.

NB:

Calorie is the amount of energy obtained from food.

Basal metabolic rate: is the number of calories that the body burns at rest. It is used for the functions of vital organs of the body. It's affected by age sex, stress, and temperature, genetics.

Autotrophic nutrition :(Nutrition in plants)

The process of photosynthesis:

Green plants which are autotrophic synthesize food substrates through the process of photosynthesis.

Defn:

Photosynthesis is a process by which green plants, having chlorophyll synthesize simple sugars (glucose) from simple inorganic raw materials: Carbon dioxide and water m using energy of the sun; Oxygen is releases in this process.

Overall equation:

$$6CO_2 + 12H_2O \xrightarrow[Chlorophyll]{sun\ light} C_6H_{12}O_6 + 6H_2O + 6O_2$$

The sugar produced is stored in forms of starch (in plants) and in form of glycogen (in animals); these food reserved provide energy to the organism when oxidized in living cells.

Site of photosynthesis:

Although all green parts of the plant are capable of carrying out photosynthesis; the leaves are the most suitable organs for this process. Its cells are specialized with specific organelles called chloroplasts which are the main sites of photosynthesis. These contain plastids which contain a light absorbing green pigment called chlorophyll.

Requirements for photosynthesis

1. Chlorophyll:

It's a green pigment in plants which is found in chloroplasts. It absorbs light of different wavelength except green light that they reflect (so we see leaves as green)

Chlorophyll mostly occurs in leaves, but also in stems & fruits. It traps light energy and converts it into chemical energy.

2. Carbon dioxide: It's a raw material for the process plants get Carbon dioxide from the atmosphere. Terrestrial plants use atmospheric Carbon dioxide while aquatic plants use Carbon dioxide dissolved in water.

3. Water: This is another raw material for photosynthesis. Plants absorb water from the soil' which is transported to leaves through xylem vessels

4. Sunlight

Light energy is used in breaking down the water molecules into hydrogen and oxygen, enabling the light dependent and light independent process of photosynthesis to proceed and produce the products and by products of this process.

Importance of photosynthesis:

- Produces energy for the ecosystem (food)
- Produces oxygen used for respiration.
- It's the only process that uses up Carbon dioxide naturally, reducing its levels in the atmosphere, whose accumulation would cause globalwarming (greenhouse effect).

Main factors affecting photosynthesis

There are 3 main factors affecting the rate of photosynthesis.

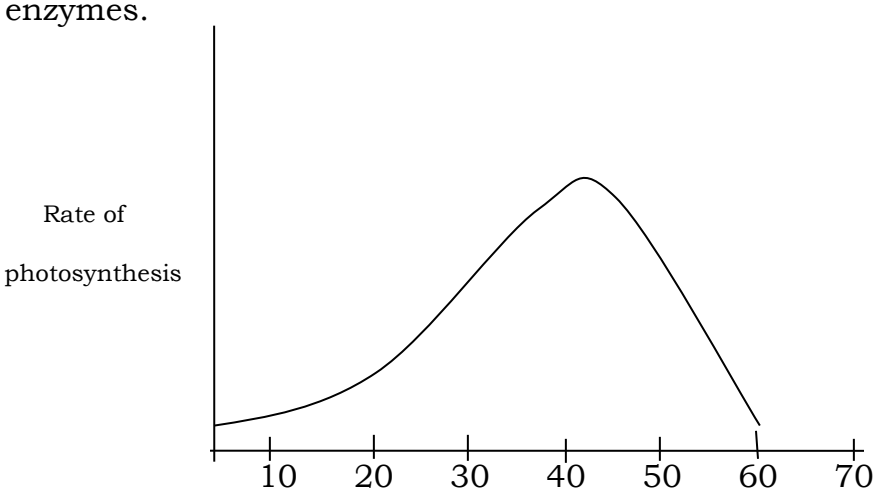
- Light
- Temperature
- Carbon dioxide

These factors are called limiting factors.

In a process like photosynthesis, which is affected by more than one factor, its rate is limited by the factor which is closest to minimum (lowest), so at any point if one of three factors is in law supply, this factor will be the limiting factor. Only a change in the limiting factor will increase or decrease the rate of photosynthesis: Changing the other two factors will have no effect:

Temperature:

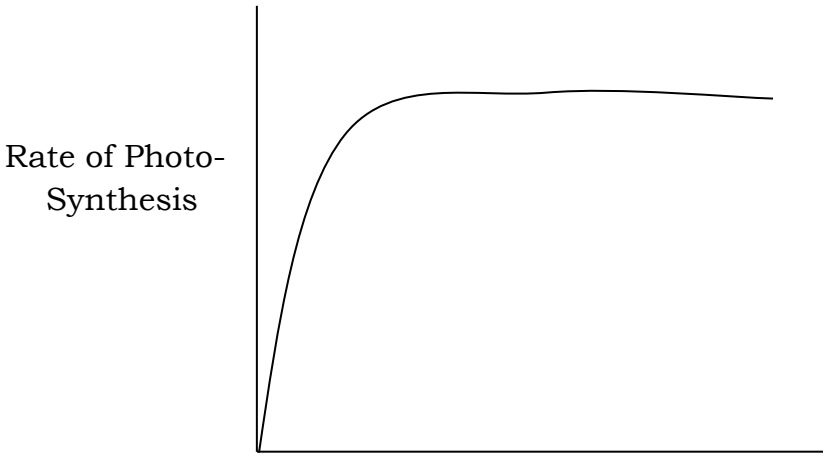
If CO_2, light and any other factors are not.Limiting; the rate of photosynthesis increases with a rise in temperature. Above the temperature of 40^0C enzymes Are denatured and rate of photosynthesis reduces. Doubling of temperature causes a rapid increase in rate of photosynthesis because high temperatures activate enzymes.



2. Carbon dioxide concentration:

The atmosphere has 0.03% Carbon dioxide and a decrease in this level makes Carbon dioxide a limiting factor of photosynthesis.

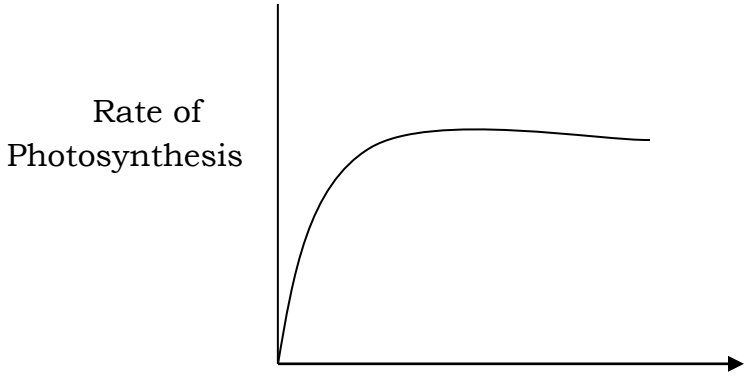
Increase in carbon oxide concentration to 1- 10 raises the rate of photosynthesis; it continues to increase untilCarbon dioxide concentration is no longer the limiting factor but any other.



3 Light intensity

Light varies in intensity, quality and duration therefore , when CO_2 and temperature are not limiting , and light intensity are low, the rate of photosynthesis increases with an increase in its intensity; until a point is reached when increased in intensity fails to induce increase in photosynthesis.

More photosynthesis occurs if plant is exposed for long periods of light.



The rate of photosynthesis may be affected by other factors like

- Oxygen

Increase in oxygen concentration reduces rate of photosynthesis when 0_2 reduces, rate of photosynthesis increased by 30%.

Increased oxygen favours rapid respiratory rate, hence inhibiting photosynthesis, Also high oxygen levels destroys chlorophyll molecules hence inhibiting photosynthesis:-

- Mineral elements

Some minerals are essential for photosynthesis e.g. Mg, Fe, Cu, hence affect the rate if in short supply.

- Pollutants decrease photosynthesis activity e.g. 0zone, SO_2.
- Chlorophyll content
- Accumulation of carbohydrates: If not translocated, they slow down the rate of photosynthesis.

- Accumulation of carbohydrates: If not translocated, they slow down the rate of photosynthesis

- Number of stomata to let in CO_2 into the leaf .

- Surface area of the leaf exposed to external conditions.

Experiments on photosynthesis:

To test for starch in a leaf

Materials

- Green leaf
- Test tube
- Methylated spirit/Ethanol
- Water bath
- Iodine solution
- white file

Procedure /method

Pluck a leaf from a plant that has been exposed to light for at least 2hours. Boil the leaf in water for 5 minutes. This bursts the starch grains and makes the cells permeable.

Now transfer the leaf to a beaker containing alcohol. Warm it over a water bath for a few minutes.

You will observe that the leaf turns white, indicating that the chlorophyll has been removed. Now wash the leaf carefully in water without damaging it. The leaf is dipped in hot water to soften it.Place the leaf in a dilute solution of iodine. This will turn the leaf bluish black.

Observation
The leaf turned to black

Conclusion
The leaf contains starch.

Experiment to show that Oxygen is given off during photosynthesis

Materials

Water

Beaker

Test tube

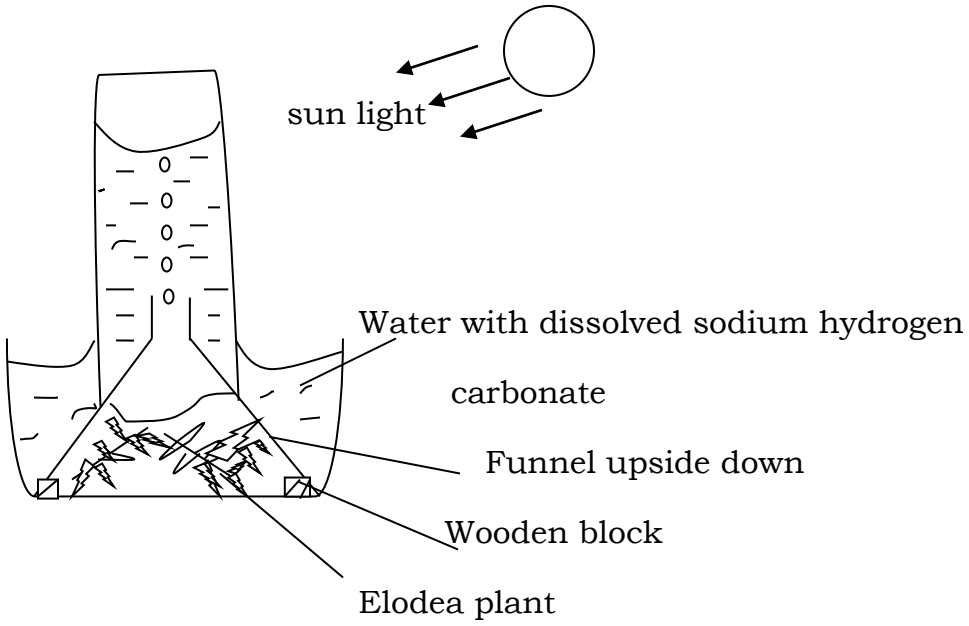
Fresh pond weeds (Elodea)

Sodium hydrogen carbonate

Method:

Place a fresh pond weed (Elodea) in a beaker of water with dissolved sodium hydrogen carbonate; which provides Carbon dioxide to the aquatic plant. Cover the Elodea pant with a short stemmed funnel and invert a test tube with waterover the funnel that is supported by small wooden blocks, in the beaker, to allow free circulation of water. Leave the set up in light for 6 hours.

Arrange a control experiment that is placed in the dark. After 6 hours remove the test tube and test for the gas collected with a glowing splint.



Observation:

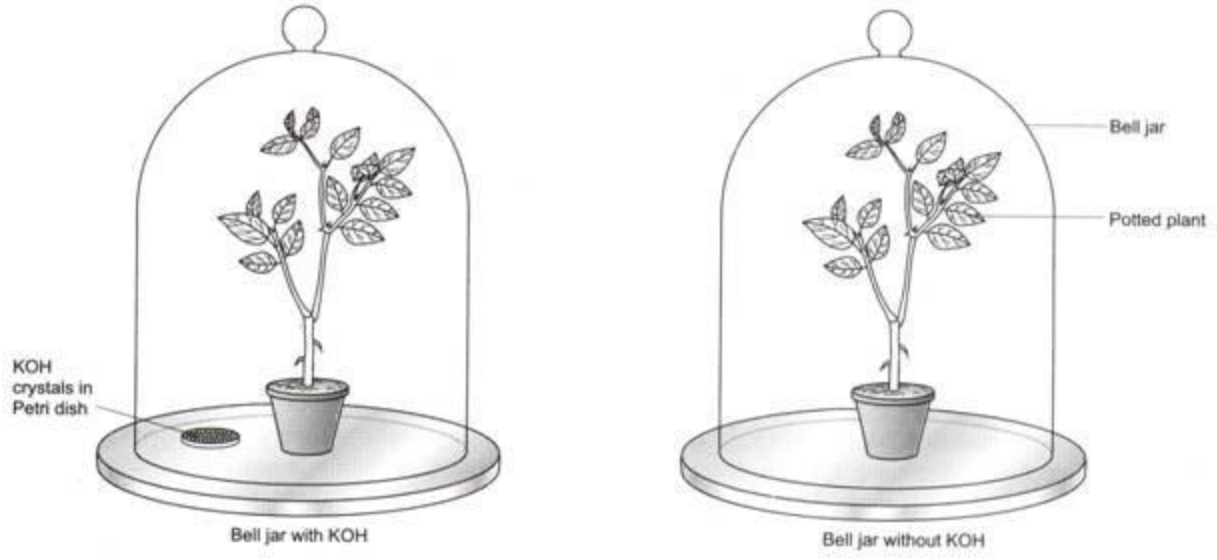
The glowing splint is relighted into a flame by the gas collected in the test tube. The setup in control does not reliht the glowing splint

Conclusion

Oxygen is given off by plants during photosynthesis

2. Experiment to demonstrate that carbon dioxide is essential for photosynthesis:

Get two healthy potted plants of almost the same size and place them in the dark for 24 hours to destarch the leaves. Now place them on glass plates. Cover the plants with separate bell jars. Keep some crystals of potassium hydroxide (KOH) in a Petri dish and place it under one of the jars. Make the set-up airtight by applying Vaseline at the bottom of the bell jars.



Experiment to show that CO_2 is essential for photosynthesis

Keep the plants in sunlight for photosynthesis to take place. After 3 to 4 hours pluck a leaf from each plant. Boil the leaves in water and subsequently in alcohol, using a water bath, to remove chlorophyll. Now use a few drops of iodine to test for starch in each leaf.

Only one leaf turns blue-black showing the presence of starch. This happens because KOH absorbs the CO_2 present inside one bell jar. As a result, the leaves do not get CO2 for photosynthesis. Thus the process of photosynthesis is inhibited and starch is not synthesized.

Experiment to show that sunlight is essential for photosynthesis

Material required:

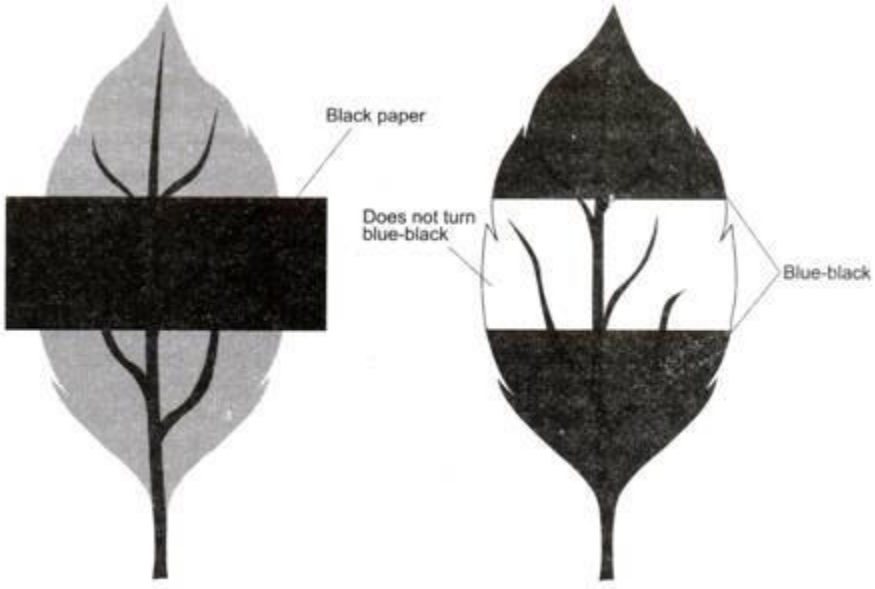
- Potted plant
- Test tube
- Aluminium foil /black paper
- White tile
- Dropper
- Ethanol

Procedure:

Keep a potted plant in the dark for 24hours on one of the leaves, stick black paper strips (one below and one above the leaf) with the help of cellotape.

Now place two plants in sunlight for a period of 2 hours. Pluck the leaf and remove the black strips.

Boil the leaf just in water then in alcohol to remove chlorophyll. After washing the leaf with water, keep it in a petri dish. Add a few drops of iodine solution.



Experiment to show that sunlight is essential for photosynthesis

Observation

The leaf turns black except in the region that had been covered . This region did not receive light and hence no starch was formed. The uncovered region received light and starch was formed due to photosynthesis.

Experiment to show that chlorophyll is necessary for photosynthesis

Requirements:

- Potted plant with variegated leaves.
- Water bath
- Test tube
- Dropper
- White file
- Alcohol

Method:

Destarch the potted plant with variegate leaves variegated leaves have green and yellow or white patches.

The plant is destarched to remove all the starch.

The plants is then exposed to the sun for 2 hours; one leaf is removed and its exact drawing put on a paper showing on the green and yellow patches . The leaf is tested for starch.

Observations:

Yellow parts of the leaf are stained brown. Parts that were green stain block with iodine.

Conclusion:

Starch is only formed in parts containing chlorophyll; no starch is formed in yellow or white patches hence chlorophyll is necessary for photosynthesis.

How leaves are adapted to the process of photosynthesis:

- Leaves are thin to reduce distance for diffusing Carbon dioxide gas.
- The leaves are broad & flat to provide large surface area for photosynthesis.
- Leaves have more stomata on lower surface to enable exchange of pail and less transformation.
- Leaves have waxy cuticle to prevent drying out of palisade cells.

- Leaves have a petiole to exposed them to the sun
- Leaves are arranged in a mosaic to enable them get exposed to the sun.
- Have branched veins to provide water to all palisade cells.
- Upper side has more chlorophyll than lower side to trap much sun light.

CARBOHYDRATES:

These are organic food compounds that contain carbon m hydrogen and oxygen, They are oxidized in the cells to release energy. They include sugars, starch and cellulose.

Sources of carbohydrates include cereals, root tubers, sugarcanes and stem tubers.

Sugars:

Sugars are soluble in cold water and have a sweet taste: A single sugar molecule is called a saccharide:

Carbohydrates can be classified depending on the number of sugars as:

Monosaccharides
Disaccharides
Polysaccharides

Mono Saccharides

These are simple sugars with general formula $C_nH_{2n}O_n$. They need no digestion and are absorbed into the body.

There three common types of simple sugars e.g. glucose, fructose and galactose.

Monosaccharaides are sweet, crystalline, and soluble in water and smaller molecules.

They are an reducing sugars is when dissolved in water and boiled with an equal amount of benedicts solution, it changeequal amounts of benedicts solution, it change from blue to green solution to yellow precipitate and finally orange /Red precipitate; Hence said to have reduced the blue copper II ions to Red /brown copper (I), a reaction that is only possible with monosaccharide's and maltose as the only disaccharide to have reducing properties.

NB: Mono saccharides are the building, blocks (monomer units) of disaccharides and polysaccharides

Disaccharides (Di = two, Saccharide = sugar)

These are sugars with two mono saccharides combined together by a condensation reaction in presence of enzymes to form a disaccharide.

They are therefore "double sugars" with a general formula $C_{12}\ H_{22}\ O_{11}$.

Examples of disaccharides:

Sucrose (sugar cane & sugar beet)
Maltose (found in germinating seeds)
Lactose |(found in milk)

Formation of dissacharides:

Glucose + galactose $\xrightarrow[enzymes]{lactose}$ lactose + water

Glucose + glucose $\longrightarrow$ maltose + water

Glucose + fructose $\longrightarrow$ sucrose + water

Properties of disaccharides

They are sweet
Soluble in water
Crystalline
Can be reducing e.g maltose and non-reducing

NB: Disaccharides can be hydrolyzed by heating with mineral acid into corresponding monosaccharides

e.g. sucrose $\xrightarrow{Acid/heat}$ fructose + glucose

Polyssacharides (Poly = many, saccharides = sugars)

They contain many repeating sugar units e.g. starch, glycogen and cellulose

Starch is a n insoluble carbohydrate: It is in this form that plants commonly store carbohydrates.

Starch has a chemical formula $(C_6H_{10}O_5)_n$.

Cellulose forms the cell wall of plants : It's not digested in our body since we have not cellulose digesting enzymes; un digested cellulose being fibrous acts as roughage; it also absorbs water and retains it and keep Pascal matter soft and prevents constipation; making movement of faecal matter easy.

Glycogen is the form in which carbohydrates are stored in animals.

Uses of carbohydrates in the body:

Source of energy
Control the isometric balance of protoplasm, by allowing osmosis.
Stored as food reserves in plants and animals
Used to manufacture other nutrients e.g. lipids
Form part of plant cell wall and other body structures.

Testing for carbohydrates in foods:

Testing for starch in solution:
Requirements:
Starch solution (A)
Iodine solution
Test tube
Glucose solutions (B)

Test	Observation	Deduction
To $1cm^3$ of solution A in test tube add 3 drops of iodine solution.	Solution turned into black solution	Starch is present
To $1cm^3$ of solution B add 3 drops of iodine solution	Colourless solution turned into brown solution	Starch is absent

Exp II

Testing for reducing sugars:

Materials:

Glucose solution (A)
Starch solution (B)
Benedict's solution
Test tube

Heat source

Test	Observation	Deduction
To 1cm^3 of solution A add 1cm^2 of Benedicts solution and boil.	Colourless solution turned to blue solution, green, yellow, orange and finally red precipitate	Reducing sugar present
To 1cm^3 of solution B add ofBenedict's solution and boil.	Turbid suspension turned to blue and remained blue solution	Reducing starch is absent

Explanation:

In test (1) m the solution contains reducing sugars; that have reduced the blue copper II ions in benedicts solution to red/brown precipitate of copper I .the reaction does not occur in test II because starch does not contains reducing sugars.

Testing for non-reducing sugars in solution:
Requirements
Sucrose solution (C)
Benedict's solution
Dilute Hydrochloric acid
Dilute sodium hydroxide solution
Water bath
Heat source,

Procedure

Test	Observation	Deduction
To 1cm^3 of solution C in test tube add 1cm^2 of dilute HCl, and boil for 5 minutes; cool in water bath, Add 1cm of dilute NaOH, followed by an equal amount of Benedict solution and boil	Turbid suspension turned into colourless solution, then blue solution, green solution , yellow ppt and change ppt.	Non reducing sugar Hydrolysed to reducing sugar

Explanations:

Boiling sucrose with dilute HCl hydrolyses the non-reducing sugar into reducing sugars (fructose and glucose): Therefore boiling withbenedict's solution results into reducing effect on the reagent.

Dilute NaOH, is added to neutralize the acid that caused the hydrolysis of sucrose into reducing sugars.

PROTEINS

These are large chemical molecules containing carbon, hydrogen, Oxygen and Nitrogen. Nitrogen is the most external element in proteins, some proteins may also contain Sulphur and phosphorous.

Protons are formed fromchemical units called AMINO ACIDS.

Amino acids of two types; namely:-

Essential amino acids
Non-essential amino acids are these which connate be synthesized by the animal body and must be supplied through food in adequate amounts.

2. None-essential amino acids are synthesized in the animal body.

Proteins inour food are digested and broken, down into among acids, which are absorbed in the ileum and transported by blood to different bodyparts. At this point, they are assimilated to forms different proteins in cells. Hair, enzymes, muscles, antibodies, Hemoglobin and hormones are all proteins, synthesized by body cells.

Proteins also provide energy in case of starvationhowever; their role is mainly building and repairing of tissues.

Lack of protein in a diet leads to a protein- energy deficiency called kwashiorkor and marasmus.

Symptoms of kwashiorkor

Dry and cracked skin
Pot bell
Skin and curved legs
Bulging eyes and reddish hair
Swelling of body

Control and prevention

A protein rich diet should be given to children.

Marasmus

This affects children aged about one year. It is caused by the deficiency of proteins and energy giving nutrients in the diet. This caused the body to use stored fats and body problems as source of energy, hence child loses weight and muscles start shedding: If not cured, it causes mental retardation and stunted growth.

Symptoms:

- Retarded physical and mental growth
- Gradual shedding of subcutaneous fat & muscles
- Dry ,loose- wrinkled skin, the arms and muscles
- Visible ribs
- Diarrhea

Control & prevention

Marasmus can be cured or prevented by a diet rich in proteins, carbohydrates & fats along with vitamins and minerals.

Experiment to test for proteins

Requirements

Egg – Albumen solution
Copper II sulphate solution
2m sodium hydroxide

Test	Observation	deduction
To $1cm^3$ of egg albumen solution; Add $1cm^3$ of sodium hydroxide solution; followed by drops of copper II sulphate	Purple solution forms	Proteins

Explanation:

The above is called the biuret test for proteins if proteins are absent in the sample, no purple colour develops.

Proteins can also be tested using millions

Reagent; and test called million's test;

However millon's reagent is poisonous and care is required while using it.

When millions is add and boiled with a protein food, a white coagulant , that turns pink, is formed.

FATS (LIPIDS)

Fats are a member of group of organic compounds call LIPIDS. They are compounds of carbon, oxygen and hydrogen made of fatty acids and glycerol

Digestion of lipids yields fatty acids and glycerol which are transported to various parts of the body, where they recombine to form fats, and deposited they also provide enegy, where they yield twice much Energy than an equal amount of carbohydrate if oxidized.

The liver produces cholesterol, a type of lipid, need to make vitamin D and some hormones.

Functions of fats

- Fats provide energy by acting as food reserves.
- Fats accumulate underneath the skin (substances) and act as insulators against heat loss from the body.
- Used to rebuild membranes of cells and organelles e.g. Those of mitochondria.
- They protect organs e.g. kidney, ovaries,eyes.
- They dissolve fat soluble vitamin eg. A, D, E K and transform them from intestines to different body parts.
- They act as a solvent for fat soluble vitamins, fats occur in plants and animals.
- They can be saturated or unsaturated.

Saturated fats are solids at room temperature and occur in animals.

Unsaturated fats are liquids at room temperature and occur in plant products.

Testing for lipids:

Translucent paper experiment:

Place a drop of oil or rub a liquid food at the Centre of a filter paper: allow it to dry and observe the part rubbed or where oil is placed.
Observation:
Cooking oil or meat has lipids.

Testing for lipids in food sample
Requirements:
Cooking oil
Ethanol
Distilled water
2 – Test tube.

Procedure:

Measure 1cm^3 of cooking oil and place it into a test tube; Add 5cm^3 of ethanol and shake to dissolve the oil. Then add 1cm^3 of distilled water.

Observation:

A cloudy white emulsion (suspension) is observed.

Conclusion:

Cooking oil has lipids

Lipids can also be tested using sudan III reagent, which is a red dye:

This is mixed with the food sample and a red stained oil layer forms on the surface of water, which remains colourless:-

VITAMINS:

Vitamins are chemical substances which help to maintain a healthy body .

Most vitamins act as catalysts or enzymes in external chemical changes in the body : but each vitamin has special function in the body.

They can be found in food naturally or can be synthesized. They are neither chemically similar nor functionally related to each other.

Vitamins can be grouped into two

i. Fat soluble vitamins
ii. ii) water soluble vitamins

Vitamins A, D, E and K are fat soluble:

Water soluble vitamins include the B group and grouped as so because they have similar properties and functions in the body. Hence called 8 – couples, which include vitamins B_1, B_2 , B_3, B_6 and B_{12}.

Vitamin is easily destroyed on storage (in day light) or prolonged boiling:

VITAMINS AND THEIR PROPERTIES

Vita mins	Types/forms	Dietary sources	Functions	Deficiency
A	**Retinol,**	Liver, orange, carrots, dark green leafy, vegetables eg. spinach	Vision , immune function, Growth healthy skin	Night blindness Keratomale, Xeropthal
B	**B_1 (Thiamine)**	Yeast, pork, liver, eggs, cereal grains (whole) oat meal, sunflower, asparagus, potatoes. Oranges.	Helps in converting blood sugar into energy, Essential for nervous system, cardiovascular system and muscle function	Beriberi- Syndrome
	B_2 (Riboflavin) (not easily destroyed by	Milk, cheese, liver, kidney, vegetables,	Energy metabolism, Metabolisms of	**Riboflavin** characterized by some throat,

	high temperature	legumes, tomatoes, yeast, mushrooms.	fats, carbohydrates and proteins	swelling of mouth, throat, inflammation of mouth corners. Scaly skin, reduced RBC , and hemoglobin
	B_3 (niacin)	Liver, chicken, beef, fish, cereals, peanut, legumes, mushrooms	Essential for energy release from carbohydrates, fats and proteins - Helps in DNA synthesis - Necessary for healthy skin, nerves, digestive system.	Pellagra
	B_5(Pantothenic acid)	Meal, cold-water fish ovaries, royal jelly, whole grains, vegetableseg. Avocado	Assists in metabolism of carbohydrates, proteins & fats -Essential for cell metabolism - legume for cholesterol metabolism , Hormone production and haemoglobin	ParaethesIS – Its characterized by sensation of tingling, pricking or numbness skin Pricking or numbness skin
	B_6 *(*Pyricloxal phosphate)	Meal, whole grain plots, vegetables , nuts, bananas	Macro nutient metabolism Neuro transmuter, Heamoglobin synthesis, and gene expression	-Aneamia - Penpheralneuropthy
	B_7 (biotin)	Egg yolk, liver, kidney	- Helps in converting food to energy . - Assists in cell growth	-Permatitis - Enteritis

	B_9(folic acid)	Leafy vegetables, spinach, legumes e.g. fresh beans, Liver, & Liver products, baker's yeast, sunflower seeds.	Synthesize and repairs DNA. -Required during rapid cell growth and division. Produces Healthy RBC.	Anaemia, fatique -Mental depression during pregnancy linked with birth defect.
	B_{12} (Cabalamin)	Bean meal, egs, dairy products e.g. milk cheese	Maintaining a healthy nervous system, Development of RBC's , affects DNS synthesis, & fatty and synthesis -Energy production.	Megaloblast anaemia.
C(Ascorbic acid)		Citrus fruits e.g. orange, melon, tomatoes. Cabbages, Sweet red pepper.	Keeps body tissues such as gums and muscles in food shape -Help in healing of woods - Resistsinfection	Scurvy
D	D_2 (ergocalciferol D_3 (Cholecaferol	Liver, egg York, fish, fortified cereals, milk, fortified with vitamin D.	Regulate body levels of calcium, & phosphorus, -Supports healthy immune system	Rickets Osteo malacia
E (a-tocophero		Whole granules wheat, oats, green leafy vegetables eg. spinach, nuts, and seeds	Maintains body tissues in eyes, skin, & liver -protects lungs, from damage by pollutants Forms RBC	Haemolytic anemia in new born.
K	K_1Phylloquinone	Oxen leafy vegetables, dairy products eg. Milk yogurt, liver.	-Helps in blood clothing, protects bone from fracture -prevent calcification of	Bleeding disorders -Osteoporosis (delayed clotting)

			arteries	

Minerals

Many metals and non-metals are required for various reactions taking place in our body. The most important minerals needed by the body include Ca, Mg, Na, K, P, S, and Cl, they are required in amounts exceeding 10gm per day, hence called MACRO elements.

The remaining of mineral e.g. Fe, I, Cu, Zn, Mn, Co, Mo, Se, Cr, and fluorine are required in very small quantities hence called TRACE or ELEMENTS

Table showing the types of mineral and their properties

Minerals	Dietary sources	Functions	Deficiency disorders
Calcium (Ca)	Dairy products, milk, cheese, yoghurt, Green leafy vegetables	-Constituents of bone & teeth - For nerve function, muscle contraction and blood clotting.	Osteomalacia , Osteoporosis, rickets.
Magnesium (Mg)	Eggs, milk dairy products, fish, nuts, legumes, whole grains, green vegetables	-Constituent of muscles, soft tissues and bones - Function in many enzymes processes	Muscles weakness. Abnormal heart phylum, cramps, fits.
Phosphorus(P)	Meat, poultry , fish, dairy products, cereal products, ghee leafy vegetables	-Essential for bone formation and maintenance -Energy metabolism, nerve function & acid balance.	Anemia, demineralization of bones; nerve disorders, respiratory problems, weight loss.
Sodium (Na)	Table salt, milk products, eggs , sea foods.	-Regulate body fluid volume - Acid –base balance - Nerve & possible activity	Muscle paralysis Heart problems
Sulphur (S)	Cheers, egg, fish, nuts onion, wheat germ.	-Health skin & nails -Detoxification	Skin disorders, muscles pain, nerve disorders, circulatory trouble, inflammation; wrinkles.
Iron (fe)	Read meat, lower, eggs, legumes,	It is important for formation of Hemoglobin of	

	green leafy vegetables, whole grain	RBCs that carries oxygen throughout the body	
Iodine(II)	Sea foods, iodized salt, food products with iodized salt.	-Essential for production of thyroid hormones-ones	Goiter cretinism

WATER

This is the most abundant substance in the body,consisting 65 % by weight of the body. It's obtained by drinking and eating food.

Functions of water:

- It's a solvent, providing a medium for most reactions

- Regulates temperature of body.

- Eliminates nitrogenous wastes.

- Raw material for photosynthesis.

Roughage:

Sources: fruits and vegetables, Beans since the cell wall of plants is made up of cellulose that acts as roughages (fibers) for over body.

Roughages play an important role in prevention of many diseases of the digestive tract.

Soluble dietary fibers in beans, oats and lentils reduce the amount of cholesterol in blood.

Balance diet

A balanced diet is one which includes all the nutrients in the required proportion along with water in the required proportion along with water and roughage.

A balanced diet ensures

- A normal mental & physical status.

- An increased work capacity

- Ability to resist diseases.

A balanced diet is essential for pregnant, lactating mothers, and growing children.

ENZYMES:

These are chemical substances, protein in nature that speeds up chemical reactions.

Enzymes are produced by living cells (exocrine glands)

Reaction would be proceeding soslowly meantenzymes were not involved:Therefore they have a role of speeding up metabolic reaction.

There are two types of metabolic reactions:

Catabolism: reaction involving breaks down of large molecules into smaller units e.g. Respiration
Anabolism: reactions involving formation of large molecules for smaller ones e.g. Photosynthesis

Types of Enzymes:

Extracellular enzymes: which are secreted within cells, but act on reactions outside these cells that produced them?E.g. digestive enzymes.
Intracellular enzymes: These are secreted and used within the cells that produced them e.g respiratory enzymes.

How enzymes are classified:

Enzymes are classified depending on the reactions they act on e.g.

Hydrolyzing enzymes: These cause decomposition of substances by addition or removal of a water molecule eg. Digestive enzymes.
Oxidation-reduction enzymes: These catalyze reaction involving oxidation of substances.

NAMING ENZYMES

Enzymes are named by attaching a suffix “ase” At the end of the name of the substrate they act on e.g.

Substrate	Name of enzyme
Maltose	maltase
Sucrose	Sucrase

Peptides	Peptidase
Lipid	Lipase
Proteins	Protease

Properties of enzymes

- Required in small quantities
- Speed up rate of chemical reactions
- Remain unchanged at end f reaction
- Can easily be denatured by heat
- They are specific to a particular substrate
- Work best in specific PH medium
- Can be inaccurate by metabolic poisons e.g. cynide.

How enzymes work:

Enzymes act by attaching to the substrate molecule at specific sites called Active sites forming an enzyme –substrate complex. Active sites are specific points on the enzyme where substrates attach by fitting and reduce the activation energy which allows the enzyme and specific inshape for particular enzyme and substrate. The complex formed later breaks down into a product; leaving the enzyme free and can be re-used again in another reaction. the above mechanism is called the lock and the key; where the enzyme is like a lock and key to the substrate molecules.

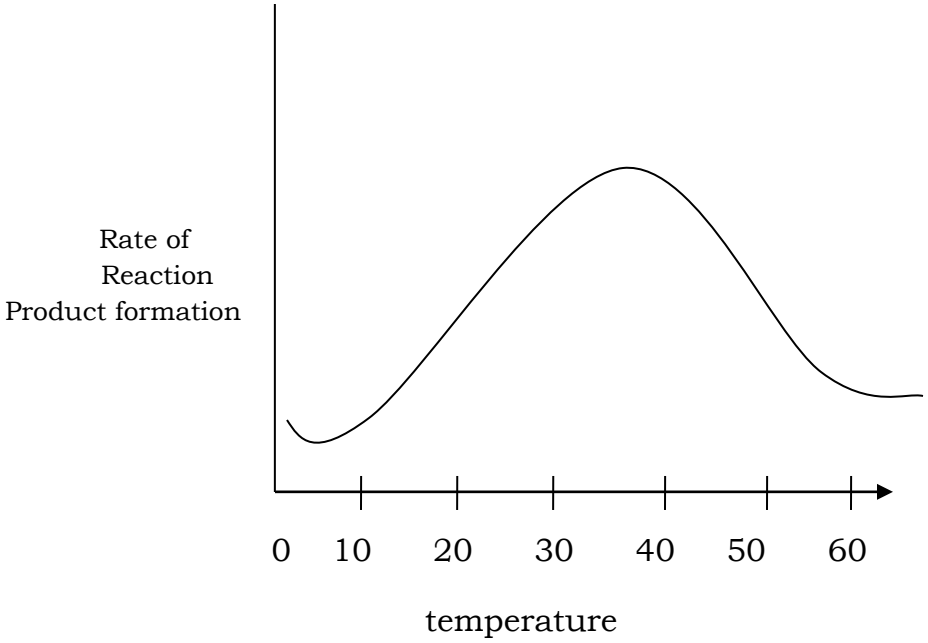
Enzymes +susbtrate ⇄ Enzyme – substrate Complex ⇄ Enzymes + product

Factors that affect the rate of an enzyme controlled reaction

Temperature

At very low temperatures, enzymes controlled reactions proceed slowly because the enzymes are inactive at low temperatures, usually below 100C.

The rate of an enzyme activity increases rapidly as temperature increases upto an optimum. This is because high temperatures activate enzymes. Optimum temperature is a point where the enzymes produce highest activity as shown below.



At temperature below 10^0C.rate of reaction is slow; at every doubling temperature there is a rapid increase in rate up to an optimum of 40^0C, rate of reaction decrease rapidly.

Explanation:

Below 10^0C, enzymes are inactive hence reaction increased gradually slowly.

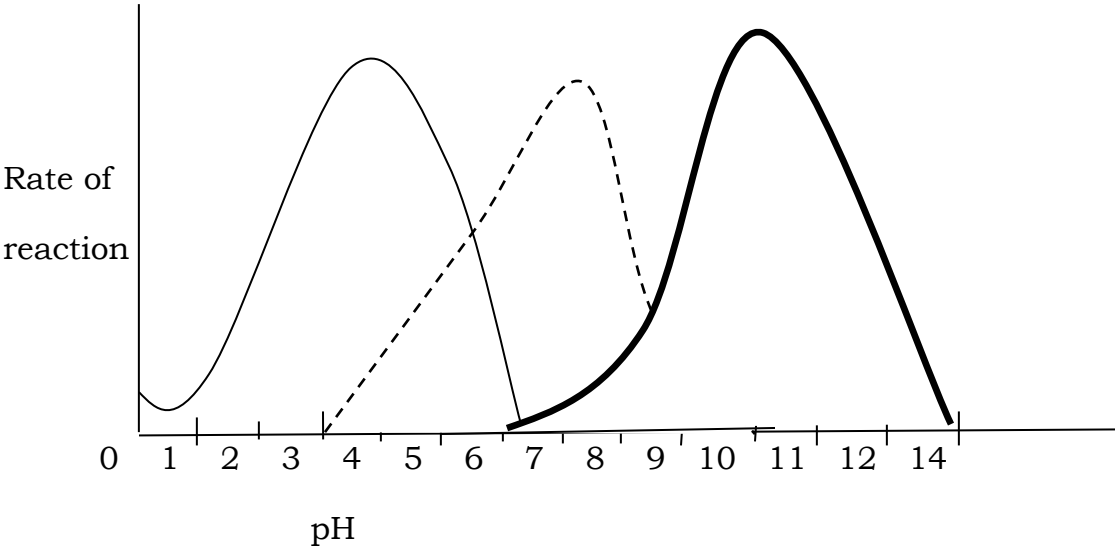
Between 20^0C to 40^0C rate increased rapidly or very fastbecause high temperatures activated the enzymes

Beyond enzymes are denatured by very high temperatures, making it impossible for formation of more products. Any impossible for formation of moreproducts.Any increase in temperature beyond optimum will cause all enzymes to be denatured and the reaction will step.

PH

Any change in PH will produce un irreversible effect on the enzyme; because they work under specific PH medium. Every enzyme has a specific PH that cause a maximum point of reaction; and a slight change in PH will affect the rate of reaction

Graph showing effect of PH on rate of three digestive enzymes.

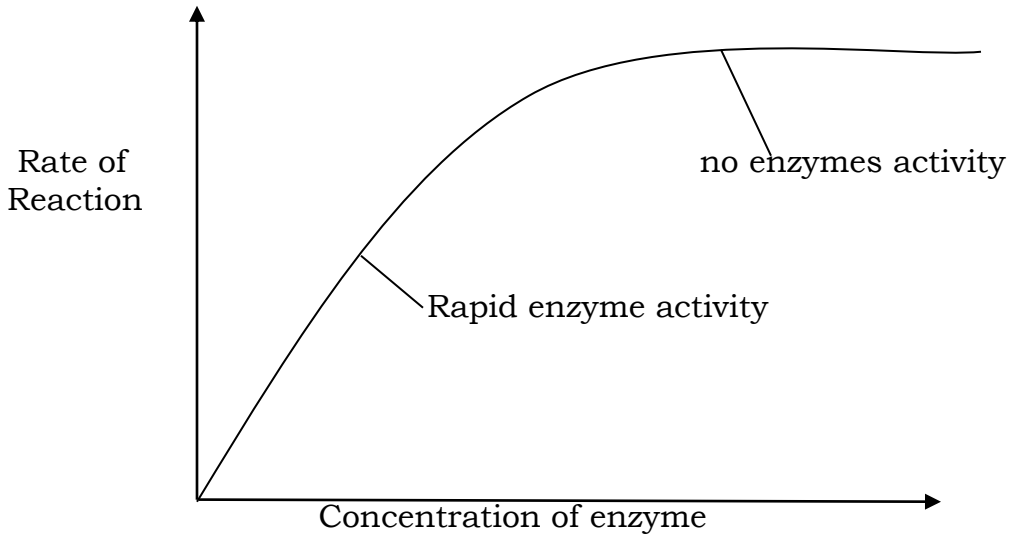


Enzyme pepsin works best under acidic PH, while Amylase has best activity under alkaline PH, PH levels outside the enzymes maximum activity reduce rate or permanently denature.

Enzyme concentration

Increase in enzyme concentration causes a rapid increase in rate of reaction, until all the substrates have bound with every available enzyme, so that any increase in enzyme concentration does not cause an increase in rate of reaction.

As Enzyme concentration increases more active sites are available for increase in rate of product formation; as there are no substrates to bind with increasing enzymes, the rate remains constant as shown below:



Concentration of substrate

As substrate concentration increases, rate increases. However a point is reached when increase in substrate concentration does not cause an increase in rate of reaction because all the active sites on the enzymes have been used up, and excess of substrate has no enzymes to bind with., hence no product is formed.

Activators e.g. cofactor and co-enzymes

These promote enzyme activity co-factors are mostly non-protein compounds e.g Fe, Cu, Zn, required for efficient working of an enzyme. Co-factors are organic not protein molecules that also increase enzyme activity.

Inhibitors: e.g poisons

These reduce the activity of enzyme controlled reactions if found present. Some attach on the enzyme and prevent formation of product or alter the shape of active sites:

End of chapter questions

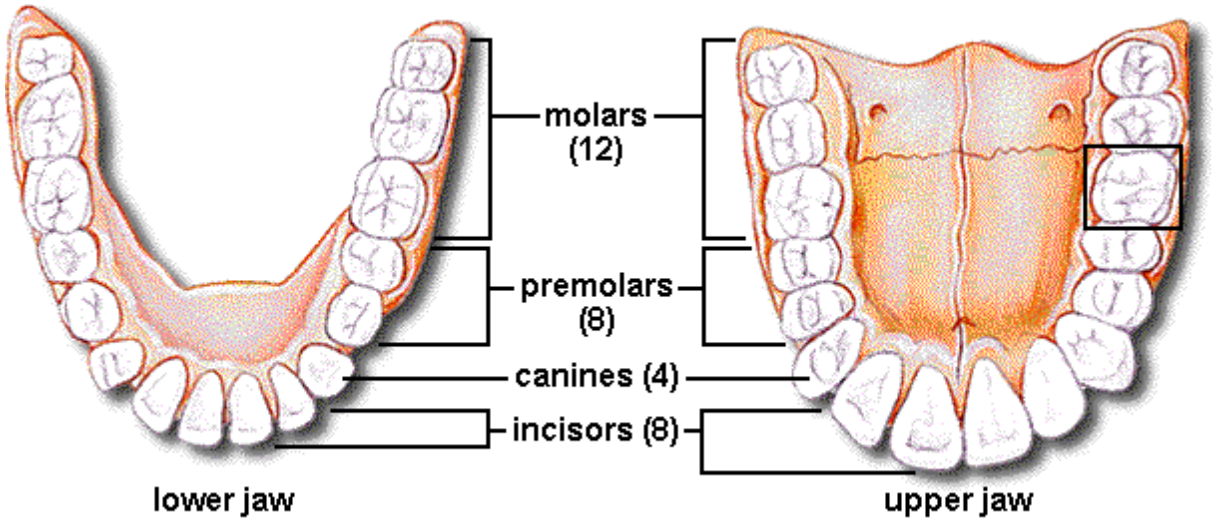
I. Define an enzyme
II. Briefly explain the factors that affect enzyme activity.
III. Explain the role of:
IV. Inhibitors and co-enzymes in the activity of an enzyme:

THE MAMMALIAN TEETH

Mammals have different types of teeth which are embedded in upper and lower jaw: These include

Incisors
Canines
Premolars
Molars

The general functions of teeth are to chew food, an action called mastication; that breaks food into tiny particles, increasing its surface area for enzyme action. This process is called physical digestion of food, along with a action of muscles of the alimentary canal onto food.

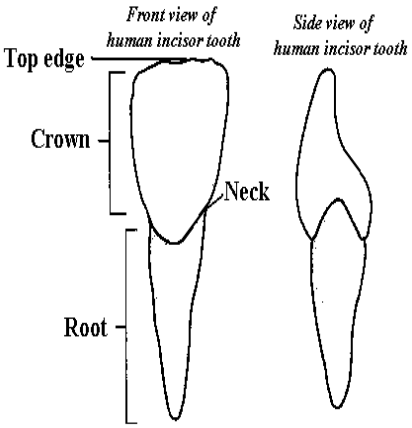


A tooth consist of 3 region

The crown – which projects the tooth above the gum and used for breaking found into tiny particles.
Neck- the junction between the root and crown
Root: The part of the tooth within the jaw bone.

INCISORS:

These have a chisel shaped crown with sharp ridged edges. They are used of r cutting &biting food into small pieces.

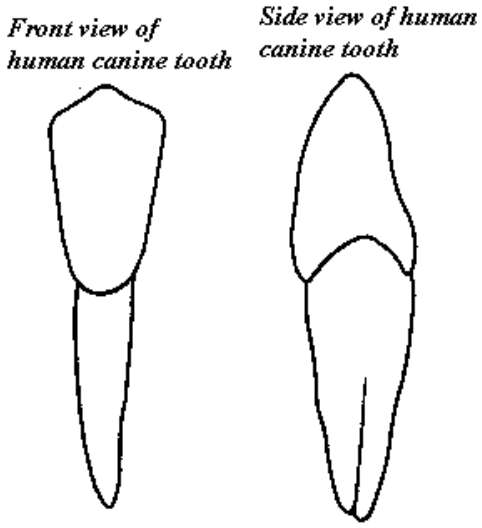


Characteristics of incisors

- Have only one root
- Have chiseled shaped crown

CANINES

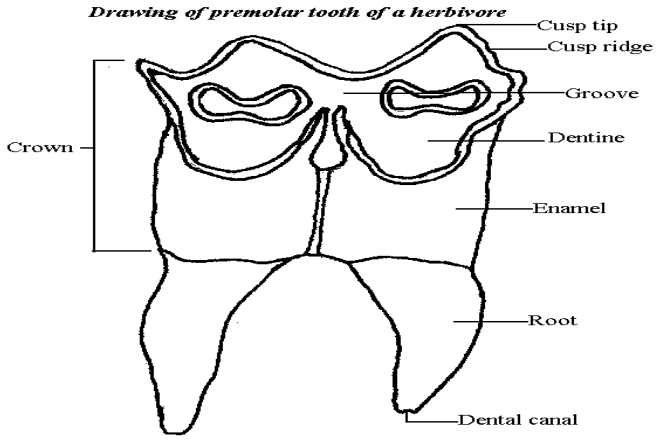
These are conical and sharp pointed. They have one root, canines are used for tearing food especially flesh. Carnivores have well developed canine teeth.



Premolars:

These have flat and broad surfaces with one or two roots. They are used for grinding and chewing food.

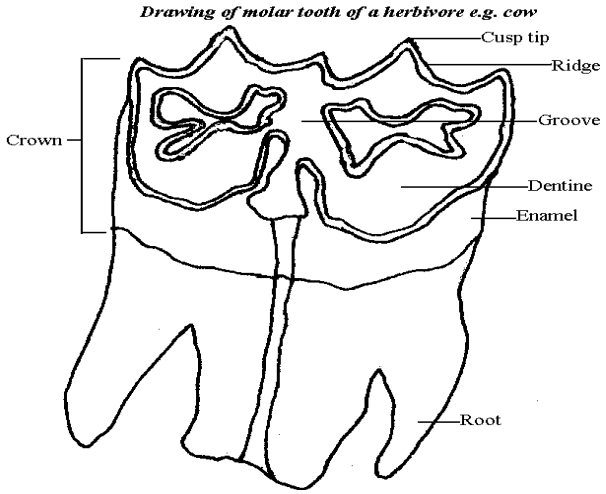
N.B: The upper premolar and fast lower Molar in carnivores on each jaw side are used for tearing flesh and crushing Bones. They form the carnassials teeth.



Molars:

They have a wide surface area for gridding and crushing food.

Molars are used for crushing and grinding food.



Dentition

This is the type , number and arrangement of teeth in an animal.

Milk set consists of 8 incisors, 4 canines and 8 molars. Therefore they are 20 teeth making up this set. This is later replaced by a permanent set between age 7 to 11 yrs.

Dental formula

This is a formula that shows each kind and number of teeth in half of the upper and lower jaws of a mammal.

In this formula , each teeth is represented by letters, while teeth in upper jaw is written as numerator, and those in lower jaws as denominator, both separated by a dash .as

Incisors (I)

Canine (C)

Premolar (PM)

Molars (M)

Total number of teeth in the mouth of the mammal is obtained by totaling all teeth in upper and lower jaws, then multiplying the number by two:

Examples of dental formulae

Human beings

$$I\ \frac{2}{2}\ C\ \frac{1}{1}\ PM\ \frac{2}{2}\ M\ \frac{3}{3} \quad (16 \times 2)$$

Total number of teeth = 32

Sheep

$$I\ \frac{0}{3}\ C\ \frac{0}{1}\ PM\ \frac{3}{2}\ M\ \frac{3}{3} \quad (15 \times 2)$$

= 30 teeth

Dog

$$I\ \frac{3}{3}\ C\ \frac{1}{1}\ PM\ \frac{4}{4}\ M\ \frac{2}{3} \quad = 21 \times 2$$

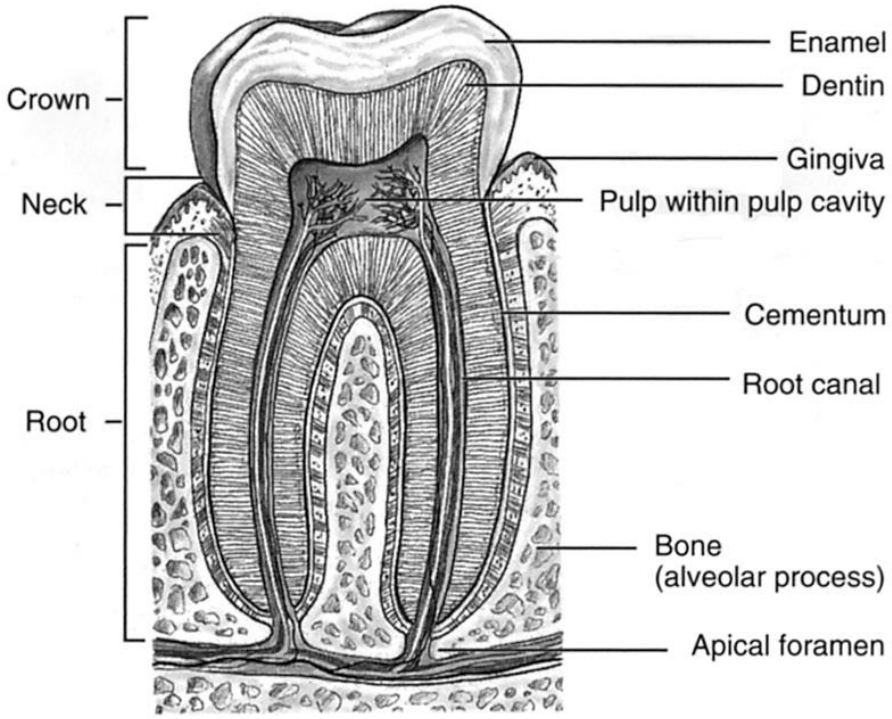
= 42 teeth

Rat

$$I\ \frac{1}{1}\ C\ \frac{0}{0}\ PM\ \frac{0}{0}\ M\ \frac{3}{3} \quad = (8 \times 2)$$

= 16 teeth

Internal structure of a tooth:



Parts of the internal structure of a tooth

Enamel:

It's the hardest material in the body. Its brittle and nonliving. It contains calcium salts. It protects the dentine and pulp cavity and strengthens the tooth.

Dentine

It contains 70% calcium. It's harder than bone. It strengthens the tooth.

Pulpcavity:

It's the living part of the tooth; it contains sensory nerve endings and blood vessels it's for sensation in teeth and formation of dentine.

Cement

It's a bone like material, which fixes the tooth to the jaw bone.

GUM: This holds and supports teeth firmly in the jaw bone,

Blood vessels

These supply nutrients to the tooth. They also circulate respiratory gases in a tooth.

Nerve endings

These defect changes in heat, pain, & coldness being exposed to the tooth

PROPER CARE FOR THE TEETH

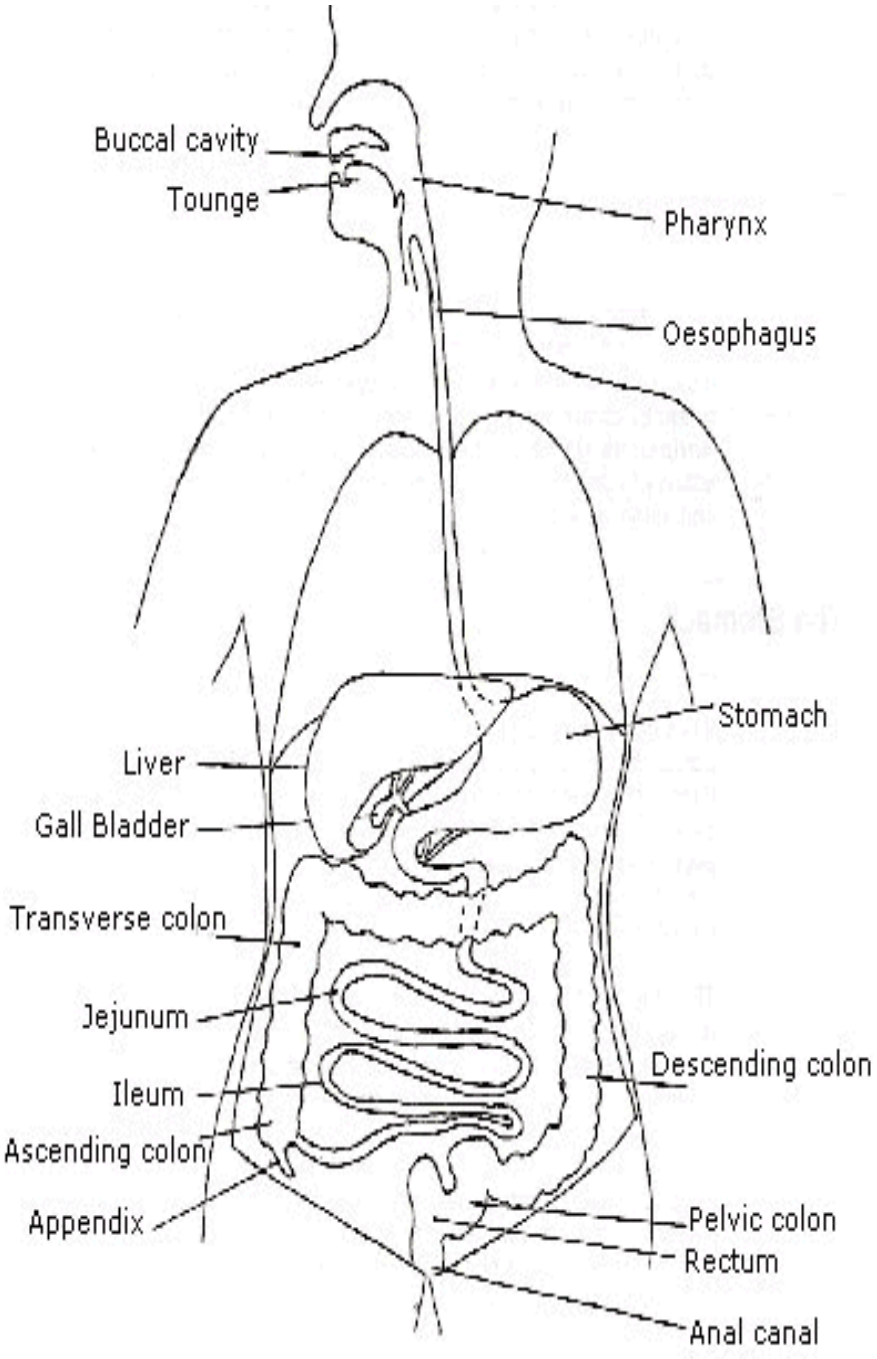
Teeth are delicate parts of the body that require proper care to prevent damage and diseases e.g. tooth decay. This is done by:

- Proper & regular brushing of tooth in the morning and before bedtime.
- Avoid eating sugary foods
- Give exercise to teeth by eating fibrous foods e,g sugar canes.
- Avoid eating food where brushing is not possible e.g in Buses.
- Avoid eating very hot or cold foods.
- Regular visits to the dentist.

The process of Digestion:

This occurs in the digestive system; which runs from the mouth to the anus.

Structure of the human digestive system.



Digestion in the different parts of the alimentary canal:

Mouth:

This has place called buccal cavity withthe digestion of food (mastication)

The tongue is an organ of taste and also rolls food into a bolus, making swallowing easy.

In the mouth there are salivary glands that secrete fluid saliva. This consists of water Enzyme ptyalin (Salivary amylase), mucus and salts.

Role of saliva

Lubricates food, making swallowing easy.
Has salivary amylase responsible for chemical digestion of starch . (NB. Digestion of starch starts in the mouth)
Saliva moistens food.
Contains salts eg.HCO_3 that prevent tooth decay.

The tongue rolls food into bolus, which moves down the alimentary canal: the alimentary canal opens into the pharynx or throat. The pharynx leads into the trachea and esophagus. The entrance of larynx called plant glottis, is guided by epiglottis, that closes glottis and prevents food going into trachea; but into the gullet in the esophagus, food moves by a wave of contraction and relaxation of muscles called peristalsis.

The esophagus conducts food in form of bolus into the stomach. The bolus is pushed down wards by wave of muscular contractions and relaxation called peristalsis.

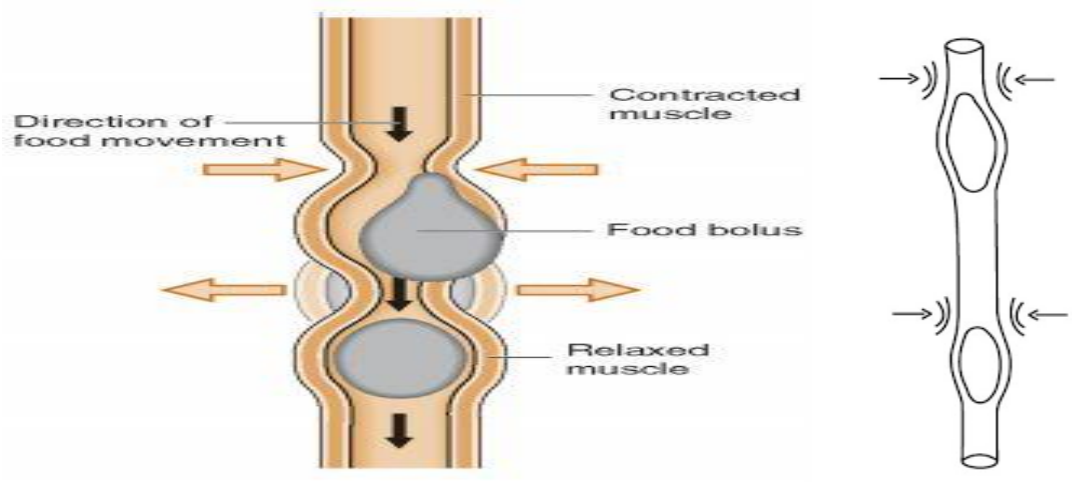


Fig an illustration of peristalsis

In the mouth, mechanical and chemical digestion of food takes place. Teeth mechanically break down food by chewing. The saliva contains salivary amylase that is responsible for chemical digestion of food (starch) which is rolled into a bolus and pushed to the stomachby peristalsis.

The stomach and the process of digestion

This is made of elastic walls. Food enters the stomach through cardiac sphincter, while another sphincter between controls amount of food entering the duodenum.

In the stomach wall has glands called Gastric glands which secrete gastric juice. The stomach wall has mucus secreting cells(Goblet cells), Oxyntic cell , which produced hydrochloric acid and peptic cells which produce enzyme pepsinogen that later activated to pepsin.

The food is mixed and chummed into a semi liquid form called chyme.

Enzyme pepsin breaks down proteins into polyp peptides:

In young mammals, rennin produced in as prorennin acts on the soluble milk proteins (caesinogen) converting them into insolubleproteins called casein, causing milk to coagulate into curds.

The small intestines and the process of digestion:

Small intestines is made of Duodenum is the first part of small intestines with cells that produced hormone secretin, which stimulates the pancreas to release pancreatic juice.

Pancreatic juice is alkaline and contains different enzymes that act on different food materials. e.g.

- Trypsin – produced as trypsinogen and activated by enzyme enterokinase . It works on proteins converting them into peptides and amino acids.
- Pancreatic amylase which works on starch intomaltose.
- Pancreatic lipase, which works on lipids in the duodenum bile is produced from liver cells and stored in Gall bladder.

Functions of bile

- Neutralizes acidic enzyme enabling enzymes in the duodenum to act on it.

- Reduces the surface tension of fats and splits them into minute Droplets, a process called emulsification of fat.

- Bile salts activate fat digesting enzymes called Lipase.

The ileum

This is the lower part of the small intestines where complete digestion of food and absorption takes place.

The walls of the ileum secrete a hormone called succus entericus or intestinal juice that contains different enzymes that act on different foods.

Enzyme	**Food acted on**	**Product**
Maltase	Maltose	Glucose
Sucrose	Sucrose	Glucose & fructose
Lactose	Lactose	Glucose) galactose
Lipase	Lipids	/fatty acids + glycerol
Peptidase	Peptides &Polypetides	Amino acids

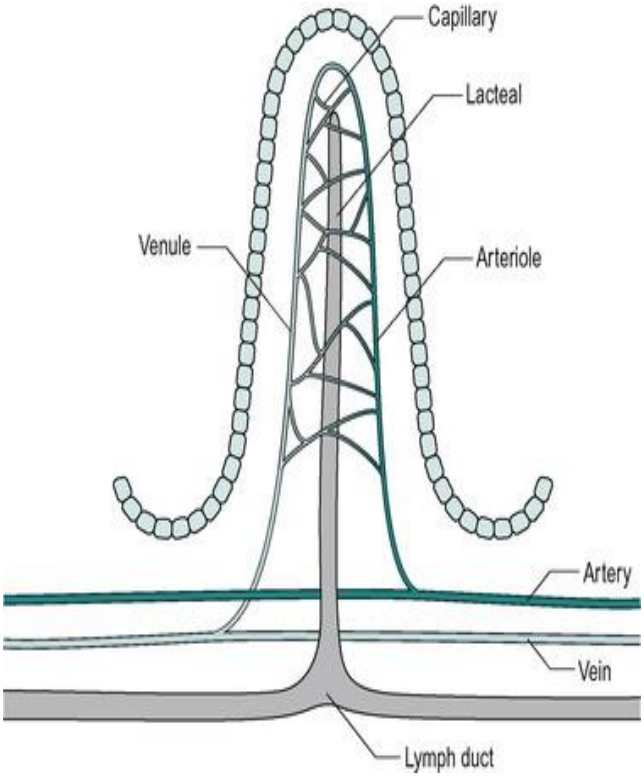
In the ileum , final digestion occurs and food is converted into soluble chyle, which is observed :

Absorption of food

This is the passage of food into the blood stream. The small intestines are well adapted for this process by being long, to increase surface area, folded and coiled to increase surface area.

- This to reduce distance for diffusion has many fingerslike projections called villi to increase surface area.
- Has a dense network of blood capillaries to absorb soluble food nutrients.

The villus structure



The lacteal contents join the lymphatic system and moves fatty acids and glycerol which later join the circulatory system from the lymphatic system.

Amino acids and glucose pass into blood capillaries and more to liver via the hepatic portal vein for assimilation.

The process of assimilation

This occurs in the liver and it involves the final usage of absorbed food nutrients.

i) Assimilation of Glucose

This oxidized to release energy by respiration. Excess of glucose is stored as glycogen in liver cells and muscles.In presence of hormone insulin, excess glucose is regulatedand loweredinto glycogen. It can also be converted back to glucose in case of reduction in sugar levels; by action of hormone glucagon; produced by pancreas.

Assimilation of fatty acids and glycerol

Fats are oxidized to release energy for cell metabolism and muscle contraction. Excess fats are stored in the adipose tissue of the abdomen, underneath the skin and around kidneys.

Fats can be burnt into cell membranes and other structures.

Assimilation of Amino acids

These are absorbed by cells and used to make enzymes. They can be used to make body structures e.g. hair, nails.

- Formation of plasma proteins; enzymes.
- They can be oxidized to provide energy in case of starvation.

Excess amino acids are not stored in the body, they are dominated.

This involves breakdown of an amino acid into a carbon compound and Nitrogen Compound called amine; the carbon compound is converted onto glycogen, while Nitrogen compound called amine is converted into urea and excreted urine.

The large intestine and process of digestion

This consists of calcium appendix and colon.Calcium andappendix are not well developed in humans and have less digestive role.

In the colon,

Water& mineral salts are absorbed. The remaining indigested food remains as a semi- solid waste called faeces into small pellets egested through the anus.

The Liver and its functionally diversified.

- Regulation of blood sugars.
- It regulates blood sugar levels, by converting excess glucose into glycogen, bring its level backs to normal.
- Deamination
  This is removal of excess amino group from amino acid molecule. The amino group is converted into urea and eliminated as urine by the kidney

- Synthesis of fibrinogen

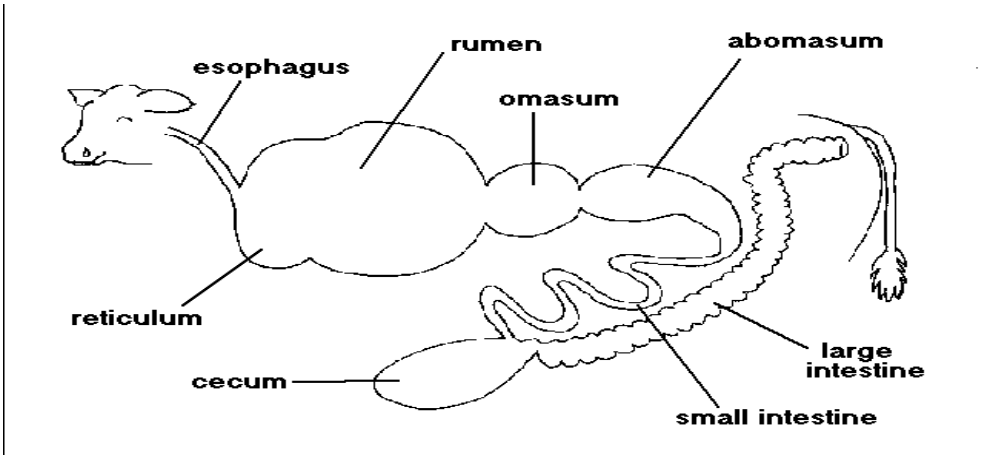
Plasma protein of fibrinogen is produced by liver cells; and it's important in blood clotting.

- **Detoxification**
  The liver converts toxic substances into non to the ones of hydrogen peroxide is converted into water and oxygen.
- Regulation of body temperature
  The liver produces energy used to maintain aconstant body temperature.
- Storage of fat soluble vitamins A, D, E & K, B, and mineral salts copper & potassium.
- Excretion of bile pigments:
  The liverproduces bile pigments, produced during breakdown of old worn out red blood cells in the spleen.
- Storage of blood:
  Liver stores about 500cm3 of blood

Digestion in Ruminants

These are herbivores with four stomach chambers. They are said to chew the cud.

Digestive system of Ruminants



Parts of the stomach

Rumen:

Food is temporarily stored as animal feeds an moved to second chamber. In Rumen, bacteria &protozoa act on food causing it to undergo fermentation.

Reticulum:

When animal stops feeding food from reticulum returns to Reticulum returns to mouth for more chewing a process called chewing the cud; this food now moves to the psalterum (omasum) for further digestion from omasum food is moved to abomasum, the true stomach, where chemical digestion proceeds.

Non ruminants

Some herbivorous animals do not chew the cud. E.g. rabbits. They have cellulose digesting bacteria in caecum and appendix

Qn.

1. State 3 differences between ruminants and non-ruminants.

   i) Briefly explain the functions of the liver.

   ii) How is the ileum adapted to its functions?

   iii) Describe the digestion of protein rich foodup to the point of absorption.

How different Organisms Obtain Nutrition:

1 fungi.

Fungi absorb nutrients from plant or animal matter around them, which may be living or dead. **They** produce long, slender threads called hyphae that spread through their food. The hyphae release enzymes that break down the food into substances that the **fungi** can easily absorb.

Ii Amoeba

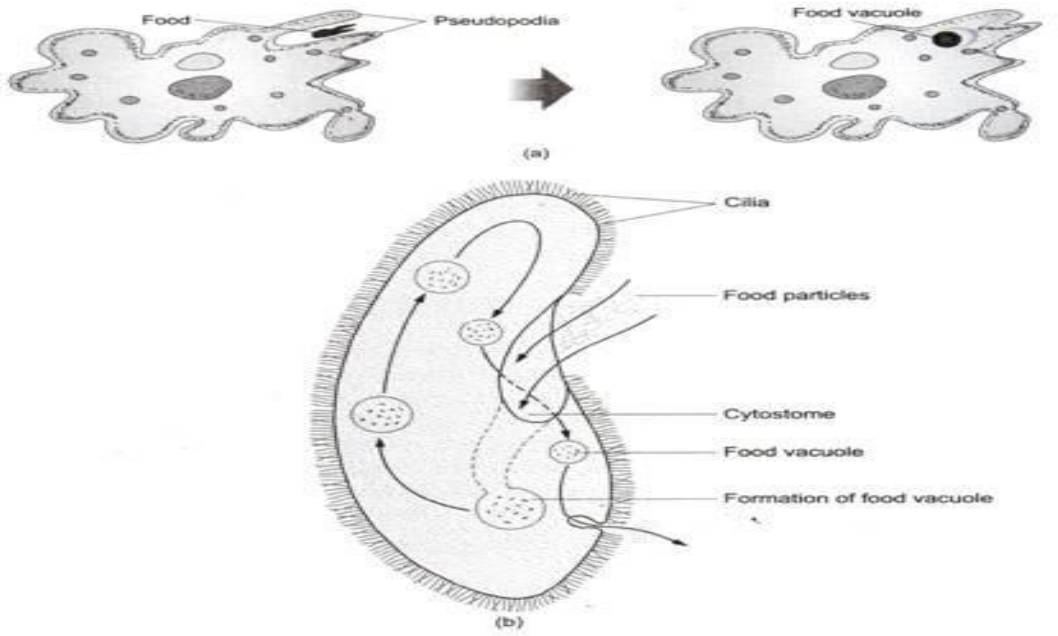
Amoeba feeds on microscopic organisms such as single-celled algae and bacteria. When the **amoeba**encounters a suitable organism, the cytoplasm flows round the prey and engulfs it, with a drop of water, in a food vacuole. The cytoplasm secretes enzymes into the food vacuole.

Different organisms obtain food in different ways. Nutrition in unicellular organisms, like Amoeba, involves ingestion by the cell surface, digestion and egestion.

Amoeba takes in complex organic matter as food. Amoeba first identifies its food. It then throws out a number of small pseudopodia (projections of cytoplasm, also called false feet). These pseudopodia enclose the food particle and prevent it from escaping. The food enclosed in the cell membrane forms a food vacuole.

The complex food is broken down into simpler molecules with the help of digestive enzymes of the organelle called lysosome. The digested food is distributed in the cytoplasm and the undigested food is egested through the cell membrane.

iii) In Paramecium, a unicellular organism with a specific shape, food is ingested through a special opening, the cytostome (cell mouth). Food is brought to this opening by the lashing movement of cilia that cover the entire surface of the cell



(a) *Amoeba* sends out pseudopodia to engulf food. (b) Feeding in *Paramoecium*

Further reading:

Feeding in Birds