NUTRITION 1

Concepts

INTRODUCTION

All the living organisms including human beings perform a number of activities such as nutrition, respiration, excretion, growth and reproduction. These activities are characteristics of living organisms, and through such activities they maintain their lives. These maintenance function of living organisms are known as **life processes.**

Chemical reactions which take place within cells or organisms during various vital activities are called **biochemical reactions**.

Metabolism is a word used to describe the sum total of all the chemical and physical changes that are constantly taking place in living matter and are necessary for life. The word **metabolite** refers to a substance which undergoes various changes during metabolism. For example, carbon dioxide and water are metabolites used in the process of photosynthesis.

The metabolic pathways are of two types :

1. ANABOLIC PATHWAYS OR BIOSYNTHETIC PATHWAYS

Anabolic pathways or **biosynthetic pathways** in which biosynthesis of organic compounds occurs, or in other words, complex substances are synthesized from simpler ones ; for example photosynthesis.

1.1 CATABOLIC PATHWAYS

Catabolic pathways in which the breakdown of complex organic substances into simpler ones occurs (as in respiration)

In anabolic pathways or processes of **anabolism** energy is used **(endothermic reactions)**, while in catabolic pathways or **catabolism**, energy is released **(exothermic reactions)**.

Following Criteria to define if something is alive :-

(a) Nutrition :- The processes by which the organisms obtain and utilise the nutrients (food).

(b) Respiration :- The process that involves breakdown of respiratory substrates through oxidation and release of usable energy.

(c) Transport :- The process in which the substances absorbed or synthesized in one part of the body are carried to other parts of the body.

(d) Excretion :- The process involved in removal of the excess or toxic wastes from the body.

(e) Control and coordination :- The process which helps the living organisms to receive information from the surroundings and behave accordingly in order to survive in the changing environment around them.

(f) Cellular organisation :- Body of all living organisms is made of cells. It is defining character of alive.

(g) Movement and Locomotion

(h) Consciousness :- All organisms from prokaryotes to eukaryotes can sense and respond to environmental factors.

2. NUTRITION

Nutrients are inorganic as well as organic substances which the organisms obtain from their surroundings in order to synthesize their body constituents and use them as a source of energy.

The process of intake of nutrients and its utilization by an organism in various biological activities.

OR

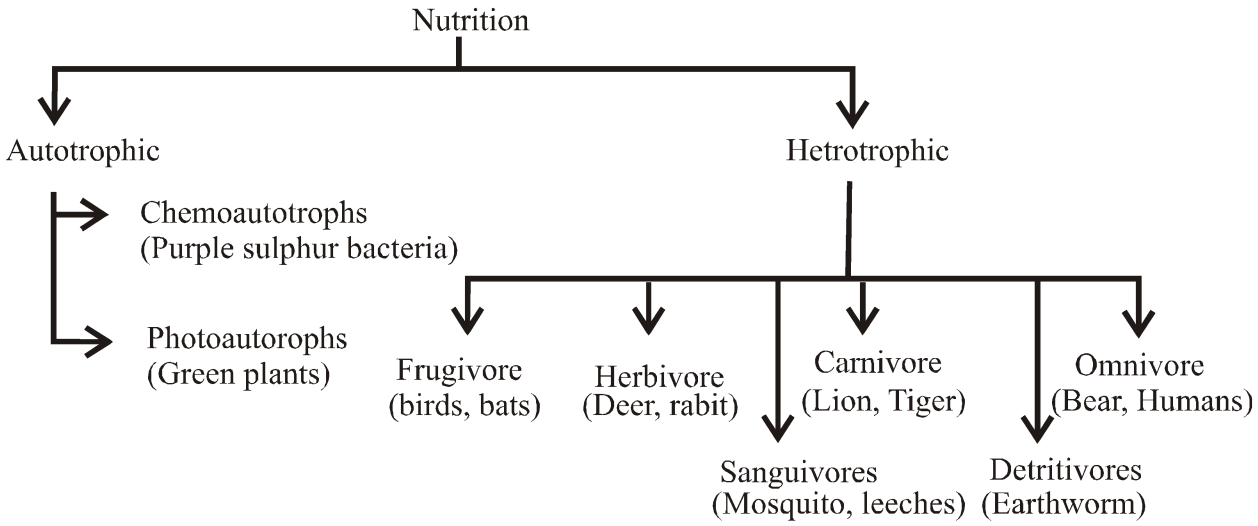
A process to transfer a source of energy from outside the body of the organism (food), to the inside is called nutrition.

Focus Point

There are various types of nutrients on the basis of function they perform :-
e.g. Energy foods :– Carbohydrates and fats.
Body building foods :– Proteins and mineral salts.
Regulating foods :– Vitamins and minerals.

2.1 MODES OF NUTRITION

Method of obtaining food by the organism is called mode of nutrition



Autotrophic nutrition

The mode of nutrition in which the organisms prepare (or synthesize) their own organic food by using inorganic raw material (CO_2 & H_2O). They are also called **autotrophs.**
e.g. Plants, Photosynthetic and chemosynthetic bacteria and cyanobacteria etc.

Heterotrophic nutrition

The mode of nutrition in which the organisms derive their nutrition from other organisms. They take ready made organic food from other dead or living plants or animals. The living organisms showing heterotrophic nutrition, are called **heterotrophs.**
e.g. All animals, fungi, many bacteria and some non-green plants (insectivorous plants) and man.

2.2 TYPES OF HETEROTROPHIC NUTRITION

Depending upon the mode of obtaining food, the heterotrophic nutrition is of following types :
(a) Holozoic nutrition (Holo-Complete + Zoon-animal)
The mode of nutrition in which all animals take in complex solid food material is called holozoic nutrition.

It contains following steps :-

→ **Ingestion :-** Taking in complex organic food through mouth opening.

→ **Digestion :-** Change of complex food into simple diffusible form by the action of enzymes.

→ **Absorption :-** Passing of simple, soluble nutrients into blood or lymph.

→ **Assimilation :-** Utilization of absorbed food for various metabolic processes.

→ **Egestion :-** Expelling out the undigested food.

e.g. All animals including vertebrates and Invertebrates.

Focus Point

✯ Depending upon the **type of the food habit**, animals are divided into three categories :-

(i) Herbivores :– Animals that depend up on green plants are known as herbivores.

e.g. Goat, Cow, Deer, Rabbit.

(ii) Carnivores :– Animals which eat flesh of other animals as food are called as carnivores.

e.g. Lion, Tiger.

(iii) Omnivores :– Animals which eat both plants and animals as food are known as omnivores.

e.g. Rat, Pigs, Crows, Cockroaches and Humans.

(b) Saprotrophic (Sapro - Rotten ; Trophos - Feeder) Nutrition :– In this type of nutrition the organisms obtain their food from decaying organic substances. Organisms are also called **saprotrophs**.

e.g. Bacteria, Fungi.

(c) Parasitic nutrition (para-other) :–

The mode of nutrition in which one organism (called parasite) derive its food from other living organism (Host) is called parasitic nutrition. e.g. Tape worm, *Ascaris*, *Plasmodium*, Liver flukes, *Cuscuta* etc.

DIFFERENCES BETWEEN AUTOTROPHIC & HETEROTROPHIC NUTRITION :-

Characters	Autotrophic Nutrition	Heterotrophic nutrition
(1) Source of Energy	Sunlight or chemical energy	Readymade food
(2) Mode of Nutrition	Photosynthesis or Chemosynthesis plants or animals	Feeding upon dead or living
(3) Occurrrence	Found in green plants, Blue-green algae, certain Bacteria	Found in Animals, fungi, Most of the bacteria

DIFFERENCES BETWEEN HOLOZOIC AND SAPROTROPHIC NUTRITION :-

Feature	Holozoic nutrition	Saprotrophic nutrition
1. Nature of food	Solid food (Whole plant or animal or their parts) is ingested	Liquid food (Dead and decaying organic matter) is ingested
2. Site of digestion	Inside the body	Outside the body as enzymes are released on the food material that convert solid food into simple soluble form
Examples	Most of the Animals	**Fungi** – Yeast

Focus Point

Animals which depend upon the blood of other animals known as **sanguivores.**
e.g. Bedbug, Mosquito, Leech etc.
Mutualistic nutrition :– The mutualistic nutrition can be defined as the interdependent nutrition in which each organism is dependent mutually on the other.
e.g. The lichens share mutualistic nutrition between a fungus and a Algae.

2.3 NUTRITION IN UNICELLULAR ORGANISMS (EXAMPLE – AMOEBA)

Food – *Amoeba* is a holozoic and omnivorous animal. It feeds upon microscopic organisms like bacteria, Paramecium, Diatoms, Algae and dead organic matter.
Mechanisms. Nutrition in *Amoeba* involves the following steps:
(i) Ingestion:– *Amoeba* has no mouth, so ingestion may occur at any point of body surface but generally it occurs at the advancing end of the body. Ingestion occurs with the **help of pseudopodia**. The opening of food cup gradually becomes narrower and narrower, and finally closes. So the food is finally enveloped and taken inside a **food-vacuole** (called **phagosome**) along with a drop of water.
(ii) Digestion:– *Amoeba* shows **intracellular** and **vacuolar digestion**. In the cytoplasm, food vacuole fuses with lysosomes containing digestive enzymes. In this , the complex and non-diffusible nutrients are changed into simple and diffusible nutrients. Medium inside the food vacuole is **first acidic but later becomes alkaline**, (as in the alimentary canal of man).
(iii) Absorption and assimilation :– In absorption, the diffusible nutrients pass through vacuolar membrane into cytoplasm by diffusion and are then distributed to all the body parts by **streaming movements** of cytoplasm called **cyclosis**. Due to this, the size of food vacuole gradually decreases.
In the cytoplasm, a part of the absorbed food is oxidised to produce energy, most of simple nutrients are combined to synthesize complex compounds.
(iv) Egestion :– *Amoeba* has no anus, so egestion may occur at any point on the body surface.

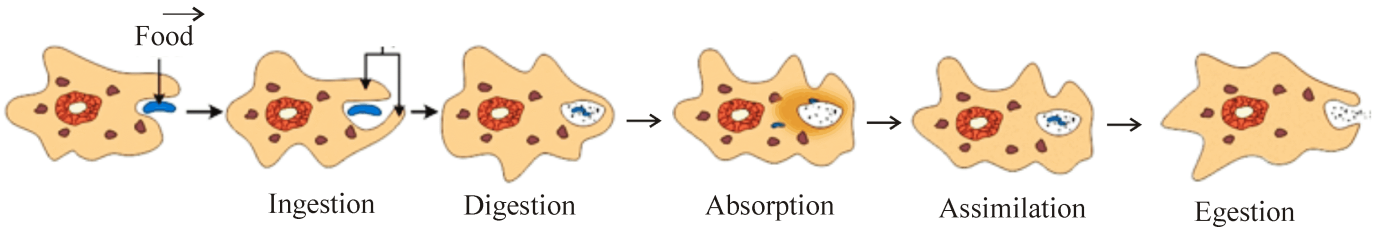


Figure : Digestion in Amoeba

Focus Point

(a) Food :- The substance which is palatable, delicious enough and energy provider is called food. Chemically food consists of six essential components :-
(i) Carbohydrates (ii) Fats (iii) Proteins (iv) Minerals (v) Vitamins (vi) Water
(b) Intracellular and Extra-cellular Digestion :-
Intracellular Digestion : This type of digestion occur inside the cell cytoplasm. The food inside the cell occurs as food vacuole. The digestive enzyme in this case are secreted inside the cell. They digest the contents of the food vacuole. So the entire process of digestion occurs inside the cell. e.g. Protozoans *[Amoeba]*, Sponges
Extracellular Digestion :- Extra cellular digestion is a process in which saprobionts feed by secrecting enzymes through the cell Membrane onto the food .The enzyme catalyze the digestion of the food into molecules small enough to be taken up by diffusion, transport and phagocytosis.
eg. Hydra and sea anemone.

3. DIGESTIVE SYSTEM OF HUMAN

Human digestive system consists of the alimentary canal and digestive glands and it involves mastication, swallowing, digestion of food and elimination of undigested matter.

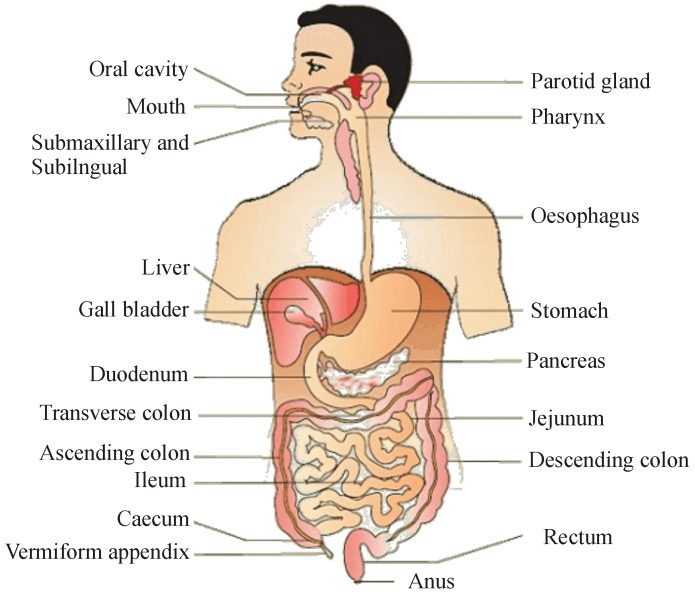


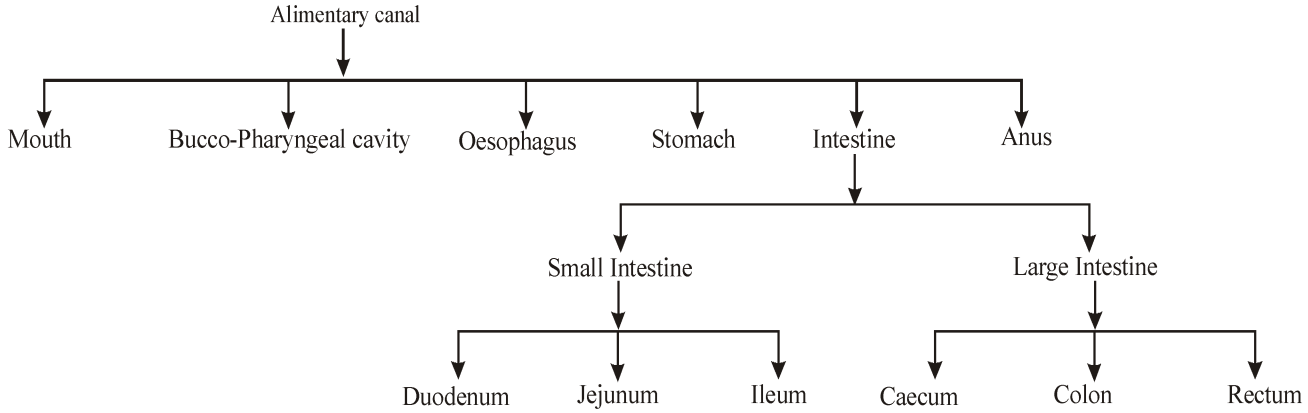
Figure : Digestive system of human

It consists two parts :-

3.1 ALIMENTARY CANAL

The alimentary canal is basically a long tube extending from the mouth to the anus.

It is differentiated into following parts.



MOUTH

It is a transverse slit bounded by movable lips. The lips serve to close and open mouth, holding the food in between and also help in speaking.

BUCCOPHARYNGEAL CAVITY / MOUTH CAVITY

Mouth leads into the **mouth cavity** or **oral** or **buccal cavity**. The roof of mouth cavity is formed by palates i.e., **hard** and **soft palate**, the floor by **tongue** and the sides by the **cheeks**. The other conspicuous structures are the **teeth** and **salivary glands**.

(a) Tongue :– The floor of the mouth cavity is occupied by muscular, large, mobile tongue. It remains attached on its under surface to the floor by fold of mucous membrane called the **lingual frenum**. The tongue is covered with mucous membrane and its upper surface is raised into **lingual papillae** which contain microscopic taste buds.

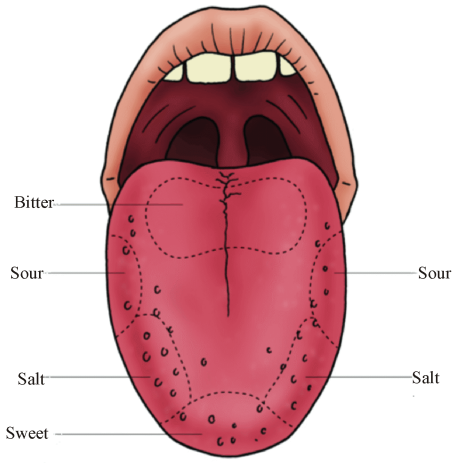


Figure : Tongue

Functions of tongue :-

- It acts like a spoon during ingestion of food.
- It brings food under teeth for mastication
- It moves food in buccal cavity for mixing of saliva.
- It helps in swallowing food.
- It cleans teeth by removing small food particles from their surface.
- It helps in speaking.
- It is the main organ of taste.
- It keeps the mouth moist by the secretion of both mucus and serous or water like fluid.
- In dogs during panting it helps in thermoregulation by quick evaporation of water of saliva.
- In some mammals tongue is used to clean skin by licking.

(b) Teeth :– Thecodont (Teeth present in bony socket), Heterodont (Teeth are of four types) and diphyodont (Teeth that come two time in life). Teeth are present in human body.

Teeth are of following types :

(i) Incisors – Biting the food.

(ii) Canines – Wearing and tearing of food.

(iii) Premolars – Crushing and grinding the food.

(iv) Molars – Crushing and grinding the food.

Dental Formula

(i) Milk teeth/ Primary

(ii) Permanent teeth

$$\frac{\text{No. of teeth in half part of upper jaw}}{\text{No. of teeth in half part of lower jaw}} \times 2 = x$$

- $\text{In child} \rightarrow I\frac{2}{2}, C\frac{1}{1}, Pm\frac{0}{0}, M\frac{2}{2} = \frac{5}{5} \times 2 = \text{Total 20 teeth}$

- $\text{In Man} \rightarrow I\frac{2}{2}, C\frac{1}{1}, Pm\frac{2}{2}, M\frac{3}{3} = \frac{8}{8} \times 2 = \text{Total 32 teeth}$

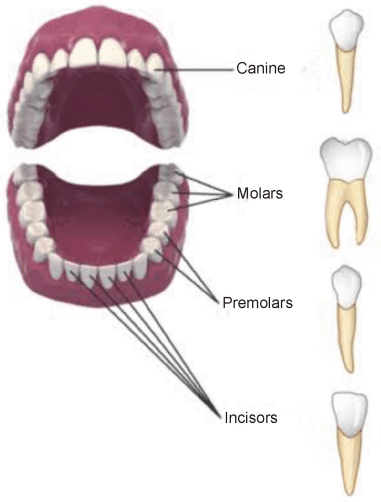


Figure : Various types of parmanent teeth of man

PHARYNX

The buccal cavity opens into a short narrow chamber called **pharynx or throat**. Pharynx is incompletely divided into three parts by soft palate – the nasopharynx dorsal to the soft palate, oropharynx below the soft palate and laryngopharynx into which both these parts communicate round the freely hanging uvula. The oropharynx and laryngopharynx are associated with swallowing. The laryngopharynx communicates with oesophagus through gullet and with larynx through glottis. The glottis is guarded by an elastic and muscular flap called epiglottis which closes glottis during swallowing to prevent food from entering into wind pipe. Thus pharynx serves two ways –

(i) as a passage between nose and wind pipe (trachea

(ii) as food passage between mouth cavity and oesophagus. Resonance of voice also occurs due to pharynx.

OESOPHAGUS (FOOD PIPE)

It conducts the food by **peristalsis** (Wave like movement).

The oesophagus is a 25-30 cm long, leading from the pharynx to stomach. It runs down the neck, behind trachea and through thorax, finally piercing the diaphragm to open into stomach. The upper 1/3rd part is composed of voluntary muscles and the lower 2/3rd of involuntary muscles. The muscular coat has a peristaltic action for driving the food towards the stomach. There are no digestive glands but only mucous glands in oesophagus.

STOMACH

It is a thick, muscular and J-shaped sac present on the left side of upper part of abdomen. Beneath diaphragm lying to the left side of abdomen is J-shaped stomach. It is the widest part of alimentary canal, size and shape of which varies according to the contents and sex. It can be distinguished into three regions – Fundic part, Body part and Pyloric parts. The exit is guarded by a pyloric sphincter. The partly digested paste like food is forced into intestine through pyloric sphincter, due to peristaltic waves of stomach.

Functions of Stomach :-

- Temporary storage of food.
- Partial digestion of food by gastric juice.
- Churning of food.
- The stomach regulates the flow of partially digested food into the small intestine.

INTESTINE

It distinguished into two parts :-

(a) Small Intestine

(b) Large Intestine

(a) Small intestine :– It is a long (about 6 meter) narrow (average diameter 4 cm), tubular and coiled part. It is differentiated into anterior duodenum, middle jejunum and posterior ileum. It is mainly concerned with completion of digestion and absorption of food.

(i) Duodenum : This proximal part starts after pyloric end of stomach. It is about 25 cm long lying against the posterior abdominal wall. It is curved like 'C' or a horseshoe and ends behind the stomach. A common bile duct and a pancreatic duct opens in middle of 'C' of duodenum by a common aperture over a raised area called ampulla of vater.

(ii) Jejunum : The Jejunum (a latin word meaning empty) is so called because it is always found empty after death.

(iii) Ileum : It is the last part of small intestine.

Small intestine designed to absorb digested food as :

- It is lengthy about 6 meters.
- Inner lining has two types of folds called villi and microvilli.
- Each villus has blood capillaries and a lymph capillary.

(b) Large intestine :–It is shorter (about 1.5 meter) and wider (Average diameter 6 cm) than small intestine. It is differentiated into caecum, colon and rectum. It is the site of aborption of water from digested food. It helps in formation and temporary storage of faeces.

ANUS

It lies at the base of trunk and is for egestion.

3.2 DIGESTIVE GLANDS

They secrete digestive juices which contain digestive enzymes. These are of following types.

SALIVARY GLANDS

In man, there are three pairs of salivary glands. These secrete saliva which contains a digestive enzyme called **ptyalin** or **Salivary amylase**.

- Parotid gland
- Submaxillary
- Sublingual glands

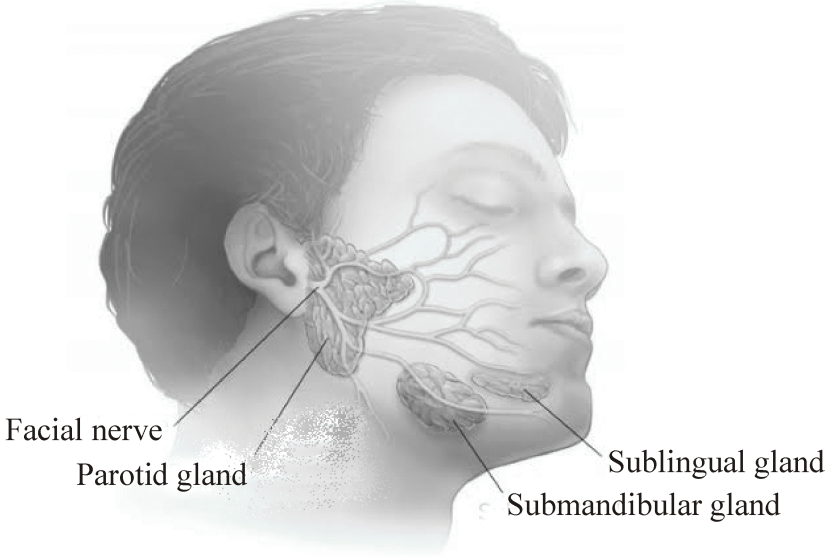


Figure : Salivary glands

Focus Point

- Saliva is an antiseptic as it kills germs and bacteria due to presence of an enzyme called **Lysozyme**. Saliva makes the food soft, slippery and helps in digestion of starch due to presence of salivary amylase enzyme.
- Our mouth starts **watering on eating** food of our interest. This water is basically the saliva secreted by the salivary gland which get activated on eating or seeing or thinking of a food.
- Involuntary contraction & relaxation movement is called **peristalsis**.

GASTRIC GLANDS

Gastric glands are present in the wall of stomach and secrete gastric juice.

LIVER

It is lobed and reddish-brown coloured largest gland of body present in the right side of upper part of the abdomen. It synthesize and secretes bile juice. Gall bladder is present below the right lobe of liver. It stores and secretes bile.

PANCREAS

It is a yellow- coloured heterocrine gland present just behind the stomach. It secretes pancreatic juice. Pancreatic duct carries pancreatic juice to small intestine.

It also secretes two hormones : Insulin and Glucagon.

INTESTINAL GLANDS

These lie in the wall of small intestine and secrete intestinal juice (Succus entericus).

3.3 PHYSIOLOGY OF NUTRITION

INGESTION

Man is **omnivorous** in feeding and is **holozoic**.

Ingestion involves carrying the food to the mouth with the help of hands and cutting of food with incisors or canines depending upon the nature of food.

DIGESTION

In man, digestion is started in **buccal cavity** and completed in **intestine**.

(a) In buccal cavity :– Here, food is chewed with the help of premolars and molars which increases the rate of action of **salivary amylase**. Food is mixed with saliva of salivary gland.

$$\text{Starch} \xrightarrow[6.8\ PH, Cl^-]{\text{Salivary amylase}} \text{Maltose}$$

(b) In stomach :–

Food is mixed with gastric juice which contains mucus, hydrochloric acid, pepsin, rennin and a weak lipase enzyme.

Mucus, lubricates the food and protects the inner lining of the stomach from the action of acids.

Functions of Hydrochloric acid

- Stops the action of salivary amylase in stomach.
- Kills the bacteria present in the food.
- Activates pepsin.
- Provides acidic medium.

Pepsin hydrolyses proteins into proteoses and peptones.

Lipase enzymes hydrolyses small amounts of fats into fatty acids and glycerol.

Curdling of milk is done by the enzyme **rennin**. (Rennin is not found in human beings, it found only in cattles).

Digestion of proteins in man starts from stomach. In buccal cavity there is no digestion of proteins because saliva contains no proteolytic (protein digesting) enzyme.

(c) In small intestine :–

The small intestine is the site of the **complete digestion** of carbohydrates, proteins and fats.

Food is mixed with three **digestive juices**, bile juice, pancreatic juice and intestinal juice.

Bile juice provide **alkaline medium** and **emulsifies fats** [conversion of larger fat globules into smaller fat droplets] but is a non enzymatic digestive juice so has no chemical action on food.

Pancreatic juice contains **trypsin, pancreatic amylase and pancreatic lipase** enzymes which digest the peptones, starch and fats into peptides, maltose and fatty acids.

Intestinal juice contains **aminopeptidase, intestinal amylase, maltase, sucrase and lipase** enzymes:–

Peptides $\xrightarrow{Aminopeptidase}$ Amino acid

Maltose $\xrightarrow{Maltase}$ Two glucose

Fats $\xrightarrow{Lipase}$ Fatty acid + Glycerol

Lactose $\xrightarrow{Lactase}$ Glucose + Galactose

Sucrose $\xrightarrow{Sucrase}$ Glucose + Fructose

ABSORPTION

Absorption of the digested food occurs through the epithelial surface of the villi & microvilli of small intestine.

- Inner surface of small intestine is raised into 4 millions of finger-like folds called **villi**.
- Each cell of villus is with electron microscopic processes called **microvilli**.
- Each villus is with blood capillaries and a lymph capillary.

ASSIMILATION

It is a process by which absorbed nutrient are utilized to resynthesize complex molecules like carbohydrates, proteins and fats inside the cells.

EGESTION

Removal of waste products from the body is known as **egestion**.

Focus Point

(a) Emulsification :- Emulsification is the phenomenon of physically breaking of large sized fat globules into large number of fat droplets by the bile-salts of the bile juice. This increases the surface area for digestion of fats by the lipase enzyme.

(b) Alimentary Canal :- The digestive canal where the entire process of digestion is accomplished, called alimentary canal.

⇒ The alimentary canal of herbivores is longer than the alimentary canal of carnivores, because herbivores have to digest the cellulose, which is difficult to digest.

⇒ The harbivorous animals like cow which eat grass need a longer 'small intestine' to allow the cellulose present in grass to be digested completely.

⇒ The carnivorous animals like tigers which eat meat have a shorter small intestine.

TABLE : DIGESTIVE GLANDS, THEIR SECRETIONS & ACTION

Name of Gland	Secretion	Enzyme	Site action	Substrates	Products
Salivary Glands	Saliva	Salivary Amylase	Buccal cavity	Starch	Maltose, Isomaltose
Gastric glands	Gastric Juice	(a) Pepsin (Pepsinogen inactive)	Stomach	Protein	Peptones
		(b) Rennin (Prorennin inactive)	Stomach	Casein	Paracasein
Pancreas	Pancreatic Juice	(a) Pancreatic Amylase	Small intestine	Starch Glycogen	Maltose, Isomaltose
		(b) Trypsin (Trypsinogen inactive)	Small intestine	Proteins	Peptides
		(c) Chymotrypsin (Chymotrypsinogen inactive)	Small intestine	Casein (milk)	Paracasein
Intestinal gland (Crypts of Lieberkuhn)	Intestinal juice	(a) Enterokinase (Hormone	Small intestine	Trypsinogen (inactive)	Trypsin (active)
Amino		(b) Aminopeptidase	Small intestine	Peptides	Smaller peptides acids
		(c) Dipeptidases	Small intestine	Dipeptides	Amino acids
		(d) Isomaltase	Small intestine	Isomaltose	2 Glucose
		(e) Maltase	Small intenstine	Maltose	2 Glucose
		(f) Sucrase	Small intestine	Sucrose	Glucose, Fructose
		(g) Lactase	Small intestine	Lactose	Glucose, Galactose
		(h) Lipase	Small intestine	Triglycerides	Monoglycerides,Fatty acids
Liver	Bile (Bile + pigments)	No enzymes	Duodenum	Fats	Fat droplets

4. NUTRITION IN PLANTS

Green plants are autotrophic. They synthesize their own food by the process of photosynthesis.Autotrophic plants are able to produce food so they are known as producers.

Focus Point

First true and oxygenic photosynthesis starts in cyanobacteria (blue green algae). 90% of total photosynthesis is carried out by hydrophytes (mostly marine algae). "The process of absorption and conversion of light energy into chemical energy by green plants is called as photosynthesis". This chemical energy is stored in the form of adenosine triphosphate (ATP) and reduced nicotinamide adenine dinucleotide phosphate ($NADPH_2$).

4.1 PHOTOSYNTHESIS

Photosynthesis is a process by which green plants synthesize organic food (carbohydrate) from carbon dioxide and water using solar energy by chlorophyll pigments. The sugar produced is stored in the form of starch in plants.

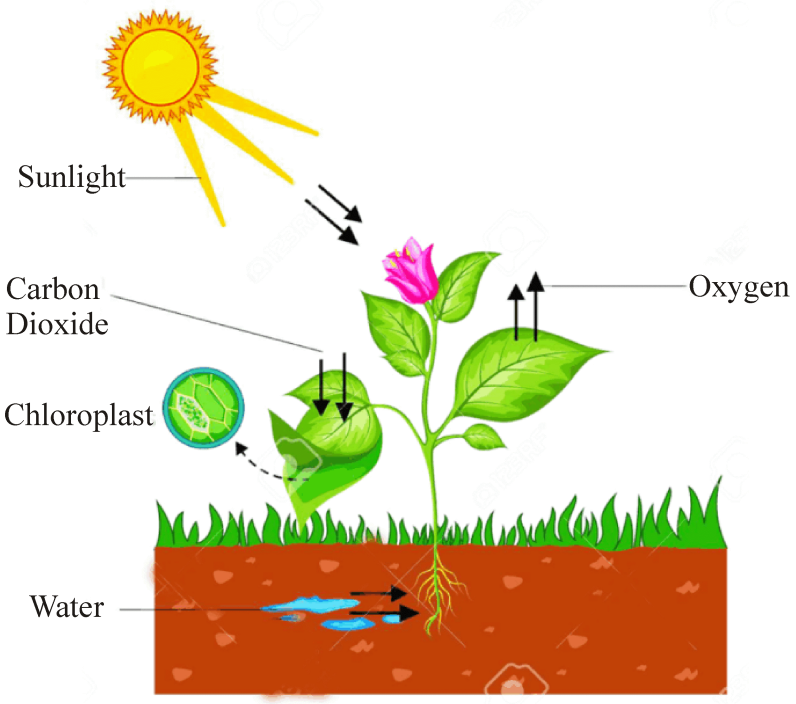


Figure : Photosynthesis

IMPORTANTCE OF PHOTOSYNTHESIS

Photosynthesis is an anabolic process in nature for providing food supply to the living organisms.

It purifies the atmospheric air, by consuming CO_2 and evolving oxygen.

The over all equation of photosynthesis is :–

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

Requirements for photosynthesis :-

⇒ **Sunlight** ⇒ **Photosynthetic pigment**

⇒ **Carbondioxide** ⇒ **water**

CO_2 and water work as raw materials which are obtained from the atmosphere and the soil respectively.

(a) Sunlight :- Sun is a natural source of light for photosynthesis. Sunlight is an electromagnetic spectrum. Photosynthetic pigments absorb only visible/white light from electromagnetic spectrum.

White light (380 nm to 760 nm) is composed of wavelength of seven different colours violet, indigo, blue, green, yellow, orange and red (VIBGYOR).

PAR (Photosynthetically Active Radiation) : 400nm to 700nm.

Focus Point

Types of chlorophyll :-

There are six different types of chlorophyll : Chl.–a, Chl.–b, Chl.–c, Chl.–d, Chl.–e and bacteriochlorophyll.

Beside chlorophyll certain other pigments are also present in plants like -

Carotenoid → Carotenes (orange colour) and xanthophylls (yellow colour).

Phycobilins : It is present in Blue- green algae and Red algae etc.

(b) Photosynthetic pigment :- These are chlorophylls carotenoids (carotenes and xanthophylls) and phycobilins. These pigments absorb only visible light. Chl-a and b absorb only blue and red light and reflect green light.

Focus Point

Compensation point

The intensity of light at which amount of CO_2 used during photosynthesis becomes equal to the amount of CO_2 released during respiration by plants is called as compensation point.

Compensation point occurs at low light intensity that is during morning and during evening hours.

The structure of guard cells in monocots is dumb-bell shaped.

(c) Carbondioxide :

All the plants need carbondioxide to form carbohydrates. The carbon dioxide is obtained by the plants from the

atmospheric air. In the terrestrial plants, the CO_2 enters into the cells of leaves through tiny pores called **stomata** which always remain present on the surface of leaves.

STOMATA

These are tiny pores or microscopic aperture guarded by two kidney shaped or bean shaped guard cells.

Functions :-

⇒ Massive amount of a gaseous exchange take place in the leaves through stomata.

Exchange of gases also occurs across the surface of stem, root and leaves.

⇒ Large amount of water is lost through stomata.

Guard cells :- These are kidney shaped cells which cover single stoma. They contain chloroplast also.

Function :- They regulate the opening and closing of the stoma and also perform photosynthesis.

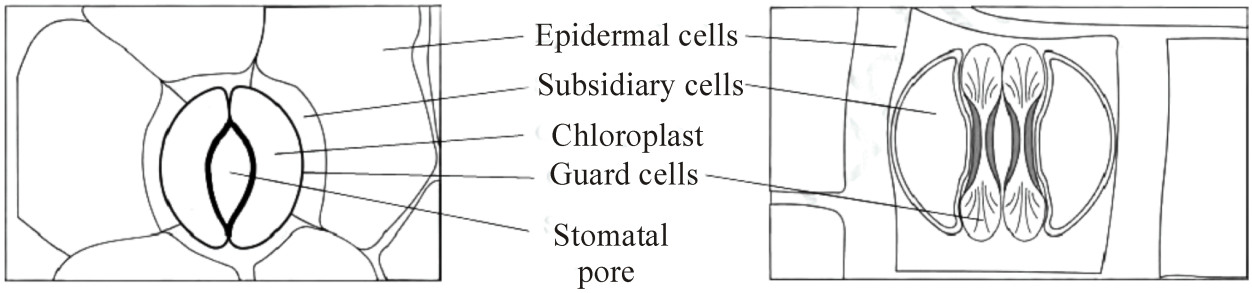


Figure : Open and Closed stomata

OPENING AND CLOSING OF STOMATA

When the guard cells swell due to the entry of water, the stomata gets opened. But when the guard cells shrink due to the loss of water, the stomata gets closed.

Focus Point

Desert plants take up CO_2 at night and prepare an intermediate which is acted upon by the energy absorbed by the chlorophyll during the day and form glucose.

In aquatic plants, CO_2 is obtained from the water where it remains present in dissolved form. Such plants absorb carbondioxide in solution form, all over their surface from the surrounding water.

(d) Water : Water is always needed by the plants for its use during photosynthesis.

Inside the chloroplasts of the leaves, the water molecules split into hydrogen and oxygen with the help of light energy of solar light.

Some mineral salts like N, P, K, Fe, Mg required by the plants are also transported to different parts of the plant along with the water.

Nitrogen is an essential element used in the synthesis of proteins and other compounds (chlorophyll, DNA and RNA).

Nitrogen is taken up in the form of inorganic nitrates or nitrites which have been prepared by symbiotic bacteria from atmospheric N_2.

4.2 SITE OF PHOTOSYNTHESIS

Green plastid (Chloroplast or Kitchen of the cell).

When we observe the cross section of a leaf under microscope, we can see the mesophyll cells full of green dots. These green dots are chloroplasts containing chlorophylls.

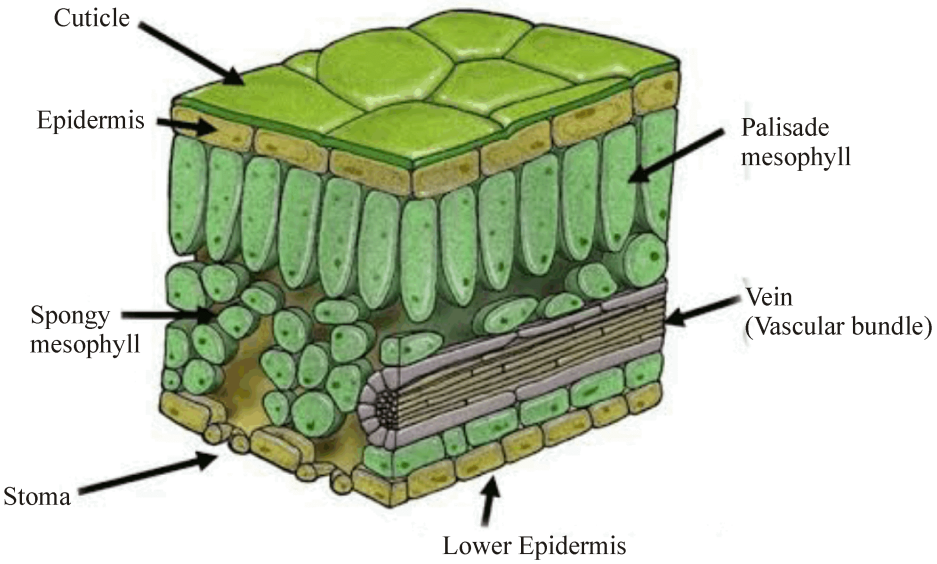


Figure : Cross section of leaf

CHLOROPLASTS

They are green coloured plastids. Their green colour is due to the presence of green pigments the chlorophylls. Each developed chloroplast has two distinct areas - grana and stroma.

⇒ **Grana (Singular-granum) :–** The light reaction of photosynthesis takes place in this part of chloroplast. In a granum large number of lamellae remain arranged like a stack of coins. These lamellae are called as **thylakoids**, which contain chlorophyll pigments.

⇒ **Stroma :–** It forms the matrix of the chloroplast. The dark reactions of photosynthesis take place in stroma.

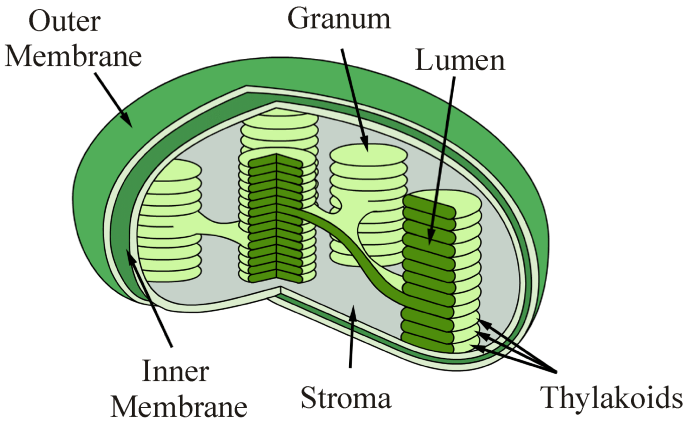
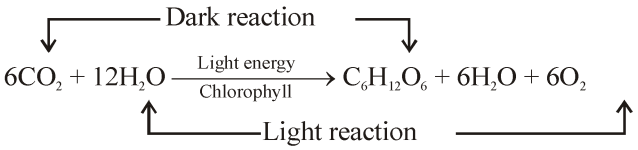


Figure : Structure of Chloroplast

4.3 MECHANISM OF PHOTOSYNTHESIS

During photosynthesis following events occur :-
(i) Absorption of light energy by chlorophyll.
(ii) Conversion of light energy into chemical energy and spliting of water molecule into hydrogen & O_2
(iii) Reduction of CO_2 to carbohydrates.
All these events can be categorised into two main phases :-
(a) Light phase (b) Dark phase



(a) Light reaction :-

- It is also called as photochemical process,
- It was discoverd by → 'Robert Hill;. Therefore it it also called as Hill's reaction
- **Site :** Grana of chloroplast.
- **Raw materials :** Light and water.
- **Products :** ATP, $NADPH_2$ and O_2
- **It consists of 3 steps :**

(i) Photo excitation of chlorophyll molecule : During this porcess chlorophyll molecule receives sunligh in the form of small energy bundles called as photons and becomes excited to higher energy level.

(ii) Photolysis of water : It is also called as photooxidation of water, this takes place in presence of Mn^{+2} & Cl^- ions.

$$4H_2O \longrightarrow 4H^+ + O_2 + 4e^- + 2H_2O$$

O_2 is librated as by product and H^+ ions are used for reduction of NADP.

(iii) Photophosphorylation : During this process ATP are produced. It takes place in quantasomes as inorganic phosphate is required to convert ADP into ATP.

$$ADP \longrightarrow ATP, \quad ADP + iP \longrightarrow ATP.$$

Focus Point

Light reaction was discovered by 'Robert Hill', therefore it is also called as Hill's reaction.
Light reaction is a photochemical process.
Photophosphorylation :-
The process of formation of ATP in the presence of sunlight is known as photophosphorylation.
Oxygen released during photosynthesis comes from water instead of CO_2 as was earlier thought.

(b) Dark reaction :– In this step synthesis of carbohydrates from carbondioxide takes place. It is not light dependent hence it is called as dark reaction. This reaction occurs inside stroma of chloroplasts where light energy is not captured.
During this reaction, the chemical energy formed during light reaction (ATP and $NADPH_2$) is utilised for the fixation and conversion of carbon dioxide into a simple carbohydrate, that is glucose.

The glucose molecules thus formed are further converted by the cellular machinery into various chemicals required by the plants.

Focus Point

Dark reaction was discovered by Melvin Calvin and Benson therefore it is also called as Calvin Cycle.

Dark reaction is a thermochemical reaction. CO_2 , $NADPH_2$, ATP, RUBP and Rubisco enzymes all are required in Dark reaction.

RUBP - Ribulose bi phosphate.

RuBisCO - Ribulose Bi phosphate Carboxylase Oxygenase.

LAB TIME

Let's Do & Learn

To prove that chlorophyll is essental for photosynthesis.

Materials required : Plant with variegated leaves, materials for starch test, test, i.e., iodine, solution.

beaker, test tubes.

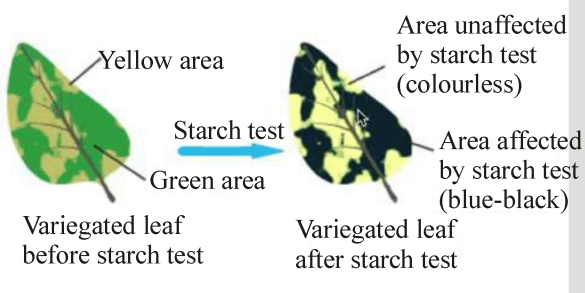


Figure : Activity to show that chlorophyll is essential for photosyntheis

Procedure :

(i) A potted plant with variegated leaf (Coleus, Croton) is kept in darkness for two days to make the leaves starch free.

(ii) A leaf is removed from the plant and tested with iodine for starch, after decolourising if first with water and then with alcohol.

Conclusion :

It is seen that the portion of the leaf which is devoid of chlorophyll remians colourless (starch-free) whereas the rest of the leaf turns blue-black due to the presence of starch.

Difference between light and dark reactions.

S.No.	Features	Light reaction	Dark reaction
1	Requirement of light	Required	Not required
2	Takes place inside	Thylakoid membranes of the chloroplast	The stroma region of chloroplast
3	ATP and $NADPH_2$	ATP and $NADPH_2$ are produced by the conversion of light energy into chemical energy	ATP and $NADPH_2$ formed during light reaction are used for the fixation of CO_2 into carbohydrate
4	Sugar formation	No sugar formation takes place	Sugar formation takes place
5	Release of oxygen	Oxygen is released	No oxygen is released

Factors affecting photosynthesis :–

(a) Light (b) Water (c) Temperature (d) CO_2 (e) Oxygen

(a) Light

The source of light for planet earth is sun, although some marine algae also utilise the light of moon.

Out of the total solar energy, only 2% solar energy is used in photosynthesis.

The quality and intensity of light also affects photosynthesis.

Quality – Red and blue lights are most effective in photosynthesis. But the rate of photosynthesis is maximum in red light.

There is no photosynthesis in presence of green light because green parts of plants reflect whole of the green light.

Intensity – The increase in intensity of light increases photosynthesis.

Intensity of sunlight $\propto$ Rate of photosynthesis

(b) Water

Water is an essential raw material in photosynthesis. Only 1% of the absorbed water is utilised in photosynthesis.

(c) Temperature

The rate of photosynthesis increases by increase in temperature upto 40°C. Above this temperature, there is a decrease in the photosynthesis. Similarly, low temperature also inhibits photosynthesis. The temperature affects photosynthesis by affecting the activity of enzymes.

(d) Carbon-dioxide

Atmosphere is the main source of CO_2 for terrestrial plants.

In atmosphere CO_2 is present at the tune of 0.03%.

The rate of photosynthesis increases by increasing the concentration of CO_2. But after a certain limit, the excess concentration of CO_2 proves to be toxic to the cells.

(e) Oxygen

Over concentration of oxygen stops photosynthesis.

Focus Point

Bacterial Photosynthesis : It is a special kind of photosynthesis in which solar energy is utilised for the synthesis of carbohydrates and H_2S is the hydrogen donor instead of water as in normal photosynthesis. So O_2 is not liberated in bacterial photosynthesis.

e.g. – Chlorobium (Green sulphur), Chromatium (Purple sulphur), Rhodospirilium, Rhodopseudomonas (Purple non sulphur)

NS. 1

What criteria do we use to decide whether something is alive?

Ans. The major criterion which is used to decide whether something is alive is movements. Movements may be that of locomotion (e.g. running of dog), movement of a part (e.g. chewing cud by cow), breathing movements, growth movements (in plants) and movement of molecules in metabolic reactions, maintenance and repair of cellular structures. Besides movements, other criteria found in living beings that distinguish them from the non-living are presence of protoplasm, self built organisation, self repair, reproduction and various life processes like metabolism, nutrition, respiration, growth, exchange of materials, transportation, excretion and irritability. All living beings have a definite life span and life cycle.

NS. 2

What are outside raw materials used for by an organism?

Ans. Outside raw materials provide energy to organisms to maintain their body processes. They are needed to prevent damage and break-down in the body.

NS. 3

What processes would you consider essential for maintaining life?

Ans. Life processes like nutrition, respiration, transportation, excretion and awareness are essential for maintaining life.

NS. 4

Where does the plants get each of the raw materials for photosynthesis?

Ans. (i) Carbon Dioxide - Air through stomata.
(ii) Water - Soil through roots,
(iii) Minerals - Soil through roots.

NS. 5

What is the role of acid in our stomach?

Ans. Hydrochloric acid (HCl) is component of gastric juice. It has five functions, (i) Softening of food, (ii) Conversion of pepsinogen and prorennin into active forms of pepsin and rennin (iii) Acidify the food for proper action of pepsin, (iv) Killing of microorganisms present in food, (v) Stoppage of action of salivary amylase.

NS. 6

What is the function of digestive enzymes?

Ans. Digestive enzymes are hydrolytic enzymes which bring about hydrolytic splitting of complex organic substances into simple, soluble and absorbable substances, e.g.,

Protein enzyme $\xrightarrow{\text{enzyme}}$ Peptides enzyme $\xrightarrow{\text{enzyme}}$ Amino acids.

NS. 7

How is small intestine designed to absorb digested food?

Ans. The inner lining of small intestine has millions of tiny finger like projections called villi. Villi are transverse folds of intestine wall that not only increase surface area but also reach deep into the lumen of intestine for absorption of digested food. Villi possess blood capillaries and lacteals (lymph vessels) for quick transport of absorbed food.

NS. 8

What are the differences between autotrophic nutrition and heterotrophic nutrition?

	Autotrophic Nutrition	**Heterotrophic Nutrition**
(1)	The process through which organisms are able to build up their own organic food from inorganic substances.	The process in which the organisms derive their nutrition by taking readymade food from other dead or living plants and animals.
(2)	The raw materials are obtained from outside, in the form of carbon dioxide and water.	The survival of heterotrophs depends directly or indirectly on autotrophs.
(3)	Chlorophyll and sunlight are essentialfor photosvnthesis.	Chlorophyll and sunlight are not required.
(4)	E.g., Green plants and some bacteria.	E.g., Animals, fungi and most of bacteria.

EXERCISE – I

ONLY ONE CORRECT TYPE

1. Chemosynthetic bacteria obtain energy from :
   (A) Sun
   (B) Infra-red rays
   (C) Organic substances
   (D) Inorganic chemicals mainly
2. A digestive enzyme, salivary amylase, in the saliva begin digestion of :
   (A) Protein (B) Nucleic acids
   (C) Fats (D) Carbohydrates
3. The visible part of electromagnetic spectrum lies in between :
   (A) X-ray and ultra-violet
   (B) Ultra violet and infra red
   (C) Infra red and microwave
   (D) X-ray and infra red
4. Partialy digested food that leaves the stomach is called :
   (A) Chyle (B) Chyme
   (C) Bolus (D) None of these
5. Peristalsis occurs in
   (A) liver (B) ureter
   (C) alimentary canal (D) hypothalamus
6. Human beings have vestigial vermiform appendix. The ancestors must have been
   (A) insectivorous (B) herbivorous
   (C) carnivorous (D) sangivorous.
7. Which one of the following lacks enzymes ?
   (A) Pancreatic juice (B) Saliva
   (C)Bile (D) Intestinal juice
8. Liver stores glucose in the form of:
   (A) Starch (B)Glycogen
   (C) Protein (D) Cholesterol
9. Gastric juice contains:
   (A) Pepsin, lipase and rennin
   (B) Trypsin, lipase and rennin
   (C) Trypsin, pepsin and lipase
   (D) Trypsin, pepsin and rennin
10. Partial removal of liver is not harmful because:
   (A) Liver being a large organ can suffice the functions even if a part is removed
   (B) Liver is not a very essential organ of the body
   (C) Liver has regenerative capacity and will grow after partial hepatectomy
   (D) The function of liver can be taken over by kidneys
11. Insectivorous plants digest insects to get an essential nutrient. Other plants generally get this nutrient from the soil. What is this nutrient ?
   (A) Oxygen (B) Nitrogen
   (C) Carbon dioxide (D) Phosphates
12. Main function of HCl present in gastric juice is
   (A) digestion of starch
   (B) emulsification of fat
   (C) conversion of pepsinogen to pepsin
   (D) detoxification of harmful constituents of food
13. What is the substrate for lipase enzyme ?
   (A) Protein (B) Carbohydrate
   (C) Lipid (D) Nucleic acid
14. Succus entericus is the other name of
   (A) gastric juice (B) intestinal juice
   (C) bile juice (D) saliva
15,. During prolong fasting, the sequence of organic compounds used by body is:
   (A) Carbohydrates, fats, proteins
   (B) Fats, carbohydrates, proteins
   (C) Carbohydrates, proteins, lipids,
   (D) Proteins, lipids, carbohydrates
16. Absorption of glycerol, fatty acids and monoglycerides takes place by:
   (A) Lymph capillaries within villi
   (B) Walls of stomach
   (C) Colon
   (D) Capillaries within villi
17. Rennin acts on:
   (A) Proteins in stomach
   (B) Milk, changing casein into paracaseinate at 7.2 - 8.2 pH
   (C) Fat in intestine
   (D) Milk, changing casein into calcium paracaseinate at 1-3 pH.
18. The human intestine is long because:
   (A) Bacteria in food can be killed gradually
   (B) It provides more surface for food storage
   (C) It increases surface area for absorption of food
   (D) None of these

19. In the lunch, you ate boiled green vegetables, a piece of cooked meat, one boiled egg and a sugar candy Which one of these foods may have been digested first ?
(A) Boiled green vegetables
(B) The piece of cooked meat
(C) Boiled egg
(D) Sugar candy

20. Glycogenesis refers to
(A) conversion of glycogen to glucose
(B) breakdown of glucose to form pyruvate
(C) breakdown of pyruvate to form glucose
(D) conversion of glucose to glycogen

21. Casein is digested in children by -
(A) Rennin (B)Renin
(C) Chymotrypsin (D)Trypsin

22. Germs entering the body alongwith food are killed in where pH is
(A) 10 (B) 7
(C) 3 (D)11

23. Which one of the following association is incorrect ?
(A) Protein -Trypsin (B) Fat - Lipase
(C) Maltose-Pepsin (D) Starch -Amylase

24. Vitamin B_6 is also called
(A)Thiamine
(B) pantothenic acid
(C) pyridoxine
(D) retinol

25. Sometimes urea is fed to ruminates to improve their health. It works by
(A) Helping growth of gut microbes that break down cellulose
(B) Killing harmful microorganisms in their gut
(C) Increasing salt content in the gut
(D) Directly stimulating blood cell proliferation

26. During phytosynthesis the oxygen in glucose comes from :
(A) Water
(B) Carbon dioxide
(C) Both from water and carbon dioxide
(D) Oxygen in air

27. A specific function of light energy in the process of photosynthesis is to :
(A) Activate chlorophyll
(B) Oxidation of CO_2
(C) Synthesis of glucose
(D) Reduce CO_2

28. Dark reaction in photosynthesis is called so because
(A) It does not require light energy
(B) Cannot occur during daytime
(C) Occurs more rapidly at night
(D) It can also occur in darkness

29. With regards to natural eating habits, a human is :
(A) An herbivore (B) A Carnivore
(C) An omnivore (D) A Granivore

30. Where is bile produced :
(A) In gall bladder (B) In blood
(C) In liver (D) In spleen

MATCH THE COLUMN TYPE

31. Match the names of the glands listed under column I with the location given under column II and select the correct option from the codes given below:

Column I	Column II
(P) Crypts of lieberkuhn	(1) Loop of duodenum
(Q) Pancreas	(2) Stomach
(R) Adrenal gland	(3) Intestine
(S) Gastric gland	(4) Kidney.

(A) P → 3, Q → 1, R → 4, S → 2
(B) P → 1, Q → 2, R → 3, S → 4
(C) P → 2, Q → 4, R → 3, S → 1
(D) P → 3, Q → 4, R → 1, S → 2

EXERCISE – II

VERY SHORT ANSWER TYPE

1. What are heterotrophs ?
2. Define saprophyte ?
3. What is carnivore ?
4. Define digestion ?
5. What is ingestion ?
6. What is the mode of nutrition of *Amoeba* ?
7. How do the guard cells regulate opening and closing of stomatal pores ?
8. Is 'nutrition' a necessity for an organism ?

SHORT ANSWER TYPE

1. Differentiate between an autotroph and a heterotroph ?
2. Differntiate beween autrophic and heterotrophic nutrition ?
3. Distinguish saprophytes from parasites.
4. Differentiate between photosynthetic and holozoic nutrition ?
5. How do saprophytic organisms obtain their nourishment ?
6. What is the importance of saprophytes ?
7. What is the action of hydrochloric acid of gastric juice ?
8. Name a digestive juice that has no enzymes. What is the role of this juice ?
9. Name the various parts of large intestine. What is the role of large intestine ?

LONG ANSWER TYPE

1. Explain the mechanism of photosynthesis ?
2. Explain the mechanism of nutrition of Amoeba with the help of suitable diagram.
3. Describe the various types of heterotrophic nutrition.
4. Briefly describe the digestive system of humans
5. What happens to food in the small intestine ?

TRUE / FALSE TYPE

1. Most of the digestion occurs in jejunum,
2. Enamel is the hardest substance of human body.
3. Pepsionogen requires alkaline medium to convert into pepsin.
4. Coprophagy is the consumption of faecal matter.
5. Bile emulsifies fat molecules.

FILL IN THE BLANKS

1. ..... is inverted U shaped tube in large intestine.
2. Liver secreates ..... which provides alkaline medium.
3. Oesophagus is also called as .....
4. Amoeba ingests its food with the help of .....
5. Dark reaction occurs in ..... of a chloroplast.

Answer Key

EXERCISE–I

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
D	D	B	B	C	B	C	B	A	C	B	C	C	B	A
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
A	D	C	D	D	C	C	C	C	A	B	A	D	C	C
31														
A														

EXERCISE – II

TRUE/FALSE TYPE

1. F 2. T 3. F 4. T 5. T

FILL IN THE BLANKS

1. Duodenum 2. Bile 3. Food pipe 4. Pseudopodia 5. Stroma

SELF PROGRESS ASSESSMENT FRAMEWORK

(CHAPTER : NUTRITION)

CONTENT	STATUS	DATE OF COMPLETION	SELF SIGNATURE
Theory			
In-Text Examples			
NCERT Exercises			
Exercise I			
Exercise II			
Short Note-1			
Revision - 1			
Revision - 2			
Revision - 3			
Remark			

NOTES :

1. In the status, put “completed” only when you have thoroughly worked through this particular section.

2. Always remember to put down the date of completion correctly. It will help you in future at the time of revision.

Space for Notes :