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Scientific Secondary

5

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PREFACE

Biology is a rapidly developing branch of science. The major advances being made continuously affect our life on earth. Some of these important advances are included here.

The results of a recent survey on the attitudes towards existing literature available to high school students showed that many were unhappy with the material used in teaching and learning. Those questioned identified a lack of the following: accompanying supplementary material to main text books, current information on new developments, clear figures and diagrams.

This book aims to improve the level of understanding of modern biology by inclusion of the following: main texts, figures and illustrations, extensive questions, articles and experiments. It is the intention and hope of the authors that the contents of this book will help to bridge the current gap in the field of biology at this level.

This book has been carefully reviewed and the language is considered suitable for students for whom English is a second language.

To the students

Being curious students, you may have wondered why you resemble your parents or why you need to breathe. In this book, I try to summarize some major subjects of biology. These are the most promising and perhaps the most complicated subjects of modern biology.

Group work will greatly enhance your learning abilities as well as give you an opportunity to share your knowledge and experience with your friends. I hope that, being assiduous students, you will work hard throughout this academic year and do your best to satisfy your scientific curiosity and, of course, to pass all of your exams successfully.

The author

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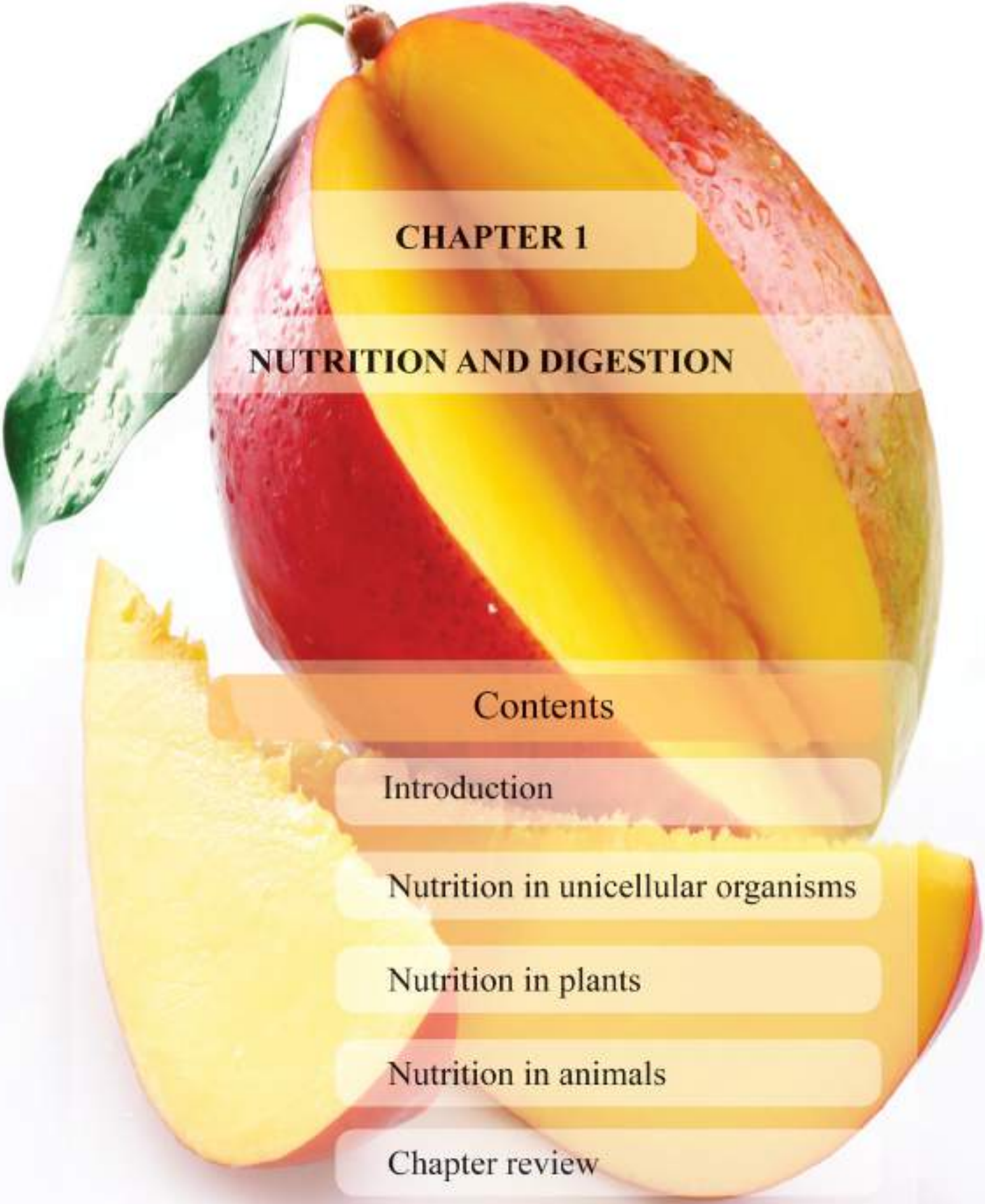


CHAPTER 1

NUTRITION AND DIGESTION

Contents

OBJECTIVES

At the end of the chapoter students must be able to;

1. Describe the nutrition concept.
2. Define the photosynthesis.
3. Compare between the light and dark reactions in photosynthesis.
4. Explain the role of chloroplast in photosynthesis.
5. Explain the importance of pigments in photosynthesis.
6. Explain the importance of water and carbon dioxide in photosynthesis.
7. Describe the concept of chemosynthesis.
8. Explain the nutrition concept in animals.
9. Understand the nutrition mechanism in animals.
10. Know the types of digestion in animals.
11. Explain the intracellular digestion.
12. Compare between the complete and incomplete digestive tracts.
13. Explain the movement of food materials in digestive tract.
14. Explain the functions of bile and pancreas secretions.
15. Define the food pyramid.

NUTRITION AND DIGESTION

Introduction

All organisms, primarily human need energy to survive. They get this energy from food they produce or from the surroundings.

Sun is the main source of energy on earth. Life on earth depends on sun light energy. Plants absorb sun light energy by chlorophyll in their chloroplast and convert sun light energy into chemical energy. As a result,plants produce their own food. Plants get water, carbondioxide and necessary minerals from their environment. Organisms which can produce their own food are called as **autotrophs**. Most of autotrophs are photosynthetic organisms and contain chlorophyll.

Some kinds of bacteria don't use sun light energy but they use chemical bond energy to synthesize the organic materials.

All animals are heterotrophic organisms because they can not produce their own food. Most of animals get energy from plants for continuity of their generation and survival. Some animals get it from other animals. And these ingested food digestion to be used as source of energy.

Nutrition in Unicellular Organisms

Unicellular organisms can be autotroph or heterotroph. Primitive autotrophic organisms can produce necessary organic materials by using sun light energy but they can take food from environment and feed heterotrophically.

Euglena is an autotrophic organism but it has heterotrophic types also. Euglena diverse in nutrition because autotrophic types get food from environment in absence of light and if live in dark continously lose its chloroplast and live as heterotrophic organism for rest of life.

Unicellular organisms can get food by **phagocytosis**. In this nutrition type cell membrane forms pseudopodia and surround the food. Then these pseuodopods unite surround the food and a food vacuole is formed in cytoplasm. This vacuole fuses with lysosome which contain digestive enzymes after completing the digestion, the digested food pass to the cytoplasm and wastes are removed by **exocytosis**.

Add to Your Knowledge

Osmosis is movement of water through a semi-permable membrane. Water exchange takes place between cytoplasm and external medium.

Cell Drinking (**Pinocytosis**)

Swallowing (**Phagosytosis**)

Taking large solid particles which cannot pass through pores in plasma membrane into the cytoplasm.

Example:
White Blood Cells devour the bacteria and viruses which infect the body.

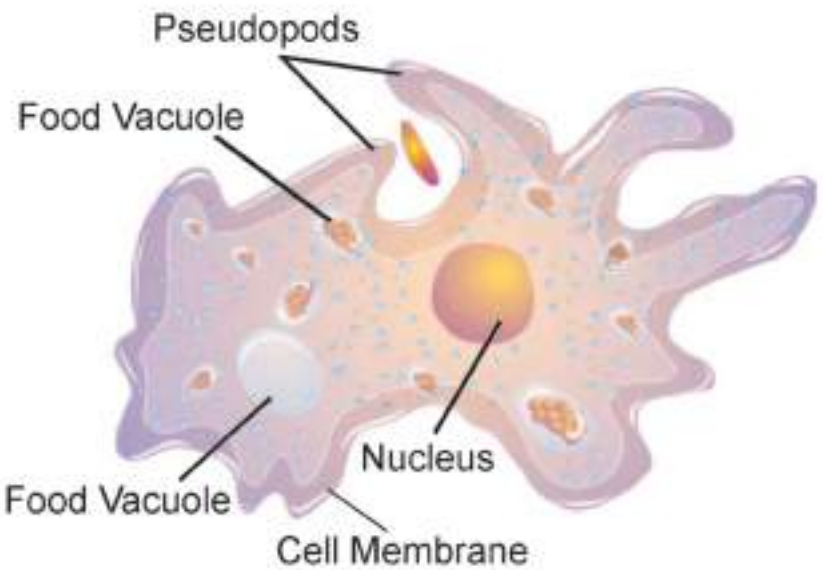


Figure 1.1 Phagocytosis in Amoeba

Do you know?

Active transport is taking of necessary materials from low concentrated medium to high concentrated medium by using energy (ATP).

In saprophytic type of nutrition digestive enzyme secreted out of cell. Materials formed as result of extracellular digestion are transported to the cell cytoplasm.

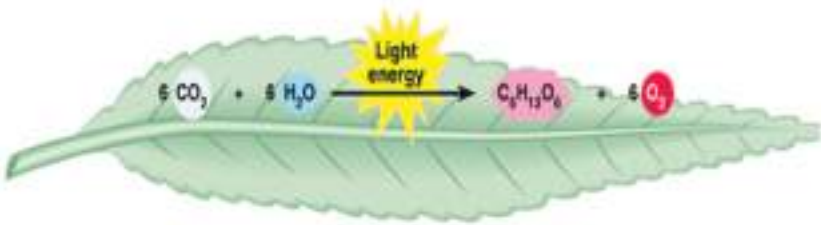
Digested food materials may pass by diffusion which is the movement of materials from high concentrated medium to low concentrated medium without using energy.

Nutrition in Plants

Photosynthesis

Photosynthesis is an anabolic reaction in which water, carbon dioxide and light energy used, glucose and oxygen are produced.

Photosynthesis can be shown by a chemical formula as follows:



sun Photosynthesis carried out by chloroplast in eukaryotic cells.

Add to your knowledge

Fungi are saprophytic organisms. They get energy by converting organic materials of dead organisms into inorganic materials. As a result they have role in recycling of materials in nature by this way.

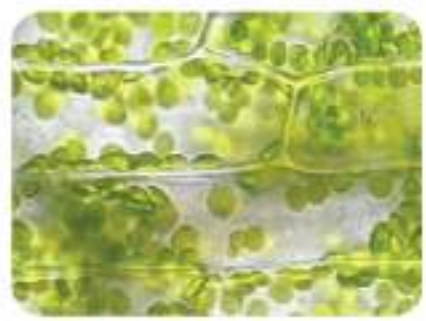
Activity

Observe one plant cell in labaratory. Can you identify chloroplast? How does it look like? Draw it.

Structure of Chloroplast

The chloroplast is the organelle where photosynthesis occurs in photosynthetic eukaryotes. The organelle is surrounded by a double membrane. Inside the inner membrane is a complex mix of enzymes and water. This is called **stroma** and is important as the site of the dark reactions.

Embedded in the stroma there is a complex network of stacked sacs. Each stack is called a **granum** and each of the flattened sacs which make up the granum is called a **thylakoid**. Each thylakoid has a series of photosystems contain chlorophyll. Thylakoid membranes are the site for the light reactions in which light energy is converted to chemical energy needed for the Calvin cycle in the dark reaction.



Chloroplasts in Elodea cells (microscopic image)

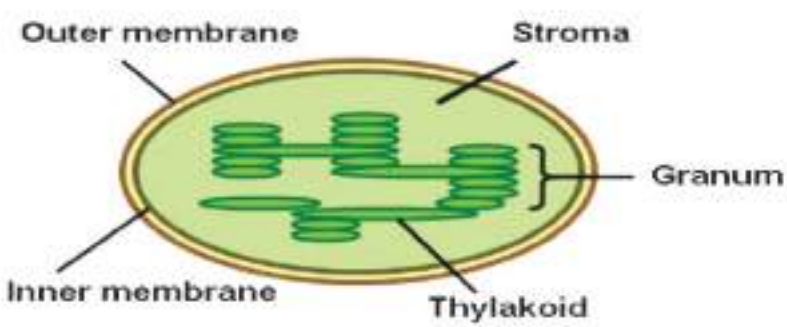


Figure 1-2 Structure of chloroplast

Photosynthesis consist of light and dark reactions according to scientist Blackman.

Doy you Know?

Nicotinamide adenine dinucleotide phosphate or NADPH is a reduced coenzyme that plays a key role in the synthesis of carbohydrates in photosynthetic organisms. It is the reduced form of NADP+ and as such is a high energy molecule that helps drive the Calvin cycle.

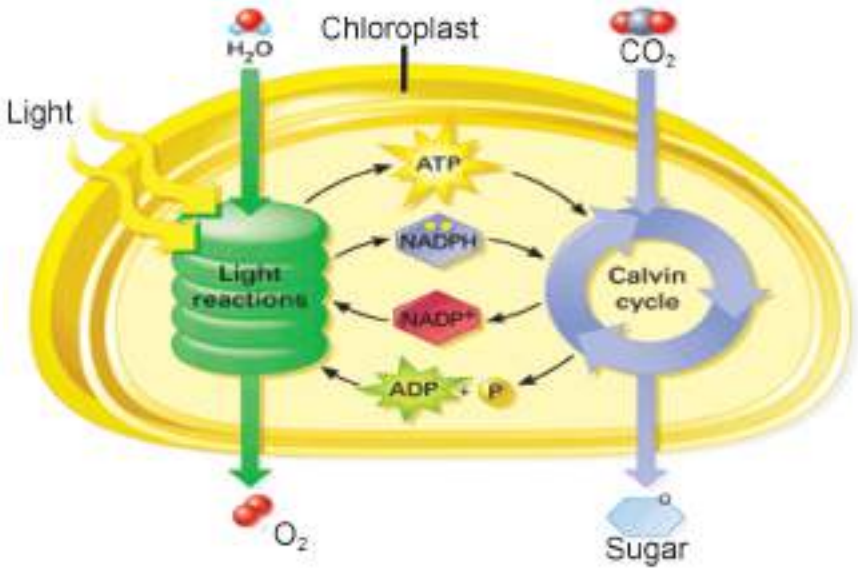


Figure 1.3 Photosynthesis consist of light and dark reactions (Calvin cycle)

a. Light reactions

There are chlorophyll pigments in **thylakoid membrane** of chloroplast and they absorb sun light. One electron separates from the chlorophyll pigment when it is activated by light and this electron transport along the electron transport system (ETS). During this transportation electron lose energy and losted energy is used in production of adenosine tri phosphate (ATP) molecule. As a result light energy transformed into chemical bond energy.

Water is split into hydrogen (H) and oxygen (O_2) as a result of light reaction. Hydrogen reduce the NADP (Nicotinamide Adenine Dinucleotide Phosphate) and forms the NADPH .

Radiant Energy (Sun) → Chemical Bond Energy (ATP, NADPH)

ATP and NADPH are two important compounds of light reactions.

b. Dark Reactions (Calvin's Cycle)

Dark reactions take place in stroma of chloroplast. (Figure 1.3) Light is not used directly in these reactions but the products of light reactions (ATP and NADPH) are used and CO_2 is reduced. ATP and NADPH are used for reduction. At the end of dark reactions carbohydrates or different organic materials are

formed. Dark reactions are also called as **Calvin`s cycle** and its discovered by scientist "**Calvin**".

Dark reactions are summarized as follows:

Chemical Energy (ATP, NADPH) → **Chemical Energy Carbohydrates**

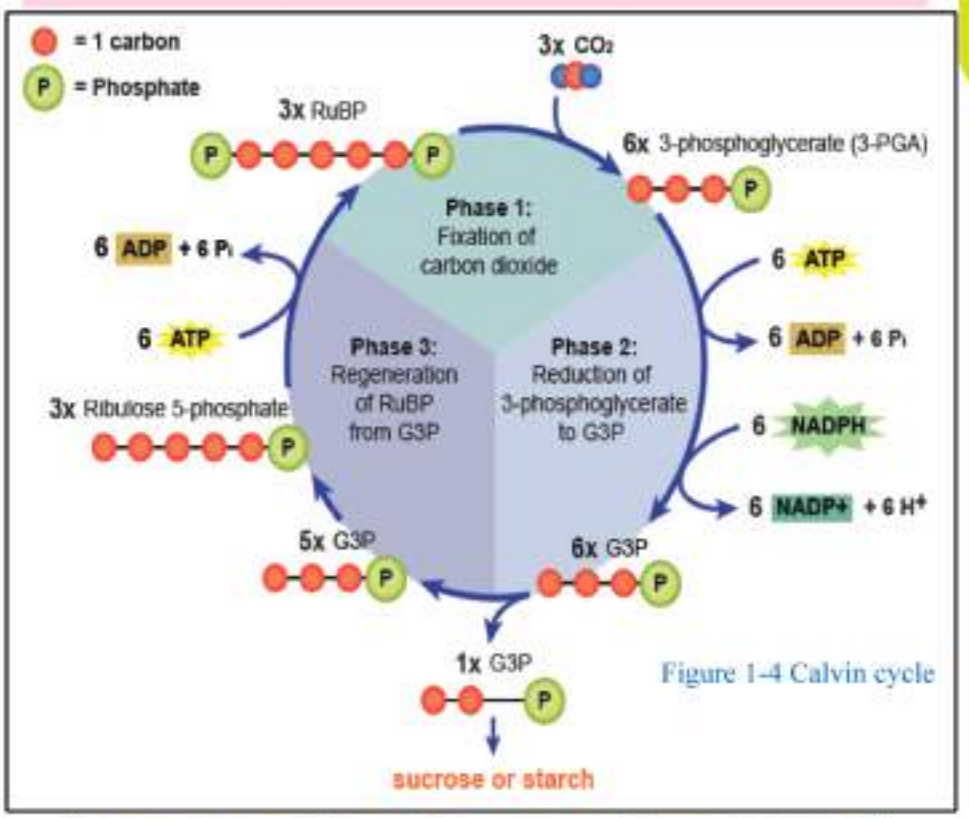


Figure 1-4 Calvin cycle

Figure 1-5 Photosynthetic organisms
A- Blue-Green Algae B- Seaweed C- Sequoia

Do you know?

Stored enegry in body of organisms can be used for many years. Coal and petrolium contain energy which stored by photosynthesis before thousand of years.

Photosynthetic pigments

Pigments are molecules which can absorb light with distict wave length and other light reflect or pass through it. Organisms are vary according to type of chlorophyll they have. Chlorophyll A and B have active role in photosynthesis. Carotinoids have role in photosynthesis.

Chlorophyll can absorb most of purple, blue and red wave length. Chlorophyll reflect most of green wave length so it is in green colour. Chloroplasts may contain chlorophyll A and B, carotinoids, xantophylls and other pigments. Xantophylls are yellow colored and insoluble lipidios pigments and appear in autumn season.

Do you know?

Only 42 % of sun light energy reach the earth.
And only 1-2 % of this energy is used in photosynthesis. Remain energy absorbed by atmosphere or transform into heat.

Organisms	Color	Main Pigments
Plants, Blue-green algae	Bluish green	Chlorophylls
Green bacteria, Purple bacteria	Green	Bacteriochlorophylls

Organisms	Color	Additinal Pigments
Plants, Algae, Bacteria	Red, Orange, Yellow	Carotinoids
Plants, Algae, Bacteria	Red, Yellow	Xantophylls
Brown algae, Diatoms	Brown	Fucoxanthin
Red algae, Bluish green algae	Blue	Phycocyanin
Red algae	Red	Phycoerythrin
Fossil bacteria	Purple	Bacteriorhodopsin

Table 1-1 Pigments used in photosynthesis (For study)

Materials used in photosynthesis

Photosynthesis is a series of reactions in which simple monomers are used and complex polymers are formed.

> ***Remember!***
>
> Mitochondria and chloroplast are similar in structure of membranes. They both have their own genetic material

a. Water

Water is an essantial reactant of photosynthesis. Water is absorbed directly through cell wall in aquatic plants and transported to the chloroplast. Plants take large amount of water from environment, but only 1 % of this water used in photosynthesis and remain water lost through stoma by transpiration.

Terrestrial plants absorb water from soil by roots and transport it to the mesophyll layer of leaves where contain large amount of chlorophyll by xylem vessels.

Some photosynthetic bacteria don't use water as source of hydrogen (H) but they use alcohol, organic acids or hydrogen sulphur(H_2S) For example reaction in green sulphur bacteria as follows:

$$2H_2S + CO_2 + \text{Light/Chlorophyll} \rightarrow 2S + (CH_2O) + H_2O$$

b. Carbon dioxide (CO_2)

Plants absorb carbondioxide from atmosphere by stoma which found in leaves and use it in photosynthesis. When carbondioxide concentration decrease in leaves the absorbed carbondioxide diffuse in spaces of **mesophyll layer.** Carbodioxide dissolve in water and pass easily through the cell wall and reach the chloroplast in cytoplasm to be used in photosynthesis.

Factors affecting the photosynthesis

1. Water

Water is used in light reactions of photosynthesis and NADPH formed as a result. NADPH is used by dark reactions of photosynthesis for organic material synthesis. Hydrogen molecules used in dark reactions decrease as a result of decreasing in water level. Decreasing in water level causes the decreasing of **osmotic pressure** in guard cell of stoma then stoma closes and gas exchange decrease therefore transmission of carbondioxide to the cells decrease and at last photosynthesis level decreases too.

Also photosynthesis level decreases when water level decrease in leaves they crisped because it affects the structure of chloroplast.

2. Carbondioxide(CO_2)

Atmosphere is main source of carbondioxide. Respiration of organisms and burning fossil products release carbondioxide to the atmosphere. Concentration of carbondioxide in atmosphere is 0.03 %. Increasing in carbondioxide concentration causes increasing in photosynthesis level.

3. Light

Light is source of energy for photosynthesis are two kinds of plants according to their respond to light. They are shadow plants and sun plants. Each kind of plants can grow at a different level of light. So less or more light affects photosynthesis level adversely. Light wavelength affects the photosynthesis level. Photosynthesis level is high in red and blue wavelength because chlorophyll absorb most of light in these wavelength.

4. Temperature

Temperature affect the dark phase of photosynthesis most since its reactions are catalysed by enzymes. Any increase in temperature up to approximately 40°C accelerates the rate of photosynthesis. Above this temperature, reactions slow as proteinaceous enzymes denature and it causes decreasing in photosynthesis level.

5. Minerals

Iron (Fe^{+3}) and Magnesium (Mg^{+}) are minerals that dissolve in soil. Insufficency of these minerals chlorophyll and photosynthesis rates decreases. There are other elements important for plants. For example Phosphate found in structure of Ribulose diphosphate and Adenosine tri phosphate (ATP) , which are important molecules in photosynthesis. Manganese and Magnesium are important elements and they are important for activation of enzymes used in light and dark reactions.

6. Soil ventilation

Soil ventilation helps root cells to absorb more oxygen. Insufficency of oxygen in soil cause root cells to lose their vitality. Roots cannot absorb enough water and minerals and it affects the photosynthesis adversely.

7. Plant diseases

Viruses, bacteria or fungi infect the leaves of plants and decrease rate of photosynthesis.

8. Atmospheric pollutant

Dust, pesticides and smoke of factories effect photosynthesis directly or indirectly. These pollutants can close the stoma on leaves of plants. Then enough carbondioxide cannot be absorbed and rate of photosynthesis decrease.

9. Genetical factors

Thickness of **cuticle layer** on surface of leaves, number of stoma, structure of cells in mesophyll layer, number of chloroplasts and amount of chlorophyll they contain are genetical factors which effect the photosynthesis. Also enzymes which used in photosynthesis and production of chlorophyll synthesis are genetical factors.

Leaves and photosynthesis

Water and carbondioxide are used in photosynthesis. Water absorbed by roots and transported by xylem vessels in plants. Carbondioxide is absorbed by stoma and diffuse to the chloroplasts. Remember chloroplast consist of two main parts; grana and stroma. (figure 1-2).

There are chlorophyll A and B inside the thylakoid membrane. These pigments absorb sun light. Reaction in which carbondioxide used take place in stroma and organic materials are used at the end of these reactions.

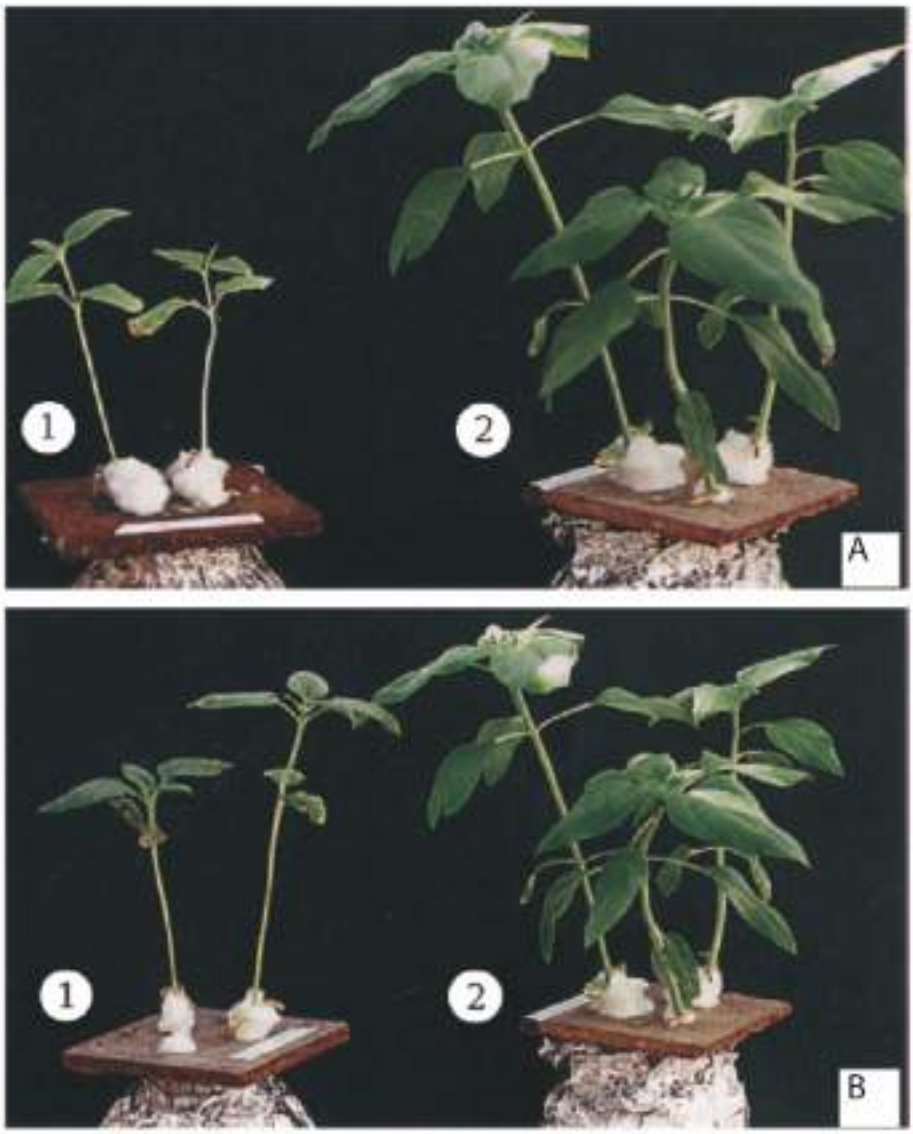


Figure 1.6 Malnutrition in plants

(A)
Plant with number 1 grown in medium without nitrogen.

Plant with number 2 grown in medium with all necessary materials.

(B)

Plant with number 1 grown in medium without phosphorus.

Plant with number 2 grown in medium with all necessary materials.

In absence of any necessary materials plant growth slow down.

Chemosynthesis

Some kinds of bacteria produce their own food by **chemosynthesis**. Inorganic materials are converted into the organic materials without sun light. These bacteria get necessary energy for production of organic substances by oxidizing some inorganic materials. There are some kinds of this bacteria;

A) Nitrosomonas

These bacteria found in soil and convert ammonia (NH_3) into nitrate (NO_2^-) *as follows:*

$$2NH_3 + 3O_2 \xrightarrow{\text{Nitrosomonas}} 2NO_2^- + 2H_2O + 2H + \text{Energy}$$

B. Nitrobacter

These bacteria found in soil and can convert nitrate (NO_2^-) into nitrade (NO_3) *as follows:*

$$2NO_2 + O_2 \xrightarrow{\text{Nitrobacter}} 2NO_3 + \text{Energy}$$

C. Sulphur bacteria

These bacteria found in sulphuric water sources. These bacteria oxidize hydrogen sulfide into water and sulphur. Energy produced at the end of reaction and used in reduction of CO_2.

$$2H_2S + O_2 \xrightarrow{\text{Sulphur bacteria}} 2S + 2H_2O + \text{Chemical energy}$$

$$2H_2S + CO_2 \xrightarrow{\text{Chemical energy}} (CH_2O) + H_2O + 2S$$

These bacteria are called as **chemoautotrophic** organisms because they get necessary energy by oxidizing inorganic material to produce food.

Nutrition in animals

Animals are heterotrophic organisms because they get organic food materials from plants or other animals. But these food particles are not so small to pass through plasma membrane so they need digestion.

Animals are divided into three groups according to source of food; **herbivores, carnivores** and **omnivores**.

Groups	Food type
Carnivores	Animals
Frugivores	Fruits
Herbivores	Plants
Insectivores	Insect
Omnivores	Plants and animals
Detritivores	Dead organic materials

Ingested large food particles are broken down into their monomers and transported to the body cells by circulatory system. Monomers like glucose are broken down by cellular respiration in cells, energy and heat release at the end of reactions. All of these reactions are called **catabolism**.

Feeding mechanisms

All organisms need to get food to survive and they have different adaptations to do it. There are different methods of getting food among animals, some of them are;

1- Direct method

Only little amount of animals take the food directly from environment. They are parasitic organisms get the ingested food in form of monomers from the host. Some kinds of worms like tapeworm is an example for these animals. Some aquatic invertabrate animals get some food directly from water.

Figure 1.7 Amphitrite

This animal feed on deposits and live in deep sand of water. Has many feeding tentacles extended in different directions and covered with mucous. Tentacles capture the food and then send it to the mouth.

2- Feeding on planktons

Planktons are tiny organisms,can be plant like (phytoplankton) or animal like (zoo planktons) which live in sea and oceans. They hunted by invertabrate and vertabrate animals by filter feeding method. Worms, bivalves and cephalochordates take the planktons with water in their body and capture them by mucous in their mouth and send them to their digestive tract. Some animals have cilia around their mouths to capture the planktons.

Some animals feed on accumulated organic materials in the deep of water and this kind of feeding is called **deposit feeding.** Some kinds of hemichordata and some insects are examples for it. Figure (1.7)

3- Feeding on solid particles

Animals have different body structures according to type of nutrition.

A. There are cutting regions in mouth of invertabrates to increase surface area of food to accelarate the digestion.

B. Insects have chitinous teeth, tongue and absorption tubes. They involved in detection, grinding and absorption of food particles.
Nereis from invertabrates has muscular pharynx supported by chitinous teeth. Pharynx extend out of body capture the food and take into the body quickly.

C. Some vertabrates catch their prey strongly by their front extremites and paralise them by poison secretion.

Complete chewing is performed only by mammals which have four different kinds of teeth. Each kind has a different function as follows;

A. Incisors: They used in biting and cutting.
B. Canines: They used in partition, especially meat fibers.
C. Premolas: They used in chewing and grinding.
D. Molars: They used in chewing and grinding.

Human also have these kinds of teeth. (figure 1.8) Teeth are different in animals according to type of nutrition. Herbivores have not canine teeth but have more developed molar teeth.

Incisors in rodents grow continously during their life span. But they corrode gradually to limit their size.

Do you know?

Elephants use their canine teeth for defence and attack.

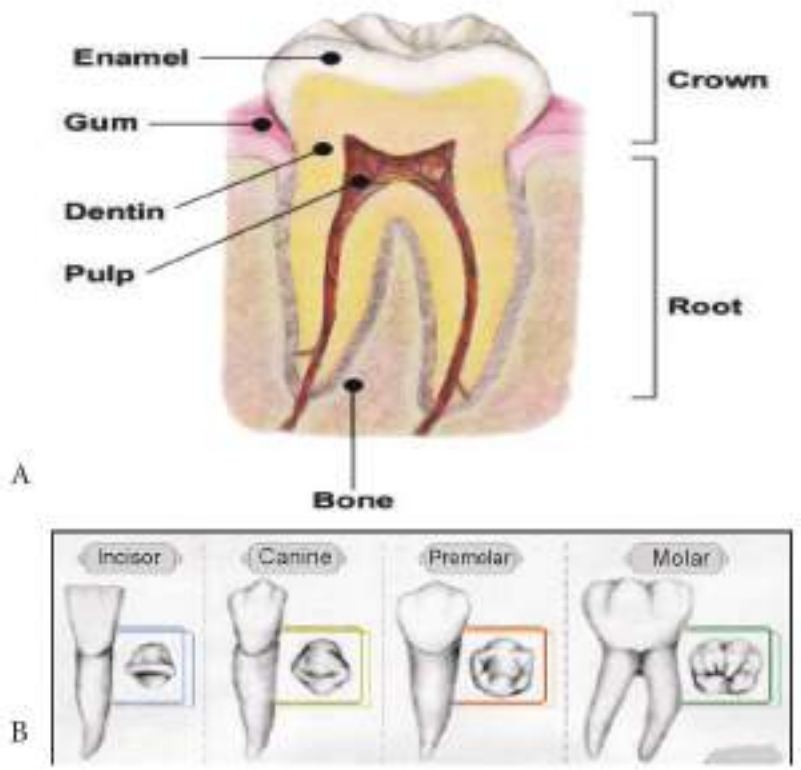


Figure 1.8 (A) Human Tooth anatomy

(B) Kinds of teeth in mammals. Many kinds of animals have teeth for cutting, chewing and grinding the food particles.

Add to your information

Some invertebrates have rodent mouth parts. Grasshopper is an example for animals which has jaws involved in cutting and grinding.

Add to your information

Herbivore mammals like horse and cow have bended molar teeth to broke the cellulosic wall of plant cell. This process facilitate the digestionof cellulose by microorganisms that live in their digestive system.

4. Feeding on liquids

It is kind nutrition in parasites but there are some non-parasitic organisms feed by this method. Some internal parasites absorb digested food of host organisms and some of them absorb blood through damaged wall of intestine. Some insects and leech feed on blood by using their driller and absorber mouth parts.

Digestion

Digestion is breaking down of big molecules into their monomers. Carbohydrates, proteins and lipids are main nutrients. These nutrients need digestion to be used by organisms in production of energy and building new organic molecules. Digestion takes place in cell (intracellular) or out of cell (extracellular).

1. Intracellular digestion

Food vacuole which formed at the end of phagocytosis unites with lysosome. Digested food particles which can be used directly, like glucose and aminoacids diffuse into cytoplasm. Wastes are removed from the cytoplasm by exocytosis. (figure 1.9)

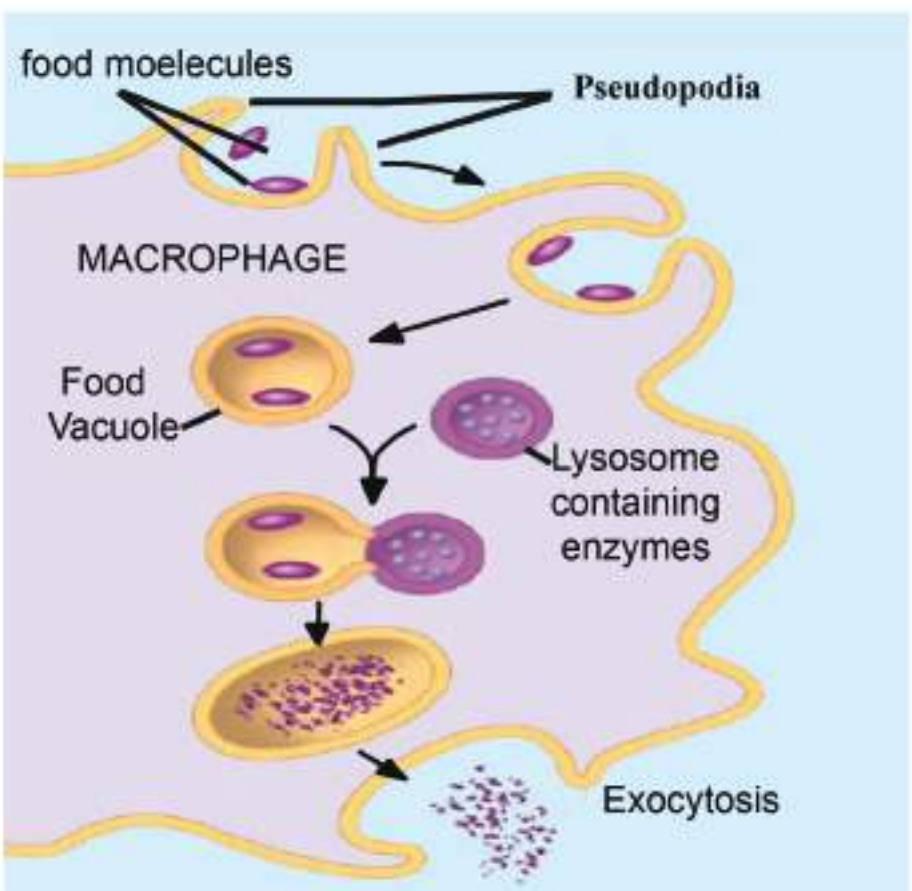


Figure 1.9 Exocytosis in cell

2. Extracellular digestion

Extracellular digestion is a process by secreting enzymes through the cell membrane into the food. The enzymes catalyse the digestion of the food into molecules small enough to be taken up by diffusion phagocytosis. Since digestion occurs outside the cell, it is said to be extracellular. It takes place either in the lumen of the digestive system, in a gastric cavity or other digestive organ, or completely outside the body.

Extracellular digestion is a form of digestion found in annelids, crustaceans, arthropods, lichens and chordates, including vertebrates.

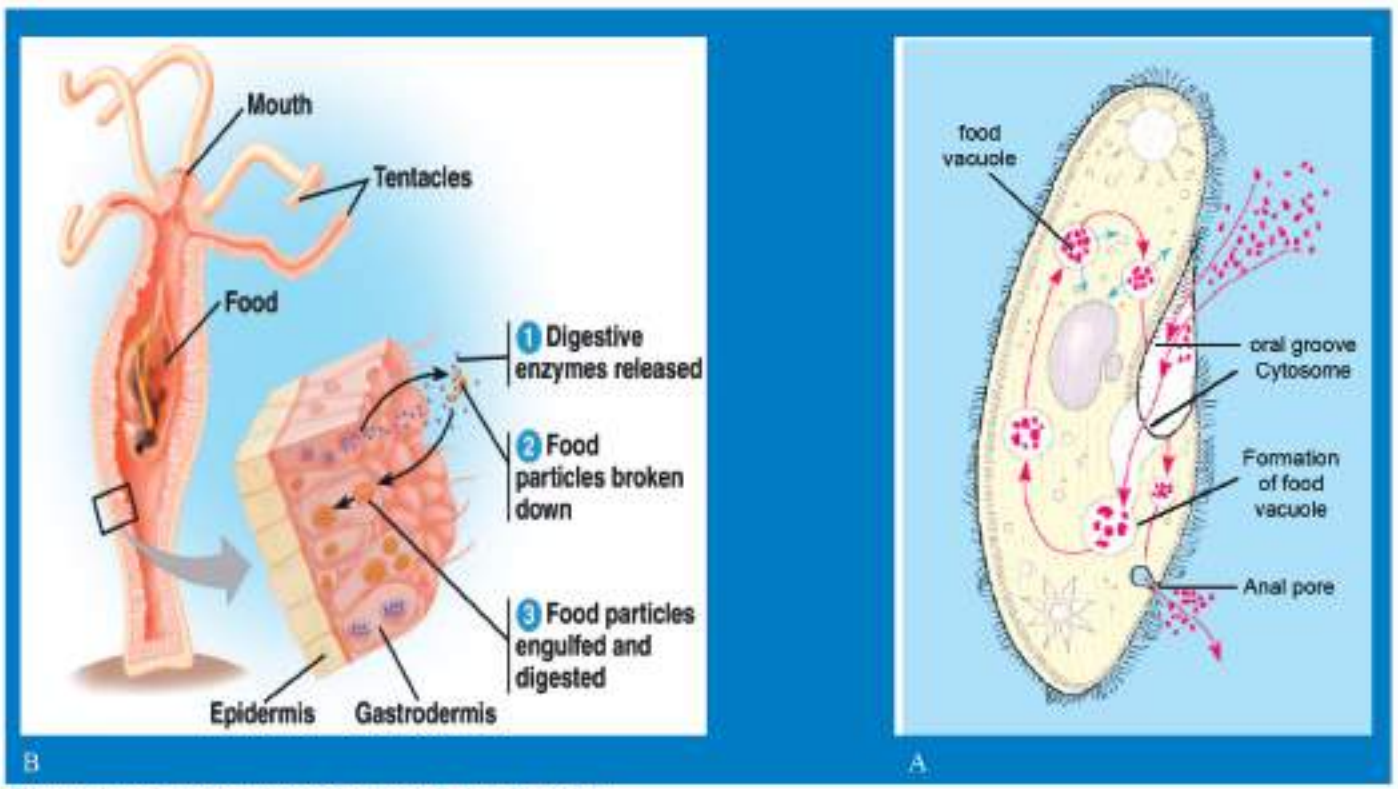


Figure 1.10 Intracellular and extracellular digestion
(A) Intracellular digestion. It can be observed in unicellular organisms like paramecium and sponges.
(B) Most of animals do extracellular digestion. For example hydra has a simple digestive system and do perform extracellular digestion.

Digestive tract

Animals have different digestive system.

General functions of digestive tract are;

A. Swallowing the food.
B. Breaking down the food into monomers.
C. Absorption of digested food.
D. Excretion of wastes.

How do parasites which cause the anemia and menengitis infect the human body?

Mosquito is carrier of these parasites. It secretes a kind of substance on human body to prevent blood coagulation and absorb blood. Only female mosquito absorb the blood. And parasites pass the human body in this way.

There are two kinds of digestive systems they are; complete digestive tract and incomplete digestive tract.

1- Incomplete digestive tract:

This kind of digestive system has only one opening called as **mouth** and it used for ingestion of food and excretion of wastes. Planaria has this kind of digestive system. Digestive system starts by mouth and muscular digestive tract and extend as branched gastrointestinal cavity. Planaria are tiny aquatic organisms and they feed on organic remains. During ingestion digestive tract extend out of body to take food and extracellular digestion is performed in digestive tract.

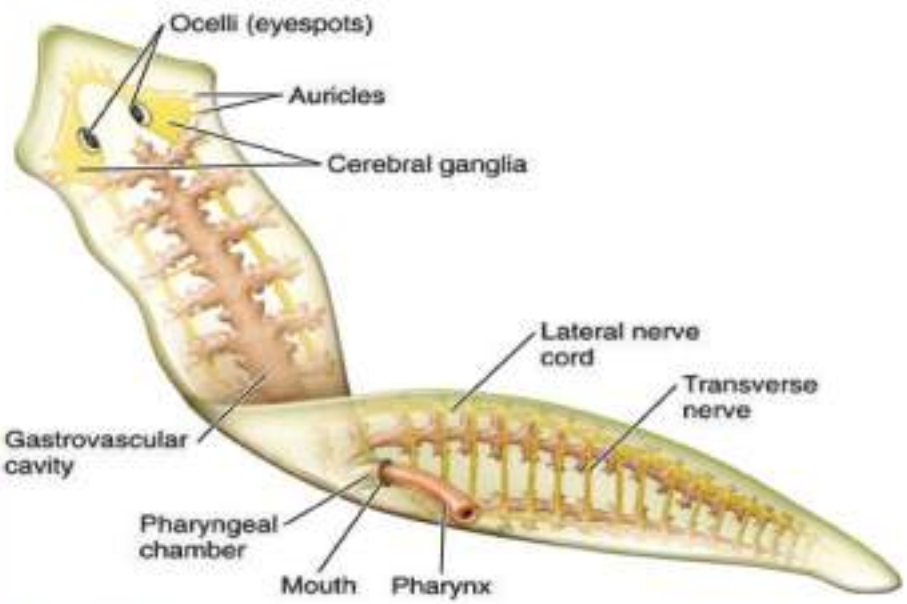


Figure 1.11 Digestive system in planaria.

Add to your information

Caecum:

It is a finger like small extention at the begining of large intestine. It is site of cellulose digestion in herbivores.
It causes dangerous medical problems in human when it is inflamated and can be removed by surgery.

2- Complete digestive tract:

This system starts by mouth and end by anus. Earthworms have this system and feed on organic materials in soil. These animals absorb nutrients by muscular pharynx and then it passes to the crop where food is stored. Then food pass to the gizzard where food broken down by help of small stones in it. Extracellular digestion happens in digestive tract digested food absorbed and wastes are removed through anus.

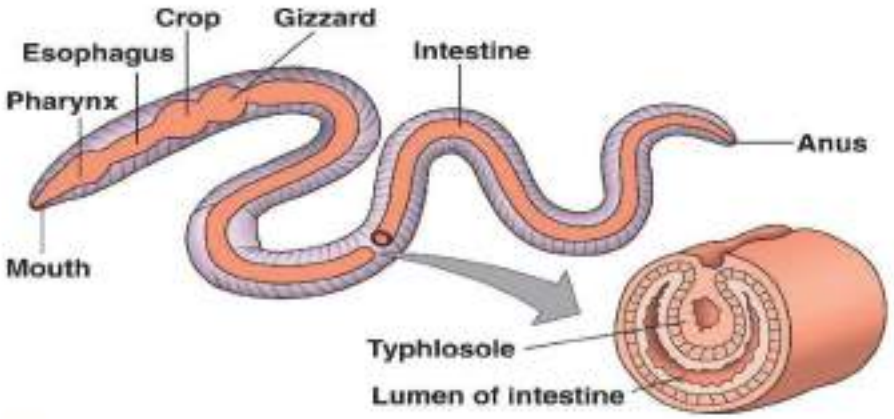


Figure 1.12 Digestive system in earthworm

Movement in digestive tract

Food transport by movement of muscles in wall of digestive tract and fimbrea. Movement of food by fimbrea performs in animals which have pseudo-coelom. In other animals food transport by contraction and relaxation of muscles in wall of digestive tract. These waves like movement of muscles is called as **peristaltic movement**. (figure 1.13)

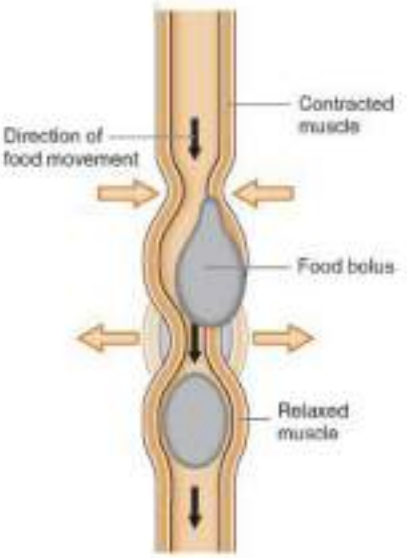


Figure 1.13 Peristaltic movement

Anatomical and physiological structure of digestive system

There are different types of digestive systems in animals depend on the nutrients they ingest.

Parts of digestive system according to their function as follows:

A. Food reception zone

It is the front part of digestive tract consist of mouth, mouth components and muscular pharynx.

Digestion start in this zone by secretion of **Ptyalin enzyme** which involved in digestion of complex carbohydrates like starch. This enzyme found in snail, some insects, mammals and human. Ptyalin enzyme lose its function when reach the stomach with semi digested food. Digestion of starch complete in small intestine. Tounge is a distinctive feature of vertabrates that help chewing and swallowing of food. **Epiglottis** closes the trachea during swallowing and food pass into esophagus then by peristaltic movement transports to the stomach.

Do you know?

Glands which found in mouth has different functions than secretion of digestive enzymes. They sometimes involved in calmness of prey, prevent pain during biting prey or prevent blood coagulation in some insects

B. Transport and storage zone

Pharynx involved in transmission of nutrients to the digestive tract of invertebrates and some vertebrates. Pharynx is followed by esophagus. It's front part enlarged to form crop in some animals. Crop stores the food, moistens it before digestion in birds. This stored food became semi digested before coming back for offsprings. (figure1.14)

Add to your information

Many planthopper species exude waxy secre tions from the abdomen, and these sometimes form long strands, such as can be seen in this photo. The long waxy strands may provide protection from predators it could be that they fool a predator into attacking the wrong part of the insect, and the wax breaks off while the insect jumps safety.

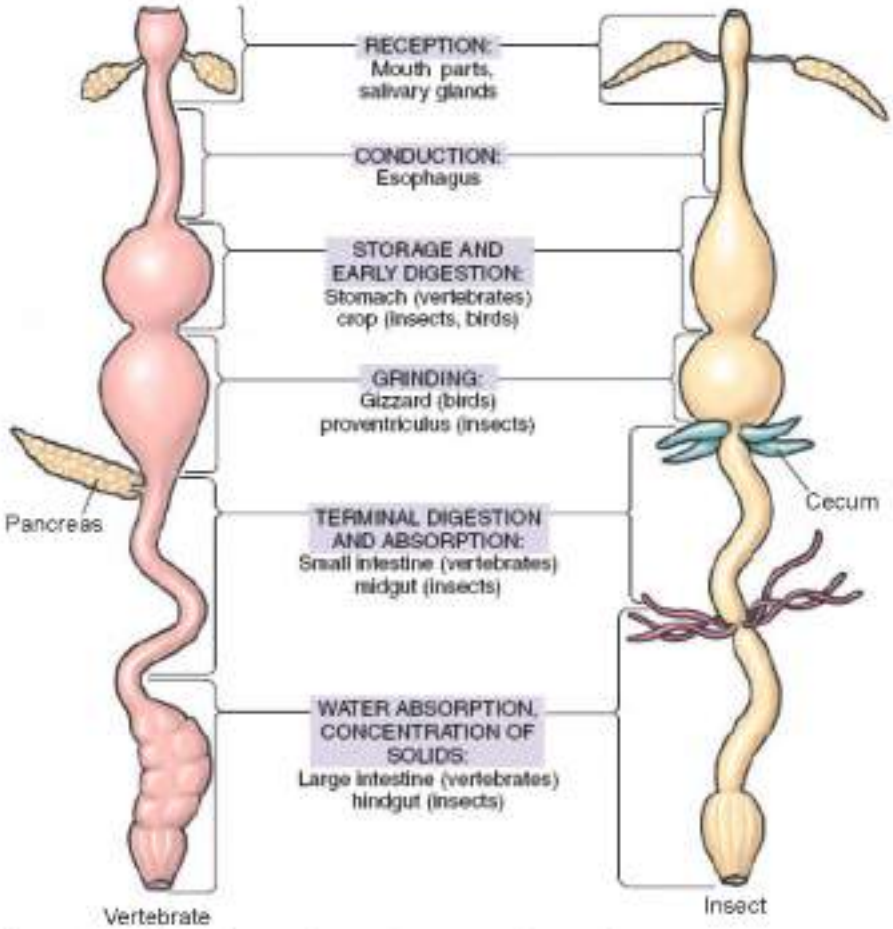


Figure 1.14 Digestive tract in vertebrates and invertebrates

Organ	Differentiated parts	Function
Mouth	Teeth, salivary glands and tounge	Chewing food and digestion of starch
Digestive tract	----------	Peristaltic movement
Stomach	Gastric glands	Food storage, destroy bacteria and digest the proteins
Small intestine	Villi	Digestion and absorption
Large intestine	----------	Water absorption and storage of wastes
Anus	----------	Defecation process

Table 1.2 Parts of digestive tract and their function

C. Digestion zone

Stomach used in digestion and storage of food in most of vertabrates and some invertabrates. Food is mixed with HCl acid in stomach and expose to the mechanical digestion by peristalsis. This digestion takes place in arthropods and birds. Stomach consist of thick muscular wall in herbivores and carnivores. There are gastric glands that secrete the **pepsin enzyme** and **HCl**. Pepsin enzyme involved in digestion of proteins.

D. Last digestion zone and absorption

It known as intestinal zone. Intestines are long and bended in herbivores while shorter in carnivores. There are finger like structures called **villi** (and microvilli on villi surface) in inner surface of intestine to increase the surface area for digestion and absorption. (figure 1.15)

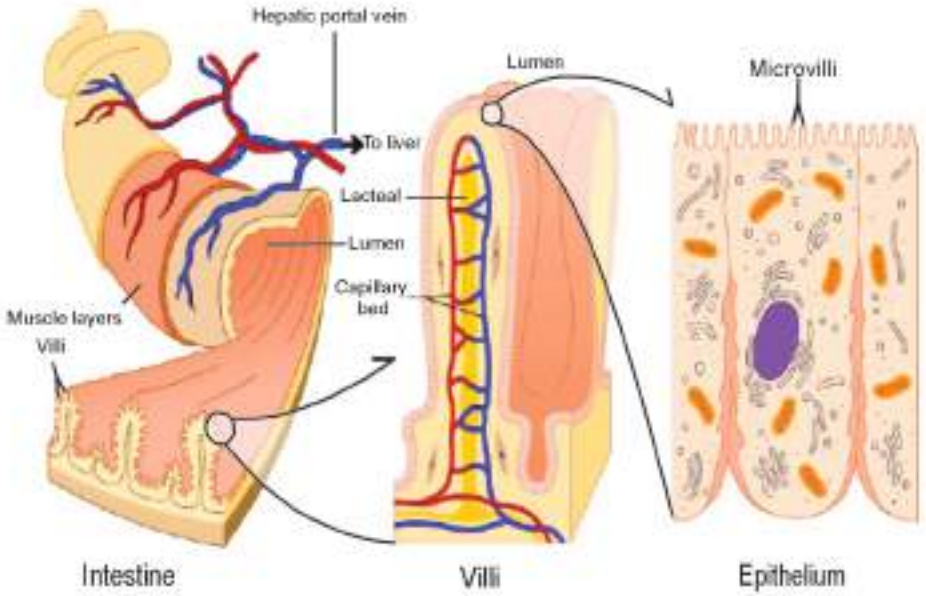


Figure 1.15 Inner structure of small intestine

Semi digested food pass into the small intestine through pyloric sphincter. First part of small intestine is called as **duedonum** and it receives the secretions from the liver and pancreas. Liver produces bile and pancreas produces the digestive enzymes. Food mass digestion complete in this part and called as **chyme**.

Pancreas contains different kinds of enzymes they are;

A. Trypsin and chymotrypsin involved in digestion of proteins.
B. Lipase digests lipids into fatty acids and glycerol.
C. Nuclease digests the nucleic acids.
D. Amylase digests the starch molecules.

Do you know?

Normally, we do not feel the intestine's movements, but, if we eat too much, we can experience a painful sensation and, if we get a food poisoning, we will suffer of violent spasms and pain. Vomits and diarrhea are caused by the irritation of the stomach and intestine caused by toxins.

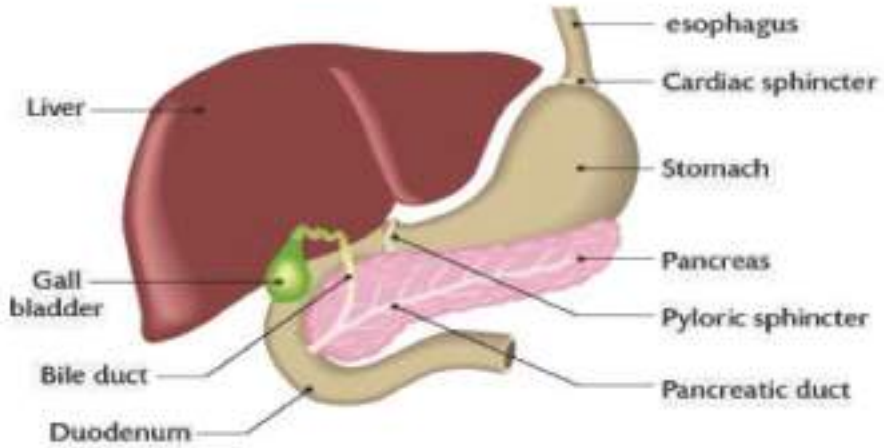


Figure 1.16 Liver and pancreas in human

Functions of liver:

A. Detoxification of blood.
B. Stores the iron, vitamin A, B_{12} , E and D.
C. Produces albumine and fibrinogen proteins.
D. Stores the excess amount of glucose as glycogen.
E. Convert ammonia to urea.
F. Produces bile from partition of old red blood cells.
G. Regulate the amount of chollesterol in blood.

Do you know?

The golden yellow color of bile is formed by partition of hemoglobin of old red blood cells. It involved in digestion of lipids in duedonum.

Functions of small intestine:

A. Completes the digestion of food and absorbs the nutrients.
B. Carbohydrates are digested into glucose, galactose or fructose and pass to the blood.
C. Proteins are digested into aminoacids and pass to the blood.
D. Fatty acid and glycerol are pass to the lymphatic system.

Add to your information

Length of small intestine depend on nutrition type. Length of small intestine in frog larvae which is herbivore longer than small intestine of adult frog which is carnivore.

E. Water absorption zone

Large intestine absorb water and defecate the undigested food in form of a solid mass. Water absorption is important for terrestrial organisms like insects birds and reptiles. There are many bacteria in human large intestine which convert some organic material into vitamin K and little amount of vitamin B.

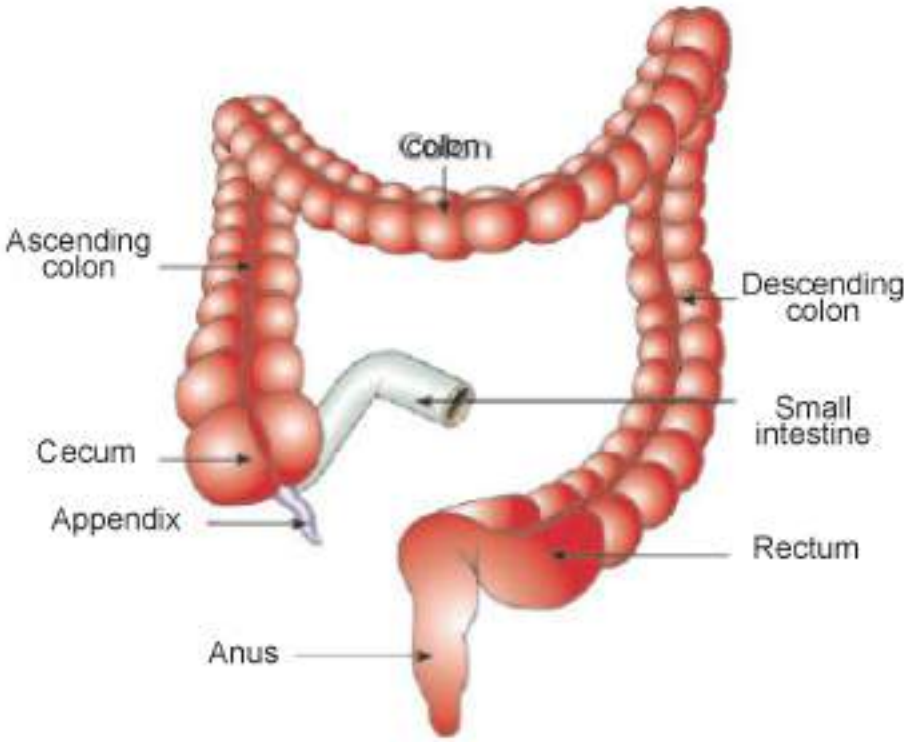


Figure 1.17 Large intestine in human

Nutritional needs

Organisms obtain the energy required for all their metabolic functions, growth and for the repair of their damaged tissues from food.

The energy that food provides is necessary for the continuity of life on earth. *Food can be divided into six groups, according to its composition:*

- Carbohydrates
- Lipids
- Proteins
- Vitamins
- Minerals
- Water

All of the above nutrients are essential for a balanced diet. A deficiency of any of them may give rise to serious metabolic disorders. Carbohydrates, proteins and lipids are used as source of enrgy but others are used in regulation and activation of metabolic activities.

A. Carbohydrates

Grains are main sources of carbohydrates. They change into simple sugars gradually in digestive system and contain amount of fibers. These fibers limit adhesion of carcinogenic material on wall of intestine and they prevent colon cancer by this way.

Dissolved fibers in oat prevent absorption of cholesterol and some harmfull acids. But large amount of fibers prevent absorption of iron, zinc and calcium from food.

B. Proteins

They are the basic structural elements of the body. The development of an organism from a zygote and the formation of its organ systems are entirely depend on proteins.

As has already been stated, proteins contain 20 different amino acids which are structurally and functionally different subunits. Some of them are synthesized within the body and some are imported. There are nine vital amino acids that can not be synthesized in the body and they have role in growth stages.

Foods vary in their quantity of vital amino acids. The qualified proteins contain adequate amounts of vital amino acids and are easily digested. Generally, animal proteins are qualified but plant proteins are nonqualified.

Add to your information:

Mother milk is main source of necessary nutrients for infants. it contains all necessary materials.

Milk secretion of mother is in three stages:

1. Colostrum secretion stage.

2. After fifth day of secretion colstrum secretion decreases and natural milk secretion start and continues until third or fourth week.

3.Completed milk secretion stage start after fourth week.

C. Fats

These giant molecules yield the most energy in comparison to other molecules. There are two kinds of fats; saturated and unsaturated. Saturated fats are generally obtained from animal products with exeption of some plants like coconut oil. Plant fats are unsaturated fats and necessary for human body for health.

Consuming large amount of saturated fats causes arteriselerosis. Fish contain omega-3 fatty acids which have a role in prevention of heart attack.

D. Vitamins

Vitamins ingested in food and plays important role in regulation of body metabolism. They cannot be produced in the body. Vitamins have two types according to their solubility; water soluble vitamins and lipid soluble vitamins.

E. Minerals

Inorganic molecules, or minerals, are as important for body functions as organic molecules. They are required for health, continuity of metabolism and in the formation of bones and teeth.

They are divided into two main groups:

Essential minerals (calcium, phosphorus, sodium, potassium)

Non essential but recommended minerals (magnesium, iron, copper, zinc and other trace elements)

VITAMIN	SOURCES	EFFECTS OF DEFICIENCY
A (Retinol)	Milk, Butter, Carrots, Fresh vegetables	Nyctalopia Dry skin.
B_1 (Thiamine)	Legumes, Peanuts, sheep Liver	Beriberi disease. Nerve disorders
B_8 (Byredoxine)	Red meat Fish, legumes.	Anaemia, depression
C (Ascorbic acid)	Citruses , green pepper	Scurvy-Tooth, Skin and Blood vessels disorders
D (Calcipherol)	Fish oil, Milk, Egg yolk	Rickets, Bone disorders
E (Tocopherol)	Vegetable oils, Seeds	Nerve damage, Reduced fertility
K (Phylloquinone)	Green vegetables, Spenach	Slow blood clotting

Table1.3 Vitamins and their sources and effects on human body

Do you know?

Human and most of animals can survive with diet that contain enough energy without carbohydrates. Eskimos diet contain large amount of fats and proteins but little amount of carbohydrates.

Chapter Review

Question 1. Read the sentences carefully and write if it is true or false,

1. Plants use inorganic materials from environment to produce necessary material.
2. Chemosynthesis is production of organic materials by oxidizing some elements.
3. Water is split into hydrogen and oxygen in light rections of photosynthesis.
4. Some invertebrates have a muscular pharynx which supported by chitinous jaws to catch and swallow the prey.
5. Incompleted digestive tract contain mouth and anus.
6. Bile liquid is produced by liver.
7. Chloroplast is a double membraneous organelle.
8. Digestion of carbohydrates completed in stomach.
9. Food materials transported by diffusion through digestive tract.
10. Oat contain dissolved fibers which are important for heart.

Question 2. Answer the following questions

1. What is the function of gizzard and which organisms have it?
2. Explain the structure of chloroplast.
3. What are the factors affect the rate of photosynthesis?
4. Explain the extracellular digestion.
5. Explain the complete digestive tract.
6. Write the parts of digestive tract and their functions.
7. Write the functions of liver.
8. Which nutrients are used as source of energy?
9. Explain feeding in planaria.
10. Write kinds of teeth and their function.

Question 3. Explain the following scientific facts.

1. Some reactions that occur in chloroplast are called as light reactions.
2. Photosynthesis rate decrease and stop after a certain degree of temperature.
3. There are finger like projections (villi) in structure of small intestine.
4. Defecated wastes are in solid mass form.
5. Some pepole suffer from arteriosclerosis.

Question 4. Define the following terms.

Photosynthesis, Thylakoid, Stoma, Nitrosomonas, Carnivores, Planktone, Phagocytosis, Chyme, Amylase.

Question 5. Compare between the followings.

1. Light and dark reactions.
2. Completed and non-completed digestive tract.
3. Feeding on planktones and feeding on solid particles.
4. Photosynthesis and chemosynthesis.

Question 6. Label the parts in the Figuers below.

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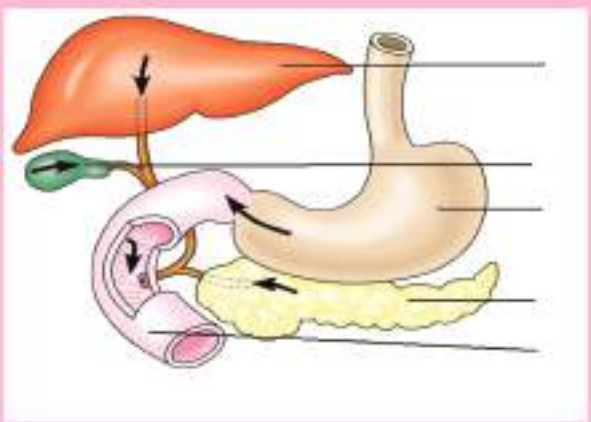

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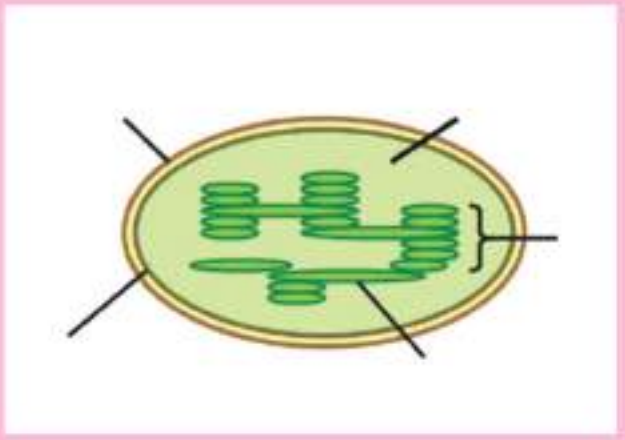

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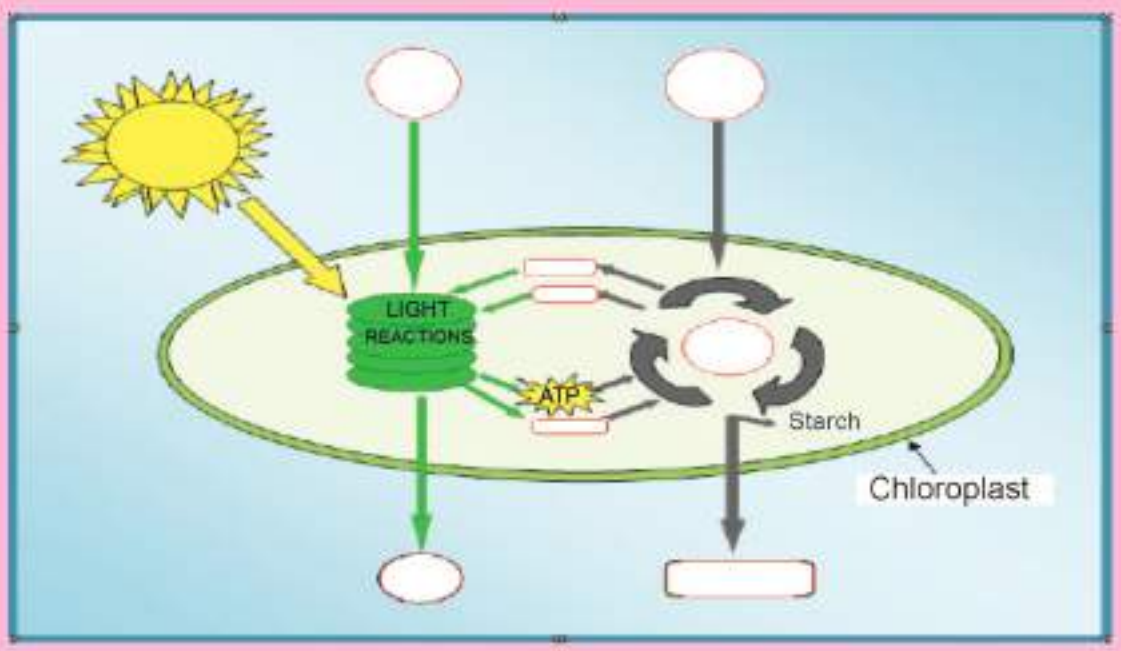
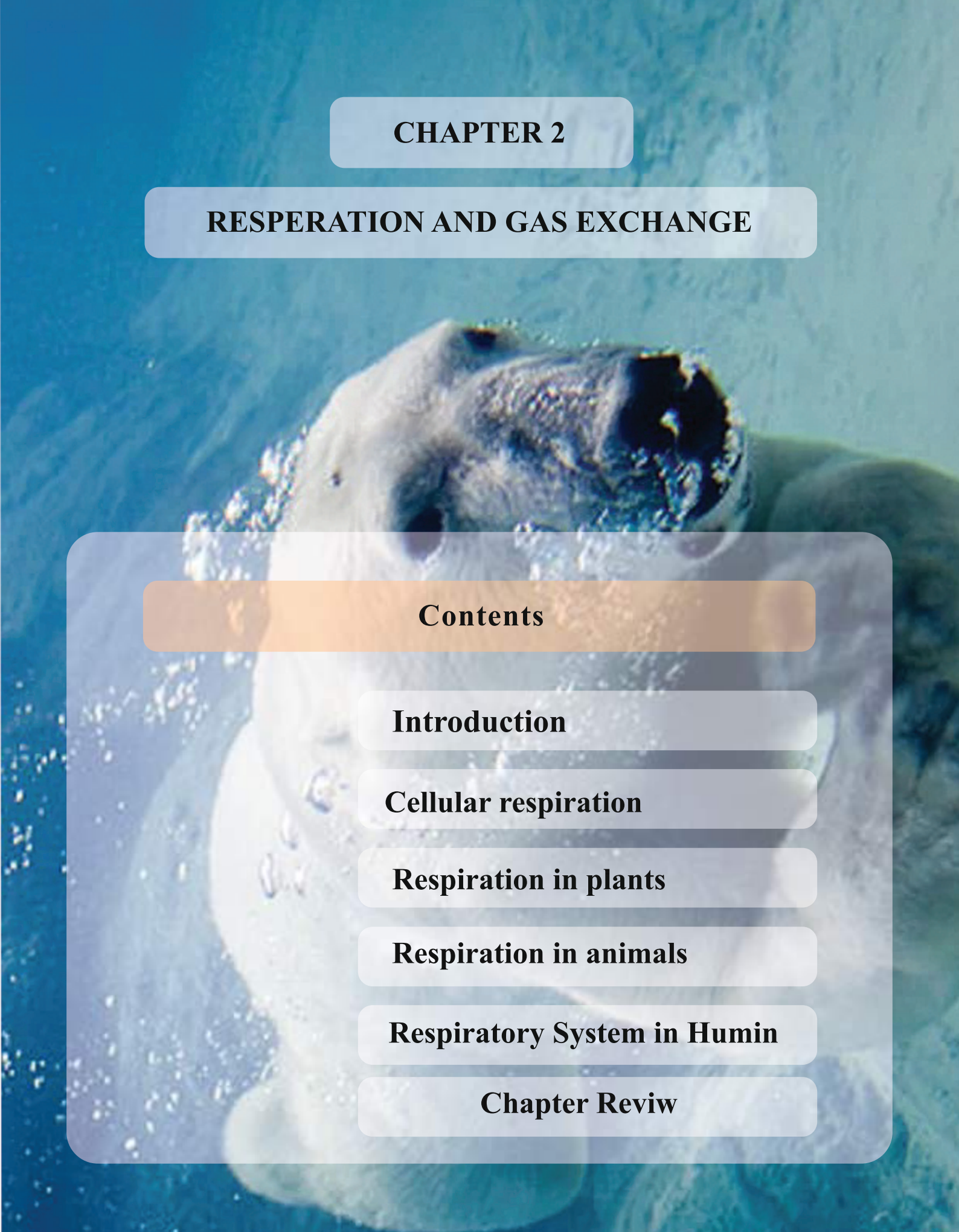


KNOW YOUR FOOD PYRAMID

TO PLAN A BALANCED DIET



CHAPTER 2

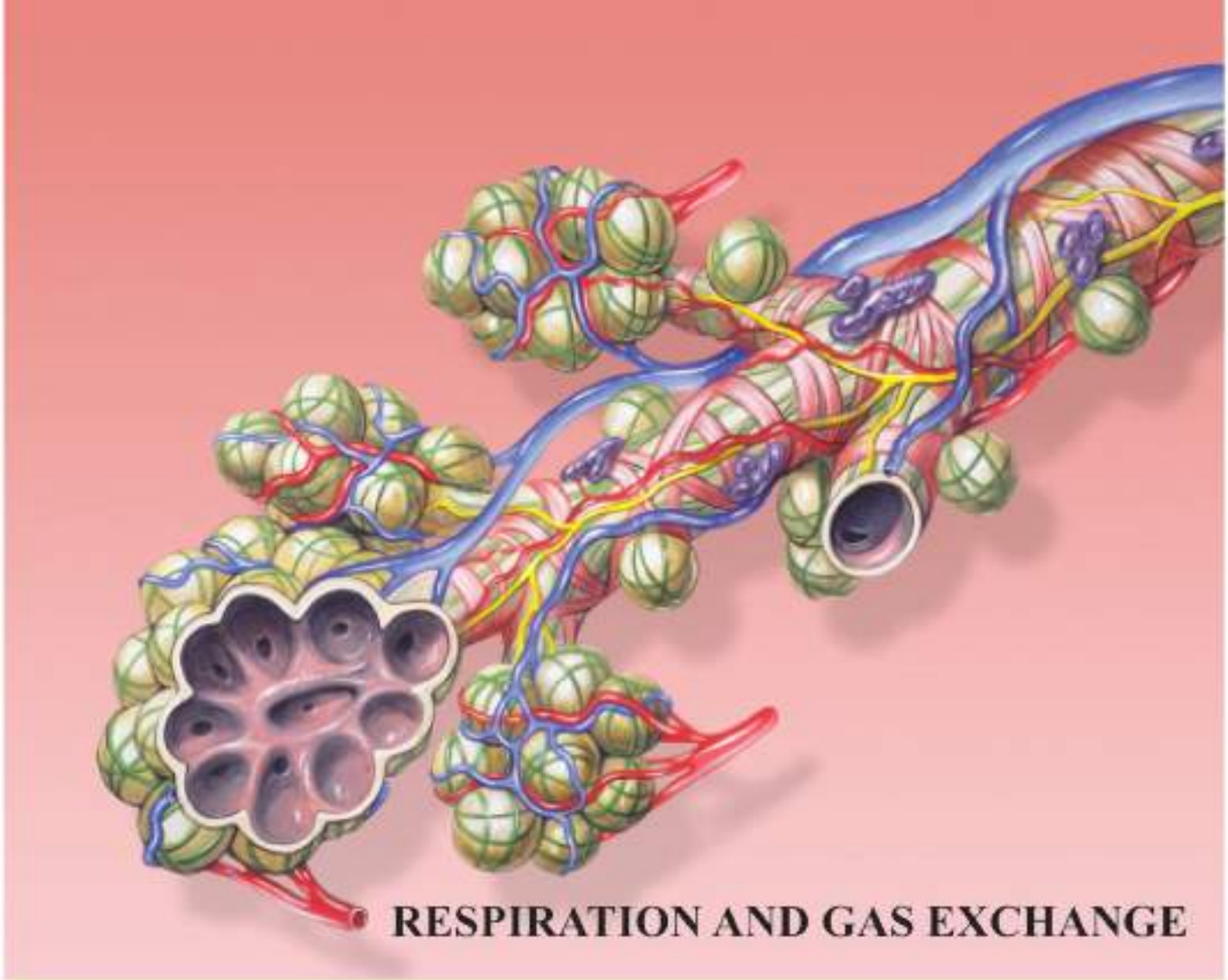
RESPERATION AND GAS EXCHANGE

Contents

OBJECTIVES

At the end of the chapter students must be able to;

1. Define the cellular respiration.
2. Explain glycolysis as a part of cellular respiration.
3. Compare between photosynthesis and cellular respiration.
4. Explain the mechanism of gas exchange in plants.
5. Define the stoma and lenticels and compare between them.
6. Compare between the internal and external respiration.
7. Explain the concept of aerobic respiration.
8. Explain the mechanism of gas exchange in animals.
9. Describe the tracheal respiration.
10. Explain the cutaneous respiration in vertebrates.
11. Explain the gas exchange mechanism in birds.
12. Numerate the parts of respiratory system in human.
13. Explain the functions of **Orgens** in human respiratory system.
14. Explain the respiration mechanism in human.
15. Explain the structure and function of alveoli in lungs.
16. Explain the gas exchange mechanism between blood and body parts.



RESPIRATION AND GAS EXCHANGE

Introduction

Primitive organisms used to get necessary energy from glycolysis reactions. One glucose molecule split into two molecules of pyruvic acid. Glycolysis is common both for aerobic and anaerobic reactions to produce energy. Energy producing cycle contain photosynthesis and glycolysis.

Disadvantages of this cycle are:

1. Less than (0.1 %) of energy releases during glycolysis rections.
2. High concentration of respiration products is poisonous for organisms.
3. High concentration of oxygen that produced in photosynthesis is poisonous for some organisms.
4. Glycolysis does not supply carbondioxide for photosynthesis.

Photosynthesis, glycolysis and respiration are main reactions of carbon cycle in nature. Sun is the main source of energy on earth. Glucose produced in photosynthesis and broken down in respiration reactions to produce energy. Water (H_2O) and carbondioxide (CO_2) produced at the end of respiration.

Some organisms can produce energy from stored lipids without ingestion for several months but they need to take oxygen continously because they cannot store oxygen.

Add to your knowledge

Gas exchange happen between organisms and their environment during respiration. Oxygen used in reactions and carbon dioxide released to environment.
Unicellular organisms provide gas exchange through plasma membrane by diffusion.
Small sized multicellular organisms provide gas exchange through body surface by diffusion. Big sized multicellular organisms need a complete system to provide gas exchange.

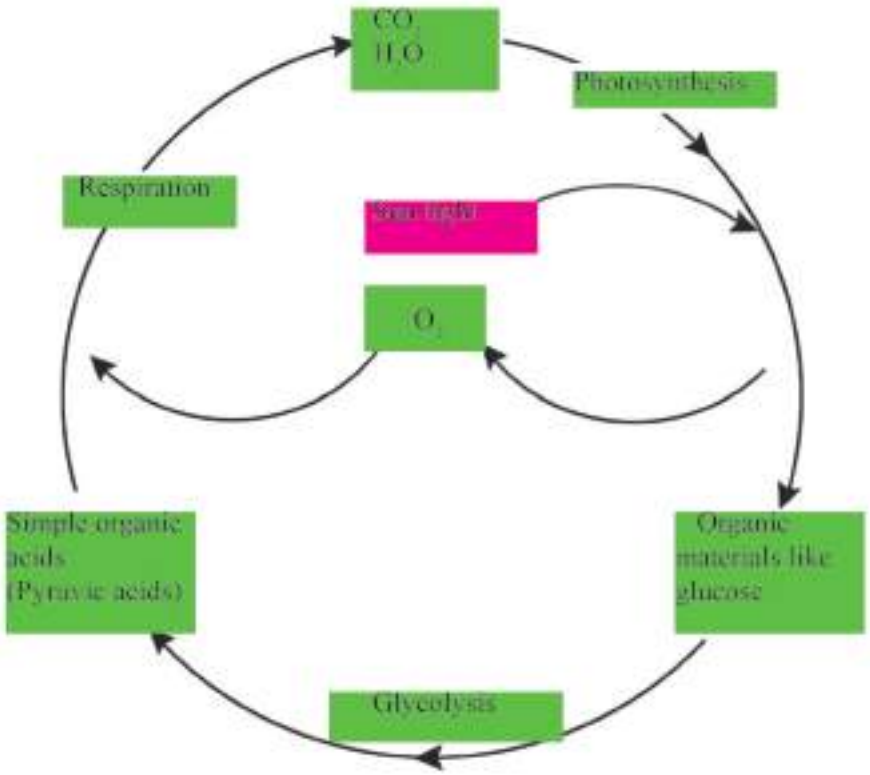


Figure 2.1 Main reactions of carbon cycle

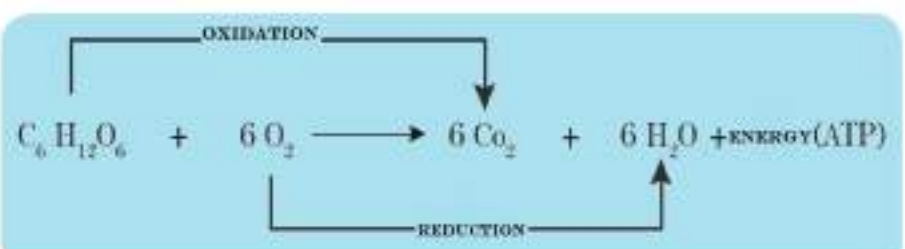
Organisms have different structures, organs or systems for respiration. Gas exchange performed by skin, gills or lungs among organisms.

Cellular Respiration

Glucose is broken down into water (H_2O) and carbondioxide (CO_2) in cellular respiration. And energy released at the end of reaction.

Glucose, fatty acids, glycerol and aminoacids are reactants of respiration. Enzymes which activated by ions and co-enzymes are used during respiration.

Respiration can be summerized in following reaction:



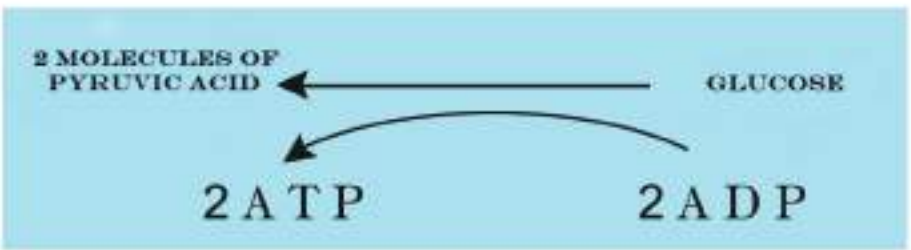
Remember!

External respiration is gas exchange between blood and environment.

Internal respiration is gas exchange between blood and body cells.

ATP (Adenosine tri phosphate) is an important compoad that provide energy for muscular contraction, secretion, impuls transmission and active transport. Chemical bond energy which obtained from ATP is also used in synthesizing of complex molecules. For instance, during production of proteins from aminoacids ATP is converted into ADP (Adenosine Di phosphate).

Glucose is primary source of energy for metabolic activities. Glucose is activated by consuming 2 ATP. Activated glucose broken down until 2 molecules of pyruvic acid and this reaction is called **glycolysis**. Glycolysis is common for aerobic and anaerobic respiration.



Phases of Cellular Respiration

Aerobic respiration occurs in four phases. Breaking of glucose molecule into two molecules of pyruvic acid occurs in cytoplasm an aerobically. Remain four phases occur in mitochondria.
These stages can be summarized as follows:

Phase 1:

Glucose molecule is broken down into two molecules of pyruvic acid during reactions that take place in cytoplasm. NADH (Nicotinamid Adenine Di Nucleotid) is reduced by hydrogen. NADH is a co-enzyme that used in production of ATP.

Phase 2:

Pyruvic acid molecules pass into mitochondria and transform into Acetyl CoA by separation of hydrogen and carbondioxide. NAD molecules are reduced by hydrogen molecules that separated from pyruvic acid. (NADH)

Phase 3 (Citric Acid Cycle):

It takes place in matrix of mitochondria, $FADH_2$ (Flavin adenine dinucleotide), NADH and CO_2 formed in these reactions. two citric acid cycles happen for one molecule of glucose ,**which known as Kreb's cycle** .

Phase 4:

The ETC makes up the final stage of aerobic respiration. In eukaryotic cells the electron transport chain lines the inner membrane of the mitochondrion; the inner membrane has many long folds called **cristae**.

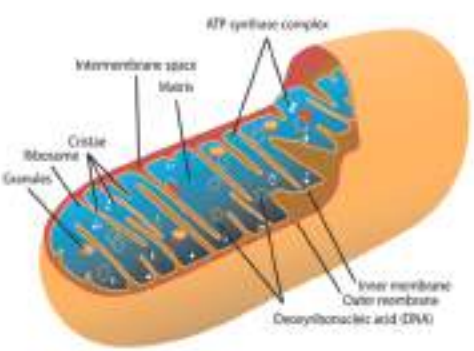


Figure 2.2 Structure of Mitochondria

These energised electrons of (H) are released during glycolysis and the Krebs cycle transported through the ETS in the form of (NADH+H) and $FADH_2$. As they move from molecule to molecule, the electrons lose some of their energy. This energy is used in production of energy by chemiosmosis. Electrons are finally gained by oxygen and water is formed. (34 ATP) is produced at the end of ETS (Electron Transport System). (figure 2.3)

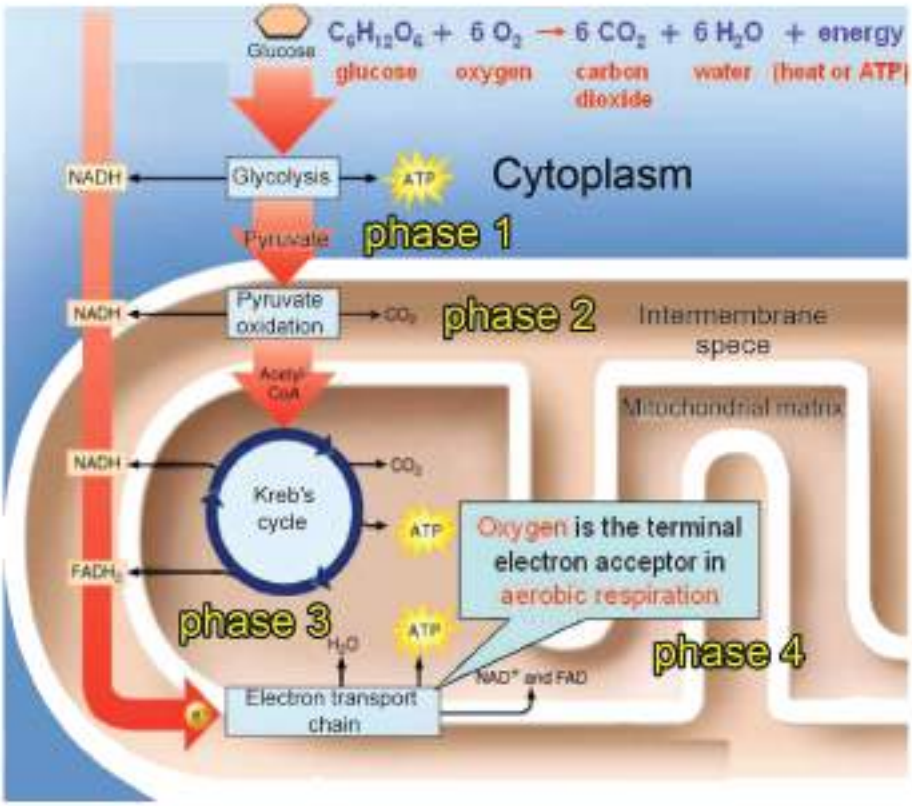


Figure 2.3 Phases of aerobic respiration

Respiration in Plants:

Plants don't have a specialized respiratory system but some structures for gas exchange. Plants get oxygen from atmosphere through tiny openings on leaves called **stomata** and take dissolved oxygen in water by roots then to the xylem vessels. Then this oxygen diffuse to the plant cells. Plants don't need oxygen during the day because they provide it from photosynthesis. Produced carbondioxide released from the plant body by stomata or by diffusion from outer cells.

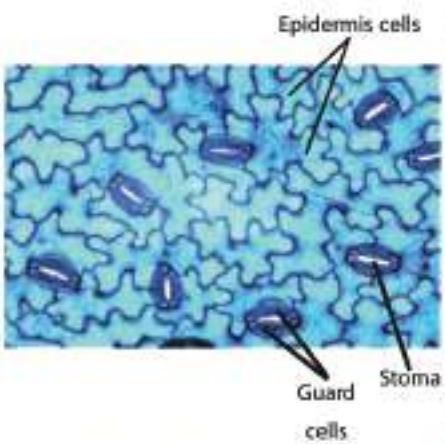


Figure 2.4 Stomata

Gas Exchange Mechanisms

A. Stomata:

Stoma is tiny structure that formed by the differentiation of epidermal tissue. Stomata play a role in exchange of O_2 and CO_2 between leaf tissues and atmosphere. A stoma is composed of a pair of bean-like cells known as **guard cells** with a space between them, known as the **stomal opening**. The inner walls of guard cells are thicker than the outer walls. This difference has a role in the opening and closure procedure of stomata.

Lenticels:

The epidermis forms a protective layer on the surface of young higher plants and the outer tissue becomes woody as the plant matures and ages. The stomata lose their ability to function and then replaced by **lenticels**. They maintain gas exchange between a woody plant and the atmosphere and are found mostly on the roots, stem and branches.

Hydrophytes absorb dissolved oxygen in water by their body surface.

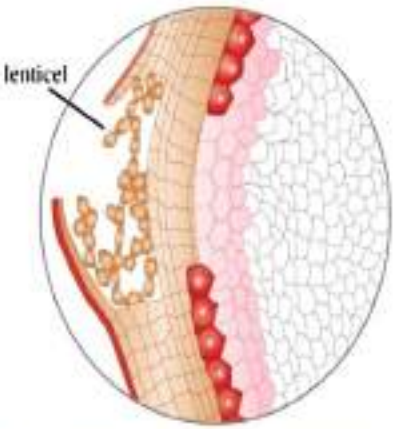


Figure 2.5 Lenticels in woody plants

Respiration in Animals

All animals need oxygen to maintain the metabolic avtivities. Animals vary according to their respiration mechanism depending on their living conditions. Animals use gills, body surface or lungs for respiration.

Levels of Respiration

Respiration occurs in three levels in animals;

1. External respiration:

Oxygen and carbondioxide diffusion takes place between blood and respiration surfaces. (figure 2.6)

2. Internal respiration:

Gas exchange takes place between blood and body cells.

3. Aerobic cellular respiration:

It is the breaking down of glucose in cell to produce energy in presence of oxygen and carbondioxide released at the end of it.

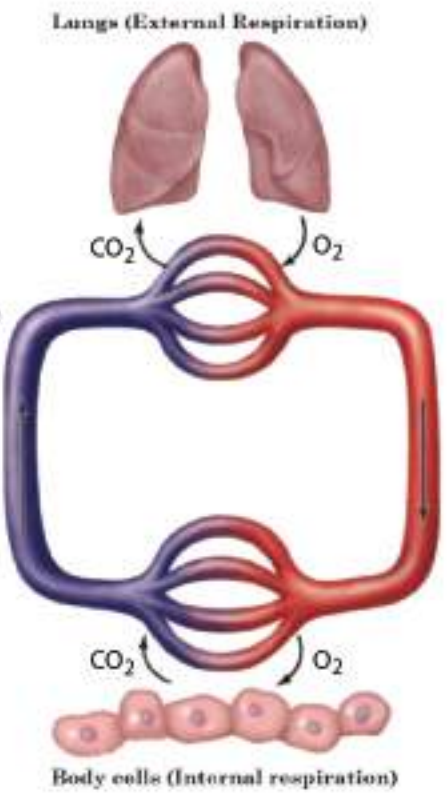


Figure 2.6 Internal and external respiratio

Breathing mechanisms

Respiration is the exchange of gases between an organism and its environment (taking in oxygen and releasing CO_2).

There are different organs used as respiratory organs by different orgnisms, including body surfaces, gills, trachea and lungs.

Trachea are system of pipes. Branches of these pipes penetrate all tissues to facilitate the diffusion of gases into all regions of the body. Mollusks, echinoderms, crustaceans, fish and amphibians respire with gills. The most important feature of gills is that they absorb oxygen dissolved in water. Adult amphibians, reptiles, birds and mammals respire through lungs.

Respiration in Invertebrates

1. Cutaneous Respiration

Unicellular orgaisms provide gas exchange by simple diffusion through cell membrane. Invertebrates use different methods to provide gas exchange their wide body surface provides enough area to take enough oxygen. This method seen in hydra and planaria. These animals provide gas exchange by diffusion through their wide body surface and body extensions. (figure 2.6)

More developed organisms like earthworm provide gas exchange by their body surface and oxygen transported to the body cells by circulatory system.

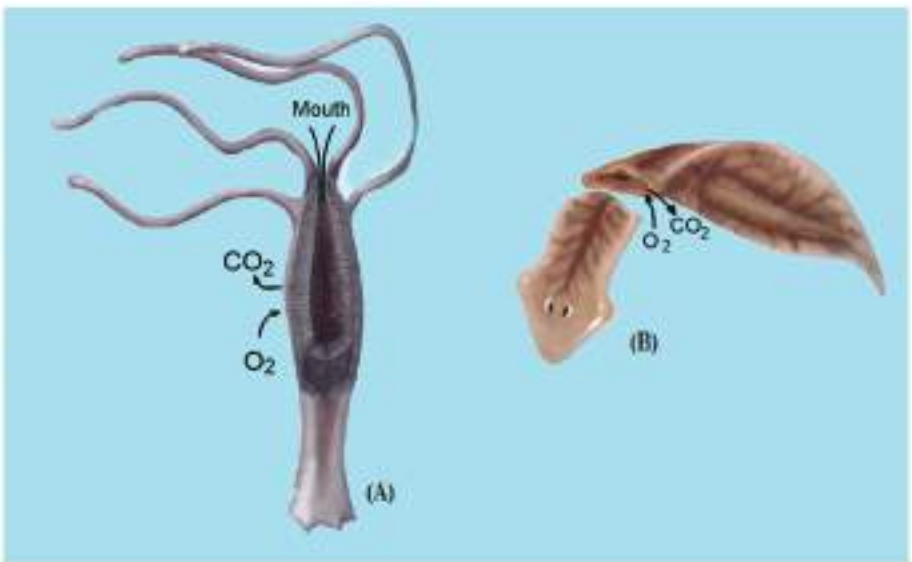


Figure 2.7 Gas exchange through body surface.

(A) Hydra; all body cells are closed to source of oxygen.

(B) Planaria; Most of body cells are closed to the source of oxygen by help of wide body surface.

2. Gill respiration

Gills are respiratory organs of aquatic organisms. They formed from projections of epithelium and are closely associated with circulatory system. Starfish and sea worms have gill respiration.

3. Tracheal Respiration

This kind of respiration seen in terrestrial arthropods like centipeds, insects with exoskeleton like spider. It branches penetrate all tissues to facilitate the diffusion of gases into all regions of the body. Each trachea open into the exterior of body by a series of spiracle, one pair in each body segment.

In tracheal system, gas exchange occurs at the tracheoles by simple diffusion. Oxygen is transmitted from spiracle to trachea then through the tracheoles and finally into tissues. Carbondioxide follows the same pathway in opposite direction.

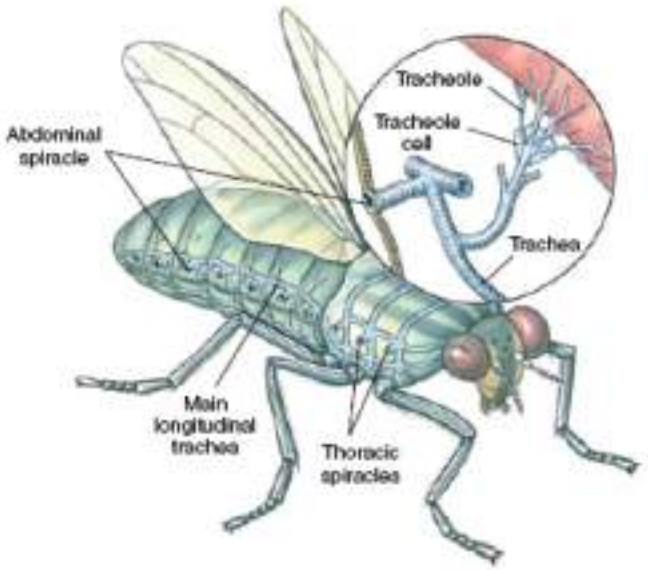


Figure 2.8 Tracheal respiratory system in insect

Do you know?

A kind of frog called Rana has 20 cm^2 area for each cm^3 of air but human body has 300 cm^2 area for each cm^3 of air.

Respiration in Vertebrates

1. Cutaneous Respiration

Some kinds of vertebrates like amphibia and some fishes use their skin for gas exchange. For example eel provids 60 % of gas exchange by its skin which is rich in blood capillaries. Cutaneous respiration has a big role for amphibia during hibernation.

Thikness of skin, being rich in blood vessels and presence of mucous glands are advantages for cutaneous respiration in amphibia. Some kinds of salamender cutaneous respiration is unique method to provide gas exchange because they don't have gills or lungs.

Salamender is an example for cutaneous respiration

2. Gill respiration

A gill is a respiratory organ found in many aquatic organisms like amphibia and fishes that extracts dissolved oxygen from water and excretes carbon dioxide. The gills are composed of comb-like filaments, the gill lamellae, which help increase their surface area for oxygen exchange.

When a fish breathes, it draws in a mouthful of water at regular intervals. Then it draws the sides of its throat together, forcing the water through the gill openings, so it passes over the gills to the outside. (figure 2.9)

Gills in a Tuna fish

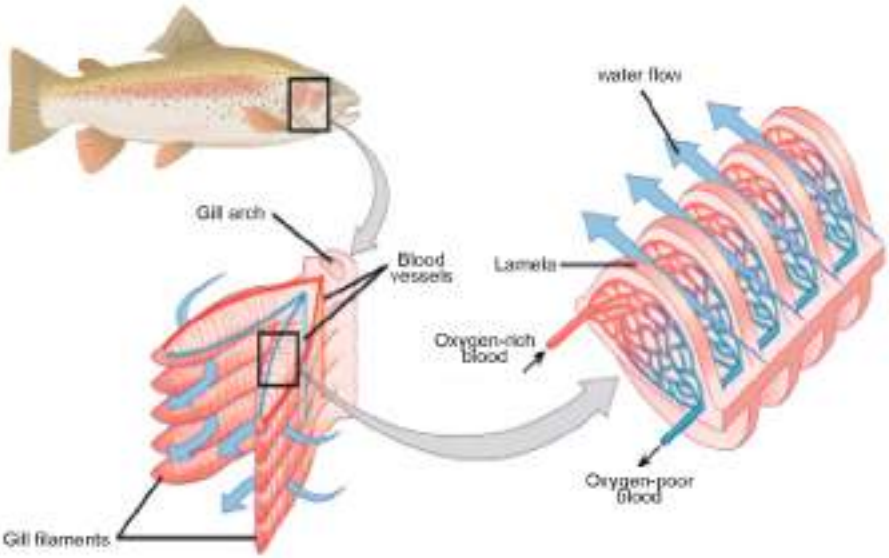
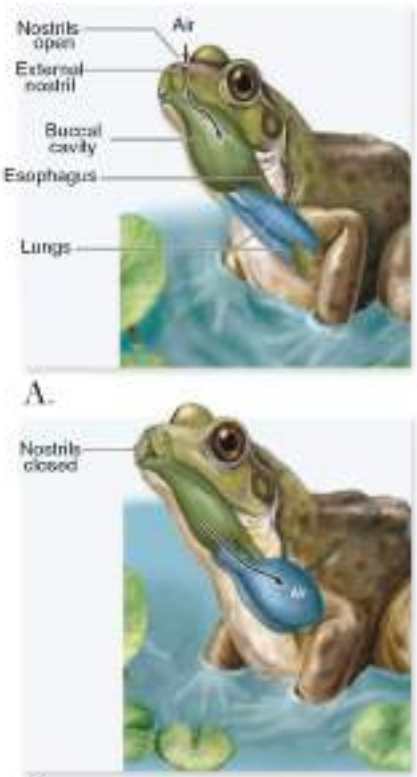


Figure 2.9 As water flows over the gills, oxygen is transferred to blood via the veins.

3. Pulmonary Respiration

1. Respiration in amphibian

The lungs of amphibia similar to the small sacs as there are no fold on their surface. Since the lungs are unfolded, no alveoli are present. In contrast to other vertebrates, the lungs attached directly to the pharynx and there is no trachea.



Inhalation(b) and exhalation(a)

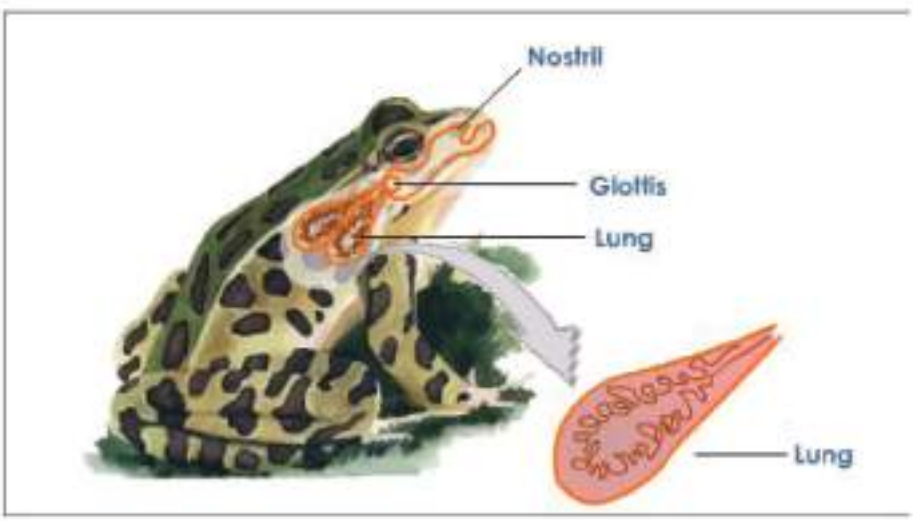


Figure 2.10 Respiratory system in amphibia.

2. Respiration in reptiles

All reptiles breathe using lungs. In reptiles, the wall of each lung is folded to form a wider surface area for gas exchange than in amphibia. Snakes differ from other vertebrates of their class since they have only a single lung. The second lung dissappeared during **metamorphosis**.
Their single lung resembles a long sac which functions as an air tank when the snake swallows its victim.

3. Respiration in birds

The structure of respiratory system in bird is more sophisticated since it includes air capillaries surrounded by network of blood capillaries.

Additionaly there are five air sacs attached to the lung. These sacs cause much of the body cavity to be filled with air. They penetrate into the bones and connective tissue under the skin, an inspact that is closely related to the flying ability of birds. Trachea divided into two bronchi then brochi divided into branchioles which are connected to the bones via air capillaries and air sacs.

Air enters the respiratory system through the nostrils and flows into the lungs and then to the air sacs. Air sacs increase the oxygen storage capacity of birds. The oxygen taken by the lungs passes to the blood and is carried to the body cells.

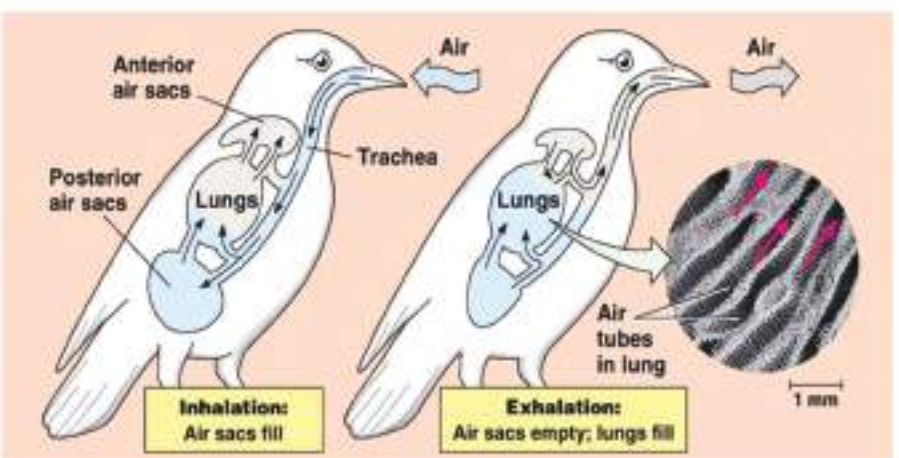


Figure 2.11 Respiratory system in birds

Do you know?

Smoking shortens lives. Many people could have lived 10, 20 or even 30 more years if they had not smoked. Among 1000 young people who smoke, about 6 will be killed on the roads, but about 250 will be killed before their time by tobacco.

Women who smoke when they are pregnant run a greater risk of miscarriage, and of their baby being born premature or underweight.

Respiratory System in Human

Respiratory system in human consist of following structures:

A. Two outer nostrils.

B. Nasal cavity that covered by mucosal membrane and contain many glands that secrete mucous.

C. Two inner nostrils that open to the pharynx.

D. Pharynx is a common passage way for food and air. It contains a small piece of cartilage called as **epiglottis**. It prevent entering of food into trachea.

E. Larynx contains vocal cords and help to produce sound hence it called as **voice box**.

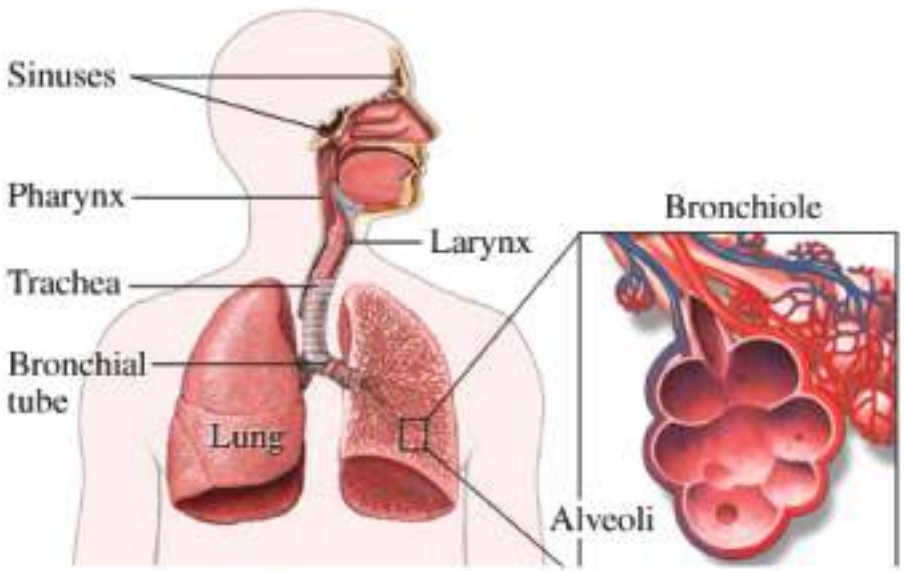


Figure 2.12 Structure of respiratory system

F. Trachea

It is a tube which is located in the chest in front of the esophagus.The inner surface of the trachea is covered by mucous glands and cilia. The mucous glands secrete mucous which moistens the air and the cilia catch and throw out the foreign particles.

Trachea is divided into two branches called as **bronchi**. The main bronchi are divided into smaller branches which are called **bronchioles** and located in the lungs. In the lungs, bronchioles are subdivided into air sacs which consist of small rooms called as **alveoli**. Alveoli have thin walls surrounded by a network of blood capillaries which are branched from pulmonary artery. The exchange of gas between blood and environment occurs through the walls of the alveoli.

In animals and in human, the lungs are located in the thorax, which is separated from the body cavity by a diaphragm.

Lungs are surrounded by a thin, double-layered membrane known as the **pleura**. The space between the pleural membranes covering the lung and the pleural membrane lining the thoracic cavity is called **pleural cavity**. A fluid in the pleural cavity provides lubrication between the lungs and the chest cavity.

Respiration Mechanism

Inhalation, or breathing in, is the intake of air into the lungs. Exhalation, or breathing out, is the expulsion of air from the lungs.

During inhalation, diaphragm contracts and becomes flattened and intercostal muscles found between the ribs contract. So, inner pressure of the lungs decreases and the volume of chest cavity increases. At the end, the air passes through the respiratory organs and enters the lungs.

During exhalation, diaphragm and ribs return to normal position; diaphragm relaxes and intercostal muscles relax. So, inner pressure of the lungs increases and the volume of chest cavity decreases. At the end, the expulsion of air from the lungs to outside happens.

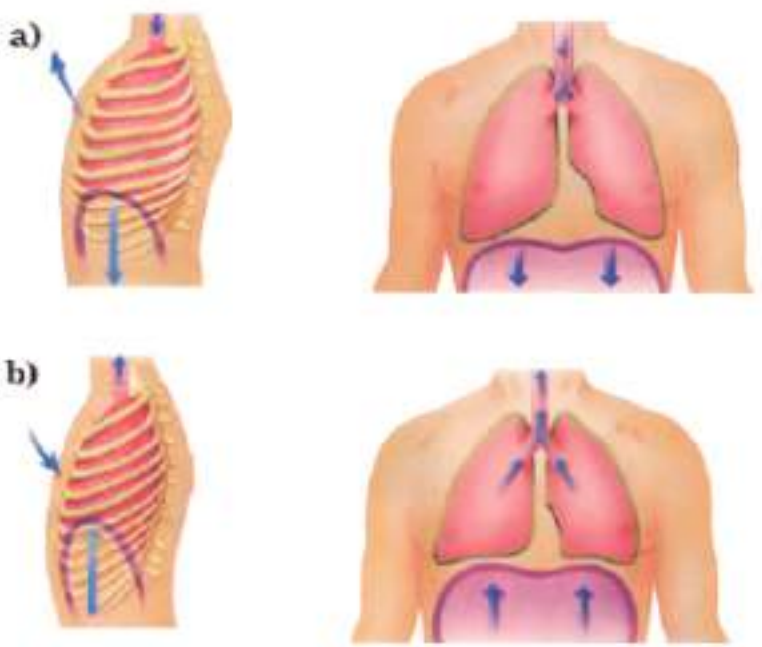


Figure 2.13 Respiratory movements

a. During inhalation, the chest cavity expands, the ribs move upward and outward, and the diaphragm flattens. The pressure in the lungs decreases, and air rushes in.

b. During exhalation, the volume of chest cavity is reduced, the ribs move downward and inward, the diaphragm moves upward. The pressure in the lungs increases and deoxygenated air is expelled.

Add to your knowledge

Hemoglobin is a pigment that consist of 5 % of iron (Fe) and 95 % of colorless protein. It gives red color to the blood and transports O_2 and CO_2.

Oxygen and Carbon Dioxide Transport

The average daily oxygen requirement of a human is approximately 300 liters. This amount may increase 15-20 times depending on physical activity. Carbon dioxide and oxygen are transported by the blood in all animals except insects. The blood of insects is colorless and contains no respiratory pigment, and therefore performs no function in respiration. This explains why the tracheal system in these organisms is involved in gas exchange. One of the unique features of blood is its high oxygen-carrying capacity, which is 6 times greater than that of water.

AMOUNT OF GASES IN INHALED AND EXHALED AIR

	% Oxygen	% Carbon dioxide	% Nitrogen
Inhaled air	21	0,06	79
Exhaled air	15	5,4	79

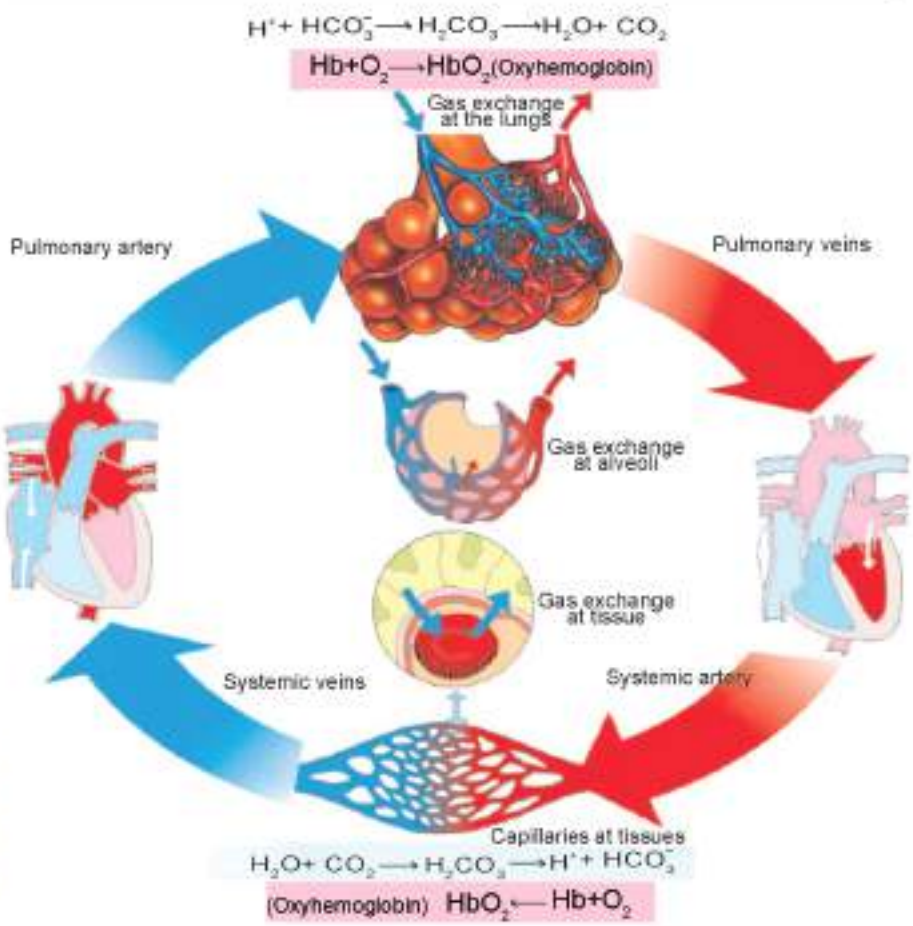


Figure 2.14
Oxygen is taken up by a hemoglobin molecule and then moves through the body using the pathway above. Carbon dioxide is transported back to the lungs to complete the cycle.

Chapter Review

Question 1. Read the sentences carefully and write if it is true or false

1. Only 20 % of stored energy released from glucose in glycolysis.
2. Glucose broken down into water and carbondioxide during respiration reactions.
3. Glycolysis takes place out of cell and engy used in it.
4. 38 molecules of ATP are released from one molecule of glucose.
5. Oxygen and carbondioxide happen by aid of lenticels in leaves and woody stems.
6. In aerobic reactions, oxygen is used and carbondioxide is released.
7. Gills are respiraratory organs for aquatic organisms.
8. Adult amphibia respire by lungs, gills and skin.
9. Alveoli provide gas exchange between blood and body cells.
10. Human body does not capture nitrogen from air.

Question 2. Answer the following questions:

1. Explain the structure of lungs in human.
2. What are the types of respiration for invertebrates?
3. Explain cutaneous respiration for invertebrates.
4. Explain the respiratory structures for plants.
5. Explain the oxygen and carbondioxide excahange in human.
6. Write the parts of respiratory system in human.
7. What are the levels of respiration?
8. What are the importance of air sacs in birds?
9. Draw the main reactions of carbon cycle.
10. Write the phases of cellular respiration.

Question 3. Explain the following scientific facts:

1. More energy is released in aerobic respiration.
2. Larynx is called as voice box.
3. 2 ATP used at the begining of glycolysis.
4. Some organisms can survive without food ingestion for several weeks but can not survive without oxygen for a few minutes.
5. Cutaneous is best respiration method for amphibia.

Question 4. Define the following terms.

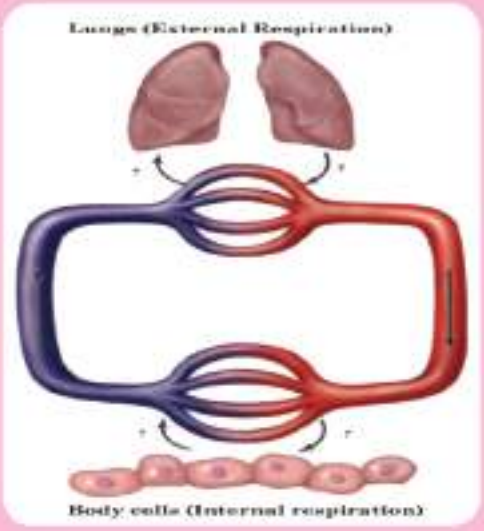
Operculum, Glycolysis, Matrix, Stoma, Alveoli

Question 5. Compare between the followings.

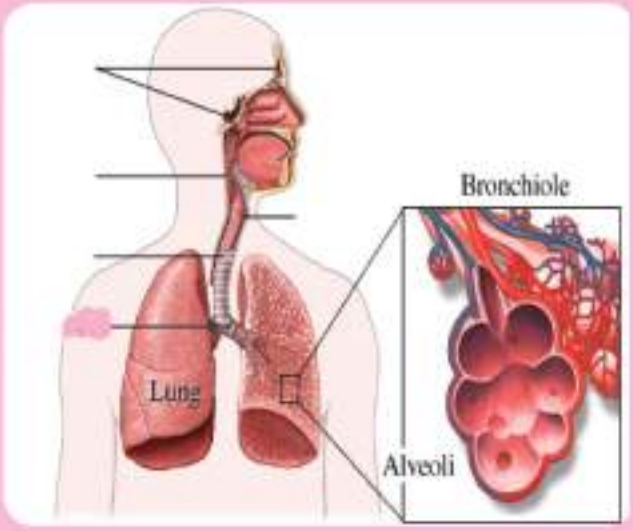
1. Inhalation and exhalation.
2. Aerobic and anaerobic respiration.
3. Gill respiration and tracheal respiration.

Question 6. Label the parts in the figures below.

1.

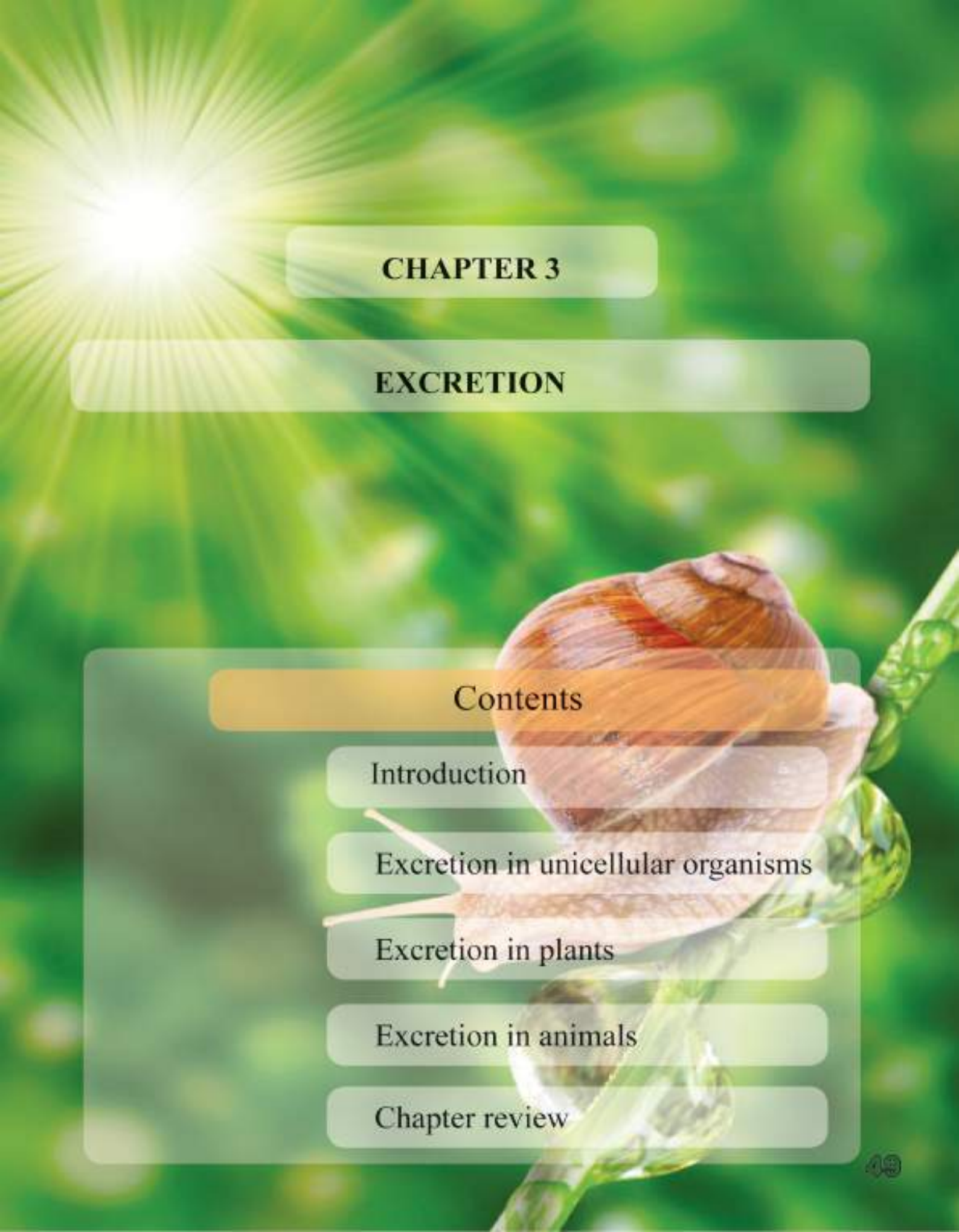


2.



CHAPTER 3

EXCRETION

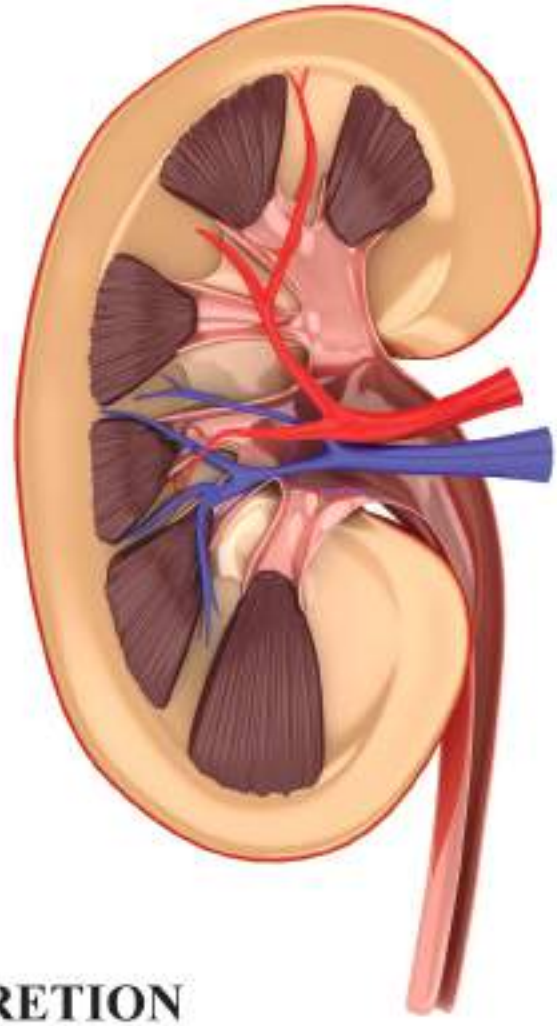


Contents

OBJECTIVES

At the end of the chapter students must be able to;

1. Define the concept of excretion.
2. Explain the excretion in unicellular organisms.
3. Explain the excretion in plants.
4. Define the flame cells.
5. Explain the excretion in earthworm.
6. Explain the excretion in insects.
7. Compare between the excretion systems in vertebrates and invertebrates.
8. Describe the types of kidneys in vertebrates.
9. Describe the parts of kidney in human.
10. Describe the glomerulus in human.
11. Explain the urine formation mechanism.
12. Compare between the excretion in plants and animals.



EXCRETION

Introduction

In the preceeding chapters, the digestion of food and the uptake of oxygen has been illustrated. Digested food and oxygen are transported to the cells by the circulatory system. The cells utilize these molecules in their metabolism.

In this chapter, the method of expulsion of metabolic wastes excreted from the body and the structures involved in these processes will be discussed. Excretion rids the body of metabolic wastes, which come from the breakdown of nutrients.

The functions of the excretory system can be summarized as follows:

1- Filtration and excretion from the blood of toxic wastes produced by the metabolic reactions of cells.
2- the maintenance of homeostasis by the balance of water and the ionic content of the blood and tissue fluid.
3- the mainteinance of the normal functions of cells; and, the regulation of blood content.

In single-celled organisms, waste products are discharged directly through the surface of the cell. Plants produce carbon dioxide and water as respiratory waste products. In green plants, the carbon dioxide released during respiration gets utilized during photosynthesis. Excess water eliminated from plant in form of drops through hydathodes by a process called as **guttation**. Wastes from animals are excreted from different organs of the body.

Excretion in Unicellular Organisms

Unicellular and fresh water organisms like paramecium and amoeba provide excretion by aid of contractile vacuoles. Contractile vacuoles discharge excess amount of water from cytoplasm.

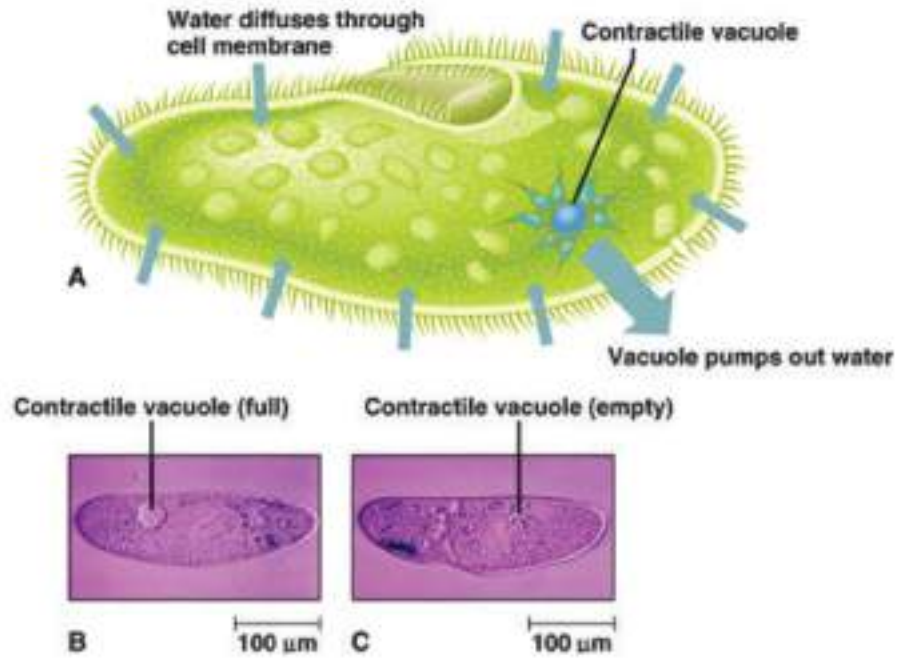


Figure 3.1 Excretion in Paramecium

Figure 3.2 Guttation

Excretion in Plants

There is no specialized system of excretion in plants. However, there are some organs are concerned with excretory processes, they are; stomata, lenticels, hydathodes, vacuoles, and roots.

Carbon dioxide and water are excreted through lenticels and stomata. Water release through these structures is known as **transpiration**.

Water is released from plants living in marshy environments through hydathodes in form of drops is known as **guttation**. Salt also excreted through. this process. In addition some plants excrete organic and inorganic salt into the soil by their roots.

Plants living in calcium rich soils store nitrogenous wastes in their vacuoles in form of calcium oxalate crystals. These crystals are expelled when the leaves are shed. Plants also convert nitrogenous wastes into color pigments in their petal.

Excretion in Animals

Excretion in Invertebrates

1. Excretion in planaria

Waste is excreted by means of protonephridia which consist of tubules and connected flame cells. The cilia of these flame cells is constantly in motion and elongates into tubules. The motion of the cilia resemble flames and for this charactheristic the name of flame cells is given. Wastes and excess water are excreted by means of these ciliary movements and the water balance of the body is regulated by these flame like protonephridia. NH_3 and CO_2 diffuse directly from the body.

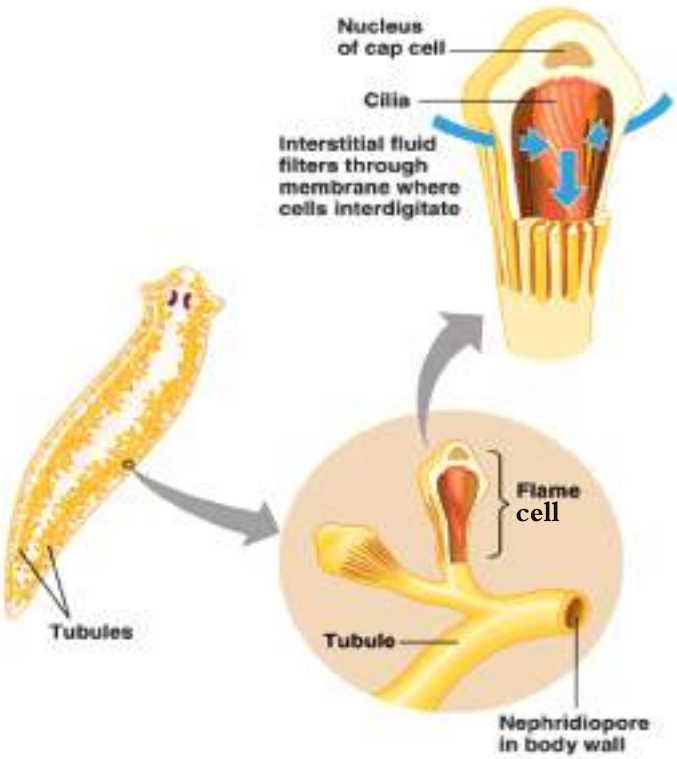


Figure 3.3 Excretory system in planaria

2. Excretion in earthworm

A pair of nephridia which functin as excretory organs are located in each segment of earthworm. A ciliary funnel shaped tip of each nephridium open to each subsequent segment. The canals of each nephridium covered by network of capillaries.

Water, glucose, and minerals are taken up from the body fluid by cilia. Although water and food are reabsorbed from the canals by capillaries, wastes are expelled from the nephridiopore.

Additionally, some cells of the earthworm are **specialized** in watre absorption. A group of these cells is located on the ventral outer surface of the intestines. Waste is absorbed and is transferred to the body wall. These cells involved in waste removal protects the internal organs of earthworms against ultraviolet light.

Do you know?

In addition to breaking down organic materials and adding nutrients to the soil, earthworms also help loosen the soil so air can circulate. This helps plants growth.

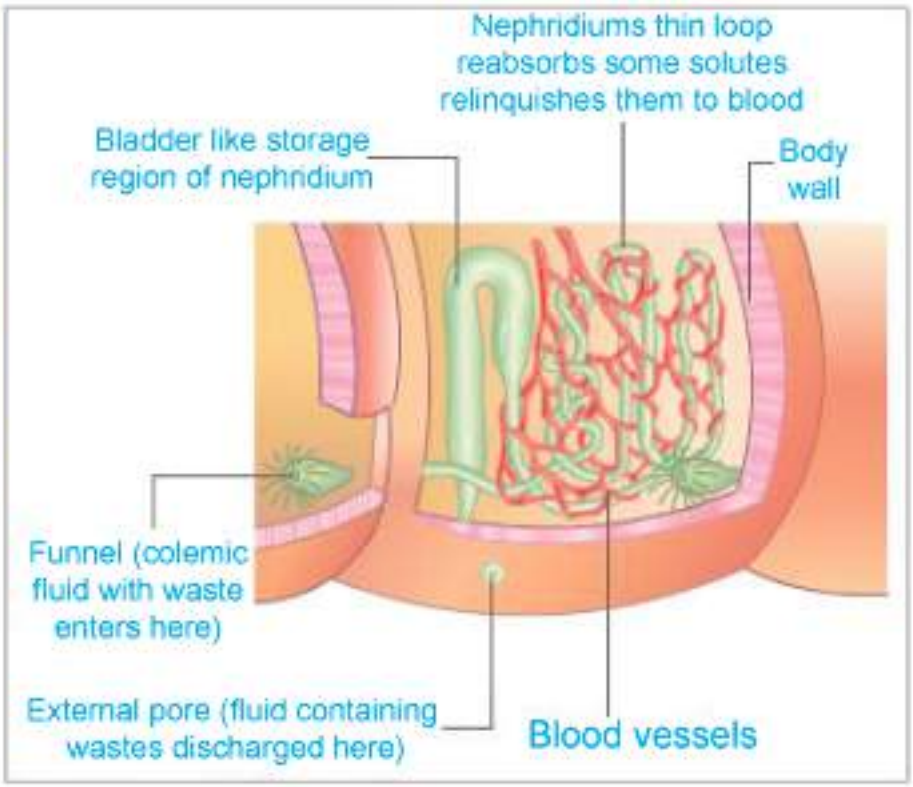


Figure 3.4 Excretory system of earthworm

Do you know?

Arthropods are the largest phylum of the animal kingdom, containing more than one milion species.

3. Excretion in insects

In insects CO_2 is excreted by means of tracheal vessels or **tracheoles**. Malphigian tubules are involved in excretion of nitrgenous wastes. One end of the malphigian tubules is blind and branches into the body cavity whereas the other end opens into last portion of digestive tract.(figure 3.5)

Metabolic wastes are carried from the body cavity to this last portion of the digestive tract by malphigian tubules and ingested water is reabsorbed from the intestine. The nitrogenous wastes of insects is uric acid which is expelled in the feces.

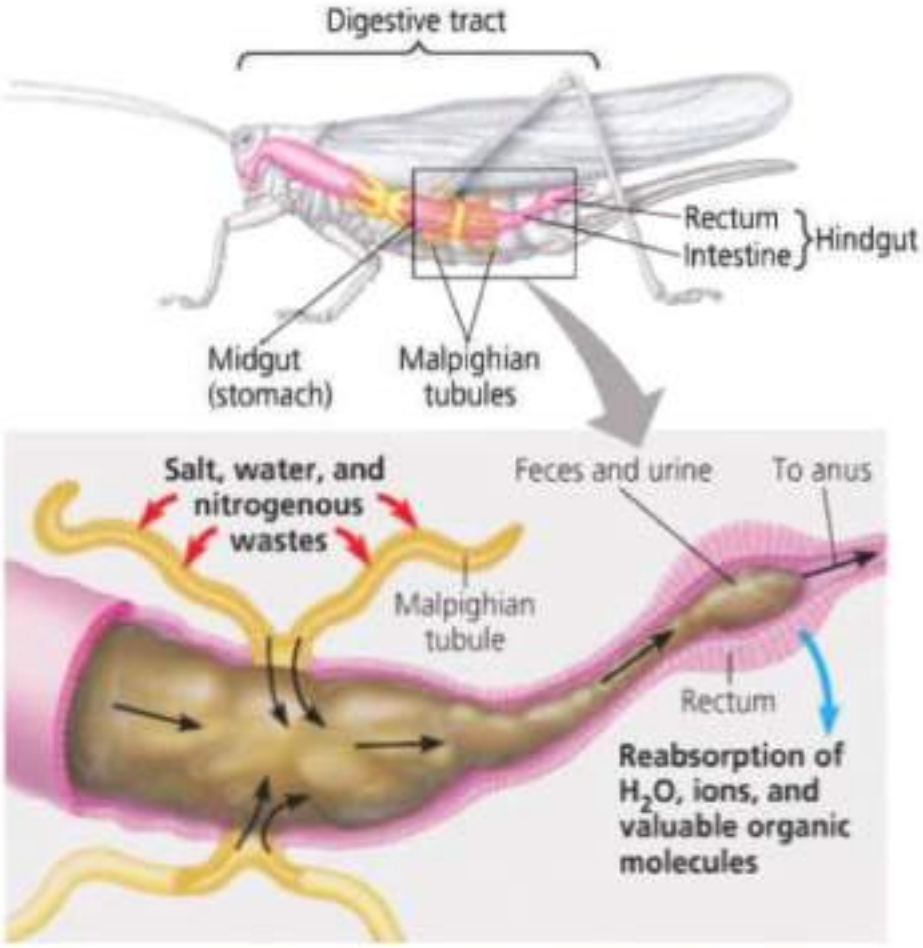


Figure 3.5 The excretory system of insects contains Malphigian tubules

Excretion in Vertebrates

The kidneys are the main excretory organs of vertabrates. There are three types of vertebrate kidneys.

1. Pronephros

It is composed of laterally ordered nephridia. The initial portion of a nephridium resemble a ciliary funnel. The canals generated from the funnels of many nephridia combine with each other to form each canal which opens into the cloaca.

Each ciliary funnel connected directly to a ball of blood capillaries (glomerulus). The wastes filtered from the glomerulus pass through the body cavity and collected by ciliary funnels and are expelled through the cloaca.

This kind of kidney is found in the embryonic stage of all vertebrates and in adult sharks. (figure 3.6)

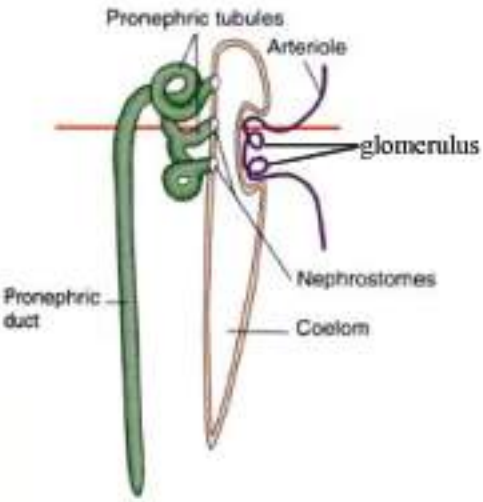


Figure 3.6 Structure of pronephros kidney

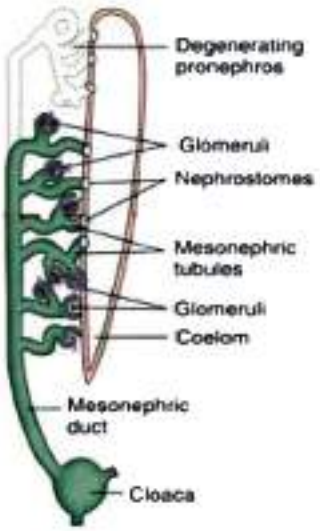


Figure 3.7 Mesonephros kidney

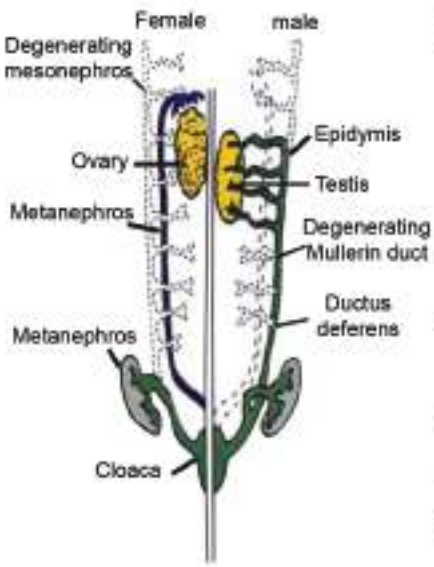


Figure 3.8 Metanephros kidney

2. Mesonephros

This type of kidney differs from a pronephros kidney in that the ciliary funnels replaced with Bowman's capsules. Additionally, a glomerulus located in each Bowman's capsule and waste flows directly into it from each **glomerulus**.Canals drain from each Bowman's capsule and drain into the mesonephric duct. This type of kidney is found in the embryonic stage of reptiles, birds, mammals and in the adult fish and amphibia. (figure 3.7).

3. Metanephros

This type of kidney found in adult reptiles, birds and mammals. Metanehpros kidneys are found in pairs and located at abdomen of the body. Each kidney contains millions of nephrons.

The first excretory canals splits into two and also known as **wolf canal**. In fish and amphibia, its functions as apart of both of excretory and reproductive system.

All vertebrates excluding mammals have a single canal through which all wastes are excreted. The same canals also forms a part of reproductive system. In mammals however, a seperate canals exists for the expulsion of waste and in reproduction.(figure 3.8).

Human Excretory System

The human excretory system is composed of kidneys, a urinary tract or ureter, urinary bladder, and urethra.

A. The Kidney

The kidneys are two bean-shaped organs situated in the lower thoracic region of the back. It is composed of three main parts:

1-Renal Cortex: It is red in color and contains the Malpighian bodies, comprising the Bowmann's capsule and glomerulus, which give it its rough structure.

2-Renal Medulla: It is located directly beneath the cortex. Urinary tracts which drain from the cortex form pyramids in this region. There are approximately (8-10) laterally arranged Malpighian pyramids. The apex of each pyramid is located in the medulla and its base is located in the cortex.

3-Renal Pelvis: It forms the innermost portion of the kidney. Its function is the collection of urine from the Malpighian pyramids, the site of 15-20 orifices opening into the pelvis. The pelvis transmits the accumulated urine to the ureter.

Kidneys are composed of units known as nephrons. In each kidney there are approximately 1200 nephrons. Nephrons filter approximately 180 liters of fluid and form 1.5 liters of urine per day.

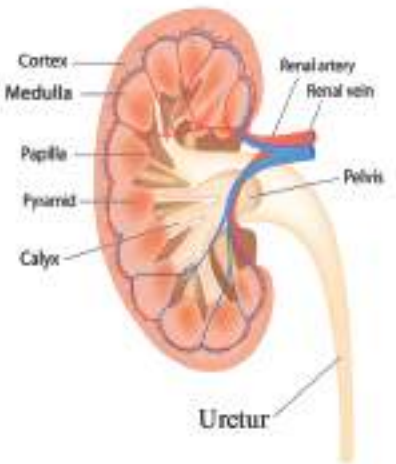


Figure 3.9 Structure of kidney

A nephron consists of:

1-Bowman's Capsule: It is a U-shaped, semi-spherical structure. The inner surface consists of squamous epithelial cells. The Bowman's capsule forms the tip of the nephron.

2-Glomerulus: It is a ball of arterial capillaries located in the Bowman's capsule. Each glomerulus is formed by capillaries from a branch of the afferent renal arteriole.

3-Malpighian body: It comprises a Bowman's capsule and glomerulus. Beneath the Malpighian body is the proximal convoluted tubule. It is formed from cuboidal epithelial cells. The proximal convoluted tubule extends into the loop of Henle and then into the distal convoluted tubule. The total length of these tubules that constitute a nephron in humans is approximately 5 cm.

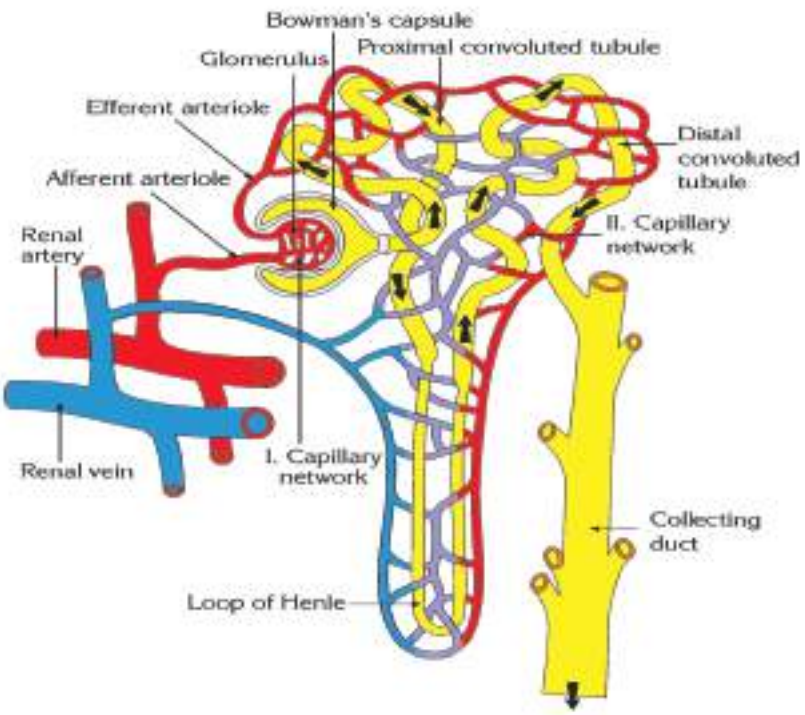


Figure 3.10 -a The structure of a nephron, detailing the path of blood flow and filtered substances.

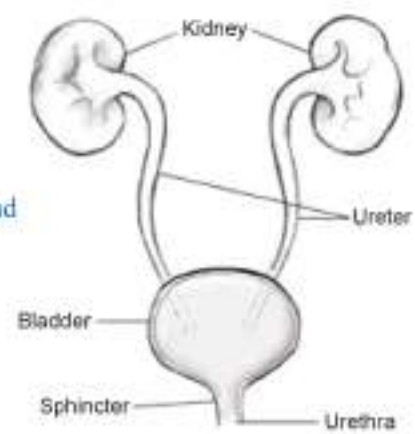


Figure.3.10-b Structure of urinary system

B. Ureters

They are muscular tubes which connect the kidneys and the back wall of the bladder. They transport urine from kidneys to bladder. Each ureter consists of smooth muscles and each one is (22cm) long.

C. Urinary bladder

It is a sac which stores urine and it consists of smooth muscles. In the connection point of the bladder with urethra, there are circular striated muscles. These muscles are voluntary muscles so we can control these muscles or we can control the urination by means of these muscles. When the bladder contracts, the urination happens.

Add to your knowledge

Ammonia is the primary nitrogenous waste product, but it is highly toxic. It is the excretory substance of freshwater organisms. Humans produce urea as an excretory product.

Urine Formation

Urine formation begins with glomerular filtration of water, various ions, amino acids, sugar and the nitrogenous wastes. These substances pass to the Bowmann's capsule from the glomerulus.

It has been proven that all amino acids, glucose and some urine is reabsorbed at the proximal convoluted tubule. Sodium, chloride and bicarbonate ions are reabsorbed and are taken up by cells by active transport. However, 99% of water is reabsorbed passively from different regions of the tubule.

The cells of the distal convoluted tubule excrete molecules such as penicillin, ammonia, hydrogen, potassium, pigments and excess acids. Blood is filtered between glomerulus and Bowmann's capsule. Needed substances are reabsorbed through the tubules of the nephron. At the end, urine is formed and excreted into the urinary bladder via the ureters.

Approximately(1-1. 5)liters of urine are produced per day. Its pH fluctuates between 5 and 7, and it contains the following substances in the following proportions:

3% organic molecules (urine, uric acidand kreatine)
2% mineral salts (sodium, potassium, calcium, chloride and phosphate).
A small amount of leucocytes and epithelial cells. The remain is water.

Do you know?

If an individual drinks a large quantity of sea water, kidneys can only filter 2% of the salt present. As his blood becomes more concentrated, water flows from the tissues to the blood. The Patient consequently loses 0.5 liters of water for each liter of sea water drunk. The subsequent water loss from the tissues results in death.

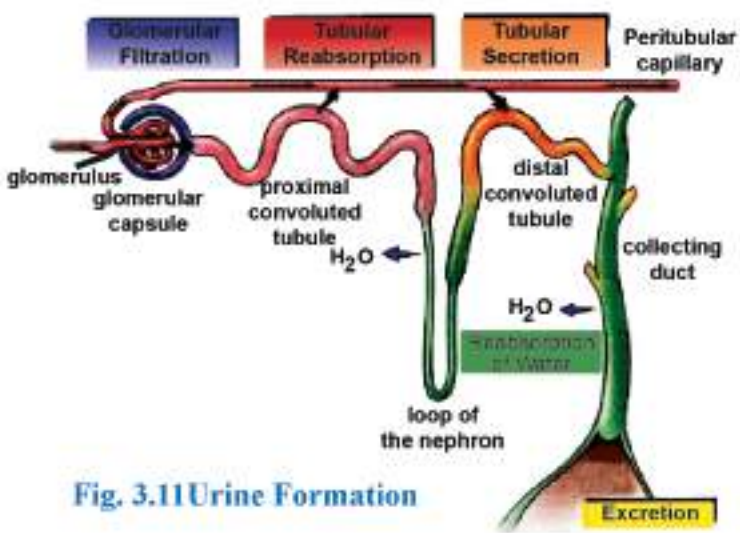


Fig. 3.11 Urine Formation

Chapter Review

Question 1. Read each sentence carefully and write if it is true or false

1. The main function of the kidneys is filtration of metabolic wastes from the blood.
2. The first step in urine formation is filtration of blood.
3. Returning of substances back into the body from the nephron is called reabsorption.
4. Unicellular organisms like Paramecium and Amoeba provide excretion by aid of contractile vacuoles.
5. In single-celled organisms, waste products are discharged by flame cells.
6. Fish has pronephros type of kidney.
7. About 5 liters of urine formed each day.
8. In insects urine is excreted by means of tracheal vessels or tracheoles.
9. There is no specialized system of excretion in plants.
10. Excess water eliminated from plant in form of drops through hydathodes.

Question 2. Answer the following questions

1. What are the main parts of a kidney?
2. Explain the mesonephrons type of kidney.
3. List the components of excretory system in human.
4. Do plants have excretory organs? How can they excrete their wastes?
5. Explain the parts of nephron.
6. Explain the excretion in Planaria.

Question 4. Define the following terms.

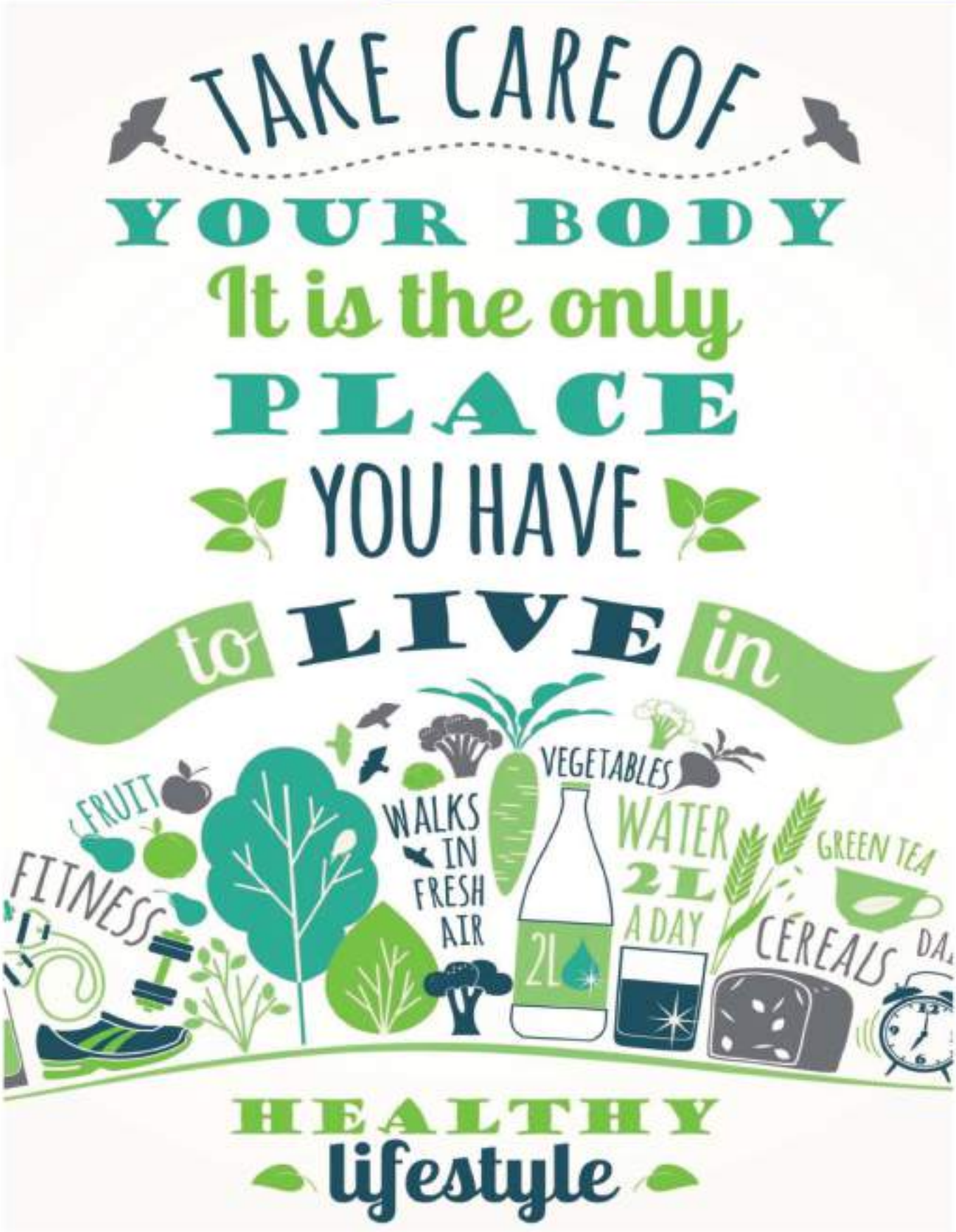
Excretion, Glomerulus, Nephron, Urinary bladder, Urea, Metanephros, Guttation

Question 5. Compare between the followings.

1. Mesonephros and pronephros
2. Excretion in Planaria and earthworm

Question 6. Draw the followings and name the parts of them.

1. Structure of pronephros kidney.
2. Structure of kidney in human.
3. Structure of a nephron.


TAKE CARE OF
YOUR BODY
It is the only
PLACE
YOU HAVE
to LIVE in
FRUIT
FITNESS
WALKS IN FRESH AIR
VEGETABLES
WATER
2L
A DAY
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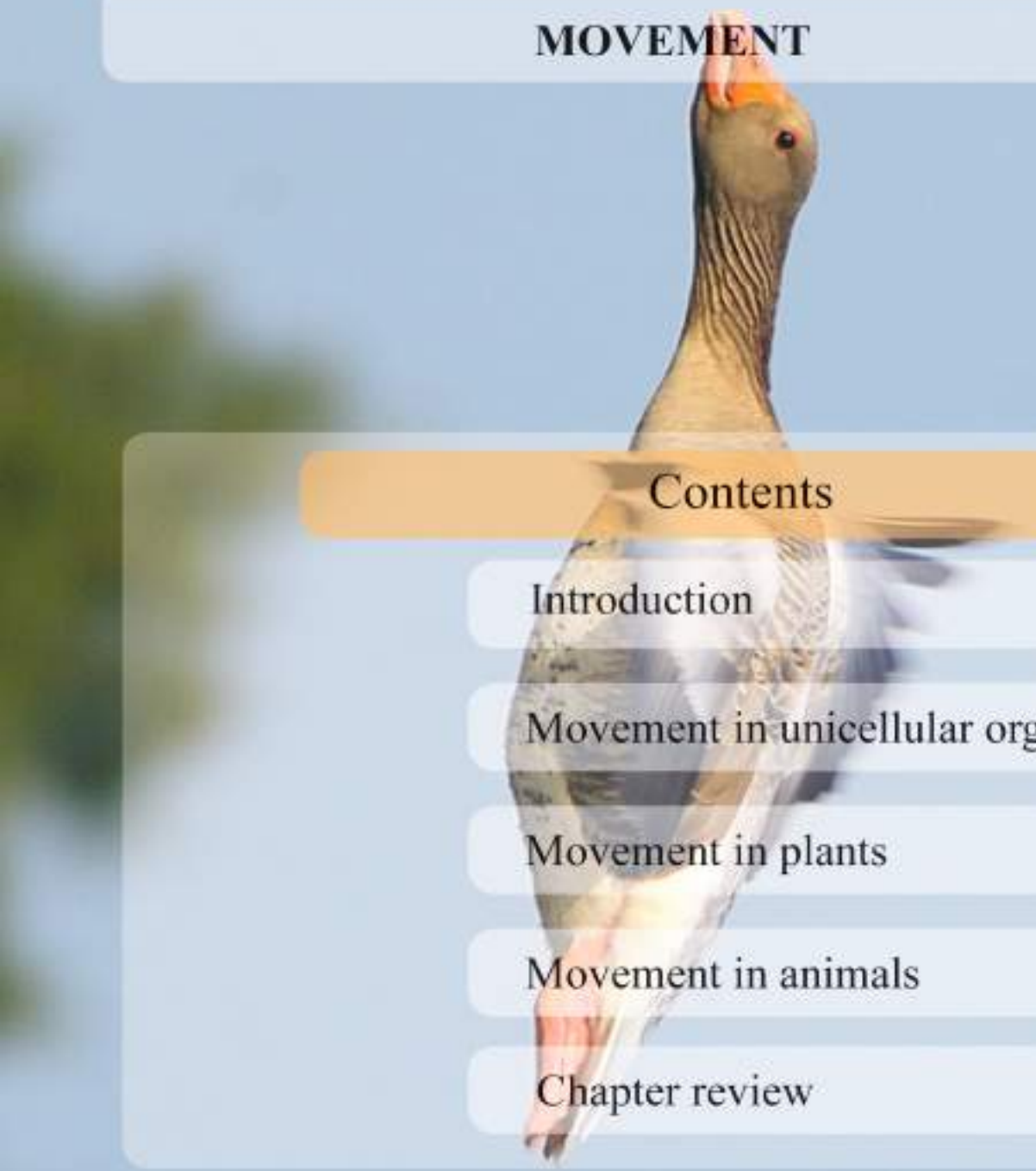
GREEN TEA
CEREALS
HEALTHY
lifestyle

CHAPTER 4

MOVEMENT



Contents

OBJECTIVES

At the end of the chapter students must be able to;

1. Define the locomotion.
2. Explain the movement mechanism in unicellular organisms.
3. Compare between the ciliary movement and movement by flagella.
4. Define the tropism and numerate the types of it.
5. Define the types of muscles in animals.
6. Explain the movement in earthworm.
7. Explain the nasty movement by an example.
8. Numerate the types of movement in arthropods and give an example for each.
9. Numerate the types of movement in vertebrates and give an example for each.

MOVEMENT

Introduction

Movement of the body is a remarkable activity to keep organisms in homeostasis. Organisms provide this important ability by means of locomotion systems. Movement is a distinguished characteristic of animals. Plants move also but not by contraction or relaxation of muscles as performed by animals.

Animal provide total or partial body movements by means of muscle fibers. And this movement depend on energy which is obtained from Adenosine tri phosphate (ATP) molecules.

Plants move their bodies parts only (partial movement). These movements are provided by increasing and decreasing in size of cell depend on water concentration in cytoplasm of cell.

Unicellular organisms provide movement in different methods like using cilia, pseudopodia, cytoplasmic movement or flagella.

Movement in Unicellular Organisms

Primitive organisms (monera and protista) have movement mechanisms according to their size and habitat.

Figure 4.1
Movement in bacteria

Ameboid Movement

It is distinctive feature of amoeba and some kinds of cells in multicellular organisms.

Example:

a. White blood cells
b. Embryonic mesenchymal cells

Amoeba moves by forming **pseudopodia**. Pseudopodia are projections that extended from any part of body in Amoeba.

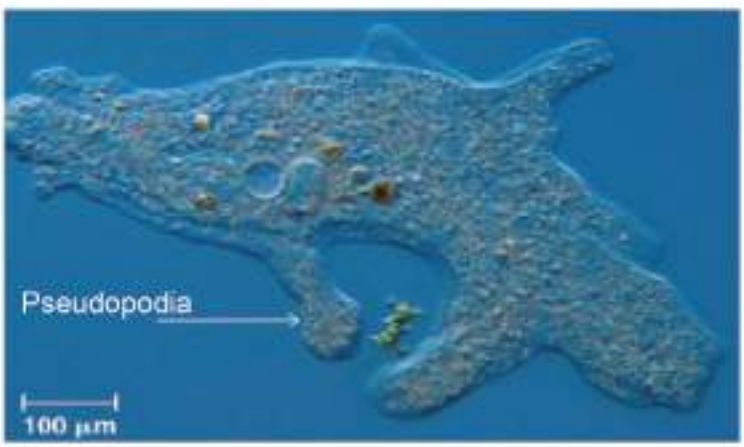


Figure 4.2 Pseudopodia in Amoeba

Amoeba is an unicellular organism which covered by thin plasma membrane. There is a jelly like layer under the plasma membrane called as **ectoplasm**. And there is a fluid layer under the ectoplasm which called as **endoplasm**.

The cytoplasmic movement in Amoeba takes place as follows:

1. Pseudopodia extend the outward.
2. Endoplasm moves to the pseudopodia region and replace with ectoplasm.
3. Ectoplasm moves inward and converted to endoplasm.
4. Endoplasm starts to form a new pseudopodia in a different direction.
5. Amoeba move regularly in environment by repetition of these movements.

Ciliary Movement

Unicellular and ciliated organisms like Paramecium move by cilia. **Cilia** are thin and movable projection extend from cell membrane.

Paramecium moves by coordinated movement of cilia. There are basal bodies located beneath the cilia and provide its movement.

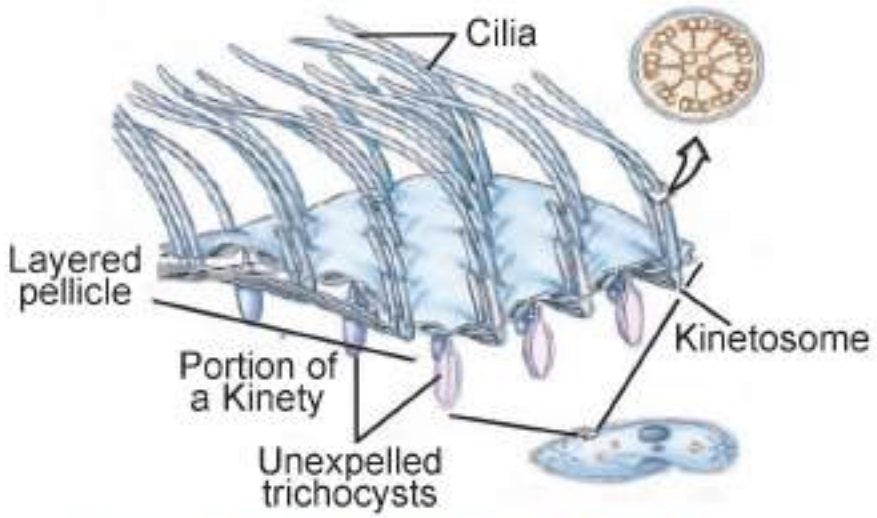


Figure 4.3 Cilia that provide movement of Paramecium

Movement by Flagella

A **flagellum** is a single lash-like appendage that produced from the cell body of certain prokaryotic and eukaryotic cells. Unicellular organisms like Euglena and human sperm cells have flagella. Although flagellum structure similar to structure of cilia (both of them consist of microtubules) but their movement mechanism is different. Flagella perform a wave like movement whereas cilia perform a strong and fast movement all in same direction.

Add to your information :
Cilia perform a rotational, like a motor, very fast movement.

Flagella perform a wave-like, undulating, sinusoidal, slow movement compared to cilia

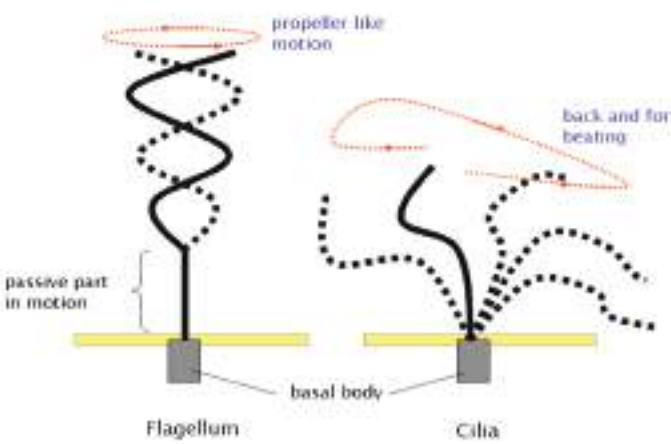
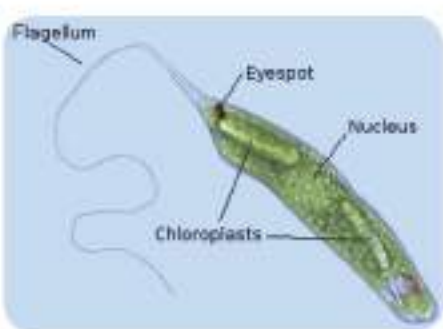


Figure 4.4 Movement mechanism in cilia and flagellum



Movement in Plants

The most important characteristic of a living organisms is adaptation to the environment and its response to it. In response to an environmental stimulus, the whole body of a lower plant, such as a unicellular algae responds. In higher plants however, distinct regions such as roots or stems respond to a stimulus.

Plant movement can be categorized into two groups where:

- Movement in response to the stimulus is dependent on direction is callled as **tropism.**

- Movement in response to the stimulus is independent on direction, also known as **nasty.**

a. Tropism

This movement is seen in higher plants and is categorized as positive tropism and negative tropism. Movement occurs due to unequal distribution of growth hormone.

Type of Stimulus	Tropism		Affected Organs
1. Light	Phototropism	Roots (–),	Stem (+)
2. Gravity	Geotropism	Roots (+),	Stem (–)
3. Water	Hydrotropism	Roots (+),	Stem (–)

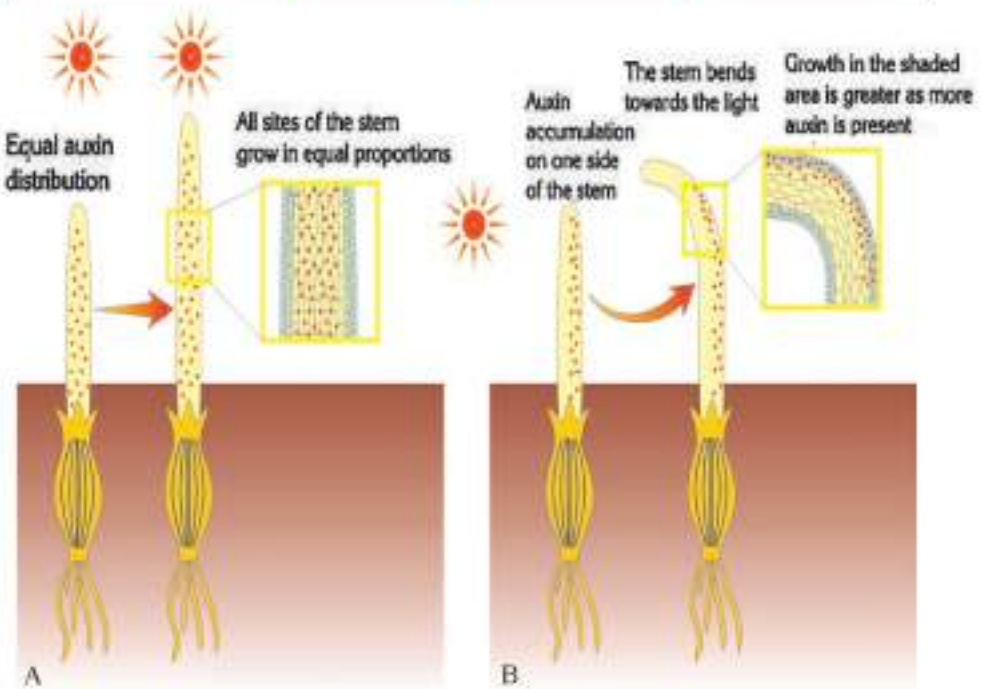


Figure 4.5

a. Positive geotropic response is seen in the growing root tip due to the secretion of auxin and calcium ions.

b. The amyloplasts of the root secrete calcium which collects on the downward side of the root, inhibiting the action of auxin. As a result the upward side of the root grows more and the tip bends in the direction of gravity.

b. Nasty

Movement of a flat plant part, oriented relative to the plant body and produced by a variety of stimuli that cause disproportioinate growth or increased turgor pressure in the tissues of one surface.

The opening and closing movements of many flowers and the responses of leaves to changes of temperature and light, are externally directed nastic movements. Specialized plants, such as the insectivorous sundew, move in response to the touch and chemical stimuli of captured insects.

Figure 4-6 Thigmonasty in insecticorus plants

Figure 4.7 Thigmonasty in Mimosa plant

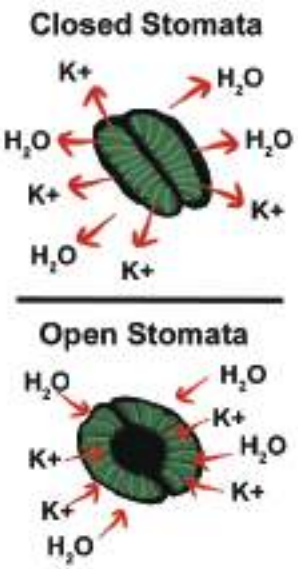


Figure 4-8
Opening and closing of stomata is a kind of nastic movement

Movement in Animals

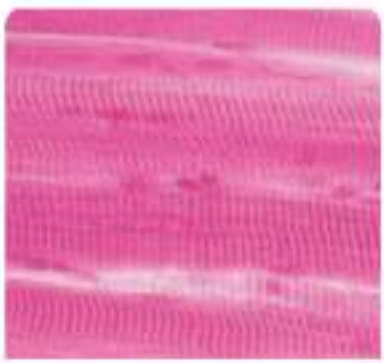
Generally movement in animals is provided by contraction and relaxation of muscle fibers which are specifically organized to perform their function. There are three different kinds of muscles which perform these movements;

- Smooth muscles
- Skeletal muscles
- Cardiac or Heart muscles

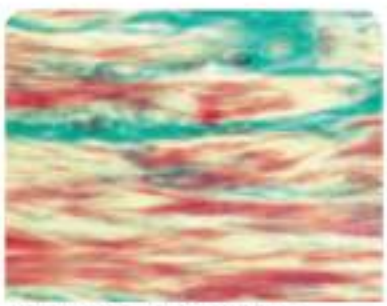
Skeletal muscle is responsible for moving parts of the body, such as the limbs, trunk, and face. Skeletal muscle tissue is made up of elongated cells called **muscle fibers**. Each muscle fiber contains many nuclei and is crossed by light and dark stripes, called **striations**. Skeletal muscle fibers are grouped into dense bundles. These bundles are bound together by connective tissue to form a muscle. Because their contractions can usually be consciously controlled, skeletal muscles are described as **voluntary muscles.**

Smooth muscle forms the walls of the stomach, intestines, blood vessels, and other internal organs. Individual smooth muscle cells are spindle-shaped, have a single nucleus, and interlace to form sheets, as shown in figure. Notice that smooth muscle lacks the striations found in skeletal muscle tissue. Smooth muscle fibers are surrounded by connective tissue, but the connective tissue does not unite to form tendons as it does in skeletal muscles. Because most of its movements cannot be consciously controlled, smooth muscle is referred to as **involuntary muscle.**

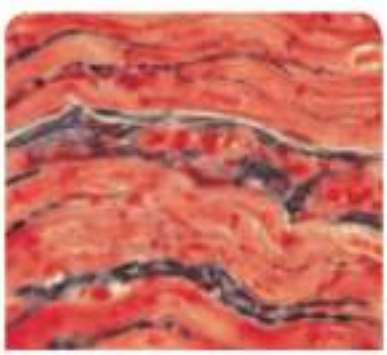
Cardiac muscle makes up the walls of the heart. Cardiac muscle shares some characteristics with both skeletal muscle and smooth muscle. As with skeletal muscle, cardiac muscle tissue is striated; as with smooth muscle, it is involuntary and each cell has one nucleus.



(a) SKELETAL MUSCLE TISSUE



(b) SMOOTH MUSCLE TISSUE



(c) CARDIAC MUSCLE TISSUE

Figure 4.9
These light micrographs show the three types of muscle tissue. Skeletal muscle tissue (a) has a striped appearance when viewed under a microscope. Smooth muscle tissue (b) is found in the digestive tract, the uterus, the bladder, and the blood vessels. Cardiac muscle tissue (c) is found only in the heart.

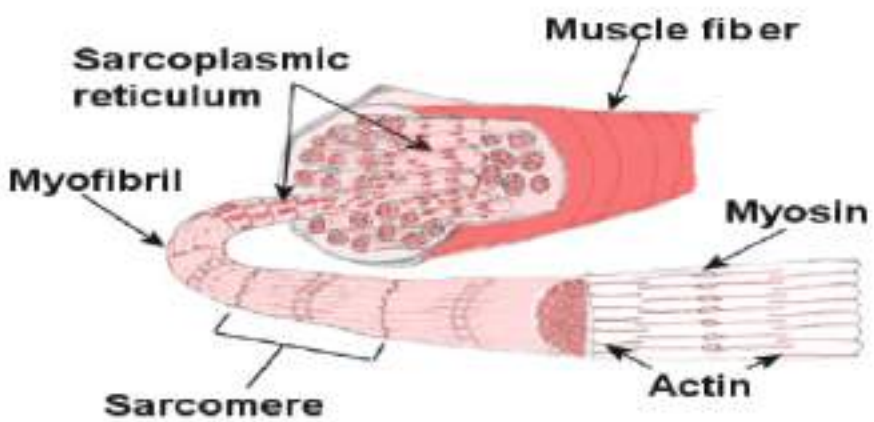


Figure 4.10 Skeletal muscles consist of densely packed groups of elongated cells, called fascicles, that are held together by connective tissue. Muscle fibers consist of protein filaments called myofibrils.Two types of filaments are found in muscle fibers : actin and myosin.

Muscle Structure

A skeletal muscle fiber is a single, multinucleated muscle cell. A skeletal muscle may be made up of hundreds or even thousands of muscle fibers, depending on the muscle's size.

Connective tissue covers and supports each muscle fiber and reinforces the muscle as a whole. The health of a muscle depends on a sufficient nerve and blood supply. Each skeletal muscle fiber has a nerve ending that controls its activity. Active muscles use a lot of energy and therefore require a continuous supply of oxygen and nutrients, which are supplied by arteries. A skeletal muscle fiber, such as the one shown in Figure(4.9)contains bundles of threadlike structures called **myofibrils**. Each myofibril is made up of two types of protein filaments—thick ones and thin ones. Thick filaments are made of the protein myosin, and thin filaments are made of the protein actin.

Muscle contraction requires energy, which is supplied by ATP. This energy is used to detach the myosin heads from the actin filaments. Because myosin heads must attach and detach a number of times during a single muscle contraction, muscle cells must have a continuous supply of ATP.

Movement in Invertebrates

Invertebrate animals have both smooth and skeletal muscles and these muscles have same functional abilities as in vertebrates. Arthropods have developed skeletal muscles.

There are different kinds of movements in different animals;

a. Movement in Mollusks

Bivalves have two different kinds of muscle fibers. First one is the skeletal muscles which used in closing and opening of their shells. For example mussels can keep their shells closed for many days. The second one is smooth muscles.

b. Movement in Earthworm

Some invertebrates including hydra and earthworm have hydrostatic skeleton. The movement of earthworm that provided by hydrostatic movement is can be summarized as follows:

1. Earthworm body is consist of segments and each of these segments has its own motion units.
2. There are long and circular muscles in body wall of earthworm.
3. Body expand and shrink by activity of circular muscles. And body become longer and shorter by activities of long muscles. By repetition of these movenets earthworm provide its movement.
4. The chitinous stingers help earthworm to attach the ground.

c. Movement in Arthropods

Arthropods do different kinds of movements like; walking, running, jumping, swimming and flying. We will study on insects as examples for movement in arthropods.

1- Walking

Insects have an exoskeleton which made up of chitin. This exoskeleton provide strength against drought, defence against preys and flexibility for movement of legs. This movement provided by actions of flexor and extensor muscles in limbs.

2- Jumping

Some insects use their skeletal muscles to jump from leaves and trees. For example American grasshopper is asymmetrical insect. Extensor muscles contraction extend the back limbs and flexor muscles get limbs closer to body.

3- Flying

Some insects achieve flight through a direct action of a muscle on each wing. One set of flight muscles attaches just inside the base of the wing, and the other set attaches slightly outside the wing base. When the first set of flight muscles contracts, the wing moves upward. The second set of flight muscles produces the downward stroke of the wing.

4- Swimming

A group of aquatic insects swim by aid of their back limbs. These limbs have flat surface to provide forward movent by pushing water.

fig. 4.11 Krill is an aquatic insect that has 3cm length and has an exoskeleton

Movement in Vertebrates

Vertebrates have endoskeleton which provide movement with muscles. Vertebrates have types of movement like, swimming, jumping, walking, running and flying.

1. Swimming

Fish swim by exerting force against the surrounding water. There are exceptions, but this is normally achieved by the fish contracting muscles on either side of its body (which provide movements of fins) in order to generate waves of flexion that travel along the body from nose to tail, generally getting larger as they go along. Most fishes generate thrust using lateral movements of their body and caudal fin. But there are also a huge number of species that move mainly using their median and paired fins.

There are some vertebrates which use their flat limbs to swim in water.

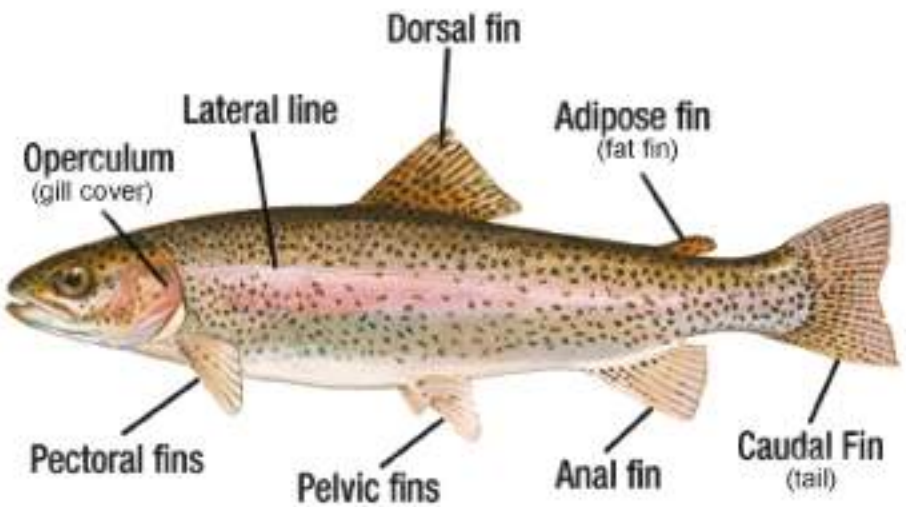


Figure 4.12 External structure of bony fish

Aquatic undulation

A Mojave rattle snake

2. Creeping

Animals which has short limbs that not enable to carry body weight and reptiles without legs like snakes perform this movement. Snake has different types of movements like;

a- Terrestrial lateral undulation is the most common mode of terrestrial locomotion for most snake species. In this mode, the posteriorly moving waves push against contact points in the environment, such as rocks, twigs, irregularities in the soil, etc.

b- Sidewinding is most often employed by snakes when the snake must move in an environment that lacks irregularities to push against, such as a slick mud flat, or a sand dune. In sidewinding all of the body segments oriented in one direction remain in contact with the ground, while the other segments are lifted up, resulting in a peculiar "**rolling**" motion. **Concertina** and **rectilinear** are also some kinds of movement in snakes.

3 - Flying

Humming bird

It is movement of birds which have different methods and body parts for flight. Flying in birds depend on air movements and methods of using their wings. Birds use their front limbs (wings) for flight. Moving their wings from up to downward cause changes in air pressure and these changes help them to move forward.

Some mammalian like bats have ability to fly. There are some types of lizards that have abiliti to fly too.

Flying mammalian; bat

Flying lizard

4- Running

Most of mammalian have body parts specialized for runnuing.Generally animals run for hunt or escape from the hunters. Horses, deers and some predators have long tendons to facilitate the movement. Another factor which enable to run fact is having light limb endings.

Running animals

Chapter Review

Question 1. Read each sentence carefully and write if it is true or false?

1. Animals perform different kinds of movement including cytoplasmic movement and free movement.
2. Animals obtain necessary energy for muscle contraction from ATP molecules.
3. Paramecium move by cytoplasmic extensions called pseudopodia.
4. Cilia and flagella similar in structure but different in working mechanism.
5. Movement in animals is provided by contraction and relaxation of muscle.
6. Skeletal muscle cells are cylindirical shaped, branched and multinucliated cells.
7. Invertebrates have smooth, skeletal and cardiac muscles as in vertebrates.
8. Geotropism is affected by stimulation of light.
9. Movement in response to the stimulus is dependent on direction is callled as tropism.
10. Connective tissue covers and supports each muscle fiber and reinforces the muscle as a whole.

Question 2. Fill in the blanks:

1. Most of mammalian have body parts specialized for .....
2. ..... and ..... are some kinds of movement in snakes.
3. Muscle contraction requires energy, which is supplied by .....
4. Vertebrates have ..... which provide movement with muscles.
5. There are three different types of muscles; ..... , ... and ..... .
6. Movement in response to the stimulus is independent on direction, also known as ..... .
7. A ..... is a single lash-like appendage that produced from the cell.
8. There is a jelly like layer under the plasma membrane called as ectoplasm in ..... .

Question 3. Answer the followings.

1. Explain cytoplasmic movement in Amoeba.
2. Draw the external structure of bony fish.
3. Explain how snakes move on sand.
4. Explain how earthworm move by hydrostatic movement.
5. Numerate the types of movement in invertebrates.

Question 4. Define the following terms.

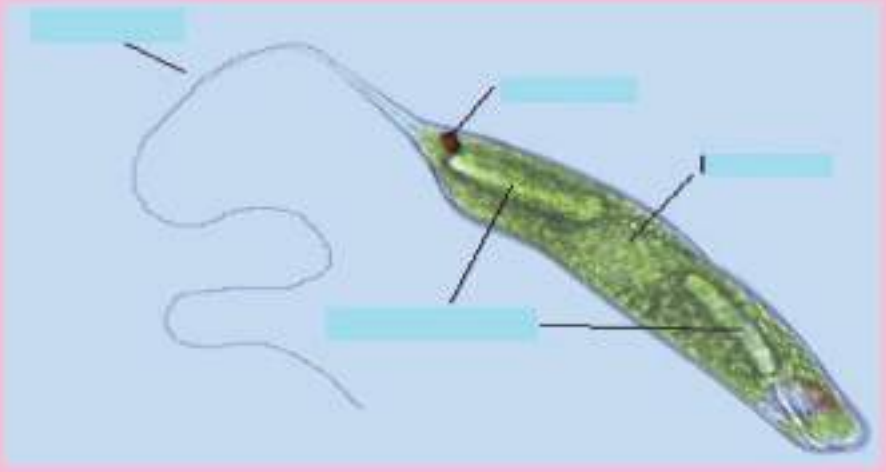
Tropism, Nasty movement, Muscle fiber, Pseudopodia, Cilia, Flagella.

Question 5. Compare between the followings.

1. Cilia and flagella.
2. Undulation and Swindering.
3. Skeletal muscles and Smooth muscles.
4. Types of movements in vertebrates and invertebrates.

Question 6. Label the parts in the Figuers below.

1.



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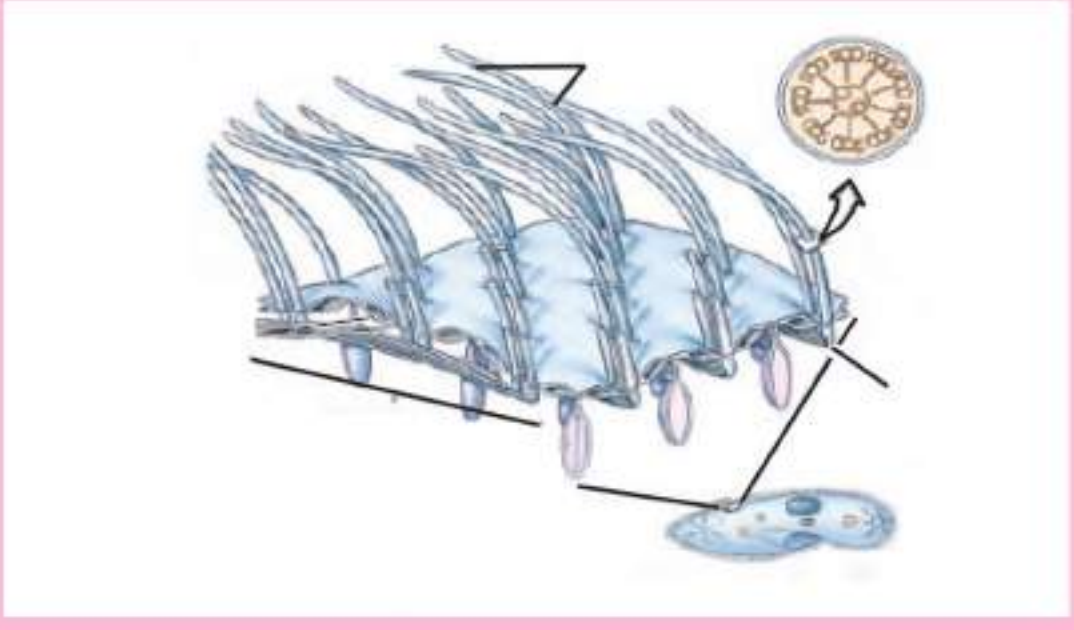
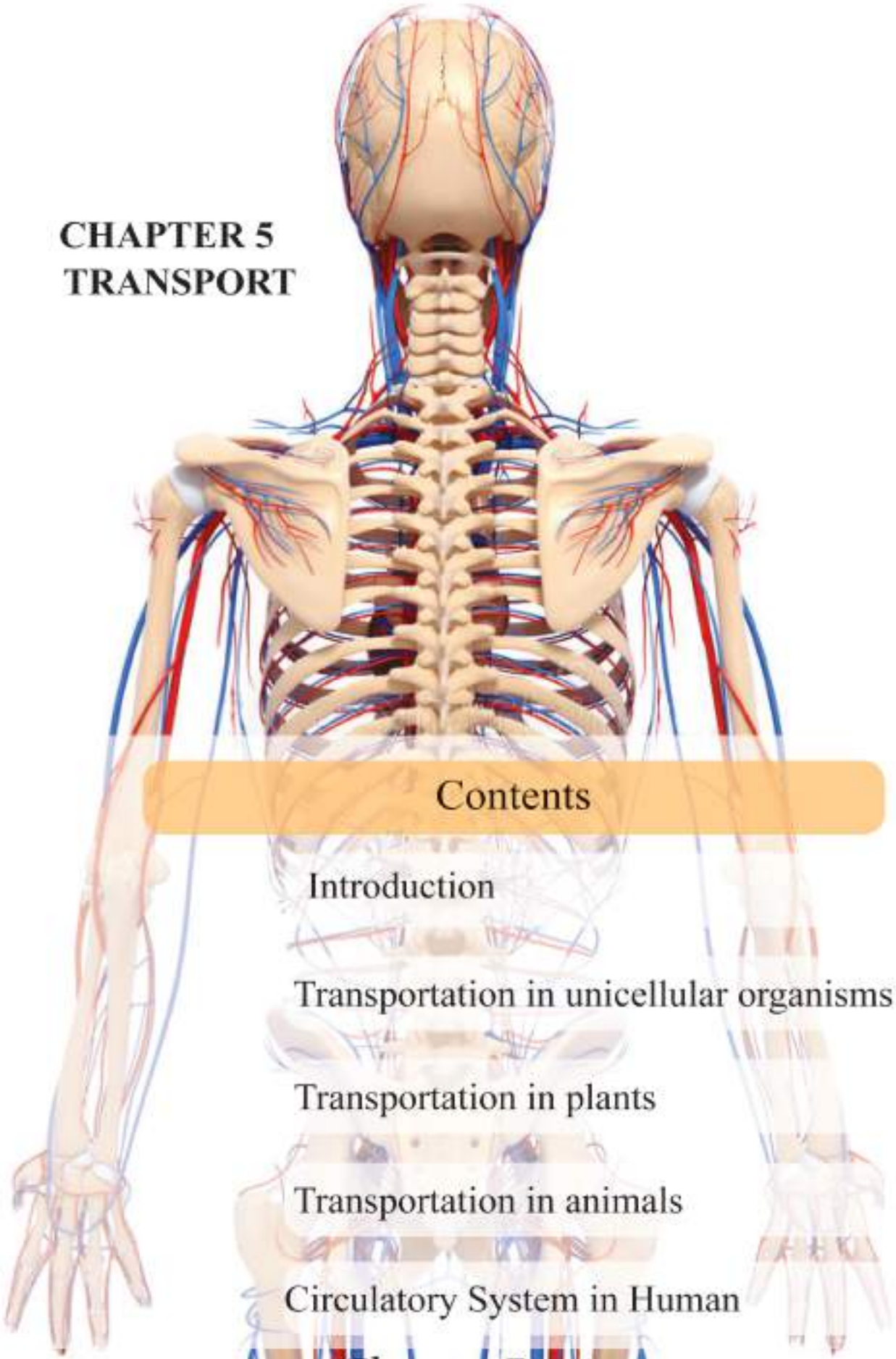


CHAPTER 5
TRANSPORT

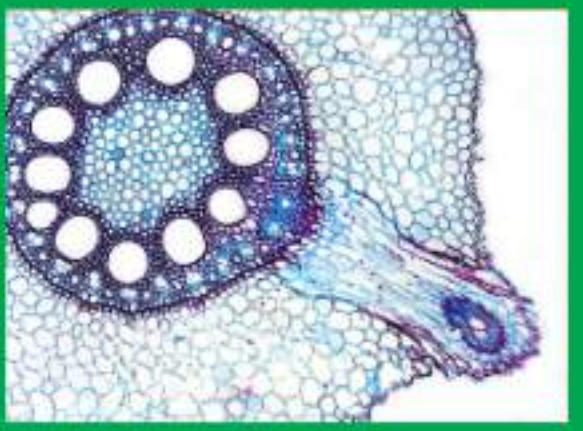


Contents

OBJECTIVES

At the end of the chapter students must be able to;

1. Explain the functions of transport systems in living organisms.
2. Explain the transportation mechanism in unicellular organisms.
3. Explain transportation in plants.
4. Describe the important activities of transportation in plants.
5. Define the transpiration and tell what influences on it.
6. Numerate the factors influence the activities of stomata.
7. Define the factors that influence on water transport in plants.
8. Compare between the adhesion and cohesion.
9. Explain how adhesion and cohesion are important for plants.
10. Give example for plants that have no transport system.
11. Numerate the types of body cavities and give an example for each.
12. Define the open circulatory system.
13. Compare between open and close circulatory systems in invertebrates.
14. Draw the circulatory system in fish.
15. Compare between the circulatory system in fish and amphibian.
16. Compare between the circulatory system in birds and reptiles.
17. Draw and explain the structure of heart in human.
18. Compare between arteries and veins.
19. Explain why blood capillaries are thin walled.
20. Describe the types of circulation in human.
21. Numerate the blood cells and their functions.
22. Numerate the organs of lymph system and their function.



TRANSPORT

Introduction

In complex multicellular organisms, there is a specialized transport system which carries oxygen and nutrients into the cells and removes carbon dioxide and other wastes. A continous supply of food substances and a system of wastes removal is a prequisite for the survival of organism.

Unlike multicellular organisms, unicellular organisms and simple colonies obtain their requirements from their surroundings by diffusion, osmosis and active transport. The uptake of material by simple method is common in algae. It is clear that material transport and waste removal from cells by a simple mechanism is impossible in complex organisms with a far greater number of cells and a surface area-to-volume ratio. They need therefore, a special system in order to transport material.

For example the transport system of trees are 100 meters tall. The movement of molecules from roots to leaves is extremely difficult due to the gravity. Great pressure would be required to pump the material to the body parts. These problems are common in multicellular organisms but transport system overcomes all the difficulties.

Transport in Unicellular organisms

Transportation in paramecium is provided through plasma membrane by two methods; **diffusion** and **osmosis**.

Plasma membrane in paramecium provides enoough surface area to remove wastes. Accumulation these metabolic wastes influences the cell metabolism and material transport.

Necessary materials is taken through plasma membrane by diffusion. Diffusion is the movement of materials from high concentrated medium to low concentrated medium without using energy. Active transport isopposite of diffusion.

Contractile vacuole and food vacuole play a role in maintaining material concentration.

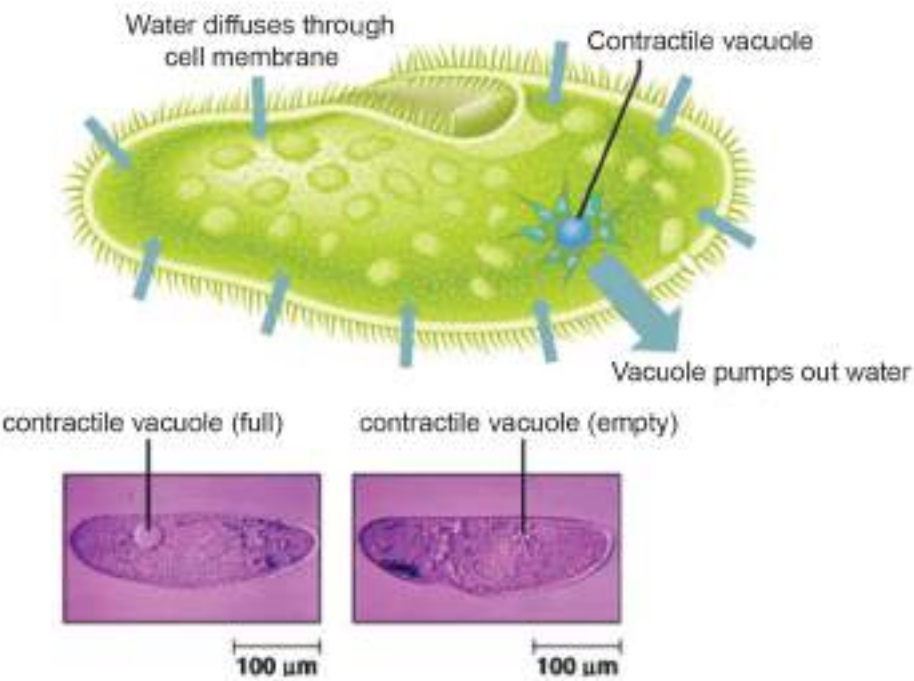


Figure 5.1 Material transport in paramecium is provided by plasma membrane. It has no special system for material transport

Paramecium live in fresh water environment and are **hypertonic** to their aquatic surroundings. As a result, water tends to move into the body . In order to deal with this water influx, Paramecia must contain a specialized organelle, a **contractile vacuole**, that is responsible for collecting this influx of water. Once the contractile vacuole fills with water, it contracts and squeezes the water out of the animal back into the external environment.

Transportation in Plants

The plant transport system consist of xylem and phloem vessels extending from roots to the leaves. The xylem absorbs water and minerals from the soil through the roots and conducts them to the leaves to be used in photosynthesis and other activities.

Carbondioxide diffuse into the leaves via the stoma and reacts with water, yielding organic molecules and oxygen.This oxygen is one of the products of photosynthesis, may be either consumed in cellular respiration or may be diffused out of leaves. The organic compounds however, are distributed to different locations within the phloem vessels.

Aquatic plants differ from the terrestrial plants because their environment is always moist and obviously, their habitat is different. Water is the medium in which aquatic plants live and obtain their nutrients and used to support the body of the plant. In terrestrial plants these functions are provided by the root, stem and leaves.

Transportation in plants provided by three important activities.

- Transpiration
- Replacement of lost water
- Absorption of water by roots

Transpiration

During the transpiration, excess water is excreted from the stomata as vapour. The transpiration rate is influenced by **wind, humidity** and **temperature**. Humidity and temperature are inversely proportional. If the humidity is low, the temperature is high and high water loss results. Conversely, high relative humidity decreases transpiration since the air is already saturated with water vapour.

The wind is a factor that most affects the transpiration. There is a constant dome of water vapour surrounding each stoma. These water vapour domes persist in high temperatures or dry climates. They can however, be dispersed by wind. Strong wind gives rise to a high rate of transpiration.

Environmental factors always influence the activities of stomata. They result in water vapour gradient differences between plant and atmosphere. These factors are;

- Humidity
- Carbondioxide
- Wind
- Radioactivity
- Light

Water and Mineral Transport

Terrestrial plants absorb water and minerals from the soil by means of their roots. The epidermal cells of the root protrude to form root hairs. They are involved in mmineral and water absorption. Water moves to the roots from soil by **Osmosis** : is the movement of water molecules from high water concentrated medium to low water concentrated medium through a semi-permable membrane. There are small amount of minerals dissolved in soil water.

The factors that affecting the transport of water from roots to the leaves;

1- Capillarity

This is the attraction between water molecules and their vessels. This situation can be explained in the figure 5.2. The level of water in a pipette is higher than that of the water filled container in which it is placed. The level of the water and the diameter of the pipette is inversely proportional. Water rises in plants as their xylem vessels are extremely narrow, in fact invisible to the eye. this peculiar aspect result in the upward transport of water.

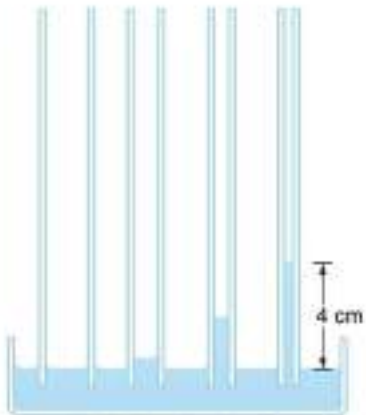


Figure 5.2 The level of water in the tube is inversely proportional to the diameter of it. Water rises more in narrow tube than in wide tube.

2- Root pressure

The concentration of water molecules in root hairs is less than that of the soil. This means that water molecules have tendency to enter the roots resulting in root pressure. The root pressure reinforces the movement of water from the soil to the root hairs. Thus, root pressure is an extra force which fills the xylem vessels with water. Experiments have shown that this pressure is between 6-10 atm. Water molecules can rise a few meters by this method.

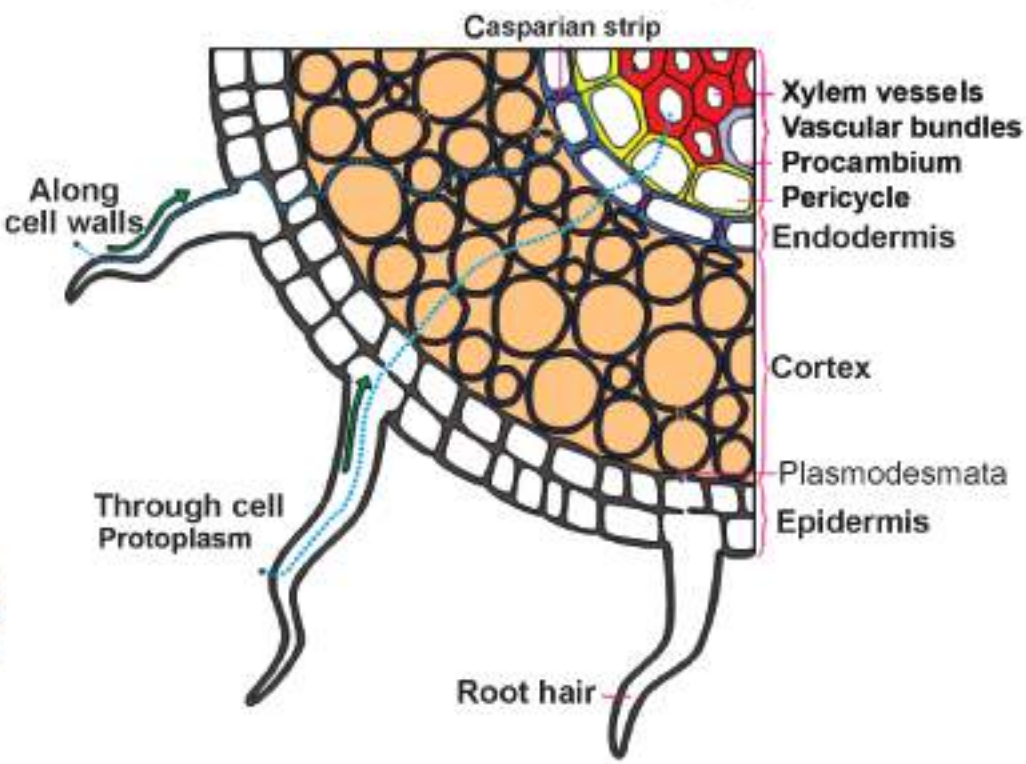


Figure 5.3
The water molecules diffuse from the outside of the root to the inside through the cortex, and epidermis.

3- Transpiration and cohesion theory

The theory was originally proposed by Dixon and Jolly (1894). Osmotic pressure increaes both during water consumption in photosynthesis and transpiration at the leaves. A force which pulls water upward is generated in the upper portion of the plant. This force is 30 times greater then atmospheric pressure. As a result, leaf cells are always active in drawing water to the top of plant. Consequently, a water chain is formed between the roots and the leaves of plant. The links of this chain are interconnected by an attractive force, known as **cohesion**. Thus, the water chain is coninous up through the plant without any break. Water elevation is halted if air bubbles enter the vessels and the chain is broken. Transpiration is a prominent factor in maintaining the chain of water from the roots to the leaves. For example in atree, transmit water molecules to a height if 100 meters or more. (Figure 5.4).

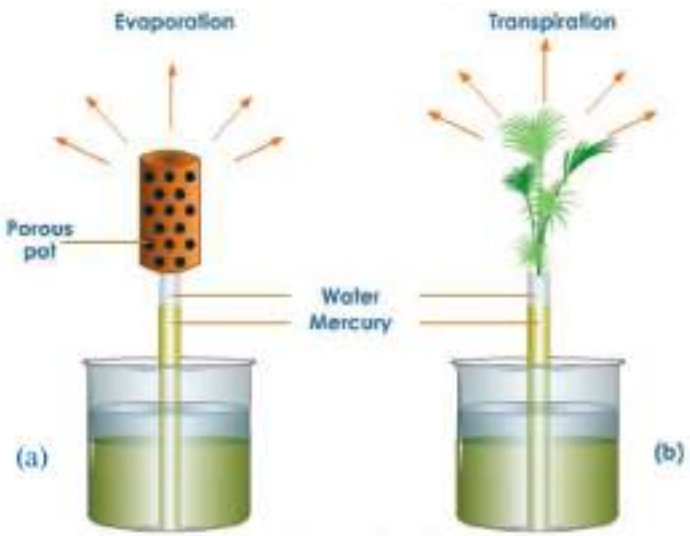


Figure 5.4
Demonstration of cohesion theory of water translocation
a. Evaporation
b. Transpiration

Cohesion

Cohesion is the force which attracts like molecules such as water with both (+) and (-) charges. The charges attract each other, maintaining cohesion. (Figure 5.5)

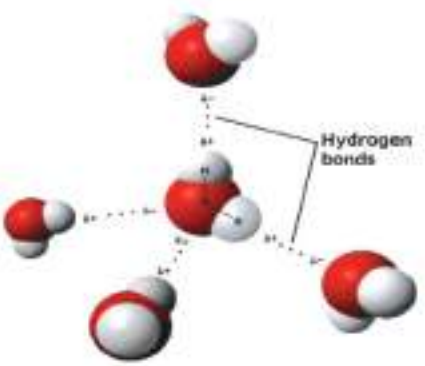
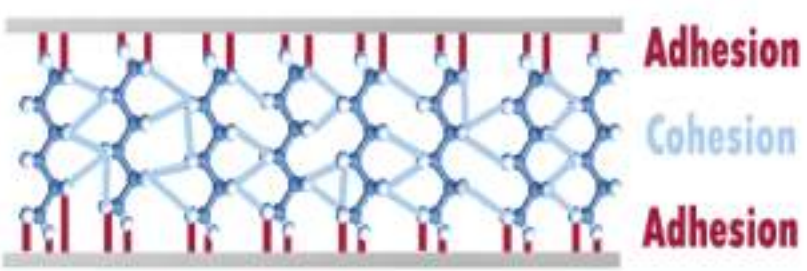
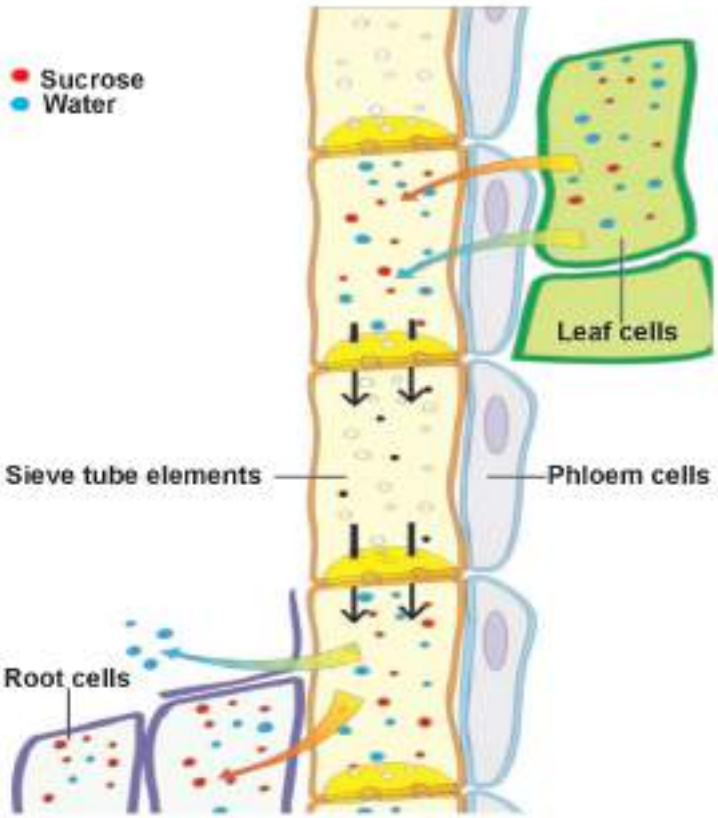


Figure 5.5 The water molecules are both positively and negatively charged. Attraction between these molecules generates a cohesive tension between them.

Adhesion

Adhesion is the force which attracts unlike molecules such as water and the walls of vessels in which it is contained. All of these forces; cohesion, root pressure and capillarity are effective in the transport of water.





Figuire 5.6
The organic molecules are transported from the leaves to the roots by means of phloem vessels.

Transport of Organic Molecules

Organic molecules are transported by the phloem vessels. The movement of molecules in the phloem cells is bi-directional. That is, they can move in two directions, either upward or downward. In contrast, water movement in xylem vessels is upward and unidirectional.

The products of photosynthesis, such as glucose and vitamins, move downward. Conversely, nitrogenous compounds are transported upward. Materials are transported through the phloem vessels due to a concentration gradient which results as follows. Excess glucose molecules synthesized by photosynthesis are converted to starch. They are then hydrolyzed back to glucose units and enter the cells of the phloem. Thus, the density of the phloem cells increases and water molecules are absorbed from companion cells.

As a result, the internal pressure of the phloem cells increases. Organic molecules move from areas of high pressure to areas of low pressure as explained by the pressure-flow theory. Glucose units move downward to the roots and are converted into starch in the leucoplasts of root cells. They are subsequently hydrolyzed if required by the root cells.

Transportation in Animals

Transportation in Invertebrates

The transport system in animals is more complex than that of plants. In animals transport system performs two vital roles; nutrient supply and waste removal.

a. Invertebrates which have no transport system

Sea anemone

Invertebrates like sea anemone and Planaria from flatworms have no complete transport system. Cells which located in outer layer of anemone body provide material exchange (nutrient intake and waste removal) directly with external environment. Cells which cover the gastrovascular cavity are specialized for digestion and absorption. And these cells absorb dissolved oxygen from this cavity. After absorbed materials pass from one cell to another by diffusion.

Gastrovascular cavity branched in tiny body of Planaria, nutrients and waste materials transport from one cell to another.

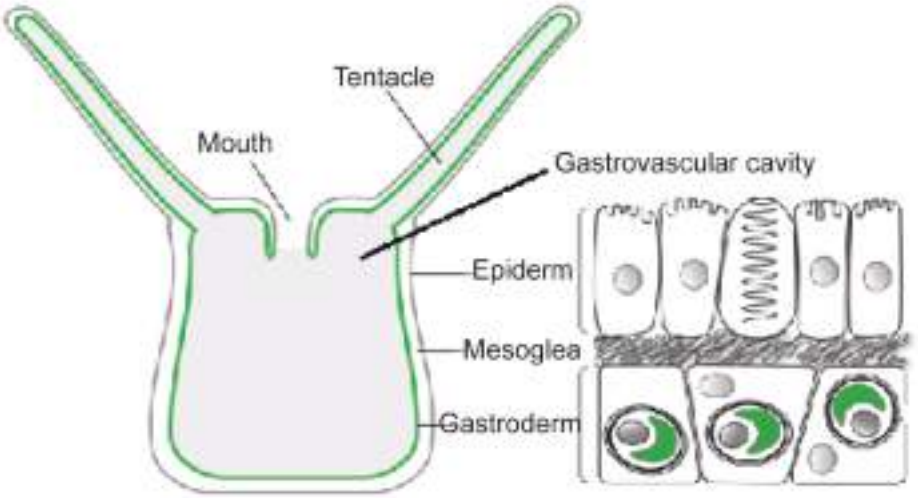


Figure 5.7 Transport system in sea anemone

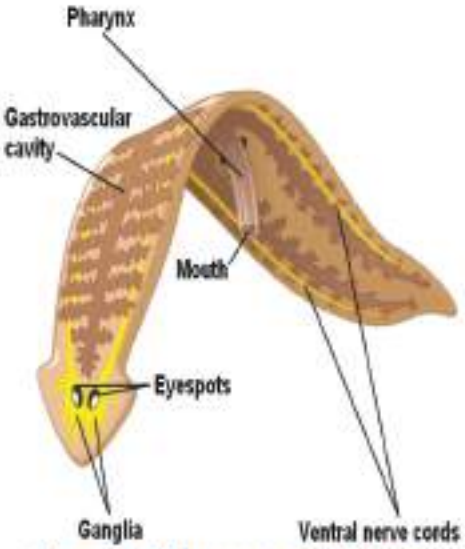


Figure 5.8 Transport system in Planaria

Invertebrates which have pseudocoelomate use internal body fluids for material exchange.

Types of Body Cavities

There are three types of animals according to their body cavities (coelom):

a. Acoelomate

Acoelomates lack a fluid-filled body cavity between the body wall and digestive tract. The coelom can be used for diffusion of gases and metabolites etc. These creatures do not have this need, as the surface area to volume ratio is large enough to allow absorption of nutrients and gas exchange by diffusion alone, due to dorso-ventral flattening.

b. Pseudocoelomate

These organisms have a fluid filled main body cavity unlined or partially lined with tissue derived from mesoderm. This fluid-filled space surrounding the internal organs serves several functions like distribution of nutrients and removal of waste

c. Coelomate

Coelomata (also known as eucoelomates — "true coelom") have a fluid filled body cavity called a **coelom** with a complete lining derived from mesoderm (one of the three primary tissue layers). The complete mesoderm lining allows organs to be attached to each other so they can be suspended in a particular order while still being able to move freely within the cavity. Most bilateral animals, including all the vertebrates, are coelomates.

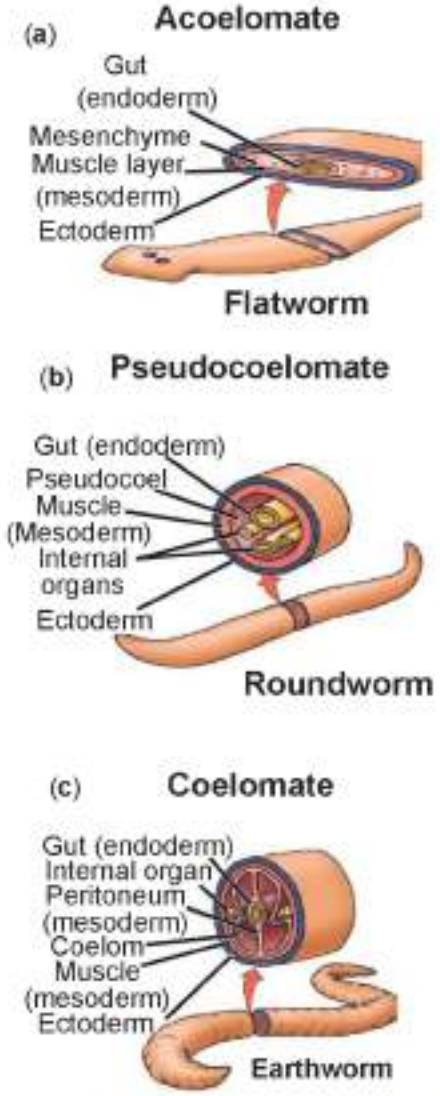


Figure 5.9 types of body cavities

b. Invertebrates which have open circulatory system

Figure 5. 10 Open Circulatory System in a grasshopper.

Grasshopper is an arthropod and has open cirsulatory system. Body cavities are filled with hemolymph which surround the internal organs.

Most of invertebrates have a circulatory system including heart. Heart pumps the body fluids into the blood vessels and there are two types of these body fluids; blood and lymph. **Hemolymph** is a body fluid that consist of interstitial fluid and blood. It seen in animals which have open circulatory system. Heart pumps the hemolymph into the body cavities in arthropods and crustaceans.

Grasshoppers have open circulatory systems, with most of the body fluid (haemolymph) filling body cavities. The one closed organ, the dorsal vessel, extends from the head through the thorax to the hind end. It is a continuous tube with two regions: the heart, which is restricted to the abdomen; and the aorta, which extends from the heart to the head through the thorax.

Haemolymph is pumped forward from the hind end and the sides of the body through a series of valved chambers, each of which contains a pair of lateral openings. The haemolymph continues to the aorta and is discharged through the front of the head. Accessory pumps carry haemolymph through the wing veins and along the legs and antennae before it flows back to the abdomen. This haemolymph circulates nutrients through the body and carries metabolic wastes to the Malpighian tubes to be excreted. Because it does not carry oxygen, grasshopper "blood" is green.

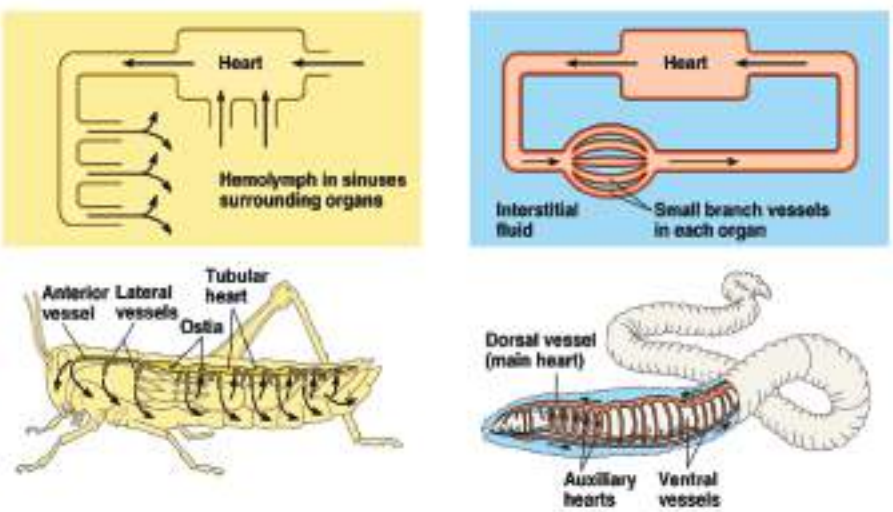


Figure 5.11
Open and closed circulatory system in earthworm and grasshopper.

b. Invertebrates which have closed circulatory system

Segmented worms, octopus and cuttle fish have closed circulatory system. Blood consist of blood cells and plasma, the heart pumps this blood into the blood vessels.

Earthworms are primitive organisms. However, they have a closed circulatory system consisting a vein in the dorsal region of the body. In the artery on the ventral side of the body in the frontal region are five pairs of contractile tubes which act as a heart. Capillaries connect the artery and vein and the heart is filled with blood when the muscle tubes relax.

Aided by the contraction of the heart, it passes through the artery in the ventral region and is pumped towards the abdomen. The blood then carried into the capillaries under the skin and other internal organs where material exchange occurs. Carbon dioxide in the blood diffuses from capillaries below the skin into the body wall while oxygen diffuses in opposite direction. Consequently, oxygen passes into the blood and is transported to the cells.The deoxygenated blood flows towards the frontal region.

Transportation in Vertebrates

All vertebrates have a closed circulatory system composed of heart, arteries, capillaries and veins.

a. Circulatory system in fishes

Fish have two chambered heart composed of an atrium and a ventricle. Fish differ from other vertebrates by their heart contains only deoxygenated blood rich carbondioxide. This blood direct to the gills by an artery projecting from the ventricle. Oxygen is supplied and carbondioxide is released while blood pass through the gills. The deoxygenated blood is collected from the capillaries into the sinus venosis by a pair of frontal and posterior veins.

Add to your information :
The sinus venosus is a large quadrangular cavity which precedes the atrium on the venous side of the fish heart.

Fish differ from other vertebrates by the blood being not return to the heart after its oxygenated in the gills. Therefore, there is no pulmonary circulation and blood pressure is low.

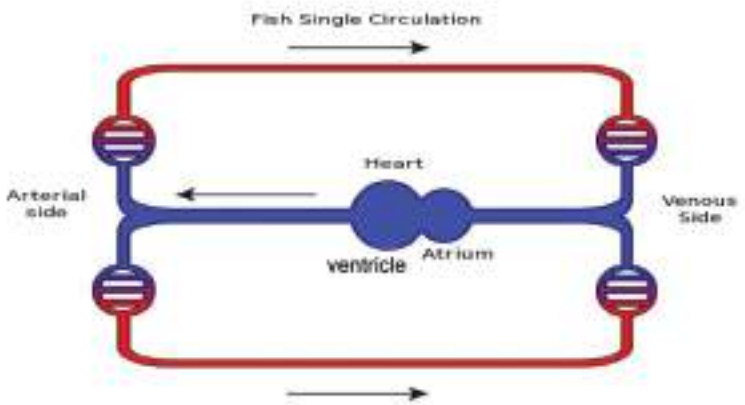


Figure 5.12 Circulatory system in fish

b. Circulatory system in Amphibia:

The amphibian heart consist of two artria and a ventricle. It pumps blood to both tissues and lungs. The left atrium contains deoxygenated blood while the right atrium contaions oxygenated blood. Both atria pump their contents into the ventricle, resulting in mixing of the blood. In amphibia, the half oxygenated blood pumped by the heart is enriched with oxygen at the skin. Skin respiration therefore is another way in which gases are exchanged. Amphibia have both systemic and pulmonary circulation.

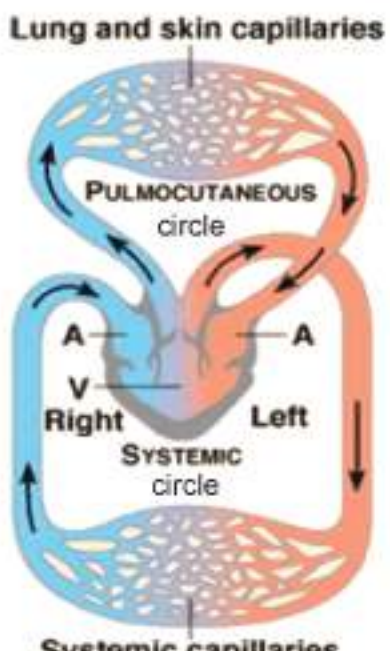


Figure 5.13 Circulatory system in amphibia

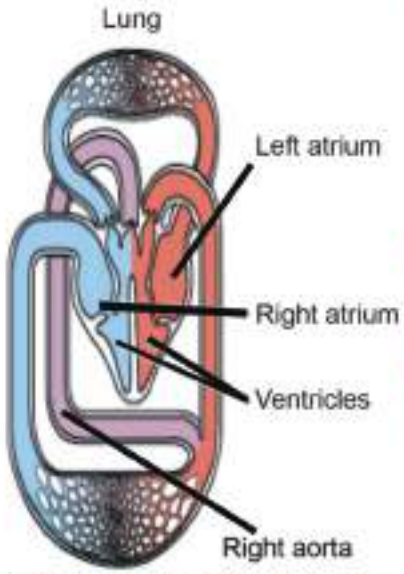


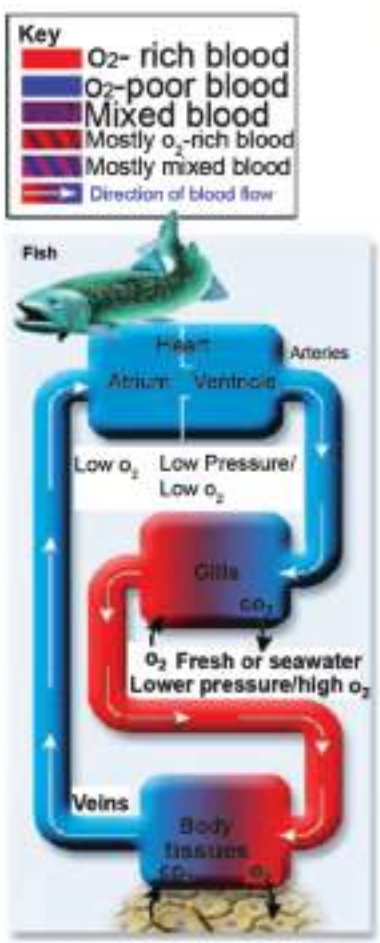
Figure 5.14 Circulatory system o in most of reptiles

c. Circulatory system in Reptiles

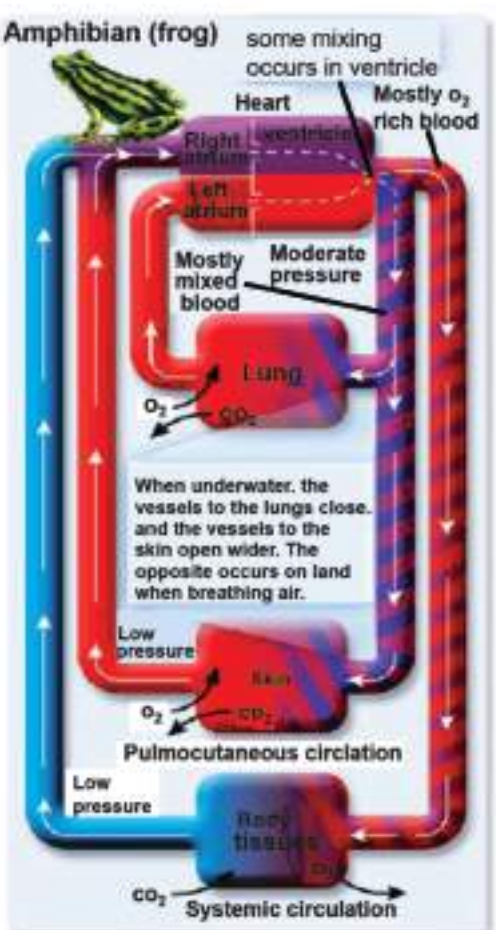
Reptiles have a circulatory system with three chambered heart. In reptiles, blood goes to the lungs to get oxygen. The ventricle of the reptile heart is partially divided. Oxygen-rich blood is almost completly separated from blood low in oxygen. In the crocodile however, the ventricle is almost completely divided into right and left ventricles except for a small orifice known as **foramen panizza**. So blood pumped to the different parts of the body carries a high amount of oxygen. The body temperature of reptile depend on environment temperature due to the mixing of blood. These type of organisms are called as **poikilotherms**.

d. Circulatory system in Birds and Mammals

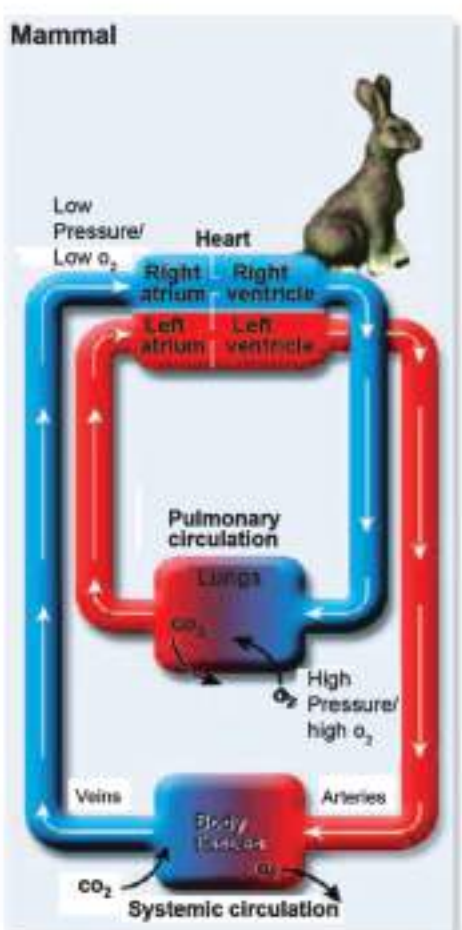
Birds and mammals have four chamberd heart, two artria and two ventricles. Oxygenated and deoxygenated blood completely separated. Deoxygenated blood accumulate in right atrium while oxygenated blood comes from lungs and accumulates in left atrium. The blood in atria pass to ventricle by their contraction. By contraction of right ventricle deoxygenated blood pumps to lungs and by contraction of left ventricle oxygenated blood pumps to body parts.



(a) Single circulation in fish



(b) Features of both single and double circulation in most amphibians



(c) Double circulation in birds and mammals

Circulatory System in Human

The human circulatory system is composed of the heart, arteries, capillaries and veins. All these structures are filled with blood, a fluid connective tissue composed of plasma , blood cells and platelets. Together they form an internal transport system within the body for substances to and from the cells.

1. Heart

The heart is divided into left and right hemispheres separated by a muscular wall, called (septum). Each half of the heart has two chambers: an atrium and a ventricle. The tricuspid, or three–flapped, valve connects the right atrium to the right ventricle and a bicuspid, or two–flapped, valve connects the left atrium to the left ventricle. Each half of the heart also has a valve known as **semilunar valve** located between the ventricle and the arteries leading away from the heart. The function of all the valves is to prevent the backflow of blood and to keep the blood moving in one direction.

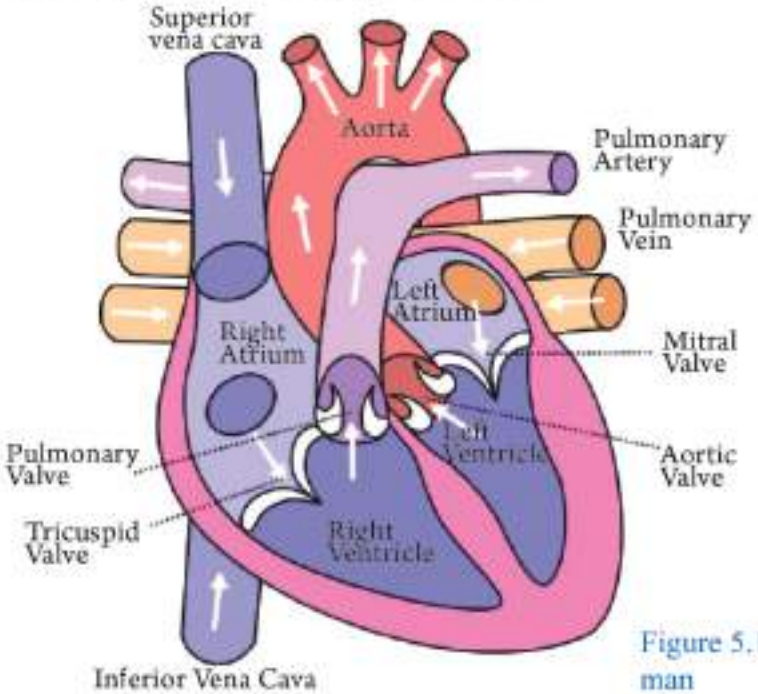


Figure 5.15 Heart structure in human

The heart is composed of three main layers:

1- Endocardium
2- Myocardium
3- Pericardium

The **endocardium**, the innermost layer of the heart, is composed of a single layer of epithelial cells. It also contains connective tissue, connecting the endocardium to the myocardium. The endocardium contains no blood vessels. Additionally, its gelatinous structure prevents the erosion of the heart during contraction and relaxation.

The **myocardium** is the middle layer of the heart and is composed of cardiac muscle. It is the main layer of heart, since the main function of the heart is pumping blood. The thickness of myocardium varies. It is thin in the artria but thicker in the ventricles. The left ventricle however, has a thicker layer of myocardium than the right ventricle.

The **Pericardium** forms the outermost layer of the heart and is composed of fibrous tissue. The space between its two surfaces is filled with fluid. The colloidal structure of the pericardium facilitates heart function and protects it from external hazards.

2. Blood Vessels

The human circulatory system consists of arteries, veins and capillaries. The blood is sequentially pumped from the heart to the arteries, then into the capillaries and veins. It is returned to the heart via the veins.

a. The structure of vessels

Both arteries and veins are surrounded by a fibrous protective layer. This layer reinforces the strength of the arteries and veins against internal pressure created due to relaxation and contraction. The middle layer is composed of elastic fibers and smooth muscles, which contract and relax to facilitate the flow of blood. In this layer there are also capillaries to supply nutrients to the veins and nerve fibers. The innermost layer of arteries and veins is composed of endothelium and provides a smooth and slippery surface to prevent friction.

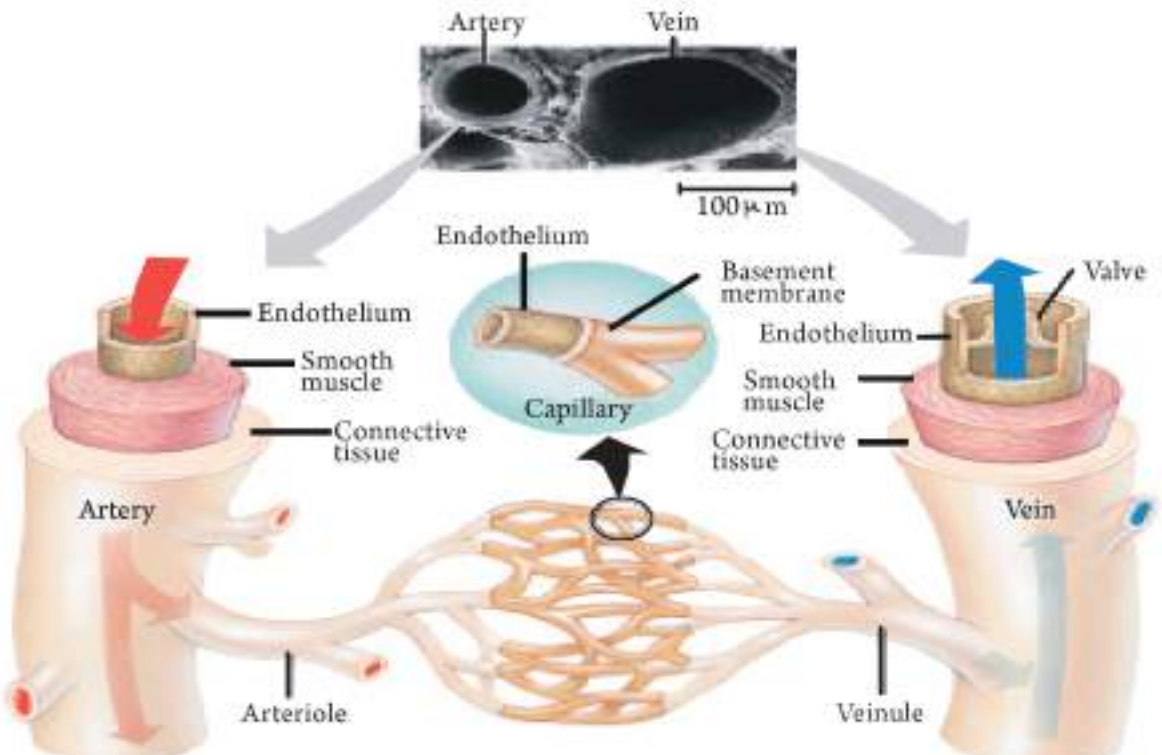


Figure 5.16 Structure of blood vessels

3. Types of Circulation

a. Coronary Circulation

The heart cells are supplied by the circulatory system, consisting of coronary arteries, capillaries and veins. The aorta directs the oxygen and nutrient containing blood to the coronary arteries.

The blood is then distributed to the capillaries where nutrients and oxygen diffuse into the heart cells. Simultaneously, nitrogenous wastes and carbon dioxide diffuse into the blood. The deoxygenated blood, together with the waste, is collected by coronary veins which enter the right atrium.

Any disruption of cardiac circulation, such as a blood clot, may cause serious disorders. Blockage of the coronary artery in any case results in an infarction, in which blood is prevented from flowing.

Angina pectoris is chest pain often, due in general to obstruction or spasm of the coronary arteries. The main cause of angina pectoris is improper contractivity of the heart muscle and coronary artery disease,due toarethrosclerosis of the arteries feeding the heart.

b. Pulmonary Circulation

Pulmonary circulation of the blood occurs between the heart and the lungs. It is initiated with the contraction of the right ventricle and the pumping of deoxygenated blood into the pulmonary artery. Branches of the pulmonary artery transport blood into both lungs. In the lungs, CO_2 diffuses out of the blood into the lungs, while oxygen diffuses in. The oxygen-rich blood is then carried into the left atrium by the pulmonary veins.

c. Systemic Circulation

Systemic circulation occurs between the heart and all other parts of the body (except the lungs) where materials and gases are exchanged. It begins with the contraction of the left ventricle and the transport of oxygenated blood to the tissues via the aorta. The aorta then branches into the main vessels which carry blood into different parts of the body. The aorta descends and branches into the diaphragm and down into the coelom (body cavity). Its branches supply nutrients to the liver, intestines and other parts of the body. Nutrients and oxygen diffuse into the tissues while wastes and CO_2 diffuse into the blood. The deoxygenated blood is then transported by the superior and inferior vena cava into the right atrium.

d. Hepatic Portal Circulation

Hepatic portal system consist of a group of veins which transfer the absorbed from digestive system to the liver before reaching the inferior vena cava.

The system extends from about the lower portion of the esophagus to the upper part of the anal canal. Many drugs that are absorbed through the digestive tract are substantially metabolized by the liver before reaching general circulation. This is known as the first pass effect.

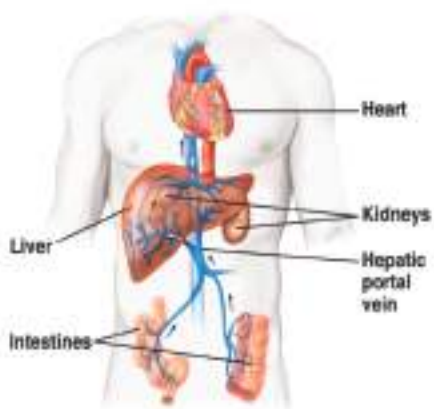


Figure 5.17 Hepatic portal circulation

Figure 5.18 Blood tissue

Blood

There are approximately 15 liters of fluid in an adult human body. Blood comprises only 5 liters of the total volume of liquid. It can be easily separated by centrifugation due to a difference in density between plasma and its other components.

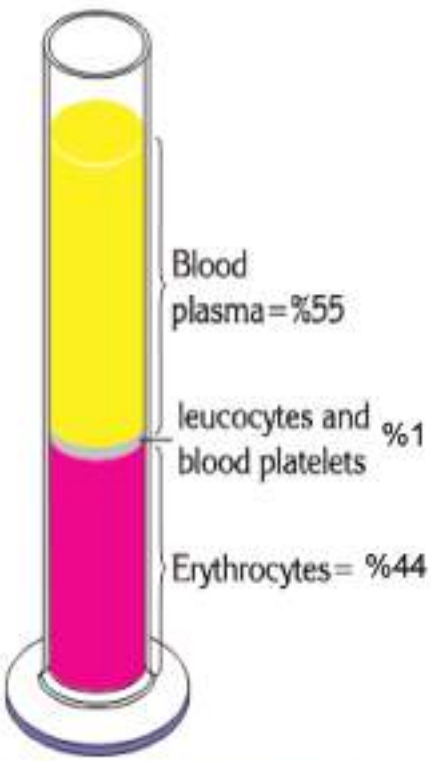


Figure 5.19 The blood componants

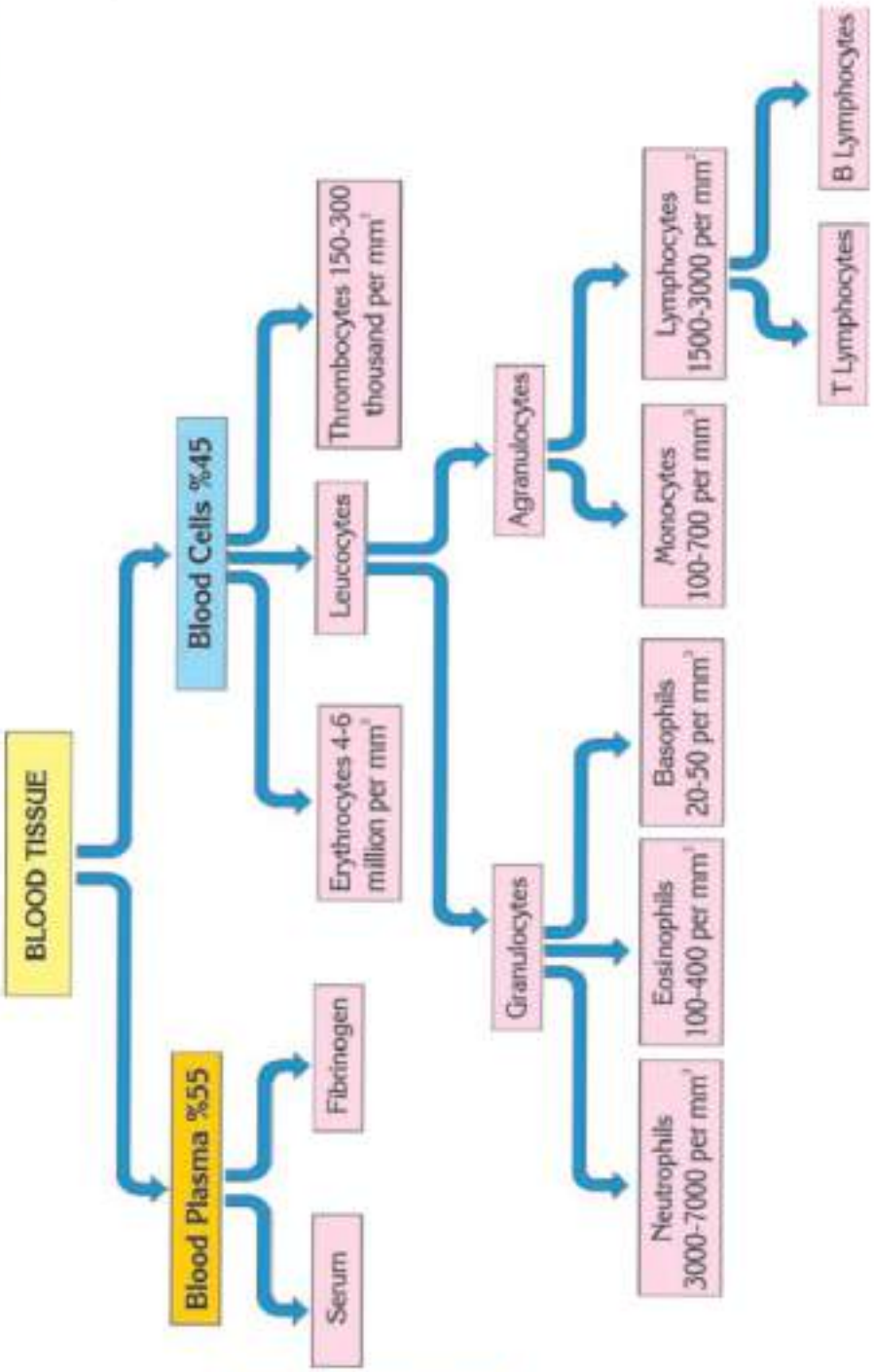


Figure 5.20 Blood contents

The structure of blood tissue

Plasma constitutes 55% of the blood, of which 90-92 % is water, 7-9% plasma proteins, and the remaining 1% is amino acids, carbohydrates, lipids, hormones, urea, uric acid, lactic acid, enzymes, alcohol, antibodies, sodium, potassium, calcium, chloride, phosphate, magnesium, copper, iron, bicarbonate, iodine and other trace elements.

Blood cells are classified as erythrocytes (red blood cells), leucocytes (white blood cells) and thrombocytes (platelets).

1. Erythrocytes

Erythrocytes are 8 mm in length and 2 mm thick. There are approximately 5 to 5.5 million per mm^3 in average male, and 4 to 4.5 million per mm^3 in the average female.

Mammalian erythrocytes are unique since they have no nucleus. Mature erythrocytes in mammals lack nucleus, mitochondria, Golgi apparatus and endoplasmic reticulum. They transport oxygen and carbondioxide in the body. In the fetus, erythrocytes are produced by the liver and the spleen. They are also produced in the red bone marrow of the skeletal system.

2. Leucocytes (White Blood Cells)

Leucocytes are nucleated, spherical, white cells. They are also referred to white blood cells due to their color. Leucocytes may be found in both blood and interstitial fluid. They can also cross the capillary walls in interstitial fluid. There are three main types of leucocytes and all of them are produced both in red bone marrow and in lymph nodes. There are two types of leucocytes according to presence of granules in their cytoplasm.

1. Granulocytes

Granulocytes are formed in red bone marrow. They are phagocytotic cells. They have segmented nuclei and granules within their cytoplasm they

have three types:

a- Neutrophils
b- Eosinophils
c- Basophils

2. Agranulocytes

The nucleus of an agranulocyte lacks lobes and is partly spherical in shape. It also differs from a granulocyte by its ability to divide. Most agranulocytes, lymphocytes and monocytes are produced in the bone marrow, the spleen and thymus.

Lymphatic System

Consists of lymphatic organs and vessels, this system has a specific role in :

1-Absorption of extra fats from small intestine walls in shape of Amino lipids and then transferred them back to blood stream

2-Forming the lymphatic cells

3-Immunity against microbes and diseases

The lymphatic Organs

The Spleen

The spleen is an organ of the immune system and is located directly beneath the diaphragm in the upper-left section of the abdominal cavity. It is approximately 200g in weight.

The spleen is involved in:

- degradation of old and dead erythrocytes.
- storage of blood as a reserve in the event of any shortage.
- production of lymphocytes active in the defense of the body. Both the spleen and liver work cooperatively in production.
- production of fetal blood until birth. It is then produced by red bone marrow.

The functions of the spleen can be performed by other organs if the spleen has to be removed from the body due to injury. Therefore its role is not vital.

Thymus gland:

is located in the chest behind the sternum , its function is to produce specialized leucocytes known as T-cells , which have important role in immunity

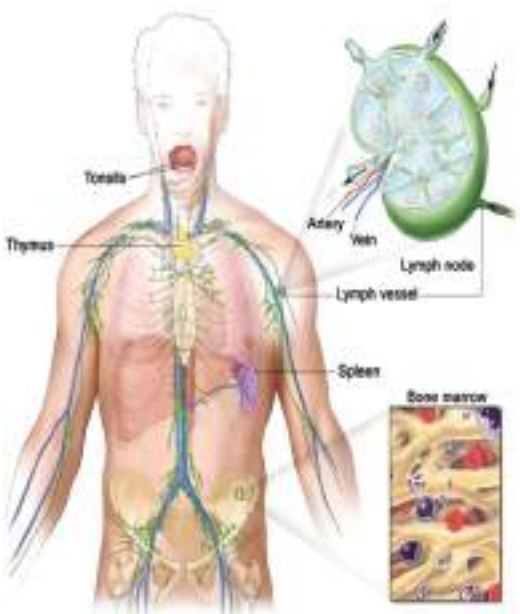


Figure 5. 21 Spleen is a lymphatic organ

Chapter Review

Question 1. Read each sentence carefully and write if it is true or false?

1. Transport system distributes water, ions and other materials .
2. In diffusion, materials transported from high concentration to low concentration.
3. Transportation of water to the top of plant is provided by transpiration and root pressure only.
4. There are three kinds of animals according to their body cavities: coelomata, Acoelomata and pseudocoelomata.
5. Most of blood cells are formed in bone marrow.
6. Grasshopper and earthworm have open circulatory system.
7. Unicellular organisms do not have a complete transport system.
8. Both spleen and liver work cooperatively in production of lymphocytes.
9. The endocardium, the innermost layer of the heart, is composed of a single layer of epithelial cells.
10. Acoelomates lack a fluid-filled body cavity between the body wall and digestive tract.

Question 2. Fill in the blanks.

1. The heart cells are supplied by the circulatory system, consisting of ....., ... and .....
2. In animals transport system performs two vital roles; ..... and .....
3. Transportation in Paramecium is provided through plasma membrane by two methods; ..... and .....
4. Reptiles have a circulatory system with a ..... chambered heart.
5. There are three different kinds of granulocytes; ....., ... and ..... .
6. ..... is another way in which gases are exchanged in amphibia.
7. The ..... reinforces the movement of water from the soil to the root hairs.
8. ..... is the force which attracts unlike molecules such as water and the walls of vessels in which it is contained.
9. Transportation in plants provided by three impotant activities ....., ... and ..... .
10. Systemic circulation occurs between the ..... and all other parts of the body

Question 3. Explain the following scientific facts:

1. Blood color in grasshopper is greeen.
2. Snake like animals are called as poikilothermic.
3. The endocardium is gelatinous structure.
4. Some animals are called as acoelomate.
5. Thymus gland swell during some inflamations.

Question 4. Define the following terms:

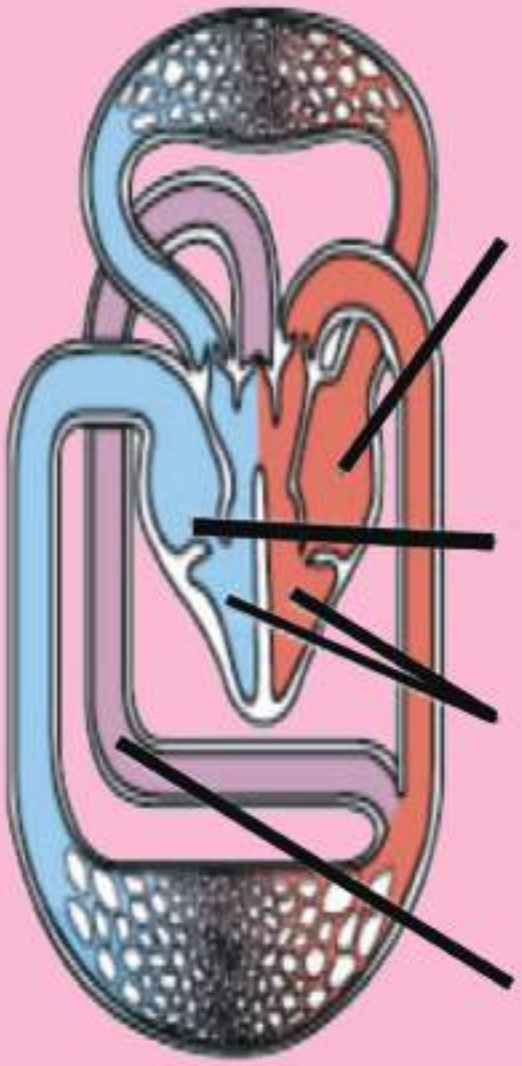
Adhesion, Cohesion, Coelom, Pericardium, T-cells , Root pressure, Artria.

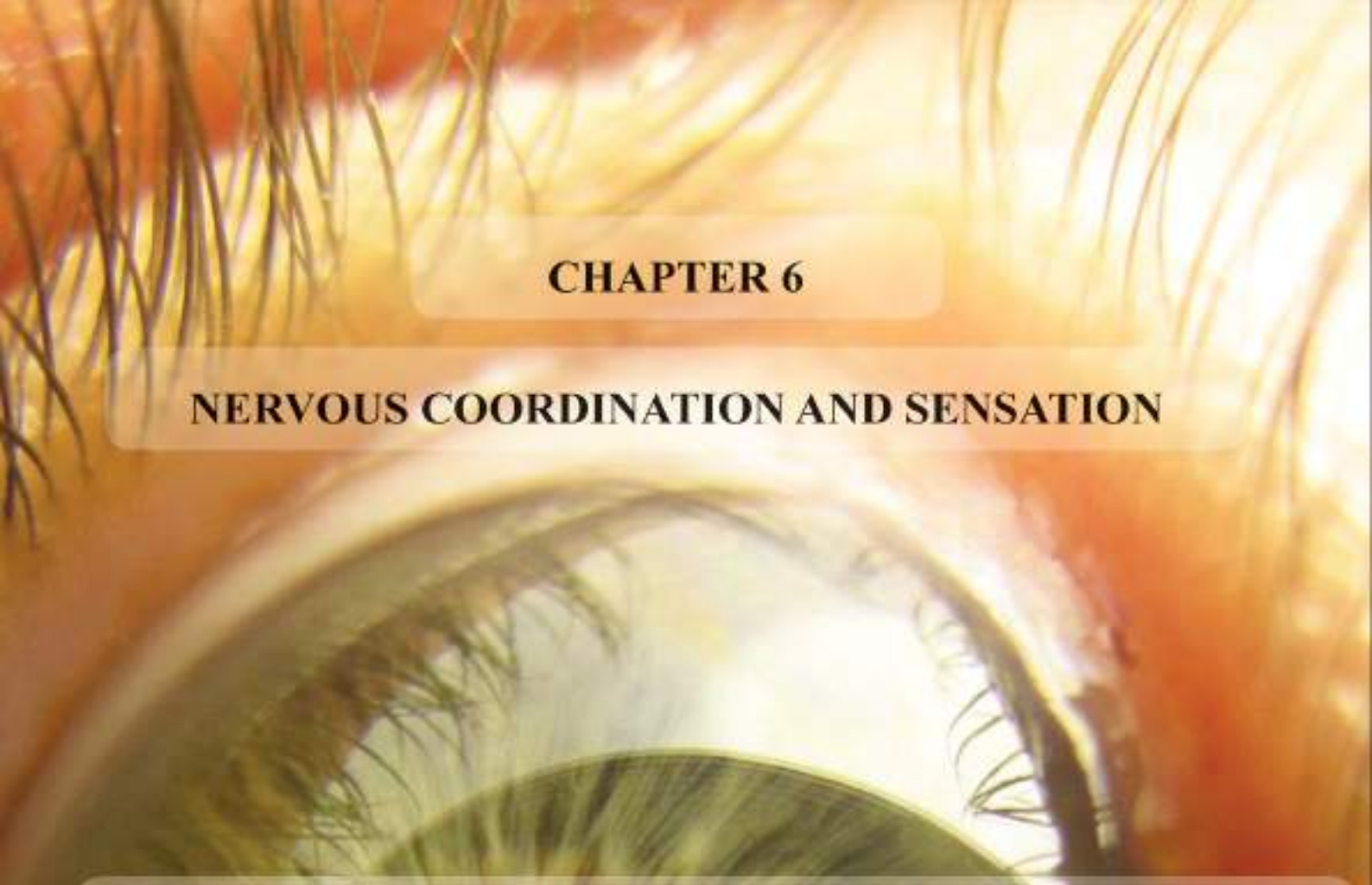
Question 5. Compare between the followings.

1. Open and closed circulatory system.
2. Transport system in frog and crocodile.
3. Circulatory system and lymphatic system in human.
4. White blood cells and red blood cells.

Question 6. Label the parts in the figure below.

1.





CHAPTER 6

NERVOUS COORDINATION AND SENSATION

Contents

OBJECTIVES

At the end of the chapter students must be able to;

1. Spesify the main functions of regulatory systems in organisms.
2. Describe the stages of nervous transmission.
3. Explain the sensation in Euglena.
4. Explain the negative and positive response in Paramecium.
5. Explain sensation in plants by examples.
6. Draw and explain the structure of neurons.
7. Describe types of neurons according to their function.
8. Define the treshold level.
9. Explain the mechanism of impulse transmission.
10. Describe the nervous system in Hydra.
11. Define the ganglia.
12. Numerate the parts of brain and their function.
13. Determine the function of spinal cord.
14. Compare between the sympathetic and parasympathetic nervous system.
15. Numerate the types of receptors and their functions.
16. Define the receptor.
17. Explain the sense of balance in animals.
18. Define the compound eye.
19. Draw and explain the structure of ear in human.
20. Numerate the layers of eye in human.

Introduction

The internal balance of organisms must be sustained in order to survive. All of these organisms require systems to maintain their internal balance and the normal functions of their bodies. There are two regulatory systems in the body; **hormonal system** and **nervous system.**

Nervous system coordinates and regulates body functions. It performs this function by a kind of cell that specialized for information transport called as **neuron**. The senses provide information on changes in external environment. This information is evaluated and a suitable response is elicited by effector organs such as muscles in animals, leaves or stem in plants and cilia or flagella in unicellular organisms.

The stages in the function of nervous transmission consist of reception, transmission, interpretation and responce. All these stages must obviously be performed in within the same cell in unicellular organisms whereas in multicellular organisms, the separate stages are performed in different structures within a system.

Sense in Unicellular Organisms

Add to Your Information

1- Receptors are specilized cells involved in receiving of environmental stimuli.

2- There are different kinds of receptor according to type of stimuli like chemoreceptors, photoreceptors or mechanoreceptors.

3- Invertebrates find their food by using chemoreceptors (chemical change). They use this receptors for communication also.

4- Mechanoreceptors detect mechanical changes like, sound waves and pressure.

Unicellular organisms don't have a nervous system or cells differentiated for sensation.

But they have some stimulations like;

- Photostimulation
- Mechanical stimulation
- Chemical stimulation
- Thermostimulation

1- Sensation in Euglena

Euglena is a protist which sensitive to the light. It use flagella for movement in absence of light. Exposing to the sunlight is fatal for Euglena due to the ultraviolet light. It has chloroplast and produce its own food by photosynthesis. Euglena has an eye spot which sensitive to the light. Euglena has some **photorecepetor** to avoid direct sunlight and deep shade. These photoreceprtors and eye spot located in frontal part of Euglena.

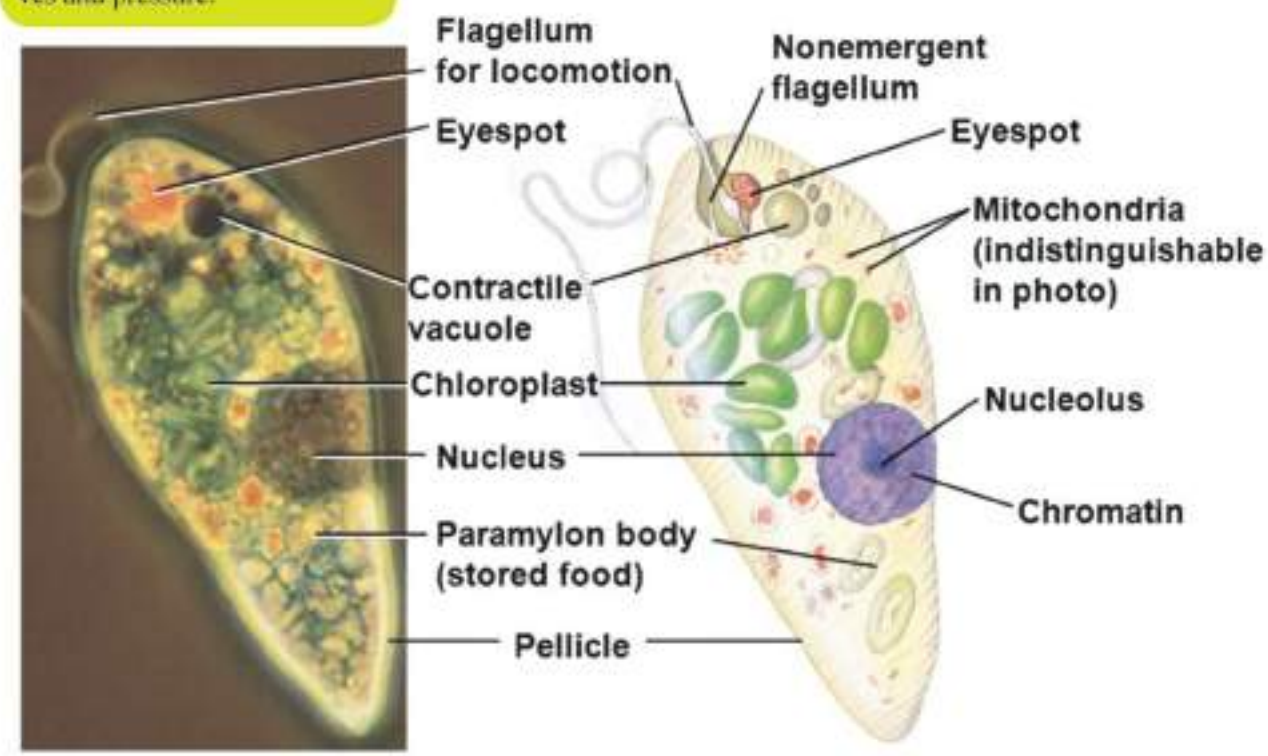


Figure 6.1 Structure of Euglena

2. Sensation in Paramecium

Paramecium gives response to the external stimuli in a high speed. Paramecium can not survive under the direct sunlight due to the ultraviolet light of sun. It does not response to the light since it has no photoreceptor or do photosynthesis.

Paramecium gives positive or negative response to the solid particles (stimuli).
It gives (+) response if stimuli is food and and give (-) if stimuli is not food.

Paramecium give (+) or (-) response to the chemical stimuli. It gives (+) response if stimuli is food or gives (-) response if stimuli is a harmful chemical material.

The optimum temperature is 24 - 28 °C for Paramecium. It moves away from the condition randomly until reach a suitable environment.

3. Sensation in Amoeba

It can identify the harmful or useful stimuli by responses to the environmental changes. It gives (+) response to the dim light but gives (-) response to the bright light.Amoeba gives (-) response to most of materials except food.

Sensation in Plants

Plants do not have a nervous system or sense organs. Coordination between body parts is provided by physical and chemical methods. Plant cells detect stimuli at a certain level. And this stimuli is transmitted to the other cells at different ratios. Generally plant cells transmit stimuli at low levels.

Plants can detect different changes like; light, gravity, mechanical changes and chemical changes. Plants give response to these changes by **tropism** which has different forms like **phototropism** and **geotropism**. These responces varies according to type of plant.

Plants mostly detect chemical changes and give response by different tropism types as above. For example plants secrete a hormone called as **cytokinin** which stimulate growth and cell division. Coordination between cytokinin and auxin hormones provide differentiation in different parts of plants.

Abscisic acid is another plant hormone which provide dormancy in buds and seeds. It has role in closing of stomata, decreasing transpiration and prevent water loss in dry conditions.

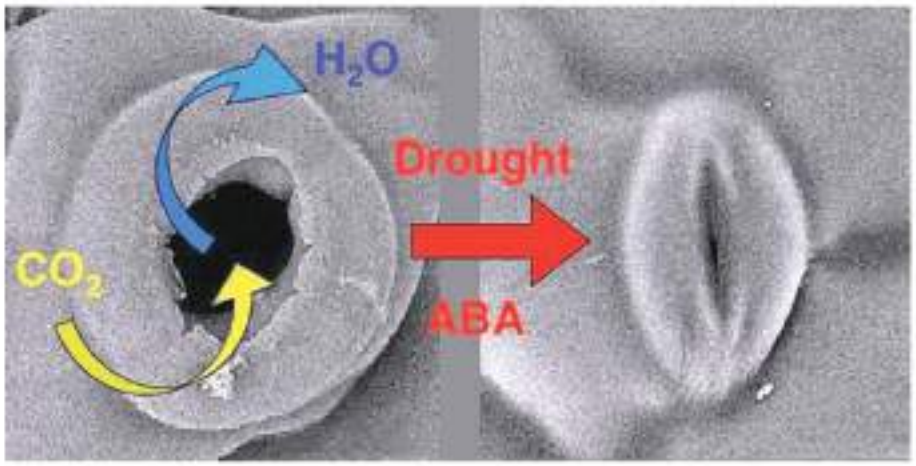


Figure 6.2 Opening and closing of stomata by act of Abscisic acid.

Ethylene has harmful effects on plant physiology. In the past, farmers warmth the orange to culture the un ripe fruits. But after they found that the reason of culturing is ethylen gas which released from the petrolium they use in heating heat. Ethylene have role in falling of leaves for plants.

Figure 6.3 Ethylene produced by the ripening of apple causes the abseission of the leaves af the holy twig on right. On the left, where no source of ethylene was present, the holy retins it leaves.

Nervous Coordination and Sensation in Animals

Nervous system is the most complex system in animals and it related to all other body parts. Special cells of nervous system that are specialized for impulse transmission through body parts are called as **neurons**. These cells cover all body parts as a network.

Do you know?

Stored enegry in body of organisms can be used for many years. Coal and petrolium contain energy which stored by photosynthesis before thousands of years.

A nerve cell, known as a neuron, consists of the following components:

a -dendrites
b-cell body
c -axon

a. Dendrites

They are short, thin, numerous projections extending from the cell body. They receive information from other neurons.

b. Cell body

It is the enlarged part of the neuron from which dendrites and axons project. It contains the nucleus of the cell.

c. Axon

This structure resembles a dendrite in that it also projects from the cell body. In contrast to a dendrite, however, an axon is generally single, long and thick. Its length varies according to the location of the neuron, and may be in excess of 1 meter in length. The axon extending from the skull to the pelvis in a giraffe is about 3 meters long.

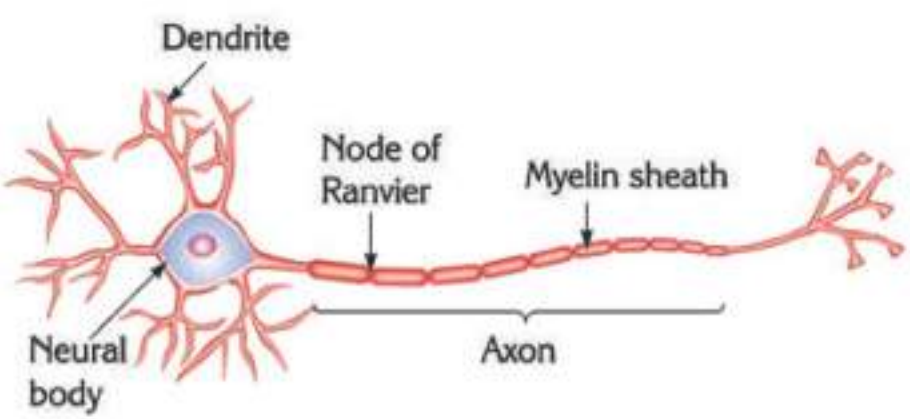


Figure 6.4 The structure of a typical neuron.

b. Types of Neurons According to Their Functions

Neurons are classified into three groups: sensory neurons, inter neurons and motor neurons.

1- **Sensory neurons** transmit stimuli (Information gathered by receptors from sense organs or internal structures) from sensory organs such as the eye, ear, and skin to the CNS. Sensory neurons are usually unipolar or bipolar in structure.

2- **Inter neurons** are commonly found in the CNS. Their main function is interpretation of information. They are multipolar in structure.

3- **Motor neurons** transmit the impulses from the CNS to muscles or glands. Motor neurons are also multipolar.

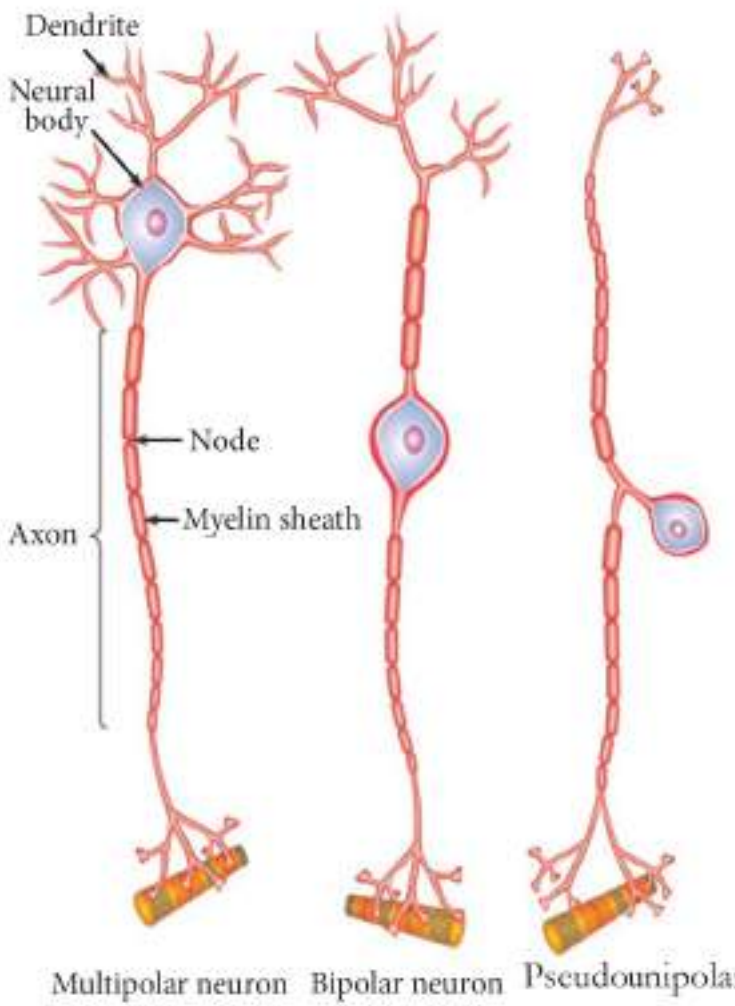


Figure 6.5 Neurons can be classified according to the number of projections.

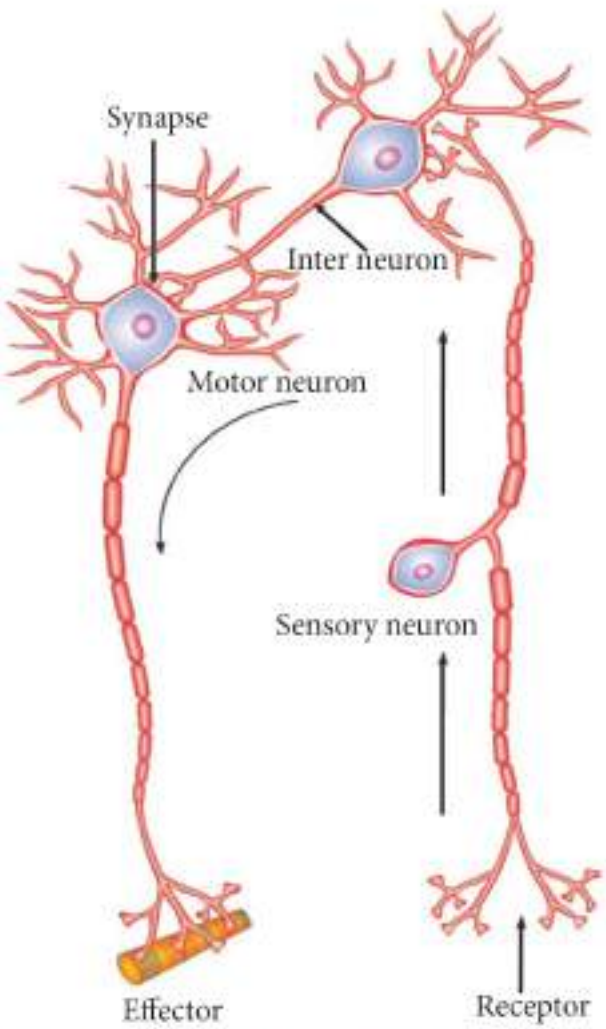


Figure 6.6 The transmission of an impulse occurs along neurons in the order

Transmission of Impulses Through Neurons

Nerve impulses are electrical signals produced by the plasma membrane of a neuron.

The impulse generated at one end of the nerve is transmitted through the nerve fiber by electrical and chemical alternations. The impulse is generated if the voltage reaches a certain critical point, known as the **threshold level**. Any voltage lower than the threshold level fails to result in the generation of an impulse. This is known as the **all-or-none law**.

In nerve fibers, impulses are unidirectional, flowing in the same direction from dendrites to cell body to axon. The impulse is then transmitted to the dendrites of the next neuron, receptors of a muscle or a gland.

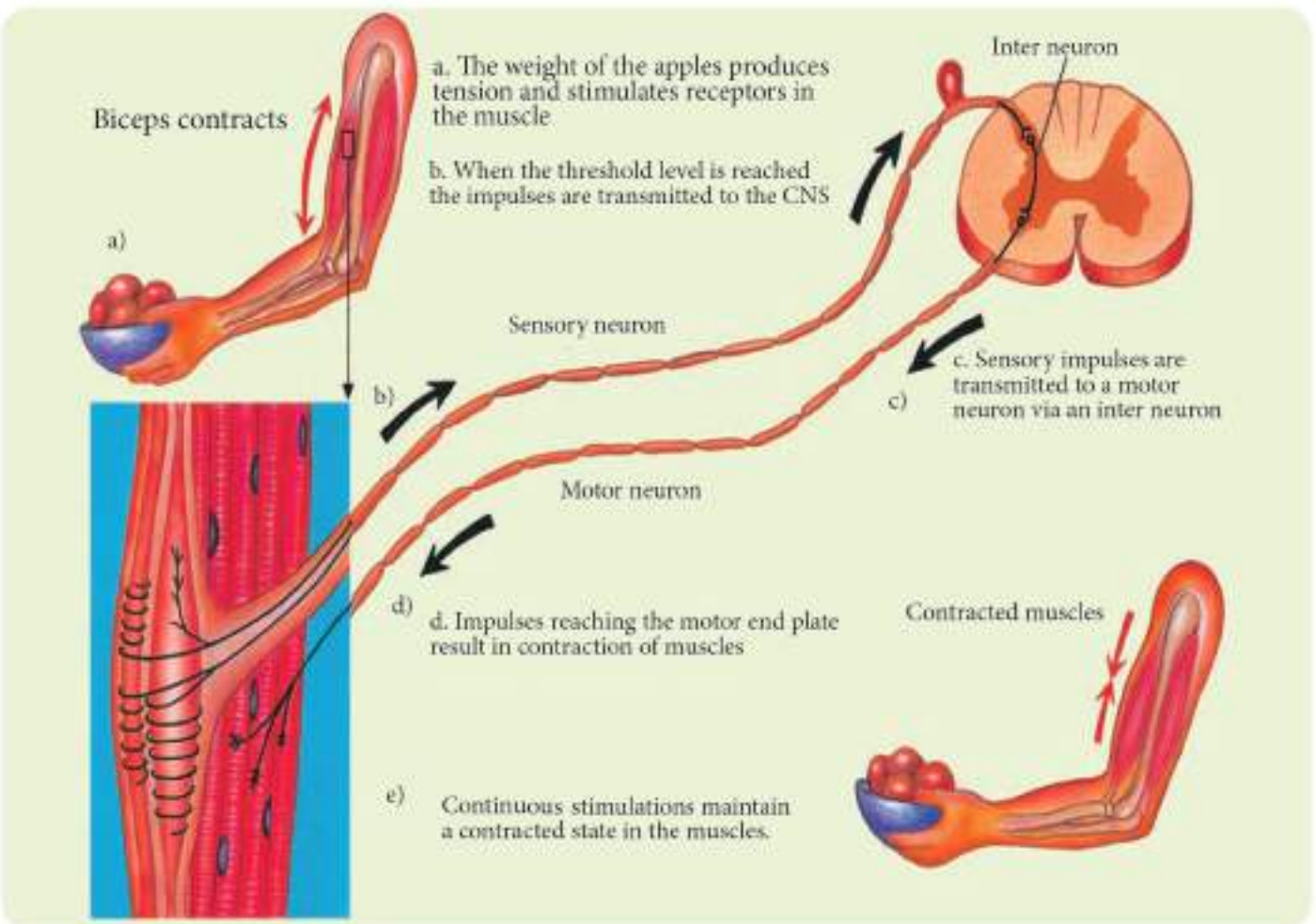


Figure 6. 7 The sequence of events that results in a response to a stimulus

Mechanism of Impulse Transmission (Generation of Action Potential)

Phases of Impulse Transmission

1-Polarization
2-Depolarization (action potential) "The conduction of a nerve impulse"
3-Repolarization

Polarization: In a resting or unstimulated nerve, the outer portion of the axon is positively charged, while the inner portion is negatively charged (resting potential). This situation is called **polarization**.

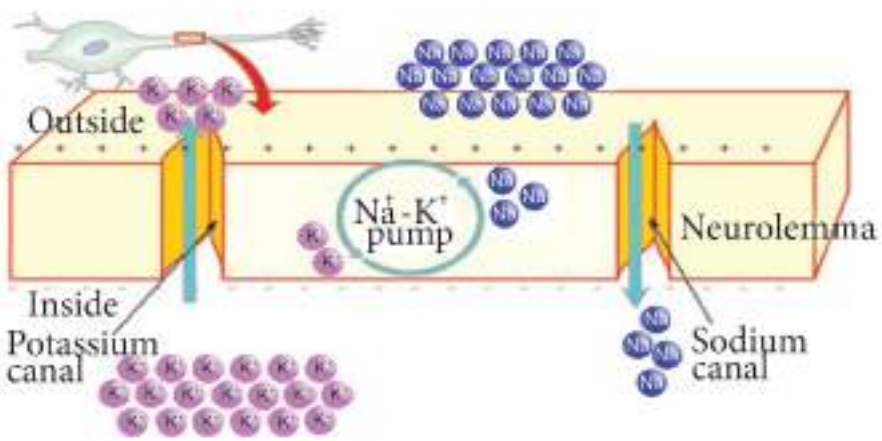


Figure 6.8 Sodium-potassium pump. An unstimulated neuron is polarized with a net positive charge on the outer surface. Sodium ions are actively extruded. By the same mechanism, potassium ions are concentrated on the inner surface. As the impulse travels along the neuron, sodium ions flow in, depolarizing the membrane. After the impulse has passed, sodium ions are again pumped out of the cell, restoring the external positive charge.

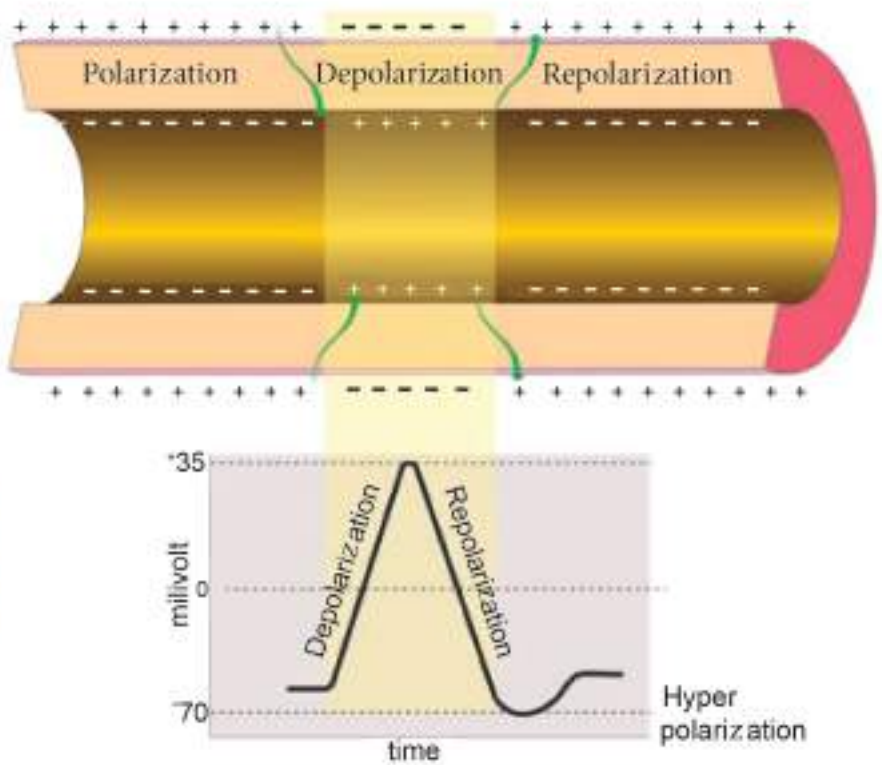


Figure 6.9 In a resting neuron, the potential difference across the membrane is -70 mV. During depolarization, this value increases to +35 mV. After the impulse has passed, the value returns to -70 mV.

Depolarization: Besides the **Na–K pump**, there are two more pumps on the axomembrane. The sodium pump, which allows Na^+ to pass, and the potassium pump, which allows K^+ to pass.

A stimulus that reaches or exceeds the threshold opens the Na^+ gates first. The sudden entrance of the Na^+ makes a particular location inside the membrane positively charged. This is **depolarization**.

Repolarization: At a certain level, sodium gates are closed and potassium gates open. As a result, K^+ moves from the cytoplasm of the axon to the exterior of the axon. As K^+ leave, the action potential once more return to the resting potential, and repolarization is achieved.

The velocity which an action potential travels along an axon is greater if the diameter of the axon is large or if the axon is myelinated. In thin, unmyelinated axons, action potentials move about 1 m/s, and in thick, myelinated axons, the rate is more than 100 m/s.

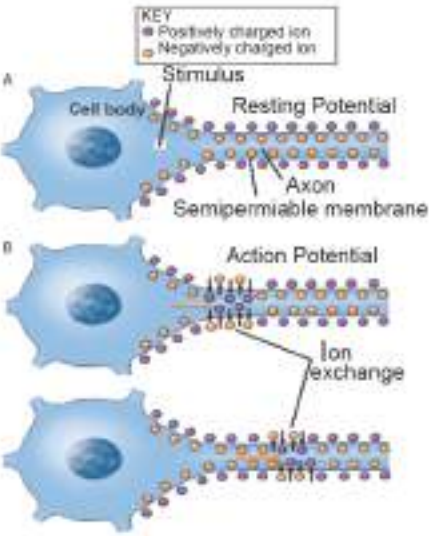


Figure 6.10 **Repolarization**

Nervous System in Animals:

A- *Nervous System in Invertebrates*

The simplest type of nervous system is found in hydras and jellyfish (cnidarians) and is referred to as a "**nerve net.**" Nerve nets do not have distinct central or peripheral regions, and lack anything that resembles a brain. Instead, the scattered nerve cells form loose networks in each cell layer of the body wall. Some of these neurons carry information from sensory organs that detect touch, light, or other changes in the environment. These neurons in turn contact neurons that control movement of the organism, such as swimming.

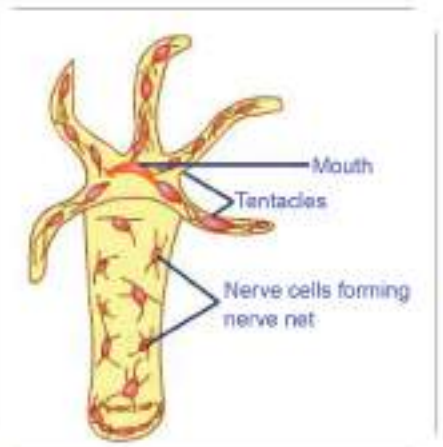


Figure 6.11 Nervous system in Hydra

At the head of the planarian there is a ganglion under the eyespots. From the ganglion there are two nerve cords which extend the length of the tail. There are many transverse nerves connected to the nerve cords extending from the brain, which makes the nervous system look like a ladder.

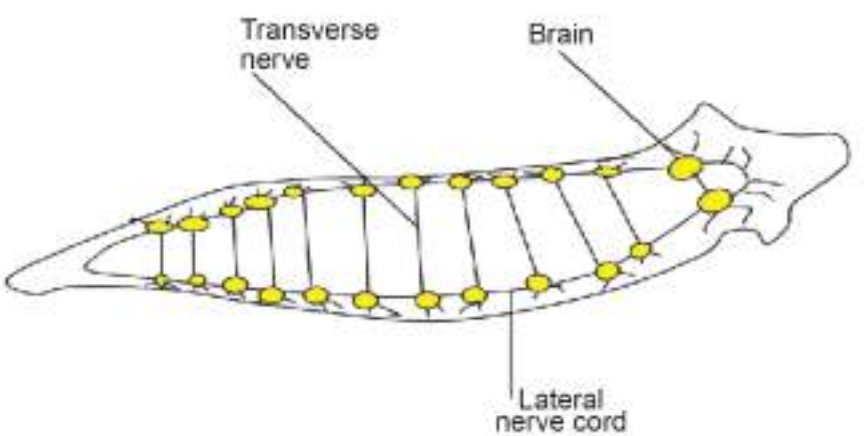


Figure 6.12 Nervous system in Planaria

A distinct separation of peripheral and central nervous systems is found in invertebrates such as worms, insects, and mollusks, like the squid. Neuron cell bodies are grouped into clusters called **ganglia** , which are usually located along the animal's midline. The peripheral component of the nervous system is formed by the extensions of the cells in these ganglia; some carry sensory information from the environment to the ganglia, while others carry signals from the ganglia to produce a response (such as movement). This type of organization permits segmentation, in which each ganglion responds to and controls an individual segment of the body. To coordinate the segments, these ganglia are connected to each other in a chain like pattern by a nerve cord, which is a bundle of neurons that runs the length of the animal.

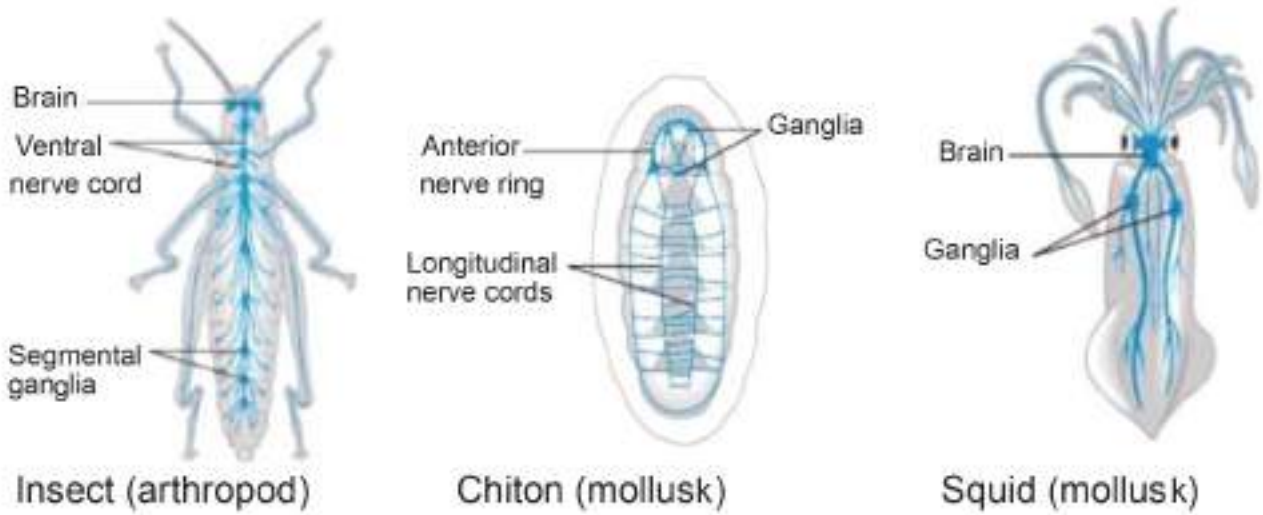


Figure 6. 13 Nervous system in different invertebrates

B- *Nervous System in Human and Animals*

Nervous system in vertebrates consist of two main parts; a spinal cord which located in vertebral column and a brain .

Nervous system in vertebrates consist of following components:

a. Central Nervous System: Consist of brain and spinal cord.
b. Peripheral Nervous System:Consist of cranial nerves that extend from brain and spinal nerves that extend from the spinal cord.
c. Autonomic Nervous System: controls the centre of involuntary activities.

All components of nervous system work cooperatively.

a. Central Nervous System

Central nervous system consist of brain and spinal cord in vertebretes. Brain is located at the front and consist of three parts.

1. Forebrain

It divided into two parts;

a- **Telencephalon** is the centre of sense of smell. Hemispheres are involved in movement coordination and sensations. They also have role in controlling mental activities.

b- **Diencephalon** consist of Thalamus and hypothalamus. Both of these parts are control center of involuntary activities.

2. Midbrain

There are two vision lobes at the posterior and it is the vision center in all vertebrates.

3. Hindbrain

Hindbrain consist of **metencephalon**(cerebellum and pons) and **medulla oblongata**. Cerebellum provide coordination between voluntary muscles to provide body balance. Medulla oblongata is the control centre of **respiration** and **circulation**.

b. Peripheral Nervous System

Peripheral nervous system consist of cranial and spinal nerves. Number of cranial nerves varies according to kind of organism; fish and amphibia have 10 pairs of cranial nerves but other vertebrates have 12 pairs of cranial nerves. Mammalian have 31 pairs of spinal nerves.

c. Autonomic Nervous System

It controls the involuntary body activities and consist of non-myelinated neurons.

It divided into two parts;

- Sympathetic Nervous System.
- Parasympathetic Nervous System.

Most of internal organs like heart and blood vessels contain perform involuntary movements. Sympathetic nervous system accelerate function of some organs while parasympathetic de accelerate function of theseorgans. For example sympathetic nervous system accelerate heart beats rate while parasympathetic system de accelerate heart beats rate.

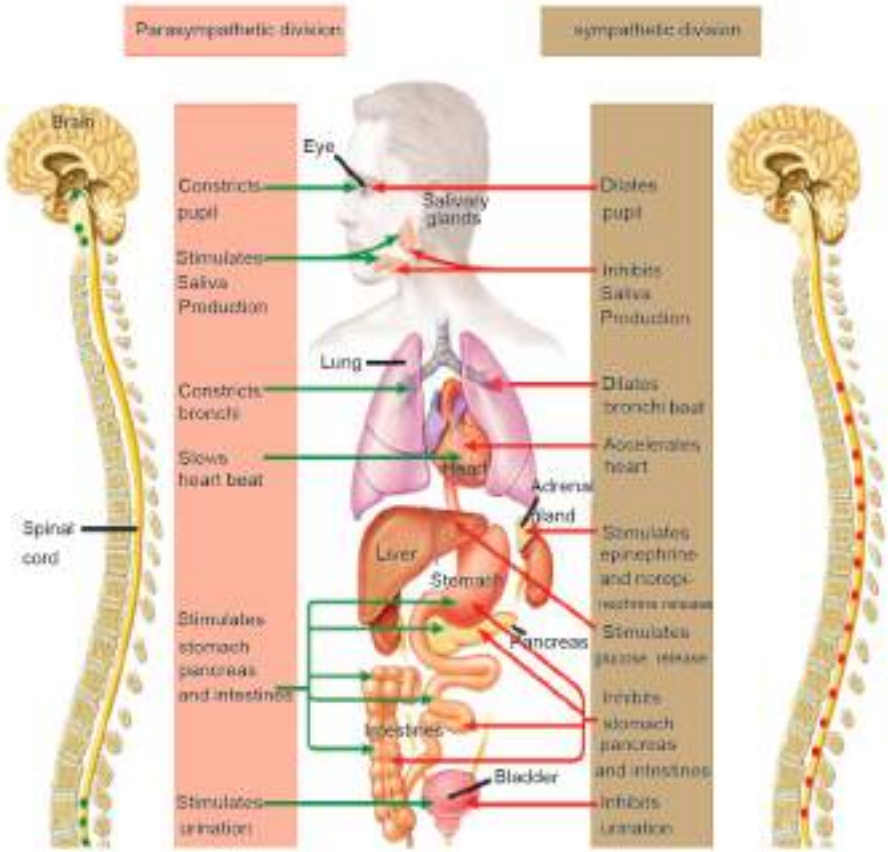


Figure 6.14 Autonomic nervous system and its effects on different body parts and functions.

Sense Organs in Human and Animals

Animals have different sense organs which detect different changes in environment.

Types of Receptors

Receptors are structures specialized to receive certain environmental stimuli and convert them into nerve impulses.
According to stimuli, receptors in humans can be classified into six types:

1. Photoreceptors detect light. Eyes have this kind of receptors.

2. Pain receptors are naked nerve endings that respond to chemicals released by damaged tissues or excess stimuli of pressure or heat.

3. Proprioceptors sense the degree of muscle contraction, the stretch of the tendons, and the movement of ligaments. Information sent to the central nervous system by these receptors is used to maintain the body's posture.

4. Thermoreceptors are stimulated by changes in temperature. Those that respond when temperature rises are called heat receptors, and those that respond when temperature decreases are known as **cold receptors**. There are internal thermoreceptors in the hypothalamus and surface thermoreceptors in the skin.

5. Chemoreceptors are sensitive to dissolved chemical substances. The sense of taste and smell are well-known types of chemoreception. Various internal organs also have chemoreceptors (one monitors the pH level of the blood).

6. Mechanoreceptors are stimulated by mechanical forces, which are most often different types of pressure. Skin and ears are sense organs that have this kind of receptor.

Figure 6.15 Taste buds map on tongue

a. Sense of Taste

Chemoreceptors are involved in detection of taste. There are papillae in dermis of tongue that contains **taste buds**. Taste buds contain receptors which detect dissolved materials in saliva and transmit to the nerves. These taste buds are renewed continuously . Different parts of tongue contains different taste buds.

b. Sense of Smell

A pheromone is a secreted or excreted chemical factor that triggers a social response in members of the same species. Pheromones are chemicals capable of acting outside the body of the secreting individual to impact the behavior of the receiving individual. For example ant produces pheromones to paralyse the prey and to mark its path.

The reception of smell takes place in chemoreceptors located in the nasal cavity. The total surface area of chemoreceptors in the nasal cavity is 10 cm^2. This region is known as the **olfactory region**. The human nasal mucosa may contain 25 million receptor cells, whereas that of a dog contains 220 million.

Add to your information

When you have a cold you think that food loses its taste, but actually you lose the ability to sense its smell. When you smell something, some of the molecules move from the nose down into the mouth region and stimulate the taste buds. Therefore, part of what we refer to as smell may actually be taste.

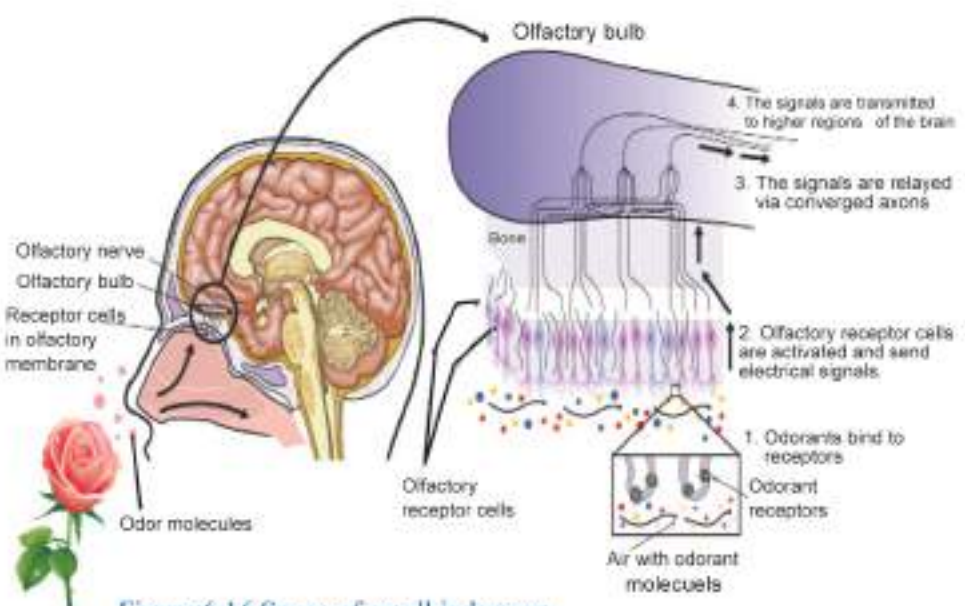


Figure 6.16 Sense of smell in human

c. Sense of Touch

Vertebrate and invertebrate animals have touch receptors. Vertebrates have touch receptors that accumulated in different regions of body.

In human touch receptors accumulated in lips and fingertips. Meissner corpuscles are involved in reception of touch in the palm, and lips. **Paccinian corpuscles** are involved in reception of mechanical stimuli. They are pressure receptors located deep in the dermis.

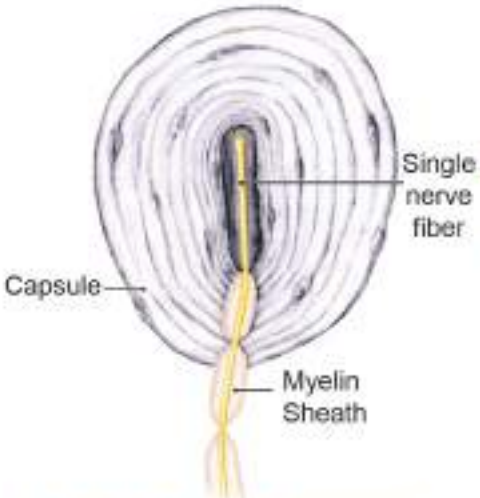


Figure 6.17 Paccinian corpuscle

d. Sense of Balance

Animals have different organs and body parts involved in body balance. Some invertebrates have statocysts. The **statocyst** is a balance sensory receptor present in some aquatic invertebrates, including bivalves and cnidarian.

The **lateral line** is a system of sense organs found in aquatic vertebrates, mainly fish, used to detect movement and vibration in the surrounding water. The sensory ability is achieved via modified epithelial cells, known as hair cells, which respond to displacement caused by motion and movement. Lateral lines serve an important role in predation, and orientation.

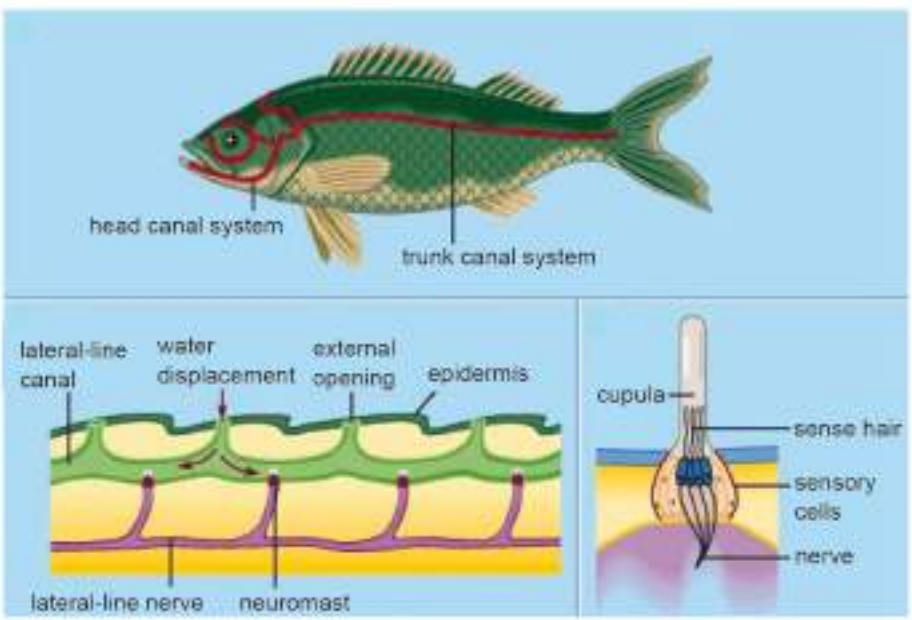


Figure 6.18 Lateral line system in fish

e. Sense of Hearing

Hearing organ contains mechanoreceptors and detect sound waves in environment. Grasshopper and most of butterflies have simple ears.

In the giant lubber grasshopper, the abdominal segment next to the thorax (behind the third pair of legs) contains the grasshopper sound detection organ. Like the ears of people and the "ears" of katydids, the grasshopper sound detector is a thin membrane called a **tympanum**. People often call it the "**ear drum**".

Human have a well developed organ of hearing which consists of three main parts.

1. Outer Ear

It consists of ear pinna and external auditory canal. External auditory canal contain hairs that covered by a waxy substance to trap the solid particles.

2. Middle Ear

It contains eardrum and ear bones and connected to the pharynx with a tube called **Eustachian tube**. This part convert sound waves into vibrations and transport to the inner ear.

3. Inner Ear

It contains semicircular canals which involved in balance and cochlea which involved in hearing.

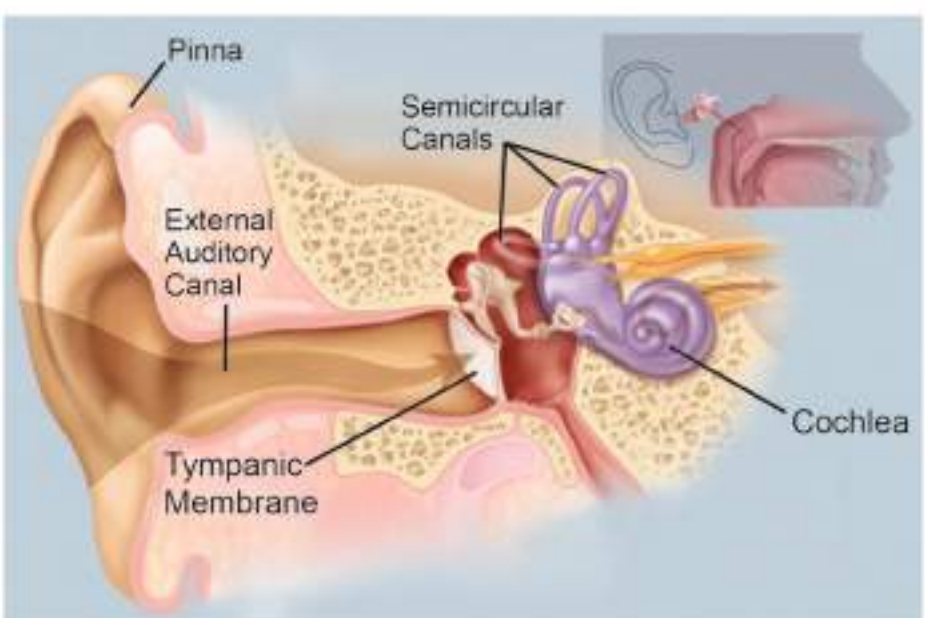


Figure 6.19 Structure of ear in human

f. Sense of Sight

The structure of an animal's eye is determined by the environment in which it lives, and the behavioural tasks must fulfill to survive. Arthropods differ widely in the habitats in which they live, as well as their visual requirements for finding food or conspecifics, and avoiding predators.

Some jellyfish, sea stars, and flatworms bear the simplest eyes, pigment spot ocelli, which have pigment distributed randomly and which have no additional structures such as a cornea and lens.

Spiders do not have **compound eyes**, but instead have several pairs of simple eyes with each pair adapted for a specific task The principal and secondary eyes in spiders are arranged in four or more pairs. The light-sensitive part of the receptor cells is next to this, so they get direct and reflected light. In hunting or jumping spiders, for example, a forward-facing pair possesses the best resolution to see the (often small) prey at a large distance. Night-hunting spiders' eyes are very sensitive in low light levels.

The human eye is an organ that reacts to light and has several purposes. As a conscious sense organ, the mammalian eye allows vision. Rod and cone cells in the retina allow conscious light perception and vision including color differentiation and the perception of depth. The human eye can distinguish about 10 million colors.

Figure 6.20

Simple eyes in spider and Ocelli in dragonfly

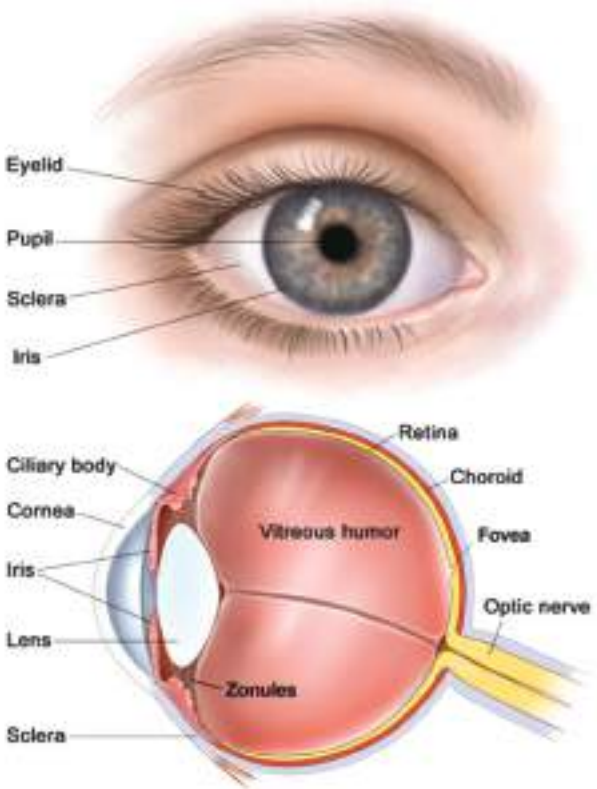


Figure 6.21 Eye structure in human

Chapter Review

Question 1. Read each sentence carefully and write if it is true or false

1. Nervous system coordinates and regulates body functions.
2. Paramecium gives only (+) responses to chemical stimuli.
3. Ethylene have role in falling of plants leaves.
4. The impulse is generated if the voltage reaches a certain critical point, known as the threshold level.
5. Planaria has a ladder-like nerve system.
6. Midbrain divided into two parts as telencephalon and diencephalon.
7. Ant produces pheromones to paralyse the prey and to mark its path.
8. Sense of taste contains chemoreceptors.
9. Pheromones are chemicals capable of acting outside the body of the secreting individual to impact the behaviour of the receiving individual.
10. Spiders do not have compound eyes, but instead have several pairs of simple eyes.

Question 2. Answer the following ;

1. Explain the sensation in Amoeba.
2. Write the types of nerves with their function.
3. Explain the lateral line system in fish.
4. Draw the structure of human ear and name the parts.
5. Explain the sense of hearing in grasshopper.

Question 3. Define the following terms.

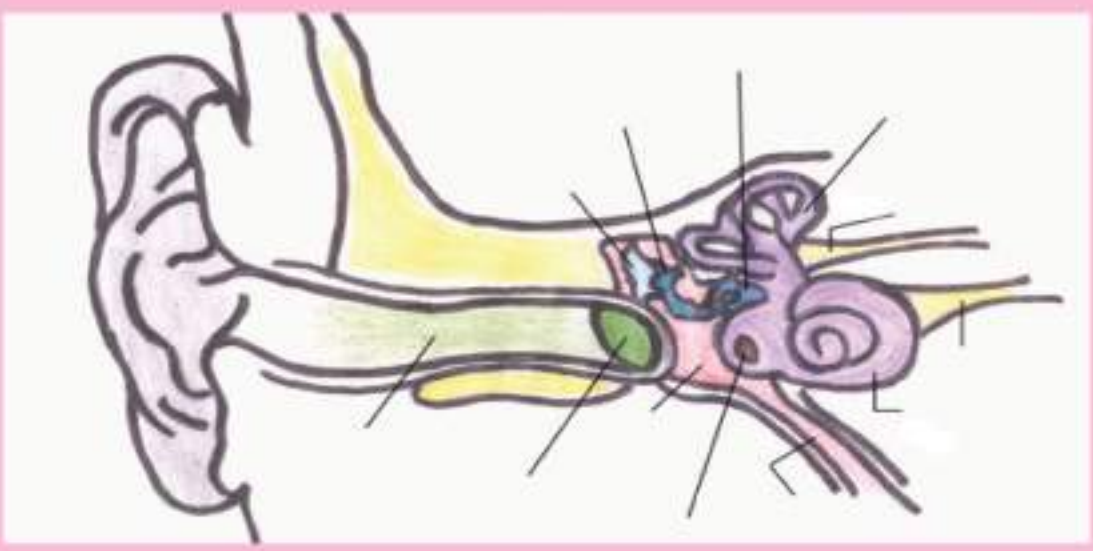
Pheromones, Neuron, Taste bud, Eustachian tube,
Eye spot, Propioreceptor, Polarization.

Question 4. Compare between the followings.

1. Sympathetic and parasympathetic nervous system.
2. Sensation in Amoeba and Paramecium
3. Dendrite and Axon.
4. Ear in grasshopper and in vertebrates.

Question 5. Label the parts in the Figuers below.

1.



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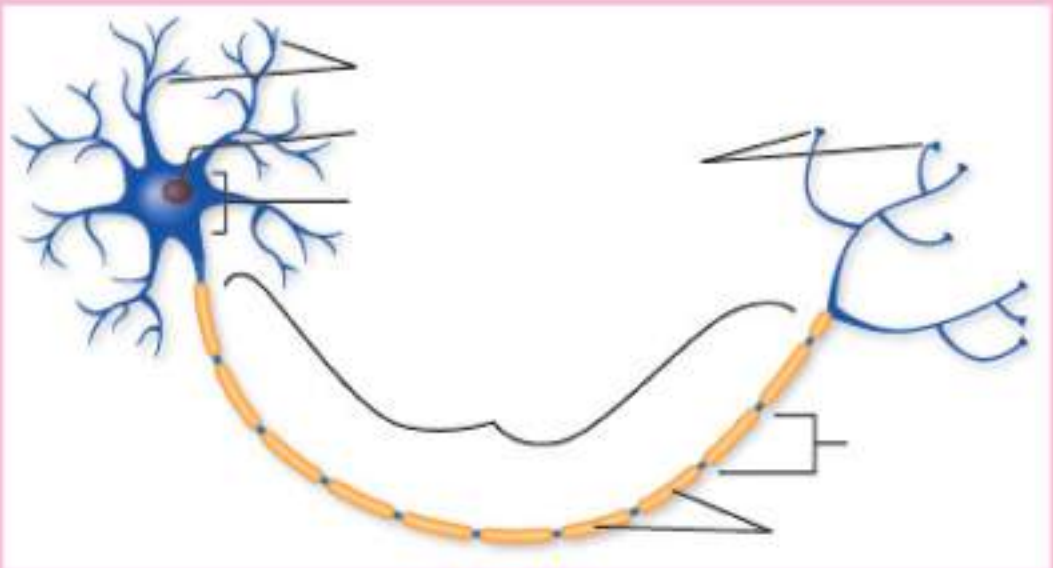
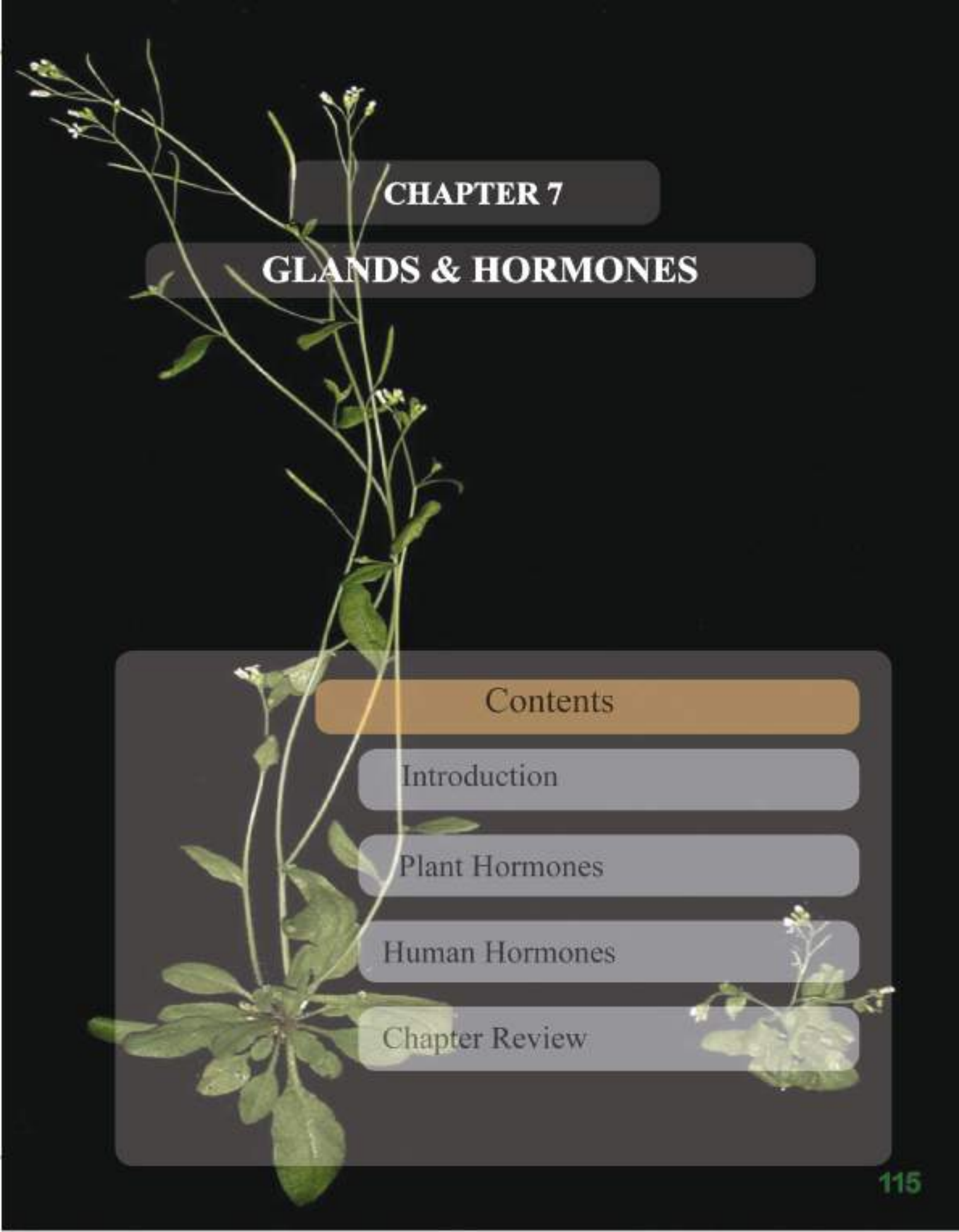




CHAPTER 7

GLANDS & HORMONES

Contents

OBJECTIVES

At the end of the chapter students must be able to;

1. Describe the structure, function and regulation of hormones.
2. Numerate the plant hormones and their effects on plant body.
3. Determine the hormones according to their chemical structure in human body.
4. Explain the regulation of hormone secretion.
5. Numerate the glands in human body and their effects.
6. Numerate the human body hormones in human body and their effects.
7. Determine the diseases appear in abnormal functioning of thyroid gland.
8. Determine the location of endocrine glands in human body.
9. Describe the neuro-hormones and their location of secretion.

Hormones and Glands

Introduction

There are two main regulatory systems in the body: hormonal (endocrine) and neural control systems. The hormonal control system is found in both animals and plants. A neural control system, however, is found only in animals.

The endocrine system is composed of endocrine glands. The secretions of the endocrine glands, known as **hormones**, are transported to their targets by diffusion (if the target is near) or in the blood. They regulate the function of the target organ. Target organ cells have special receptors peculiar to special kind of hormone.

Hormonal regulation is seen in both plants and animals. Invertebrates, such as segmented worms, insects,mollusks and crustacea, secrete hormones. All vertebrates regulate their metabolic functions by means of hormones. Hormones are extremely effective chemical substances due to their great potency.

Structurally, many of the hormones are proteins. They can be isolated and their chemical composition identified. A particular hormone can then be synthesized in vitro and the synthetic product used in the treatment of disorders caused by either a deficiency or an excess of that hormone.

Plant Hormones

Hormones are chemical messengers within an organism that control growth and development. Complex plants have hormones, much as other multicelled organisms. A hormone is a molecule released from one cell that changes the activity of target cell. A target cell is one having a receptor for a given molecule, either within the cell or at the surface of its plasma membrane.

Most flowering plants are known to produce five types of hormones: **auxin, cytokinins, gibberellins, abscisic acid,** and **ethylene**. Hormones are produced in small concentrations, but minute quantities have a huge effect on the cell by controlling plant growth and development through division, elongation, and differentiation of cells.

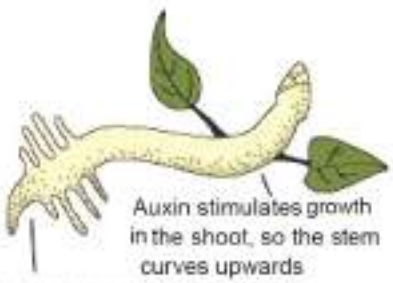


Figure 7.1 Auxin effect on root and shoot

The mechanism of plant hormone action closely resembles that of animals. Plant hormones are synthesized by a specialized group of cells and transported to the target organ or structure. Hormones have become tradley available in recent years.

Plant hormones can be categorised into two groups: growth promoters and growth inhibitors.

1. Growth promoters;

- Auxin
- Gibberellins
- Cytokinins

2. Growth inhibitors;

- Abscisic acid
- Ethylene

a. Auxin

Auxin is a type of hormone that controls elongation of coleoptiles and thus elongation of the plant cell.
In plants, the natural auxin extracted is indoleacetic acid (IAA), and is produced in the apical meristem of the shoot. The hormone works by moving from the shoot apex down to the region of cell elongation and then stimulating the growth of cells.

Auxin also affects cell division and differentiation at various other regions in the seed, and because of these various functions, the auxin is often made synthetically into herbicides, as well as for inducing fruit development without pollination.

b. Cytokinins

This group of hormones is produced in the embryo and the roots and are transported upward in the xylem vessels of adult plants. In an adult plant, growth and seed production is regulated by cytokinins. They play an important role in the prevention of decay in picked fruits and are involved in dormancy, the condition in which all metabolic activities of a plant are greatly reduced as a response to environmental conditions.

Cytokinins stimulate cell division, or cytokinesis, and influence the path of differentiation by stimulating RNA and protein synthesis. The production of proteins could be the cause of cytokinins' ability to trigger cell division.

The most common cytokinin found in plants, Zeatin, is produced in actively growing tissues, in particular, roots, embryos, and fruits. Cytokinins can also slow down the aging of some plant organs by stimulating RNA and protein synthesis, and by mobilizing nutrients from surrounding tissues.

Figure 7.2 Cytokinins have two functions, they are involved in the repair of damaged tissue and also in the differentiation of meristematic cells.

c. Gibberellins

Gibberellins stimulate growth in the leaves and stem. They are produced in roots and young leaves. In stems, gibberellins stimulate cell elongation and cell division, as well as bolting. The plant will begin the process of bolting during the non-flowering stage, when some plants develop low to the ground with short internodes. A surge of gibberellins causes reproductive growth and induces the stem to elongate rapidly. They stimulate the growth of cereal seedlings by stimulating the synthesis of digestive enzymes that mobilize stored nutrients.

Gibberellin injected into plants requires sunlight and low temperatures for germination and flowering. Additionally, gibberellins are responsible for germination, flowering and growth of seedless fruit of long-day plants.

Figure 7.3 Effect on giberellins on cabbage plant. Plant on right hormonized only.

d. Abscisic Acid (ABA)

Abscidic acid (ABA) is produced in the terminal bud, and helps prepare the plant for winter and the onset of seed **dormancy**. The ratio of ABA to the gibberellin concentration determines whether the seed will remain dormant or germinate. ABA also acts as a "stress" hormone, helping the plant cope with adverse conditions. ABA will accumulate in leaves and cause the stomata to close, reducing transpiration and preventing further water loss.

High concentration of ABA has the following effects;

- It reduces the rate of cell division in meristematic tissues

- It initiates the formation of a bud scar from the seed leaves.

Figure 7.4 Abscisic acid promotes the formation of bud scars which protect the meristematic tissue against adverse conditions.

The bud scar protects the meristematic tissues against low temperatures and drought during the long winter season. The presence of abscisic acid is important for the protection of the seed in the soil during the winter. In spring, the concentration of ABA decreases and the concentration of gibberellin increases, resulting in germination. This proves that ABA is an inhibitor of embryo and bud growth.

e. Ethylene

Maturation of fruit and the life span of the plant are both determined by ethylene. Its production is directly related to the concentration of auxin. If the amount of auxin is in excess, ethylene production is stimulated in order to suppress the effects of auxin by inhibiting growth. Fluctuations in auxin concentration stimulate the secretion of ethylene which then activates some enzymes in order to:

- convert starch and acids to sugar molecules.
- degrade pectin or the cell wall to soften fruit.

Ethylene secreted during fruit development affects the ethylene secretion of other plants. Thus, all plants in the field develop together.

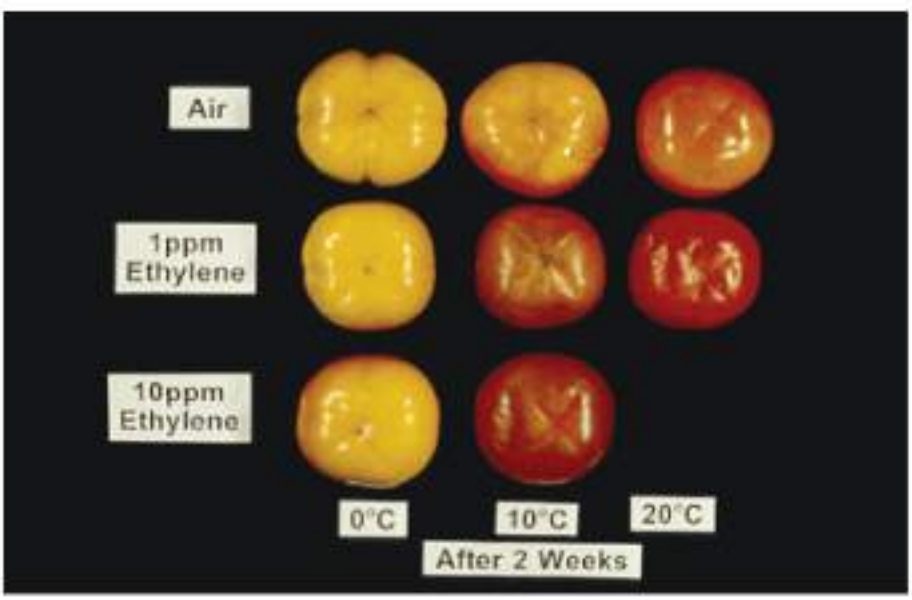


Figure 7.5 The function of ethylene in the maturation of fruit.

Human Hormones

Generally, hormones have a determined effect on metabolic functions; development, production, the level of glucose in the blood and on the concentration of minerals and water at specific levels. They also affect the permeability of the cell plasma membrane.

Hormones According to Their Chemical Structure

There are two main types of hormones, according to structure.

1- Peptide hormones are made of amino acids or their derivatives. They can not pass through the cell membrane. They connect to specific receptors on the membrane and trigger an increase of a secondary messenger compound within the cell, such as cAMP. The secondary messenger in turn activates enzymes that alter the cell's function.

2- Steroid hormones are derivatives of lipids. As a result, they can pass through the cell membrane without the aid of a receptor molecule. Inside the cell, they bind with receptor molecules. The hormone-receptor complex then enters the nucleus of the cell, where it acts on DNA to produce proteins. These proteins (enzymes) control certain body processes.

The Regulation of Hormone Secretion

Hormones are synthesized by endocrine glands when required.

Hormone synthesis is usually regulated in the following ways:

- An increase or decrease in the amount of different substances (minerals, water,etc.) in the blood.

- The effect of one endocrine gland on another, according to the amount of hormone in the blood.

- The effect of the nervous system on the endocrine system.

- Feedback mechanisms play an important role in the regulation of secretion.

RF (releasing factor), secreted by neurosecretory cells of the hypothalamus, stimulates hormonal secretion by the pituitary. It then stimulates hormone secretion by other endocrine glands.

If the amount of such a hormone increases in the blood, secretions from the hypothalamus and pituitary glands decrease. If the amount of hormone decreases, the secretion of the hypothalamus and pituitary increases.

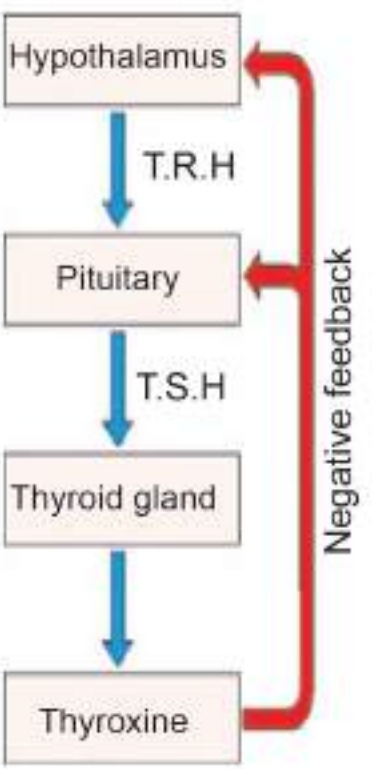


Figure 7.6 When thyroxine reaches a certain level in the blood, the hypothalamus is stimulated and the thyroid stop producing thyroxine.

Endocrine Glands in the Human Body

A.

a. Hypothalamus

The hypothalamus plays an important role in the secretory system of the body. It controls the pituitary gland and secretes hormones simultaneously. Its functions include the regulation of body heat and blood pressure, the regulation of water in the blood and formation of a regular sleeping pattern, as well as controlling the endocrine system via the pituitary. The secretions of the hypothalamus are known as **neuro-hormones.**

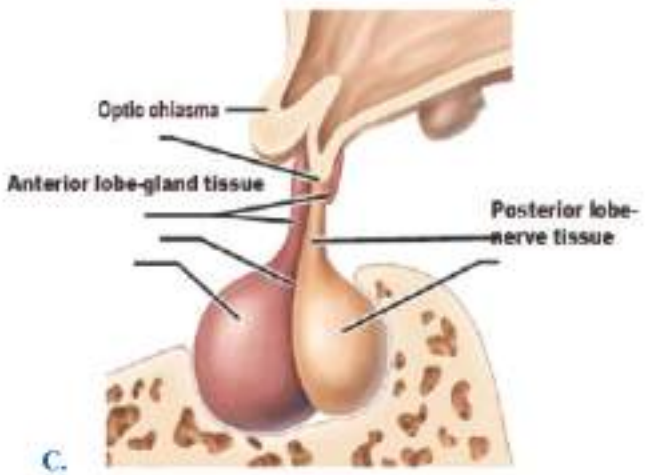
B.

b. Pituitary Gland

The pituitary is a gland which is connected directly to the hypothalamus region of the brain via a thin stalk. It is a very efficient gland and produces many hormones. However, it is amazingly tiny, about the size of a marble or a pea (1 cm in diameter). It consist of three main lobes:

1. Anterior Lobe

This lobe constitutes two fifths of the volume of the pituitary and is composed of epithelial tissue. Many hormones are released into the blood by this lobe. The anterior lobe mainly produces six different types of hormones. Four of them are tropic hormones, whose secretions cause other endocrine glands to release their own hormones.



C.

Figure 7.7 : A- Hypothalamus
B-Pituitary gland
C-Thyroid gland structure

2. The Middle Lobe

The middle lobe is composed of epithelial tissue. It is seen only during the fetal stage of development. From this lobe, MSH (melanin stimulating hormone), which stimulates melanocytes, is secreted. It affects the cells located within the skin containing melanin pigment. MSH determines the color of the skin. It is active in amphibia, reptiles and birds. Its effect is uncertain in mammals.

3. The Posterior Lobe

The posterior lobe is composed of nerve tissue and the following hormones are secreted from this region:

- ADH (Antidiuretic hormone)
- oxytocin

c. Thyroid Gland

The thyroid gland is located at the front of the neck, directly beneath the larynx. The thyroid gland is found in all vertebrates, and in humans it weighs approximately 25 g. In mammals, the thyroid gland is composed of two lobes. It has the highest capillary content as compared to all the other endocrine glands.

If the thyroid gland removed from a young individual, body growth stopes and the rate of metabolism decreases and this may even result in death.

These effects are less serious in adults. When thyroxine is given to adults, the effects of its deficiency disappear. When the thyroid gland secretes less hormone than normal in adult humans, the normal body temperature decreases by two degrees. In addition, the body accumulates lipids and obesity results, as does acne and loss of hair. The patient's face also swells and there is bagginess under the eyes. These conditions are symptoms of the disease **myxodema** (hypothyroidism in adulthood).

Figure 7.8 Hyperthyroidism

If the thyroid fails to develp properly in childhood, a condition called **cretinism** results. Individuals with this condition are short and stocky. Thyroxin therapy can initiate growth, but unless treatment is began within the first two months, mental retardation results.

On the other hand, if the thyroid produces too much of the thyroid hormones, T3 and TSH sy mptoms as a rapid heartbeat, nervousness known as **hyperthyroidism**.occured

Figure 7. 9 Simple goiter usually occurs when iodine is insufficient in the diet.

The synthesis and release of thyroxine from the thyroid gland is regulated by TSH secreted from the anterior lobe of the pituitary.

d. Parathyroid Gland

It comprises four distinct areas of tissue embedded in the thyroid gland. Parathyroid hormone (PTH) produced in these glands regulates the amount of calcium and phosphate in the blood. It causes the blood phosphate (HPO_4) level to decrease and the blood calcium (Ca^{++}) level to increase. The exact amount of calcium is necessary for the normal functioning of muscles, heart, skeleton and nerves, and is regulated hormonally by the thyroid and parathyroid, which transfer calcium between the bones and the blood.

e. Pinal gland

This gland considered as the canal between the nervous system and the endocrines because its transmitted the nerve impulse to excretion
This gland secrets the **Melatonin** which is responsible to sexual adultery.

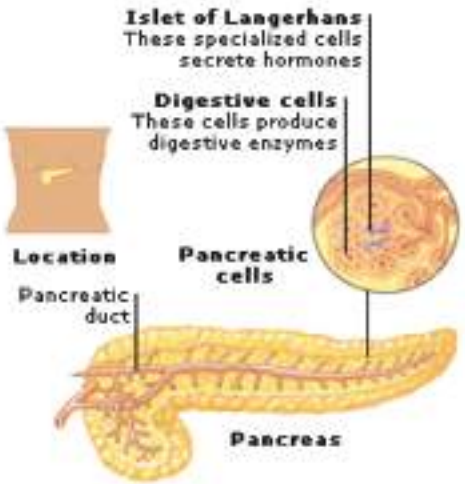


Figure 7. 10 Structure of pancreas

f. Pancreas

This gland produces and secretes two well-known hormones: **insulin** and **glucagon**.

Insulin decreases blood glucose concentrations by either causing cells to use it as an energy source or convert it to glycogen, a much less soluble form of carbohydrate, and storing it in the liver and muscles to be used later. A lack of insulin is known to cause **diabetes mellitus**. There are two main types of this disorder.

Glucagon, a second hormone secreted by **the islets of Langerhans**, enables the concentration of blood sugar to increase by increasing the rate of glycogen catabolism in the liver. When the blood glucose level is low, glucagon triggers the liver to convert glycogen to glucose. As the concentration of glucose increases, glucagon secretion is reduced. The presence of insulin acts as an inhibitor.

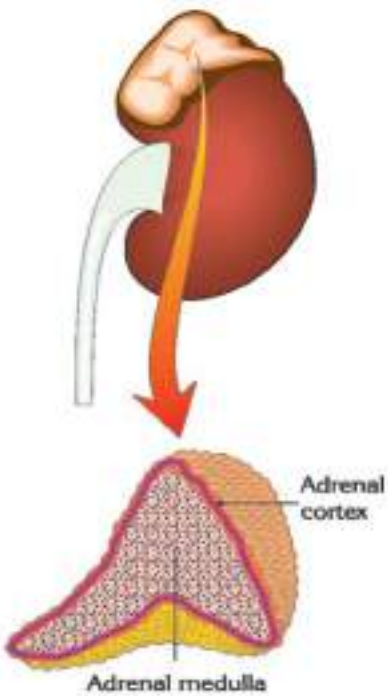


Figure 7.11 Adrenal gland

g. Adrenal Glands

The human body has two adrenal glands, each positioned on top of a kidney. Each one is approximately 12 g in weight and is characterized by its rich capillary network. The adrenal glands have a more extensive capillary network compared to other organs of the body. In adults, the adrenal glands have fibrillar contact with the kidneys and, if a kidney is removed, adrenal gland remains unaffected.

The adrenal glands are composed of two distinct regions. The outer, light yellow region is known as the **adrenal cortex**, and the inner dark-brown region is known as the **adrenal medulla.**

The adrenal cortex constitutes the most important part of the gland, since it is the site of hormone secretion. These hormones are known as **corticoids**, and are steroidal in structure.

The adrenal medulla is different from most other endocrine tissue in that its cells are derived from cells of the peripheral nervous system and are specialized to secrete hormones. Hormones of the adrenal medulla are epinephrine (**adrenaline**) and norepinephrine (**noradrenaline**). These hormones respond to stress. They are involved in the immediate response to stress. If a person continues to be highly stressed over a long time, the result can even be death.

H. Gonads

The main function of the male and female gonads is the development of the reproductive system. They also function as endocrine glands. The hormones secreted by the gonads are steroid in structure. LH and FSH hormones stimulate hormone secretion from the ovaries and testes. In the presence of these hormones, estrogen and progesterone are secreted by the ovaries and testosterone is secreted by the testes.

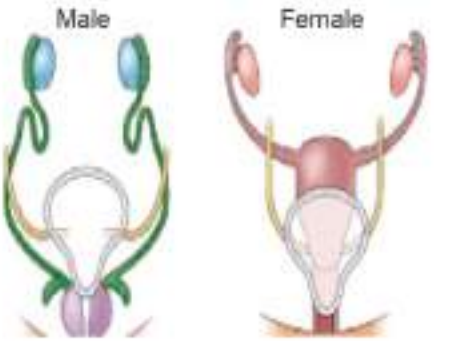


Figure 7.12 Male and female gonads

I. Thymus Gland

The thymus gland is located in the thorax cavity.
The thymus produces a variety of hormones to promote development of certain immune cells called **T lymphocytes**. This gland is quite active during childhood, but is replaced by fat and connective tissue and becomes non-functional in adulthood.

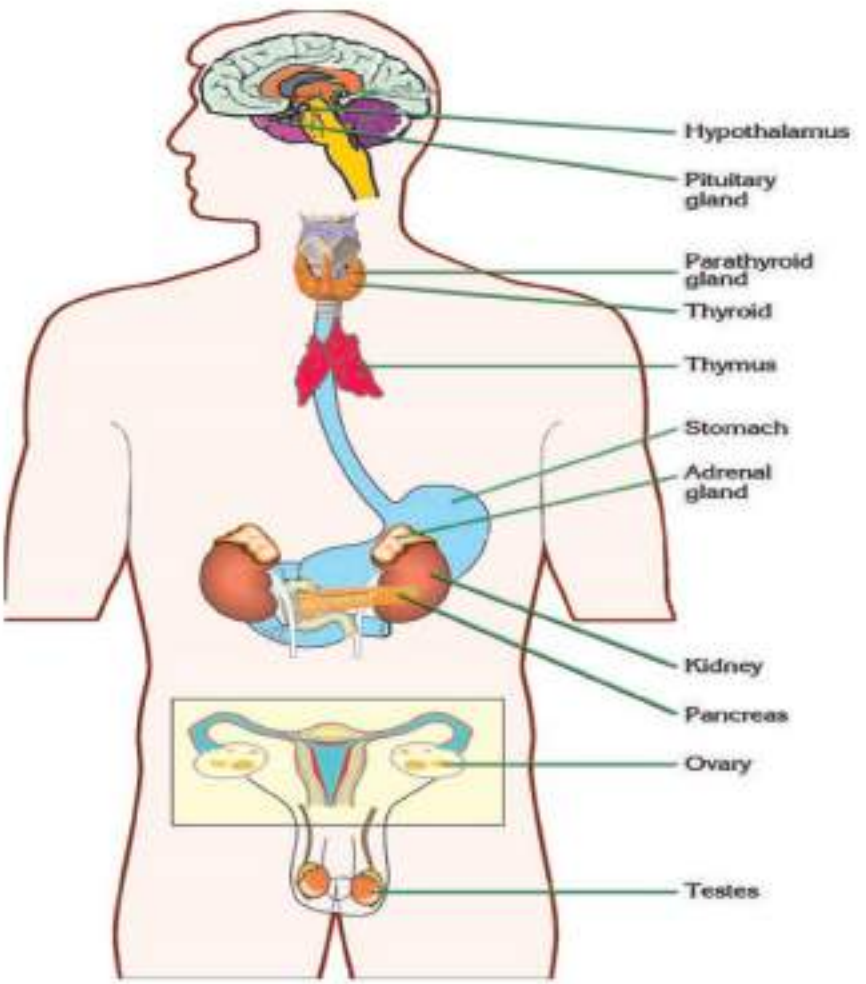


Figure 7.13 Human endocrine glands

ENDOCRINE GLANDS - HORMONES & THEIR EFFECTS

GLAND		HORMONE		EFFECTS
Pituitary	Posterior lobe of the pituitary	Antidiuretic hormone (ADH) (Vasopressin)		It stimulates the contraction of smooth muscles, increases blood pressure and increases reabsorption of water from the kidneys.
		Oxytocin		It stimulates milk secretion and contraction of uterine muscles.
	Anterior lobe of the pituitary	Growth hormone (Somatotropic hormone = STH)		It controls growth and bone formation since it affects carbohydrate, lipid and protein metabolism.
		Gonadotropins	Prolactin (LTH)	It promotes development of mammary glands during pregnancy and then regulates the production of milk after birth. It also initiates the mothering instinct.
			Luteinizing hormone (LH)	It is involved in release of the ovum from the follicle and release of progesterone from the corpus luteum in females. It triggers the secretion of testosterone in males.
			Follicle stimulating hormone (FSH)	It stimulates the development of an ovum from one of the ovaries. It also stimulates the secretion of estrogen from the developing follicles.
			Adreno-corticotropic hormone (ACTH)	It stimulates the secretion of cortisol from the adrenal cortex.
		Thyroid-Stimulating hormone (TSH)		It stimulates the secretion of thyroxine from the thyroid gland.
		Melanocyte stimulating hormone (MSH)		It stimulates melanin production from melanocytes in the skin.
Thyroid gland		Thyroxine		It accelerates metabolism and heart rate.
		Calcitonin		It reduces the concentration of calcium in the blood.
Parathyroid gland		Parathormone		It increases the concentration of calcium in the blood.
Adrenal glands	Cortex	Cortisol		It influences carbohydrate, fat and protein metabolism. It is mainly involved in the conversion of proteins to carbohydrates.
		Aldosterone		It maintains homeostasis of sodium in the blood by regulating the concentration of sodium reabsorbed in the loop of Henlé. It is also involved in the excretion of excess potassium.
	Medulla	Epinephrine (Adrenaline)		They increase blood pressure, glucose level and flow rate.
		Norepinephrine		
Pancreas (islets of Langerhans)	β cells	Insulin		It maintains glucose homeostasis in the blood by converting any excess into insoluble glycogen..
	α cells	Glucagon		It maintains glucose homeostasis in the blood by converting glycogen into glucose.
Ovarium	Follicle	Estrogen		It stimulates formation of secondary sexual characteristics, maturation of reproductive structures, and thickening of the endometrium.
	Corpus luteum	Progesterone		It stimulates the development of mammary glands. It maintains the endometrium (lining of uterus) during pregnancy.
Testes		Testesterone		It stimulates the formation of secondary sex characteristics..
Placenta		Estrogen, progesterone		It is secreted during embryonic development.

Chapter Review

Question 1. Read each sentence carefully and write if it is true or false.

1. The synthesis and release of thyroxine from the thyroid gland is regulated by TSH secreted from the anterior lobe of the pituitary.
2. Gibberellin injected into plants requires sunlight and low temperatures for germination and flowering.
3. The thymus produces a variety of hormones to promote development of red blood cells.
4. Hormonal regulation is seen only in plants and nervous regulation seen only in animals.
5. Glucagon desreases the sugar level in blood.
6. Maturation of fruit and the life span of the plant are both determined by ethylene.
7. Giberellins affects cell division and differentiation at various regions in the seed.
8. Thyroid hormone (PTH) regulates the amount of calcium and phosphate in the blood.
9. RF (releasing factor), secreted by neurosecretory cells of the pitutary gland, stimulates hormonal secretion by the hypothalamus.

Question 2. Answer the following questions

1. What are the effects of giberellin hormone on plants?
2. Explain the effects of auxin hormone.
3. What is the usage of ethylene hormone?
4. Why hormones effect only some specific parts of body?
5. What are the ways of hormon regulation?
6. What are the functions of thyroid gland?
7. What are the hormones produced by pancreas and their function?
8. What are the functios of hypothalamus?
9. Explain the types of human hormones according to their structure.

Question 3. Explain the following scientific fact.

1. In diabetes, blood sugar cannot be controlled.
2. The adrenal cortex is most important part of adrenal glands.
3. The swelling of thyroid gland
4. Generally human hormones have no effects on plants.

Question 4. Define the following terms.

Hyperthyroidism, Auxine , Releasing factor, Adrenaline, Hormone, Gland

Question 5. Compare between the followings.

1. Insulin and Glucagon.
2. Auxin and Giberellin.
3. Adrenal cortex and adrenal medulla.
4. Pituitary galnd and hypothalamus.
5. Polypeptide hormones and steroid hormones.

Question 6. Label the parts in the Figure below.