NUTRITION IN ANIMALS AND PLANTS

[THE PRIMARY NEED FOR LIFE]

4

SYLLABUS

1. Classes of foods (carbohydrates, fats, proteins) and examples of these — why the body needs them.

   Vitamins — A, B group, C, D, E — sources, need, deficiency symptoms (in brief).

   Minerals — iron, calcium, phosphorus, iodine — sources, need, deficiency symptoms (in brief).

   Water and roughage.

Energy obtained from food is measured in calories. (Definition of calorie not required) — link with nutritional information often available on food packets. The daily requirement of calories is dependent on age and occupation.

(**Note** : Most foods contain more than one class of foodstuff — however they may be rich in one particular group. Students need to have a clear concept about this).

2. A balanced diet — analysis of daily diet to find ways of improving the same, if needed.
3. Food fads — fast foods, additives, obesity, developing good food habits.
4. What animals eat — herbivores, carnivores, omnivores (revision).
   * Games involving classification of everyday foods into the groups, developing good food habits etc. These may even be developed by students with guidance from the teacher (E).
   * Testing raw and cooked foods for starch with a dilute aqeuous solution of iodine. (**Note** : include *dals* and discuss why they test positively for starch) (E).
   * Testing foods for fats by rubbing them on paper (E).
   * Test for protein (D only).
   * Analysing their own food, checking if the daily diet is balanced (E).
5. Plants are the only living things that make their own food. Photosynthesis and factors that affect it — macro and micronutrients for plants — some examples — deficiency diseases in plants (e.g. nitrogen, iron).

   How plants obtain their requirements for photosynthesis.

   The working of the stomata.

   Experiments to show the need for light and chlorophyll during photosynthesis — **to be demonstrated only**.

   Transport of food to different parts of the plant.

   Plants also use the food they make for their own growth/repair.
6. Autotrophic and heterotrophic nutrition — parasitism and symbiosis with examples.
7. Food chains, food webs — revision.
   * Location of vascular bundles in the stem (D).
   * Observing root hair in germinating seeds (E).

FOOD FOR LIFE

Food is a kind of "fuel" as well as a kind of building material for all living organisms. Food contains nutrients — the raw materials our body needs to build everything from muscles and bones to the brain and the heart.

We drink milk and eat different types of food like bread, *chapati*, rice, butter, ghee, vegetables, fruits, meat, eggs, pulses, etc. The food provides us nutritive substances for growth and energy. Good choice of foods gives the body what it needs to grow and do its daily tasks. Choosing the wrong foods deprives the body of some of the nutrients it needs to function properly.

The food provides our body :

- Energy to do work.
- Nutrients for the growth, repair of damaged cells and tissues.
- Materials for keeping us healthy and disease-free.

Food that provides us all the above substances is a **nutritive food.** Such food contains various **nutrients** like **carbohydrates, proteins, fats, minerals** and **vitamins**. A nutrient can be defined as **"a constituent of food that helps one way or the other in the body functions"**.

The food constituents are categorised into carbohydrates, fats and proteins as **macronutrients** (bulk requirement) and minerals and vitamins as **micronutrients** (minute requirement).

Nutrition

It is a process by which living things receive food and utilise it to grow and become healthy. **Animals** eat food for getting energy and nutrients, but the **green plants** obtain nutrients by synthesising food through photosynthesis. **For an infant**, food is just the mother's milk, which provides everything for growth and good health. But, as the child grows, he or she requires a variety of other items in the food so that the needs of the growing body are fulfilled.

Types of Nutrients

Nutrients are classfied into five major groups :

- **Carbohydrates** (like rice and potato provide starch and sugar cane provides sucrose) provide energy.
- **Proteins** (like pulses, milk, egg, etc.) to provide body building material.
- **Fats** (like ghee, oil and butter) to provide energy.
- **Minerals,** such as iron, sodium, calcium, phosphorus, etc., for their specific role in the body.
- **Vitamins** are needed for the normal functioning of various body processes.

CLASSIFICATION OF FOOD

We have a variety of foods that provide us energy. A group of some foods help us in body building, while some foods are protective foods. As such, foods can be classified into three groups

on the basis of the functions they perform in our body. These are (Fig. 4.1):

(1) Energy-giving foods,

(2) Body-building foods, and

(3) Protective foods.

(1) Energy-giving Foods

Our body is continuously at work, when we are walking, running, or in any other motion. Even while sitting and reading, our body is doing some work. Even while sleeping, many parts of our body, like the heart, lungs, intestines, etc., are at work. All such activities consume energy. This energy comes from two major types of food — **carbohydrates** (cereals, sugars, etc.) and **fats** (butter, oils, etc.).

Carbohydrates

Carbohydrates are the main source of energy to work, and heat for the warmth of the body. They are formed of carbon, hydrogen and oxygen. There are two types of carbohydrates – simple and complex. Simple carbohydrates include

Fig. 4.1 The three groups of food — energy-giving foods, body-building foods, and protective foods

sugars such as *glucose* and *fructose*, commonly found in fruits, and double sugars like *sucrose* and *lactose* found in sugarcane and milk respectively.

Complex carbohydrates include *starch* found in wheat, rice, potato etc., and *cellulose* which comprises the cell walls of the plant substances.

ACTIVITY 1

Test for a carbohydrate (starch).

Take two test tubes. Mark them as A and B. Take some starch solution in test tube A and water in test tube B. With the help of a dropper, put in a few drops of iodine solution. The iodine solution (orangish) imparts blue-black colour to the starch solution. Make a note of your observations.

Food	Colour change into blue-black (Yes/No)	Food contains starch (Yes/No)
Potato	.....	.....
Bread	.....	.....
Cucumber	.....	.....
Onion	.....	.....

- Add 5–7 drops of dilute iodine solution in each test-tube and observe the colour change, if any.

Observation :

Test tubes	Observations	Inference
Test-tube 1 (crushed potato)	....	.....
Test-tube 2 (rice powder)	....	.....
Test-tube 3 (boiled dal)	....	.....

A blue-black colour appears in test-tube 1 and 2 as both potato and rice are rich source of starch. Dal does not contain much starch.

Fats

Fats provide energy, as well as they serve as some of the building material for the body. Fats contain about twice as much energy as carbohydrates. Sources of fats are oil, butter, meat, ghee, nuts, whole milk, etc.

Fats are large molecules made up of smaller ones called **fatty acids** and **glycerol**.

ACTIVITY 2

Test for starch.

- Take 3 test tubes and mark them as 1, 2 and 3.
- Put some *crushed potato* in test-tube 1; *rice powder* in test-tube 2; and *crushed boiled dal* in test-tube 3.
- Add some water in each test tube. Shake them well for few minutes.

ACTIVITY 3

Test for fat.

Take a long strip of brown paper. Divide it into sections and label each section with the name of a food item which is to be tested for the presence of fat. One at a time, crush and rub each food item on its labelled section of the brown paper. Let the brown paper dry

for some time. Hold the paper up to a light source. Look for a translucent spot in each section. Foods that contain fats (oil) leave a translucent spot on the brown paper. In a table, record the name of each food and whether or not it contains fat. You can perform the test on peanuts, mustard seeds, soybeans, onions, potatoes, almonds and cashewnuts.

ACTIVITY 4

Test for fats.

Materials required :

1–2 ground nuts, almonds, walnut, butter, ghee, a pestle and mortar, and a piece of white paper.

Procedure :

- Take 1–2 peanuts/almonds/walnut and place them on a clean sheet of white paper. With the help of the pestle, crush the nuts on the paper. Remove the crushed nuts, and observe.
- Take 1–2 drops of ghee or a little butter and smear it on another clean sheet of white paper. Wipe off with a napkin and observe.

Observation :

A greasy transluscent spot is seen on the white paper where the substances were applied in both the cases. This shows the presence of fats in butter/ghee as well as in peanuts, almonds, walnut, etc.

(2) Body-building Foods (rich in proteins)

These provide materials for growth and repair. Growth means addition of living substances in the body (more cells, more blood, etc.). Food provides for these additional substances. During activities, some cells of the body may become weak, damaged or they may even die. Food also provides material for **repair** of any such wear and tear. Even otherwise different tyes of cells have different life spans. For example, the red blood cells live only for about 120 days, during which they grow old and die. Thus new red blood cells have to be produced. Sometimes, the skin gets cut. The cut is healed by regeneration of new skin. Here also, new cells are formed. The body-building foods are rich in proteins (examples: dal, pulses, milk, egg, fish, etc.).

Proteins

Proteins are nutrients that provide the body with materials for cell growth and cell repair. Proteins are made up of smaller molecules called **amino acids.**

Amino acids contain carbon, hydrogen, oxygen and nitrogen. Usually, atoms of sulphur and phosphorus are also found in proteins. Pulses, beans, meat, chicken, fish, egg, peanuts, nuts are rich sources of proteins. An important protein in milk is **casein.** Egg white is rich in the protein **albumin.**

Every plant and animal makes its own special protein. Protein found in peanuts is not the same as protein in meat. Fish protein is different from meat protein. Protein in liver is different from protein in brain or in muscle tissue.

There are thousands of different proteins in our body. But, there are only 20 amino acids, which combine to form these proteins. Each tissue makes its own protein by putting these amino acids together in its

own special way. This is like making thousands of words from just twenty-six letters of the English alphabets.

ACTIVITY 5

Test for protein (To be demonstrated by the teacher) :

Put a little quantity of the white of an egg in a test tube. Add a few drops of dilute nitric acid (HNO_3) and heat. It turns yellow. Pour the acid out and let the white of an egg remain in the test tube. Add a few drops of ammonium hydroxide and note the colour change. It turns from yellow to orange.

(3) Protective Foods

By protective food, we mean such foods that helps to keep us disease-free. Such foods are rich in minerals, vitamins, and water (examples: whole cereals, green leafy vegetables and fresh fruits). We may suffer from common cold and cough if we do not take vitamin C in our food; or we may suffer from **anaemia** (blood shortage) if our food lacks iron.

Vitamins

Vitamins are nutrients found in very small amounts in foods. Most vitamins are available in green plants. The body needs some vitamins every day, for good health and proper growth.

Vitamins are found in many foods but no single food contains all the vitamins that the body needs. Eating a variety of foods provides all the vitamins. Vitamins of B and C groups are water-soluble whereas Vitamins A, D, E and K are fat-soluble and can be stored in the body.

When the food does not contain enough amount of a certain vitamin, a person can become sick. This kind of sickness is called a **deficiency disease.** Fat-soluble vitamins, if taken in excess, get accumulated in the body and may even cause harm. The table below gives a list of vitamins, the foods which provide them, their functions and the related deficiency diseases.

Table 4.1 : Vitamins, Vitamin-deficiency diseases, their symptoms, and sources

Vitamin	Deficiency	Symptoms	Food Sources
1. Vitamin A (Retinol)	Night blindness, Xerophthalmia	Poor vision in dimlight Dryness of the cornea	Milk, cheese, butter, eggs, cod-liver oil, yellow or red vegetables like carrots, yellow fruits like mangoes, papaya.
2. Vitamin B_1 (Thiamine)	Beri-beri	(i) Pain in hands and feet, (ii) Swelling of the body.	Milk, cheese, liver, yeast, meat, green leafy vegetables, whole grains.
3. Vitamin B_2 (Riboflavin)	Riboflavinosis	(i) Retarded growth (ii) Mental disorder	Milk, liver, meat, eggs, peas, yeast, whole grains, green leafy vegetables.

(contd.)

4. Vitamin B_7 (Niacin)	Pellagra	(i) Dermatitis (skin-eczema) (ii) Diarrhoea	Milk, fish, eggs, meat, legumes, whole grains, green leafy vegetables.
5. Vitamin B_{12} (Cyanocobalamin)	Pernicious (severe) anaemia	(i) Retarded growth (ii) Paleness of skin,	Cheese, milk, eggs, meat, liver, fish.
6. Vitamin C (Ascorbic acid)	Scurvy	(i) Bleeding gums, (ii) Pain in joints	Amla, tomato, cabbage, lemon, orange, guava, pineapple, sprouted grains.
7. Vitamin D (Calciferol)	Rickets in children and osteomalacia (in adults)	(i) Bow legs (ii) Pigeon chest (iii) Softening of bones	Milk, cheese, egg, cod liver oil, fish, butter, exposure to sunlight for synthesis of vit. D inside the body.
8. Vitamin E (Tocopherol)	Sterility in males and aborption may occur in females	Abnormal functioning of reproductive system and muscles.	Green leafy vegetables, milk, butter, meat.

Minerals

A mineral is an element that helps the body to function normally. Minerals are necessary for the growth and development of bones and teeth, the growth of cells and the formation of red blood cells. They are also important for proper functioning of the circulatory and the nervous systems.

To get all the nutrients, you should eat a variety of food items. Some of the **minerals** needed by the body and their importance are listed in the table given below.

Table 4.2 : Some of the minerals needed in our body, their deficiency symptoms and the sources

Minerals	*Needed for*	*Deficiency symptoms*	*Sources*
Calcium	Building bones and teeth and in blood clotting.	Softening and deformation of bones, loss of teeth enamel.	Milk, eggs, fish and vegetables.
Phosphorus	Building strong bones and teeth.	Softening of bones, bow legs, pigeon-chest.	Milk, meat, nuts, beans and cereals.
Iron	Formation of haemoglobin in RBCs	Weight loss, looks pale (anaemia), loss of apetile.	Green leafy vegetables, egg yolk and liver.
Iodine	Producing a hormone (thyroxin) which controls the oxidation of food inside the body.	Goitre (swelling in neck), dwarfism, mental retardation, swelling of face and hands.	Iodised salt and seafood.
Sodium - Potassium	Normal functioning of nerves and muscles.	High blood pressure, fatigue, loss of appetite.	Banana, milk, vegetables, meat.

ACTIVITY 6

Take a packet of oral rehydration solution (ORS) from a chemist's shop. Make a list of all the minerals present in it. Why do you think that it is given to people suffering from diarrhoea and vomiting ?

Water

Several chemical changes that take place in the our body occur only with water as the medium. Ninety per cent of our blood is composed of water. Water transports the nutrients and other materials throughout the body. Water helps in eliminating wastes from the body. It also regulates the body temperature.

An average adult loses about 2-5 litres of water each day. Only one litre of water is replaced by drinking water and other fluids. The remaining amount is replaced by eating food that contains water.

Roughage

Roughage is the fibrous material present in whole cereals, vegetables and fruits. It consists mainly of an indigestible part of carbohydrate called **cellulose.** Since cellulose a is a fibrous material, it absorbs lot of water and retains it. This keeps the faecal matter soft and prevents constipation. Thus, the movement of the undigested food through the intestine also becomes easier.

ACTIVITY 7

➢ Given below are pictures of 25 items, most of which we generally consume in our daily food.


APPLE

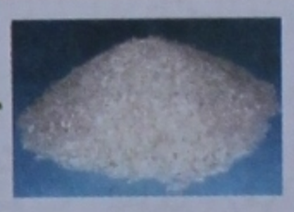

FENUGREEK LEAVES (Maithi)


GRAM


EGG


LEMON


CARROT


RICE


PUMPKIN


RAJMAH


BEANS


SPINACH (Palak)


TOMATO


BREAD


BANANA


ANISEED (Saunf)


CARDAMOM (Elaichi)


BUTTER


WATER MELON


FISH


CHAPATI


MANGO


CABBAGE


PIGEON PEA (Arhar)


PAPAYA


MILK

Categorise the items as rich sources of the undermentioned nutrient food groups. You can repeat any one or more of these items under the different food groups. **(contd.)**

Food groups	Items included
1. Carbohydrates	.....
2. Fats	.....
3. Proteins	.....
4. Minerals	.....
5. Vitamins	.....
6. Roughage	.....

- Do you find some items from amongst the pictures not strictly falling under any of the six groups ? Yes/No.....

If so, write their names .....

What purpose do these items serve in your food ? .....

BALANCED DIET

How do you know that you are getting all the nutrients which your body needs ? When your diet supplies *all the nutrients* in the *right quantity* according to the requirement of the body, it is called a *balanced diet*.

However, a balanced diet is not the same for everyone. It depends on age, sex and the type of work that one does plus personal likings.

- In early childhood, the child grows rapidly. He or she needs more proteins.
- Nursing mothers and pregnant women also need more proteins to serve the needs of the growing baby.
- A hard-working labourer needs more energy which he can get by eating more fats and carbohydrates.

There are hundreds of food items which you can eat. How do you know which one will give you the right balance of the nutrients you need each day ?

Fig. 4.2 The four basic food groups

Table 4.3 : An example of balanced diet for a 12 - year-old child

Foodstuff	*Weight (vegetarian)*	*Weight (non-vegetarian)*
Cereals	320 g (rice 160 g. wheat 160 g)	320 g (rice 160 g, wheat 160 g)
Pulses	70 g	60 g
Green leafy vegetables	75 g	100 g
Other vegetables	75 g	25 g
Fruits	50 g	50 g
Milk	250 g	250 g
Fat	35 g	35 g
Sugar or jaggery (gur)	50 g	35 g
Meat, fish or egg	-	30 g or 1 egg

All foods can be divided into *four* basic food groups (Fig. 4.2). Each group contains some of the nutrients that are needed by the body. By taking the proper amount of food from each group, the body gets all the nutrients that it needs for a balanced diet.

The recommended daily intake of the important nutrients for a 12-year-old child are :

Calories : 2200 (girl), 2600 (boy)
Proteins : 2 - 5 g x body weight
Fats : 30 - 50 g
Minerals : 10 - 30 mg
Vitamins : 1 mg of vitamin A,
1 mg of vitamin B,
50 mg or more of vitamin C

ACTIVITY 8

- Given below is the list of food items which we normally eat in our breakfast, lunch, dinner and snacks between the main meals.

  Chapati/bread, rice/biryani, dals/ pulses, beans/peas, cabbage, potato, tomato, dahi, milk, egg, fish, meat, chicken, butter milk, some sweets, ice creams, idli-dosa, dhokla, uttapam, upma, dalia, fruits, etc.

- Write from amongst the above list, the names of items which you normally include in your food most of the days in your breakfast, lunch, dinner and snacks between the main meals.

(contd.)

1. **Breakfast :**.....
2. **Lunch :** .....
3. **Dinner :**.....
4. **Snacks :** .....

➢ Classify the food items you are eating under each of the following categories, and check that your diet is balanced.

1. **Carbohydrates :**.....
2. **Proteins :**.....
3. **Fats :**.....
4. **Minerals :** .....
5. **Vitamins :**.....
6. **Roughage :** .....

➢ Check from your book whether your diet includes all the items in the required quantity under the six categories given above.

ACTIVITY 9

Make a list of foods you had eaten yesterday for breakfast, lunch and dinner. Do not forget to include snacks eaten in between the two meals. Now check whether you ate enough food from each food group. Group the food items according to whether they contain carbohydrates, fats, proteins, vitamins and minerals.

HOW MUCH SHOULD YOU EAT

A balanced diet provides sufficient amount of energy (measured in calories).

A *calorie* is the amount of heat required to raise the temperature of one gram of water by one degree Celsius. Considering the energy value of foods, usually the term *"Kilocalorie"* is used which is written either as "Kcal" or "Calorie" with capital letter "C". A Kilocalorie is 1000 times greater than the calorie.

When we say that a slice of bread has 70 Calories, what does this mean? It means that if the slice of bread is completely burnt, it will give off enough heat to raise the temperature of 1000 ml of water by 1°C. The same amount of energy is released when bread, after digestion, is oxidised in the body cells.

The calorific values in calories of different food items are presented in the Table given below.

Table 4.4 : Calorific value of some common foods

Food	*Portions*	*Calories*
Bread	1 slice, white	65
Chapati	1	150
Apple	1 medium	80
Rice	100 g	500 - 600
Milk	1 cup	150
Butter or ghee	1 tablespoon	100
Egg	1 boiled	80
Meat	50 g	100
Carrot	1 medium	30
Orange juice	1 cup	120
Potato (baked)	1 medium	145
Tomato	1 medium	50
Potato chips	1 small bag	135
Hamburger	1	250

Calorie Requirement of Different People

How many calories does one require everyday ? This depends on the person's

age, body size, nature of occupation and the amount of energy he uses.

An **adult labourer** doing heavy physical work needs about 3500 calories per day, a **clerk** mostly doing table work requires between 1800 and 2500 calories and a **child** of about six years needs roughly 1100 calories. An **adult lying at rest** requires about 1600 calories per day and a **woman at complete rest** needs about 1450 calories.

If a person takes in the same number of calories that are used up, his or her weight will remain constant. If the daily intake of food does not provide sufficient calories, a person would lose weight (as it rapidly happens during fasting). In that situation, the existing food stores of the body are used up and the capacity to work is reduced.

The bar graph shows the number of calories required per day by persons of different age groups for normal activities.

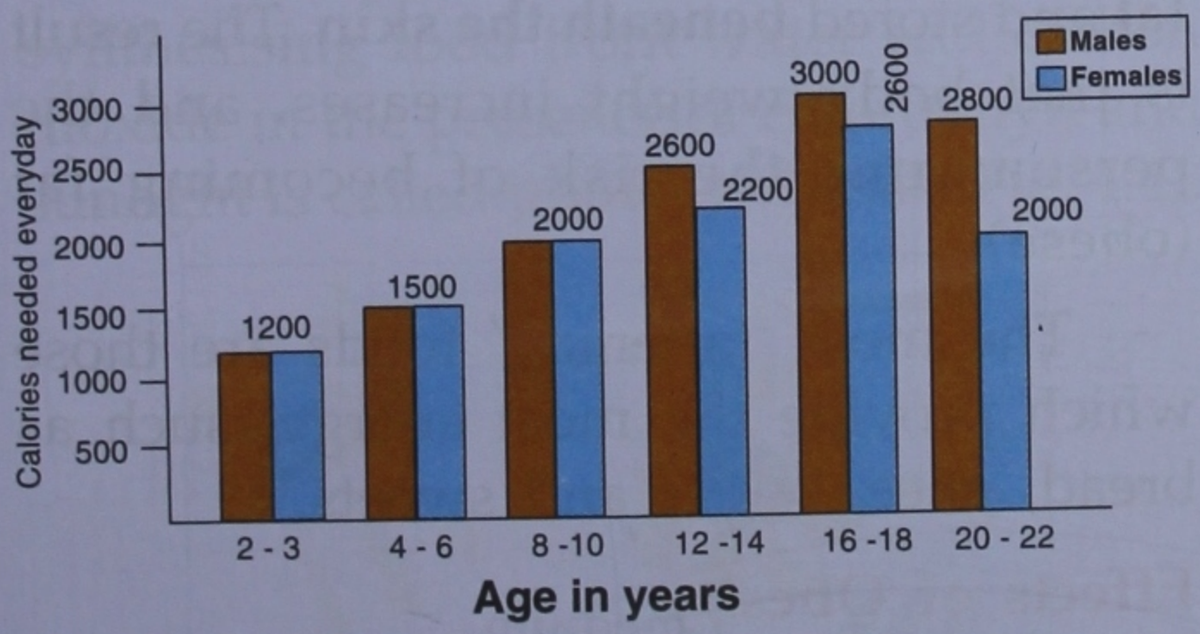


Fig. 4.3 Calories required everyday for normal activities

Athletes and people involved in hard physical work require more calories.

An ideal diet is one which contains a proper balance of proteins, fats, carbohydrates, minerals and vitamins. Most races of the world take a mixed diet of meat, cereals, fruits and vegetables to complete a balanced diet. Vegetarians can meet their requirement by substituting meat with milk, cheese and pulses, etc.

FOOD FADS — JUST BELIEFS

Sometimes, lack of knowledge leads to wrong beliefs about certain foods. People feel that if some food is **costlier** and difficult to get, it must be more nutritious. This is one example of a food fad.

Some other misconceptions about few foods are discussed below.

- Eating 'bhindi' (lady's finger) makes one good in mathematics.

  No. There is no relationship between eating bhindi and being good in mathematics.

- White eggs are better than brown ones. *No. Both types of eggs have the same amount of nutrients.*

- Fish is a brain food. It makes you intelligent. *No. Fish is just a protein-rich food. It has got nothing to do with intelligence in particular.*

- A very recent misbelief is about a new variety of papaya which has almost no seeds in it. They say that seedless papaya leads to infertility. [*Infertility means inability to produce young ones.*]

FOOD ADDITIVES

We live in a society where some greedy and sinful merchants sell foods in an adulterated form by mixing such

other materials in it, which are not edible and may even be harmful for health. Such substances are called food **additives** (added to food) and the food which contains such additives is called an **adulterated food**.

Adulteration and Adulterants

Adulteration is the deliberate contamination of food stuffs with low quality, cheap, non-edible or even harmful substances.

The substance which lowers the quality of food is called an **adulterant**.

The additives are used to make the colour of the product more attractive.

Common adulterants : Some common examples of food-adulteration are listed below :

1. Dhania powder is mixed with dung powder.
2. Haldi powder is mixed with lead chromate (a sort of poison).
3. Red chilli powder is mixed with a red coloured chemical compound named "red lead".
4. Black pepper is mixed with dried papaya seeds.
5. Honey is mixed with jaggery syrup.

GOOD FOOD HABITS

- Have a balanced diet which will give you all the nutrients needed by your body.
- Eat at the same time everyday.
- Drink plenty of water.
- Eat fruits and vegetables everyday.
- Chew the food well before swallowing.
- Drink the liquids little by little and not at a stretch.

Remember the saying : "Eat the liquids and drink the solids".

OBESITY (Overweight / Fattiness)

When a person takes in more calories than are required by the body, the excess energy produced gets stored in the body as fat, and the person gains weight. Obesity is a condition in which a person's weight is at least 10 per cent more than the normal for his or her height. Such people have a higher risk of suffering from heart ailments.

If you eat too little, you lose weight and feel weak and restless. This normally happens when people start dieting to lose weight and do not eat properly.

Suppose a person eats more food than required. What happens to such food taken in excess? Most of it is **turned into fat** and stored **beneath the skin**. The result is that body weight increases, and the person runs the risk of becoming fat (**obese**).

The most 'fattening' foods are those which provide the most energy, such as bread, ghee, butter and sweets.

Effects of Obesity

Obesity can cause discomfort, shortness of breath, swollen ankles, etc. It also causes heart diseases, anaemia, arthritis, diabetes and high blood pressure. In short, obesity lessens the age of a person.

To Avoid Obesity, One Should

1. Eat food according to age, sex and nature of job or work.
2. Stop eating when hunger is satisfied. Over-eating is harmful.
3. Cut down on carbohydrates such as bread, cakes, biscuits, sweets, sugar, fat, oil and fried food.
4. One should eat unsaturated fats like vegetable oils.

NUTRITION IN PLANTS

All green plants have the capability to prepare their own food, and are therefore called *autotrophs* (*auto* = self ; *trophe* = nourishment). This method of nutrition is called **autotrophic nutrition**.

For preparing food, the plants require the following :

1. Water (from soil).
2. Carbon dioxide (from air).
3. Chlorophyll (contained in the leaf).
4. Energy (from sunlight).

The process of preparing or synthesising food from water and carbon dioxide in the presence of chlorophyll and sunlight is called **photosynthesis** (Fig. 4.4).

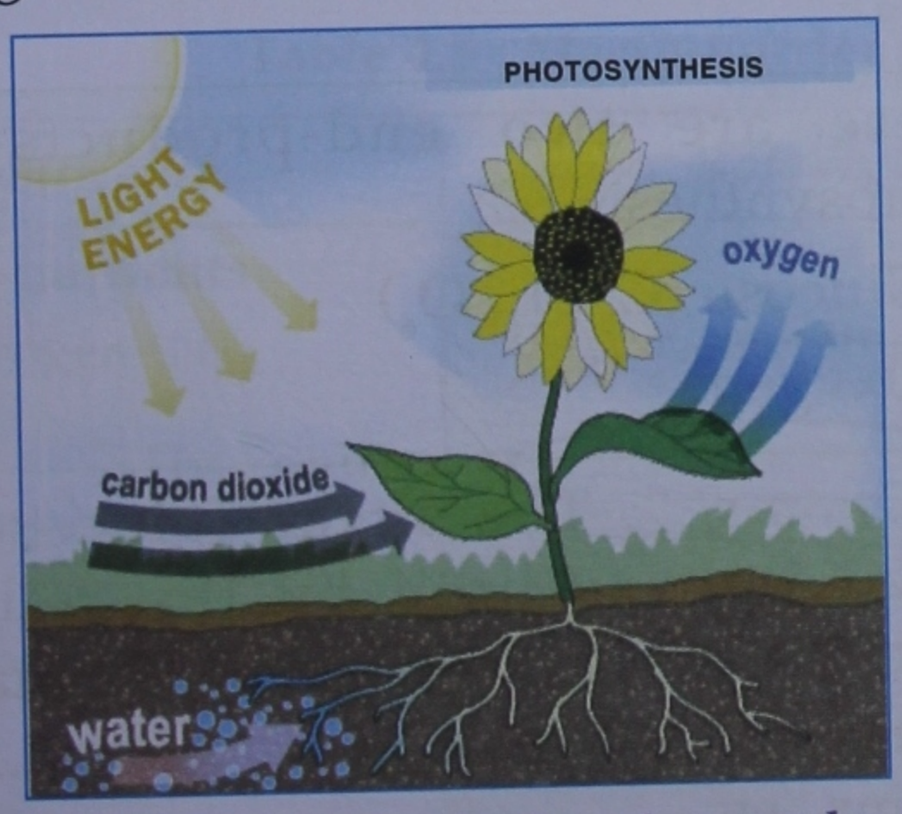


Fig. 4.4 Leaf : the site for photosynthesis

Photosynthesis is represented as follows :

$$\text{carbon dioxide + water} \xrightarrow[\text{and sunlight}]{\text{chlorophyll}} \text{glucose + oxygen}$$

Photosynthesis

Photosynthesis occurs in the leaf. The leaf contains cells filled with a green pigment **chlorophyll**. These cells are more abundant on the upper side of the leaf where they can receive more sunlight (Fig. 4.5). In the interior of the leaf, there are veins which bring water to the chlorophyll-containing cells. On the lower surface of the leaf are numerous pores called **stomata** (singular : stoma), which open into small air cavities inside the leaf. Carbon dioxide from the air diffuses into the leaf through the stomata and reaches the chlorophyll-containing cells.

> The term photosynthesis means combining by light (*photo* = light; *synthesis* = combining). During photosynthesis, water is combined with carbon dioxide to produce glucose and oxygen.

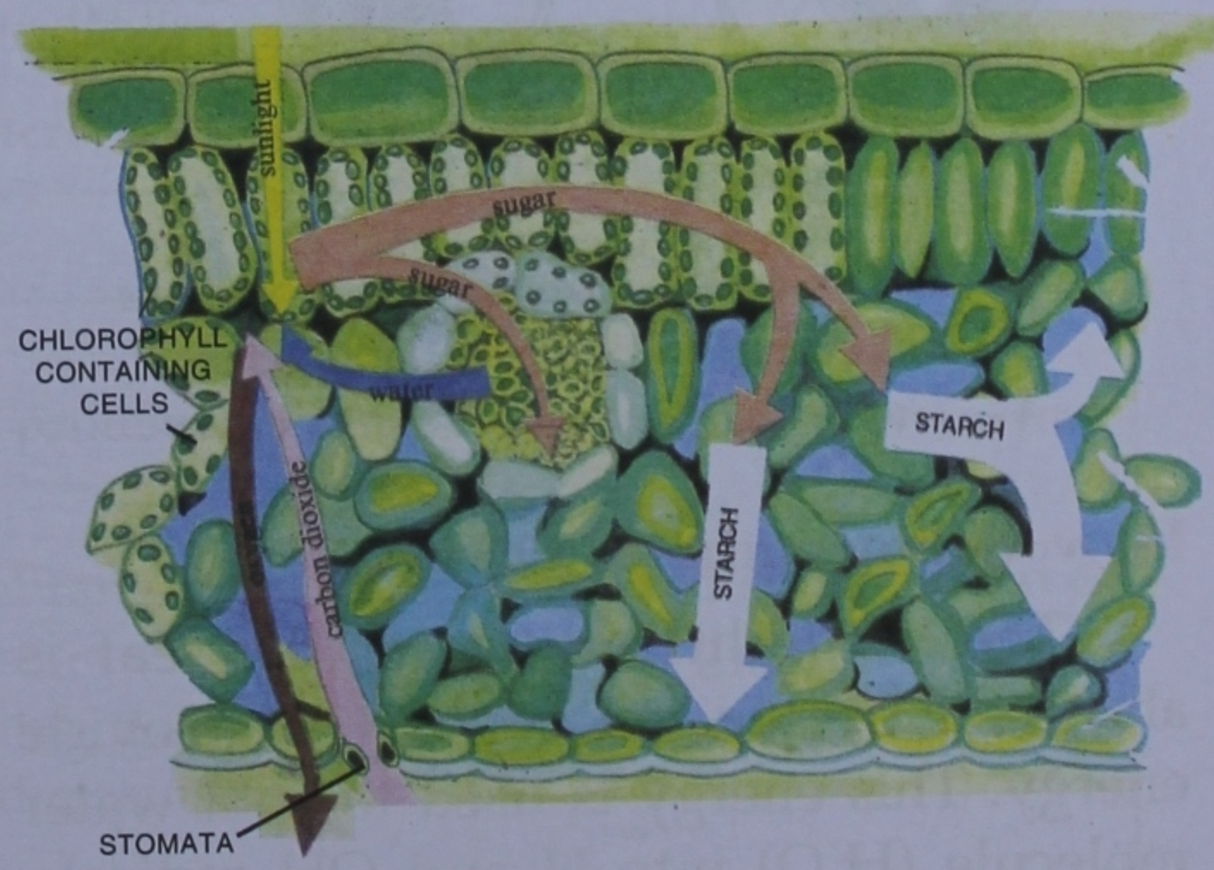


Fig. 4.5 Section of a leaf

The Working of the Stomata

The main function of the stomata is to let in CO_2 from the atmosphere for photosynthesis. When stomata are not in use *i.e.* when it is dark, they tend to close their openings so that no water is lost from the leaves through transpiration. When there is light, as after sunrise, they reopen to allow CO_2 to diffuse in. The movement of water in and out of the guard cells is regulated by the closing and opening of the stomata. In sunlight, water diffuses in, to make the guard cells turgid and their outer thin walls bulge outwards. Thus, the inner thick walls are drawn apart from each other which helps in the opening of the stomata. The reverse happens in their closing. Water is drawn out of the guard cells, which makes them flaccid. Hence, their inner thick walls get straightened to close the stomata (Fig. 4.6).

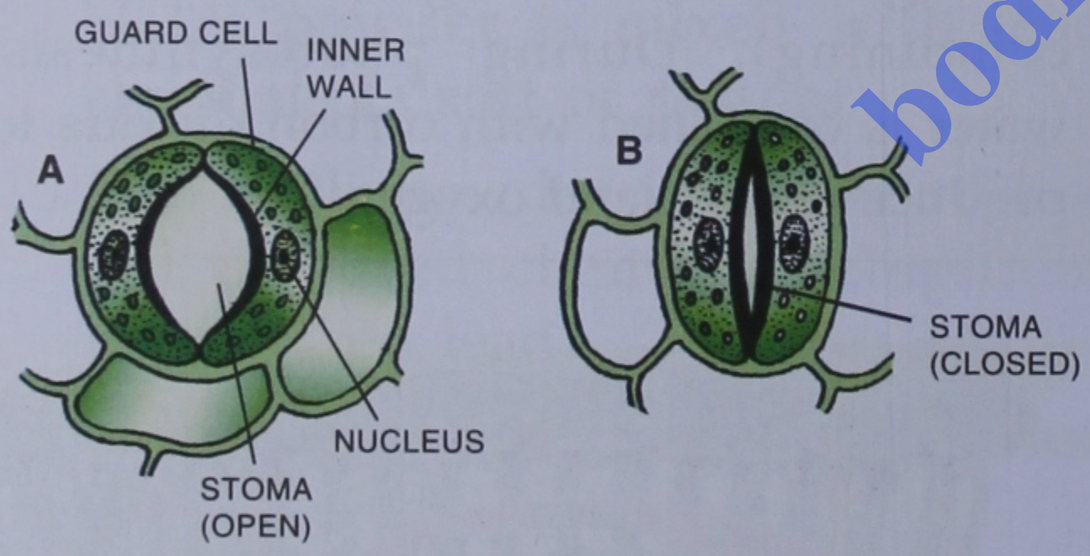


Fig. 4.6 The opening and closing of stomata
A – Guard cells turgid, the stoma opens,
B – Guard cells flaccid, the stoma closes

How Photosynthesis Occurs ?

The sunlight falling on the leaf is absorbed by the chlorophyll to provide energy. This energy is used to split water molecule (H_2O) into H and OH radicals. Subsequently, a series of chemical reactions occur :

(1) Oxygen from OH is released into the air and (2) hydrogen combines with carbon dioxide to form glucose ($C_6H_{12}O_6$).

Factors Affecting Photosynthesis

Of the several factors which affect photosynthesis, three are the most important : carbon dioxide, light and warm temperature (but not higher than 40°C because it slows down and even stops the enzyme action). All the three factors are inter-dependent and each of these factors limits the other. *For example*, if CO_2 is less and the other two are more, there will be less photosynthesis. Similarly, less light will slow down the process even if there is lot of CO_2 and warm temperature. Similarly, if the temperature is low, there will be less photosynthesis even if CO_2 and sunlight are plenty.

Too much light beyond a certain limit destroys chlorophyll and the process of photosynthesis is hampered.

Result of the End Products of Photosynthesis

There are two end-products of photosynthesis :
1. Glucose ($C_6 H_{12} O_6$)
2. Oxygen.

Glucose : The **sugar** (glucose) is immediately utilised by the cells or stored in the form of insoluble **starch, sucrose,** or used in synthesising fats, proteins, etc.

Oxygen : Some of the oxygen released may be used in respiration in the leaf cells, but the major portion of it is not required, and **diffuses out** into the atmosphere through the leaf surfaces (specially through stomata). In a way, even this oxygen is not a waste, because all organisms need oxygen for respiration.

Utilisation of Synthesised Food and Its Transportation

Food manufactured in the leaf is required for use by all other parts of the plant. Glucose is formed in the leaf very rapidly during photosynthesis and it cannot be transported to other parts with the same rapidity. So, it is converted into **insoluble starch for temporary storage** in the leaf. At night, this starch is reconverted into soluble sugar. This sugar is transported in solution through the veins of the leaf and down through the phloem of the stem. In this way, it gets transported to different parts of the plant where it may be reconverted into starch for storage (as in potato). This may be utilised to produce energy for various functions in the plant.

Significance of Photosynthesis

1. Food for all : Plants prepare their own food by photosynthesis, and the plants in turn are eaten by the animals.

2. Oxygen for respiration : All the free oxygen in the atmospheric air is the result of photosynthesis. No animal can survive without oxygen as it is needed for respiration. Even the plants use the same oxygen in dark for their own respiration.

Nutrient Elements of Plants — Macro-nutrients and Micro-nutrients

Nutrient elements are essential for the plants to grow well and complete its life-cycle properly.

The nutrient elements are divided into two broad categories – **macro-nutrients** (*macro* : large) required in larger concentrations and **micro-nutrients** (*micro* : small) required in very small amounts. All of them are obtained from soil.

Some of the macro- and micro-nutrients, their occurrence in the plants and the plants suffering in their deficiency are given in the table. There are several others under each category.

Table 4.5 : Macro-nutrients and micro-nutrients for the plants

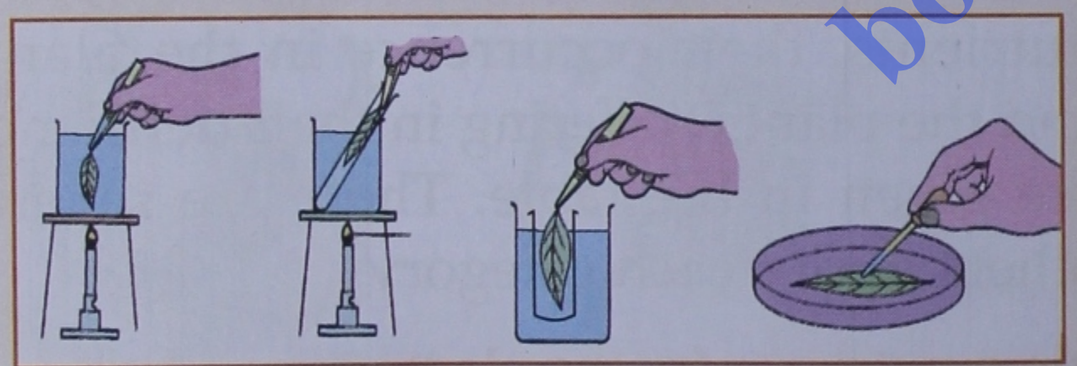
Nutrients	*Role in the Plant*	*Major Deficiency Symptoms*
Macro-nutrients		
1. Nitrogen (N)	Major constituent of all proteins.	Yellowing of leaves, wrinkling of cereal grains.
2. Phosphorus (P)	Constituent of cell membrane and certain proteins.	Purple and red spots on leaves, delay in seed germination.
3. Potassium (K)	More abundant in growing tissues, involved in opening and closing of stomata.	Poor growth.

Nutrients	*Role in the Plant*	*Major Deficiency Symptoms*
Micro-nutrients		
1. Iron (Fe)	Constituent of proteins.	Yellowing of leaves.
2. Manganese (Mn)	Constituent of enzymes.	Yellowing of leaves, with grey spots.
3. Zinc (Zn)	Constituent of plant hormones, activates enzymes.	Deshaped leaves, yellowing of leaves, stunted growth.

ACTIVITY 10

To show that starch is produced in green leaves during photosynthesis :

Pluck a green leaf from a plant which has been growing in bright sunlight. Put the leaf in a beaker with boiling water and boil the leaf for about 2-3 minutes so as to destroy its cytoplasm, denature the enzymes and make the leaf more permeable to iodine solution. Take the leaf out of the beaker and place it inside a tube containing boiling methylated alcohol. Put the tube of alcohol in a beaker of boiling water. Do not warm the alcohol tube directly over the flame.



Preparing a leaf for iodine test

After 10 minutes, the leaf will lose its chlorophyll entirely and will turn almost colourless and transparent.

Wash the decolourised leaf with water to remove the alcohol.

Now put the decolourised leaf in a petridish and pour a few drops of iodine solution over it. Soon, it becomes blue-black in colour. This indicates the presence of starch in the leaf.

ACTIVITY 11

To show that chlorophyll is necessary for photosynthesis.

The green colour of a leaf is due to the presence of chlorophyll. Though most leaves are green, some have white or yellow patches on them, for example, the leaves of Coleus. Such leaves are described as ***variegated.***

Only the green part of a leaf show production of starch. Carry out a starch test on a variegated leaf of a plant that has been kept in sunlight. Only those parts of the leaf will turn blue-black which were green, while the white or yellow patches remain unchanged.

This shows that photosynthesis occurs only in chlorophyll-containing parts.

(i) Variegated leaf (b) After testing for starch

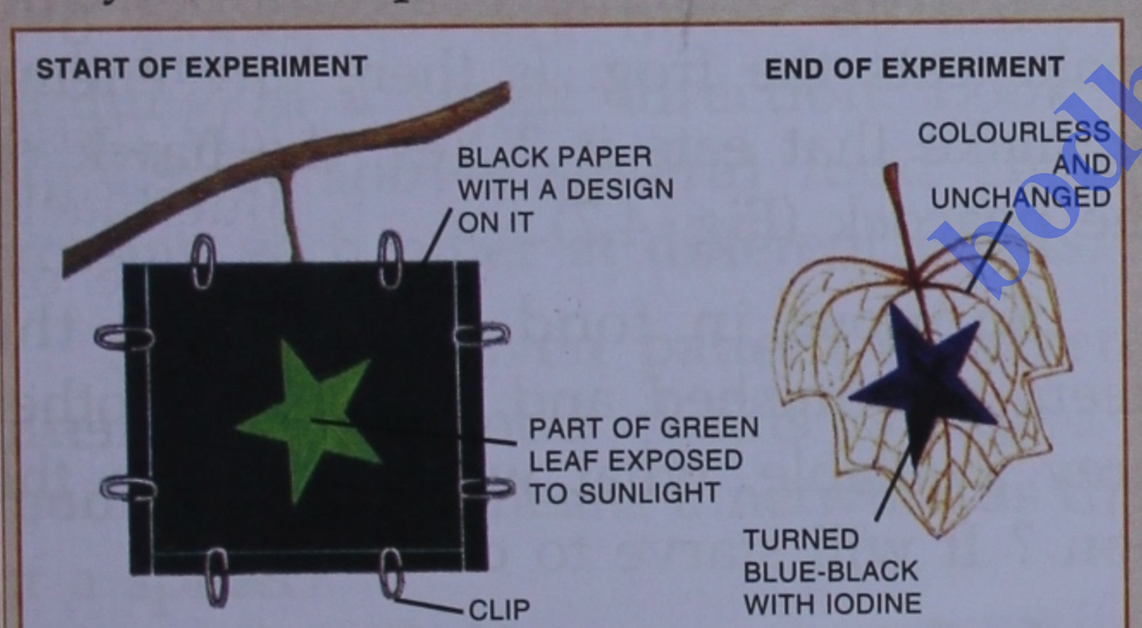
Chlorophyll is neccessary for photosynthesis

ACTIVITY 12

To show that light is necessary for photosynthesis.

Take a potted plant which has been destarched by keeping in a dark room overnight, and cover its one leaf on the upper surface by black paper which has a design cut out on it. Clip the paper firmly as shown in the figure. Thus, the parts of the leaf adjacent to the cut-out design are exposed to light, while the covered parts are not. Keep this set-up in sunlight for 6-8 hours. Next, pluck this leaf from the plant and remove the black paper. Perform the starch test on the leaf as suggested in activity 10.

The parts of the leaf left uncovered and exposed to sunlight will turn blue-black showing that photosynthesis occurs only in those parts that receive light.



Only the part of the leaf exposed to sunlight performs photosynthesis

Types of Nutrition

Green plants which have chlorophyll can make their own food. This mode of nutrition is called **autotrophic** (*auto* : self, *trophe* : nourishment). Non-green plants, animals and all human beings depend on readymade food; this mode of nutrition where food is derived from others is called **heterotrophic** (*hetero* : different/other).

Organisms show the following types of nutrition :

Holozoic Nutrition

In this type of nutrition, animals take in readymade solid or liquid food, digest, absorb, and assimilate it in the body. Organisms that carry out holozoic nutrition can be classified as follows :

(i) *Herbivores (Plant eaters)* – Animals which feed on plants, e.g., cow, goat, horse, etc.

(ii) *Carnivores (Flesh eaters)* – Animals which feed on flesh, e.g., lion, tiger, dog, cat, etc.

(iii) *Omnivores* – Animals which eat all kinds of food both from plants and animals, e.g. man and crow.

Parasitic Nutrition

This type is found in the animals who derive nutrition from the host body, e.g., head louse, tapeworm, roundworm, etc.

Saprophytic Nutrition (*sapro.* : decaying)

It occurs in the organisms drawing nourishment from dead decaying organic remains. *Examples*: Bread mould growing on bread, bacteria and fungus growing on dead decaying plant or animal material.

Symbionts (Feeding Partners)

Symbionts (*sym.* : together, *bionts* : living forms) are a different category

altogether. These are such partners – animal-animal, animal-plant or plant-plant which live together for mutual benefit. For example :

- Protozoans living inside the gut of white ants (termites). Termite eats wood which they cannot digest. Protozoans digest the wood for themselves as well as for the white ant, while in return, the protozoa get a secure place to live in as well as the supply of raw food (wood).
- Horses, cows, etc., eat grass which mainly consists of cellulose. Bacteria in their intestine digest the cellulose. Like the previous example, here also, the two partners live together and benefit each other.

FOOD CHAINS AND FOOD WEBS

Any living organism, such as a plant or an animal, cannot live alone. The inhabitants of the living world are interdependent for many things, specially for food. In Class 6, you have read about **food chains**. A food-chain means a sequence of organisms in which each is the food of the next member in a chain. Examples of two food chains are given here :

(1) Plant → Deer → Lion

(2) Plant → Grass hopper → Frog → Snake → Hawk

In food chain 1, given above, deer eats plants, and the deer is eaten up by a lion. Is there an animal which eats lion ? Perhaps there is none. But the lion too dies sometime or the other. The dead lion is eaten up by vultures, dogs and other animals. Those that eat corpses of dead animals are called **scavengers**. Finally, if any bit of flesh of the dead animals is left uneaten, it is broken down into chemical elements by bacteria. Such bacteria are called **decomposers**.

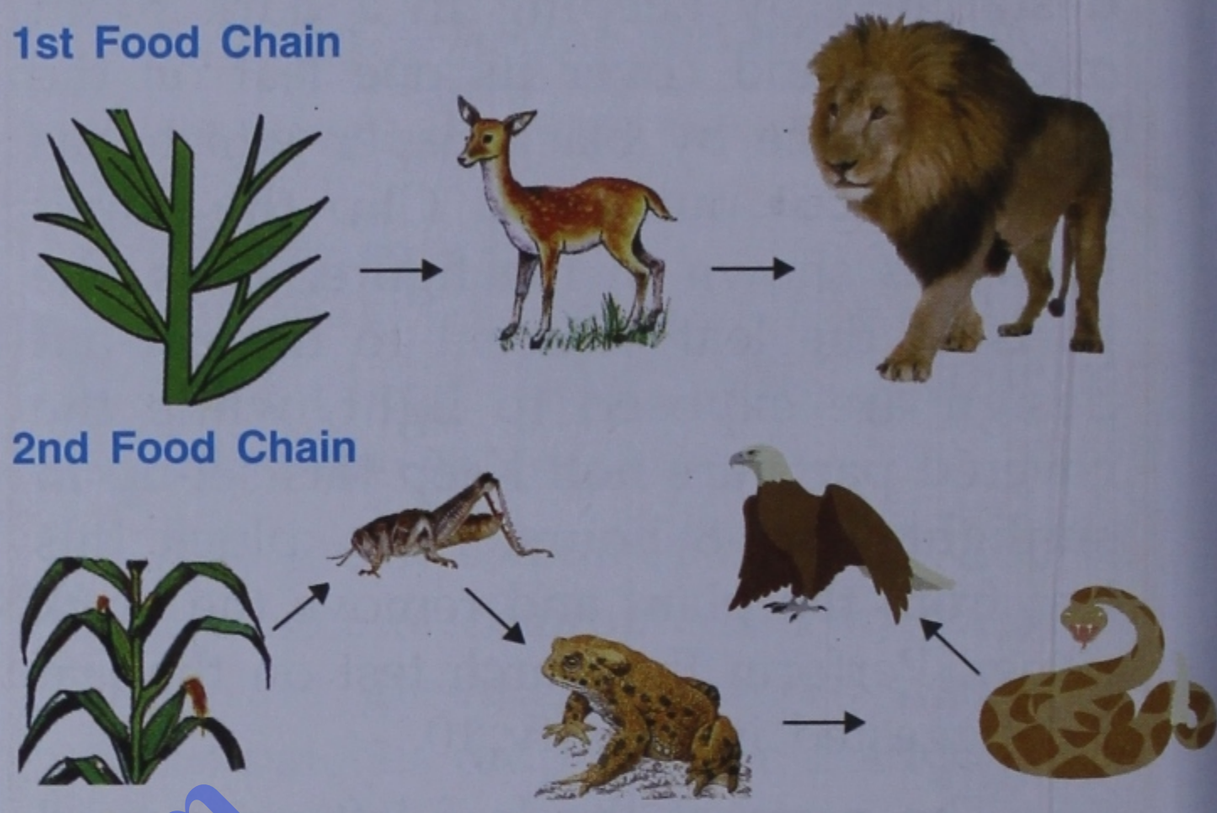


Fig. 4.7 Food chains

In food chain 2, the grasshopper eats grass, frog eats the grasshopper and snake eats the frog. Is there any enemy of snake that eats it ? Yes, the hawk or the peacock (Fig. 4.7).

Suppose in food chain 1, all the deers are finished and there is no other prey available, what will happen to the lion ? It will starve to death.

In the same way, if there is no frog in food chain 2, the snake is likely to starve. Suppose the snake is able to get an alternate prey such as a rat or a squirrel, it will survive.

Thus we have different categories of organisms according to food relations.

Producers (Green plants) : All green plants are producers. They produce food by making use of carbon

dioxide and water in the presence of sunlight.

First stage (primary) consumer (Herbivores, the plant-eaters) : These feed on plants and plant products.

Second stage (secondary) consumer (Carnivores, the flesh-eaters) : These are the animals which kill and eat the plant-eating animals.

The carnivores consume the hervibores. Since herbivores are the first stage consumers, the carnivores are called the **second stage consumers**.

In the same way, there may be third (tertiary) or even fourth stage of consumers.

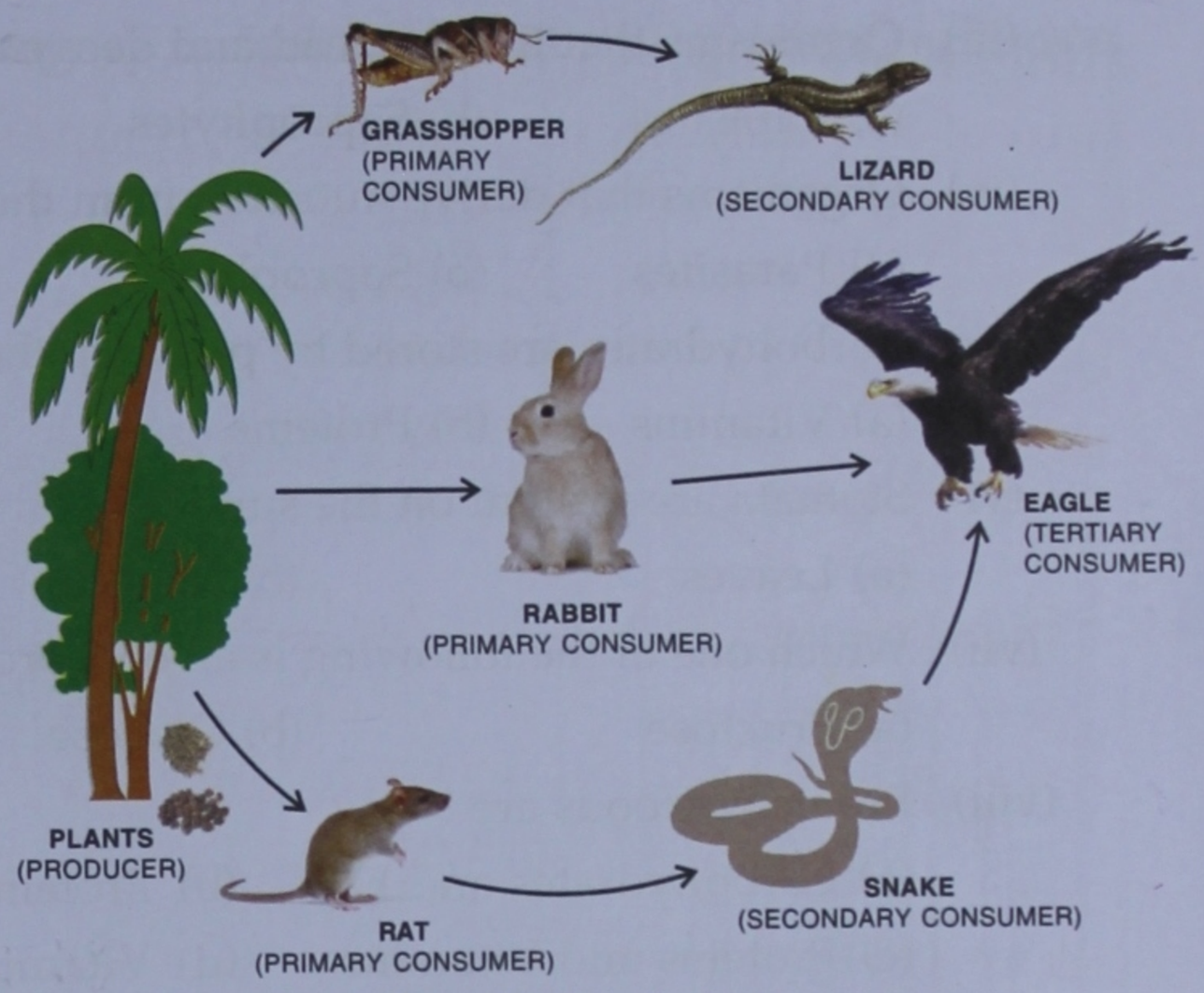


Fig. 4.8 Food chains

FOOD WEBS

Food chains, as given above in the two examples, are never so simple, running in a single direction. Look at Fig.4.9. It shows several food chains crossing each other at different points.

Such interwoven pattern of several interconnected food chains is called a **food web**. (Web means a network as that of a spider).

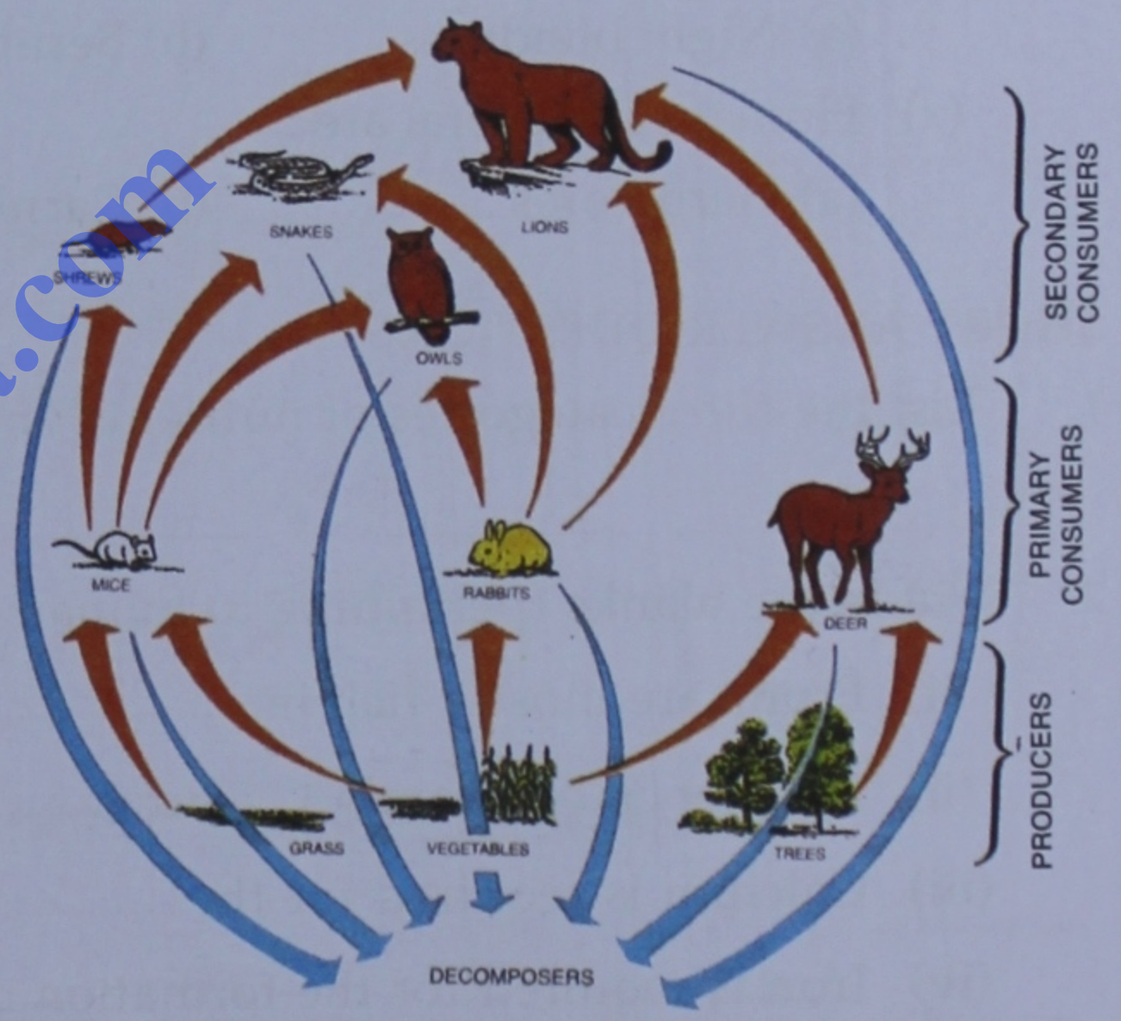


Fig. 4.9 Food web

REVIEW QUESTIONS

MULTIPLE CHOICE QUESTIONS

1. Choose the correct option :

(i) Which one of these type of nutrients primarily provide energy ?

(a) Minerals (b) Vitamins (c) Proteins (d) Carbohydrates

(ii) Which of these is an essential mineral for plants ?

(a) Calcium (b) Phosphorus (c) Copper (d) Iron

(iii) Organisms that live on dead and decaying organic matter are known as :

(a) Parasites (b) Saprophytes (c) Carnivores (d) Omnivores

(iv) Organisms that derive nutrition from the host's body are called :

(a) Parasites (b) Saprophytes (c) Carnivores (d) Omnivores

(v) Carbohydrates are stored by plants in the form of :

(a) Vitamins (b) Proteins (c) Fats (d) Glucose

(vi) Stomata are present on the surface of :

(a) Leaves (b) Roots (c) Stem (d) Flower petals

(vii) Which one of the following is an end-product of photosynthesis ?

(a) Fructose (b) Glucose (c) Cellulose (d) Lactose

(viii) Protective foods are :

(a) Carbohydrates and Fats (b) Proteins and Fats

(c) Proteins and Vitamins (d) Vitamins and Minerals

(ix) Deficiency of vitamin A can cause :

(a) Night blindness (b) Beri-beri (c) Pellagra (d) Scurvy

(x) Humans in general are :

(a) Herbivores (b) Carnivores (c) Omnivores (d) Parasites

SHORT ANSWER QUESTIONS

1. List the *three* categories of nutrients one needs.

_____ _____ _____

2. Fill in the blanks (pertaining to human nutrition) :

(i) Fruits are mostly rich in ..... .

(ii) Deficiency of vitamin C causes .....

(iii) Calcium is required for the .....

(iv) Iron is required for the formation of the substance called .....

(v) The mineral ..... protects teeth from decay.

3. Mention whether the following statemens are *True* or *False*

(i) Carbohydrates are the building blocks of our body.

(ii) Fats are found in pulses only.

(iii) Proteins mainly provide us energy.

(iv) Iodised salt is rich in iodine.

(v) Bread, maggi and pizza are rich in carbohydrates.

4. Pick out the odd one out from the general category in each of the following, and give reason for separating it out.

(i) Grape, sugarcane, beet root, ghee.

_____ Reason : _____

(ii) Meat, milk, butter, nuts, spinach.

_____ Reason : _____

(iii) Calcium, iron, sodium, potassium, protein.

_____ Reason : _____

(iv) Citrus fruits, tomatoes, cabbage, sunlight.

_____ Reason : _____

(v) Rice, bread, potatoes, butter.

_____ Reason : _____

5. Why do leaves generally look green ?

_____

_____

6. Which *four* of the following are needed for photosynthesis in a leaf :

(a) carbon dioxide, (b) oxygen, (c) nitrates, (d) water,
(e) chlorophyll, (f) soil, (g) light.

_____

_____

7. What is the source of energy for photosynthesis ?

_____

8. Which gas is taken in and which one is given out by the leaf in bright sunlight ?

(i) Taken in : _____

(ii) Given out : _____

9. Suppose we compare the leaf with a factory, match the items in ***Column* A** with those in ***Column* B**.

Column A	*Column* B
LEAF	**FACTORY**
Cells in the leaf	Raw materials
Chloroplast	Power
Sunlight	Machinery
Oxygen and water	End product
Carbon dioxide and water	Byproduct
Glucose	Work room

10. State whether the following statements are *True* or *False* :

(i) Green plants prepare their food by using two raw materials, oxygen and water.

(ii) The chlorophyll enables the plants to use light energy.

(iii) The free oxygen in the atmospheric air is the result of photosynthesis.

(iv) Photosynthesis occurs only in chlorophyll-containing parts of the plant.

11. What scientific terms are given herbivores and carnivores in a food chain.

LONG ANSWER QUESTIONS (Write the answers in your note book)

1. Define nutrition. On the basis of nutrition, living beings are classified into which types ?
2. What are sugars ? How many types of sugars are there ?
3. What is the importance of a balanced diet ?
4. Why do we need roughage and water in our diet ?
5. Do the plants need oxygen ? If so, what is its source ?
6. Why are the following required in our body : Carbohydrates, proteins and fats.
7. Define the following terms — Malnutrition, balanced diet, vitamins.
8. Write down the importance of water in our body.
9. Young children are advised to include more proteins in their diet than fatty foods. Why ?
10. Name the proteins found in milk and egg.
11. Name the vitamins which are fat-soluble and mention their important functions.
12. What substances must a plant take in, for carrying out photosynthesis ? From where are these substances taken in respectively ?
13. What is the role of chlorophyll in photosynthesis ?
14. Names of three diseases caused due to vitamin deficiency are hidden in the following maze. Try to locate them (Hint : The hidden diseases can appear horizontally, vertically; forwards or backwards). For example : "Beri-beri" in the third line in reverse (backward) order.

K	A	A	R	G	A	L	L	E	P	C
N	T	R	I	C	K	E	T	S	O	S
Q	R	T	I	R	E	B	I	R	E	B
F	N	Y	V	R	U	C	S	M	C	A

(i) .....

(ii) .....

(iii) .....