CHAPTER 4

Modes of Nutrition

Different modes of nutrition are exhibited by organisms.

These modes can be broadly grouped as autotrophic nutrition and heterotrophic nutrition.

Autotrophic Nutrition

In this type of nutrition, the organisms are able to **manufacture** their own food from simple inorganic substances, either utilizing light energy in photosynthesis or chemical energy in chemosynthesis.

Such organisms are called autotrophs and their mode of feeding is said to be autotrophic. All green plants and some bacteria are autotrophic.

Photosynthetic Nutrition

All green plants manufacture their food in the presence of sunlight using light energy, carbon(IV) oxide and water with the aid of enzymes.

$$6H_2O + CO_2 \xrightarrow[+\text{ enzymes}]{\text{light} + \text{chlorophyll}} C_6H_{12}O_6 + 6O_2 \uparrow$$

This process is called photosynthesis (see Chapter 2). Hence, green plants are said to be photosynthetic.

In like manner, some bacteria are photosynthetic autotrophs. These are bacteria that lack chlorophyll but contain purple or green pigments and are able to synthesize their own food from carbon(IV) oxide and hydrogen sulphide.

The net chemical equation of the reaction can be represented thus:

$$12H_2S + 6CO_2 \longrightarrow C_6H_{12}O_6 + 6H_2O + 12S$$

Chemosynthetic Nutrition

Some bacteria synthesize organic compounds from simple inorganic substances such as carbon (IV) oxide, ammonia, water or nitrates to obtain their food.

The energy used for the synthesis comes from the oxidation of these inorganic substances. Hence, the process is called chemosynthesis

and the type of nutrition is called chemosynthetic nutrition.

Examples of chemosynthetic bacteria are, some nitrifying bacteria in the soil, e.g. *Nitrosomonas*, which can convert ammonia to nitrites; *Nitrobacter*, which can convert nitrites to nitrates. Examples of their chemosynthetic actions can be represented by the following net chemical equations:

$$2NH_3 + 3\ O_2 \xrightarrow{\text{Nitrosomonas}} 2HNO_2 + 2H_2O + \text{energy}$$

$$HNO_2 + O \xrightarrow{\text{Nitrobacter}} HNO_3 + \text{Energy}$$

Heterotrophic Nutrition

This mode of nutrition is carried out by all animals and certain plants that lack chlorophyll and so cannot manufacture their food. An organism which cannot manufacture its own food is a heterotroph. Thus, all animals, fungi and most bacteria are heterotrophs. Heterotrophs depend directly or indirectly on autotrophs for their food.

Heterotrophic nutrition results in different types of associations among different animals and plants. Below are some of the heterotrophic feeding relationships that exist among organisms.

Holozoic Nutrition

Holozoic nutrition is the ingestion of solid, complex food substances and changing them into simple, soluble forms during digestion. This nutrition is characteristic of animals. Some modes of holozoic nutrition, for example are filter feeding and fluid feeding, are discussed in Book 2, Chapter 4.

Parasitic Nutrition

Many organisms live on other organisms and derive their nourishment from them. This type of nutrition is called parasitic nutrition and the association is called parasitism.

Parasitism is a relationship between two organisms, generally of different species, in which one, the parasite, clearly obtains advantages from its associations with the other — the host, which as a result suffers some injurious effects. The relationship may be between one animal and another, between one plant and another, between a parasitic animal and a plant host or vice versa, between a bacterium and a plant or animal, between a virus and a plant or animal, and finally, between a bacteriophage and a bacterium. The characteristics of parasites associated with nutritional processes include the following:

1. Production of exoenzymes by parasitic plants and animals which digest the hostâ€™s tissues external to the parasite e.g. fungi, *Plasmodium.*
2. Lack of photosynthetic pigments in some parasitic plants, e.g.

Cuscuta and *Lathrea.*

3. Absence or degeneration of feeding organs and sometimes the alimentary canal, e.g. *Taenia solium, Plasmodium.*

4. Development of highly specialized haustorial structures by some parasitic plants, e.g. dodder plant, mistletoe. Examples of animal parasites are round worms (e.g. *Ascaris)* and tapeworms (e.g. *Taenia solium) (Fig. 4.1).*

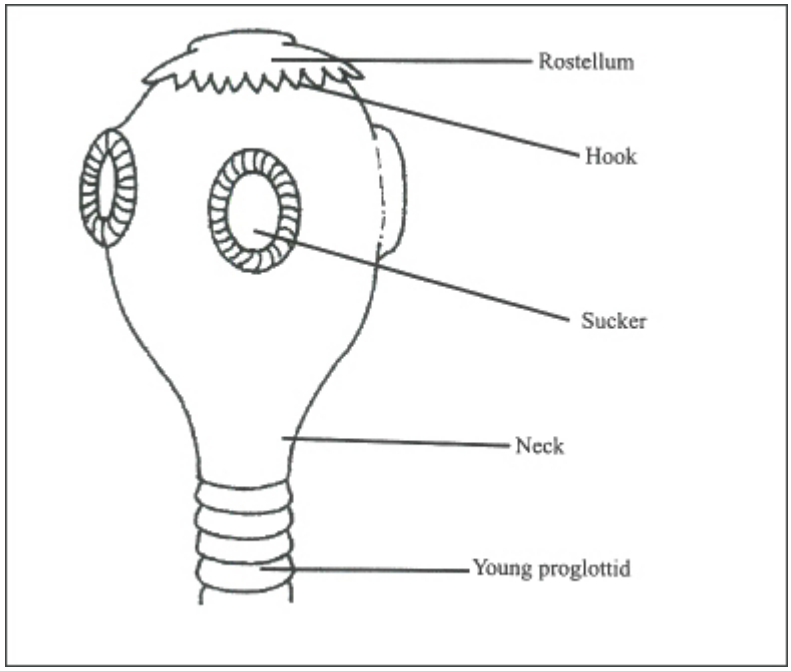

Fig. 4.1 Head of Taenia solium

Taenia solium is a flattened ribbon like animal that lives in the gut of pigs and man. The head or scolex is a small round knob. On top of the scolex is a projection called rostellum which has hooks round it and four suckers. The tapeworm fastens itself to the lining of the hostâ€™s intestine with these hooks and suckers. The body consists of numerous proglottides which are flat segments budded off from the narrow segment behind the scolex. The tapeworm has two hosts: man who is called the primary host and pig, which is called its secondary host. They live on the digested food of the host and simply absorb this through their cuticle or outer covering.

Examples of plant parasites are *Cassytha* and *Cuscuta* (dodder plant) which are flowering plants that lack chlorophyll and now live on other plants as parasites. Others are fungi like *Phytophtora palmivora* (black pod parasite of cocoa).

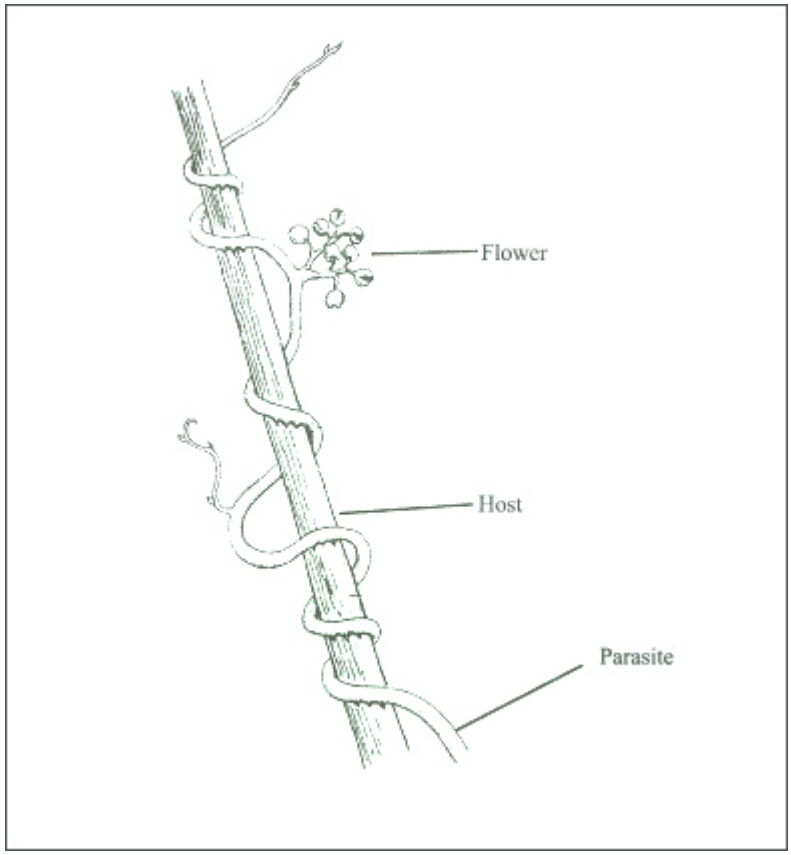

Fig. 4.2 Cuscuta (dodder plant) on host.

Cuscuta (the dodder plant) is a genus of flowering plants in the family convolvulaceae. It lacks chlorophyll and parasitizes a wide variety of higher plants. When fully developed, the parasite is seen twining vigorously around the stems, leaves and other aerial parts of other flowering plants (*see Fig. 4.2*). The twining parts are the stems and these are slender, whitish-yellow or red in colour, bearing tiny scaly leaves, from the axils of which branches or in later stages inflorescences arise. The stem has no connection with the ground and a root system is never developed. At intervals along the stem, contact is established with the internal tissues of the host. This is achieved by the penetration of haustorial growths through the hosts outer tissues to effect a union with the vascular tissues within. By this means, the parasite is able to tap the supplies of food and water moving through the host.

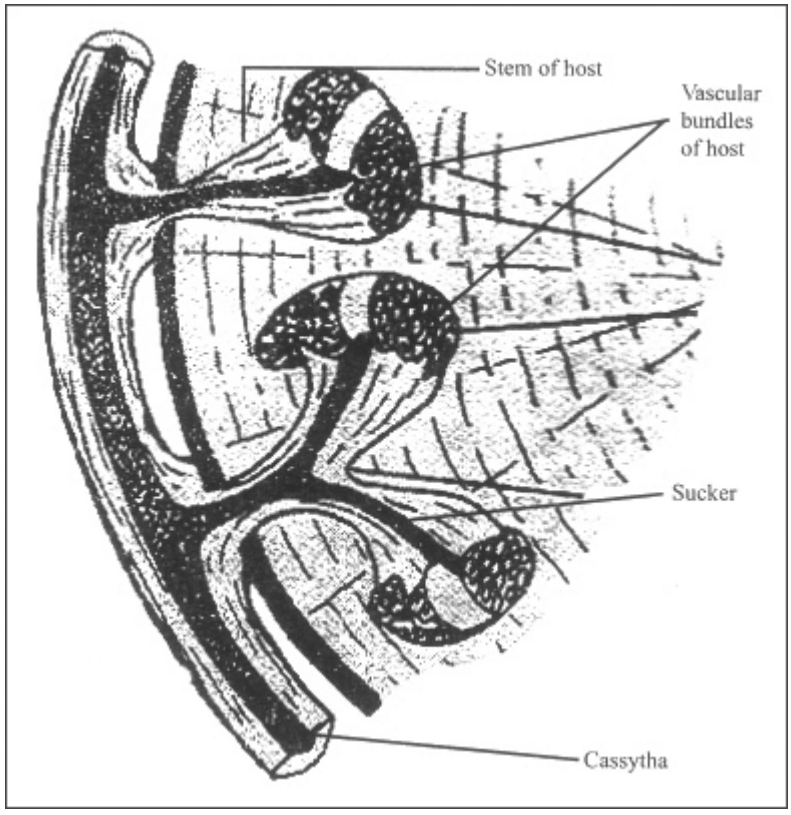

Fig. 4.3 Section through Cassytha and stem of host

Cassytha filiformis is a fairly common parasitic plant. The stem is thread-like and curls round the stem of the host plant. It is fixed to the stem of the host by small suckers or haustoria. These grow through the stem of the host into its vascular bundles and absorb water, salts and organic substances from the xylem and phloem. *Cassytha* has no roots, no chlorophyll, and small scaly leaves. The mature plant bears spikes or small white flowers.

Symbiotic Nutrition

Many organisms of different species live together and obtain their nourishment from each other. This type of nutrition is called *symbiotic nutrition* and the association is called symbiosis – a condition in which two organisms derive mutual benefit from their association with one another. The partners are referred to as symbionts. They may be a plant and another plant, a plant and an animal or an animal and a bacterium. Such association usually confers nutritional benefits upon the members. The capabilities of one often being augmented by the capabilities of the other. Other benefits that could still be derived include the sheltering of one by the other and increased chances of reproduction and dispersal.

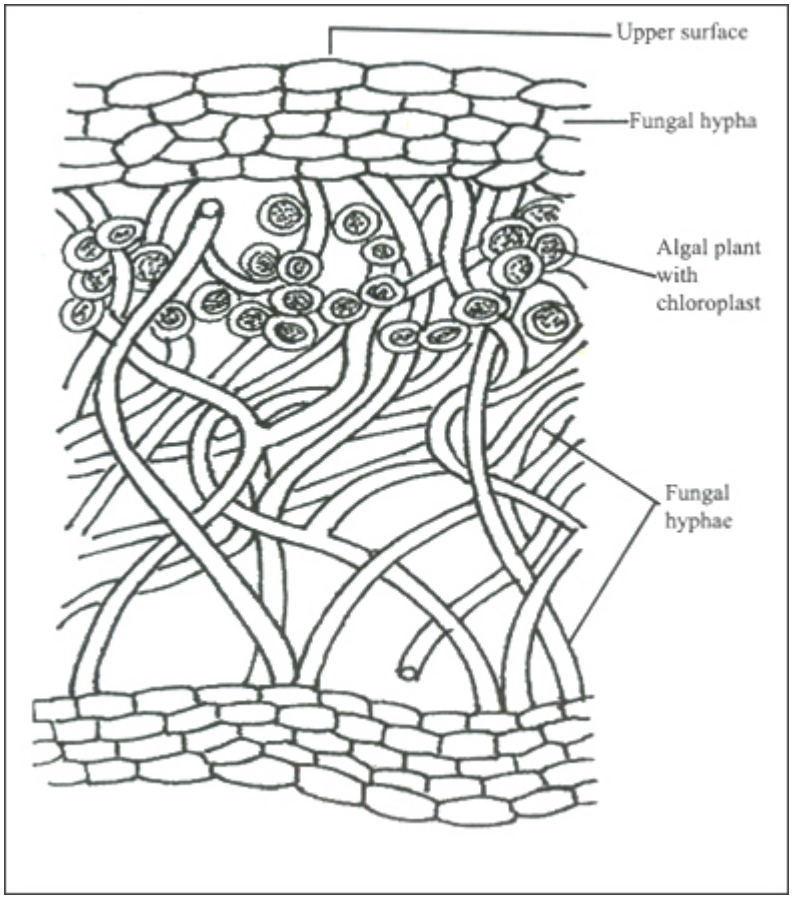

Fig. 4.4 Section through a piece of a lichen thallus

For a symbiotic union to be permanent, reproductive bodies produced by the partners must consist partly of one organism and partly of the other. There can, of course, be no sexual union between them, but in many instances of symbiotic partnerships, the normal reproductive bodies of one partner are infested with cells of the other, so that from the commencement of development the two are united. Examples of organisms that undergo symbiotic nutrition are lichens (an alga-fungus partnership), convult and alga (an animal-plant relationship), termite and trichohymphid (an animal-animal relationship), leguminous plants and bacteria in their root nodules, hermit crab and sea anemone.

The lichens

Each lichen is usually two organisms: a fungus and a unicellular alga, living closely together. The thallus or plant body of a lichen consists mostly of fungal hyphae, with alga cells embedded in them. The alga cells are arranged in a definite layer *(Fig. 4.4)*. The green alga manufactures food for both plants, while the fungus protects the alga and absorbs water from the atmosphere.

The hermit crab

Hermit crabs, inhabiting molluscan shells, almost invariably carry other organisms on the shells (*Fig. 4.5)*. These may be a group of sea anemones which offer concealment and protection for the crab, and

themselves obtain transport, better oxygenation and possible particles of food floating up while the crab is feeding.

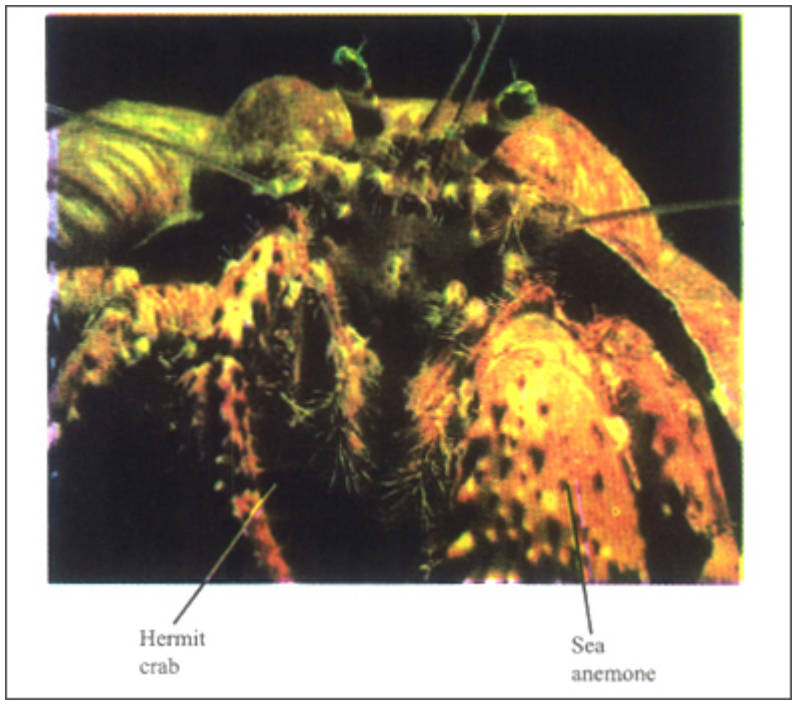

Fig. 4.5 Hermit crab and sea anemone

Saprophytic Nutrition

In saprophytic nutrition, the organism derives its nutrition from dead or decaying organic matter. These organisms are called saphrophytes and the association is called saprophytism.

This mode of life is exhibited by some fungi, bacteria and some animals, in which their energy-giving and body-building requirements are derived from the products of, or the dead remains of other organisms. Before such remains can be absorbed by the saprophyte, they must be rendered soluble, and the saprophyte is thus often instrumental in intiating the conversion.

Saprophytes secrete digestive enzymes onto the substrate on which they feed, and the digestion takes place outside the organism. This type of digestion is called extracellular digestion, and it is the process which causes decay. The enzymes act only in the presence of moisture and the chemical reactions are usually speeded up by a rise in temperature.

Examples of saprophytes are *Rhizopus*, mushroom, termites and earthworms.

Rhizopus

Rhizopus is a saprophytic fungus. The body (mycelium) consists of a mass of branched threads called hyphae. The hyphae are of different types:

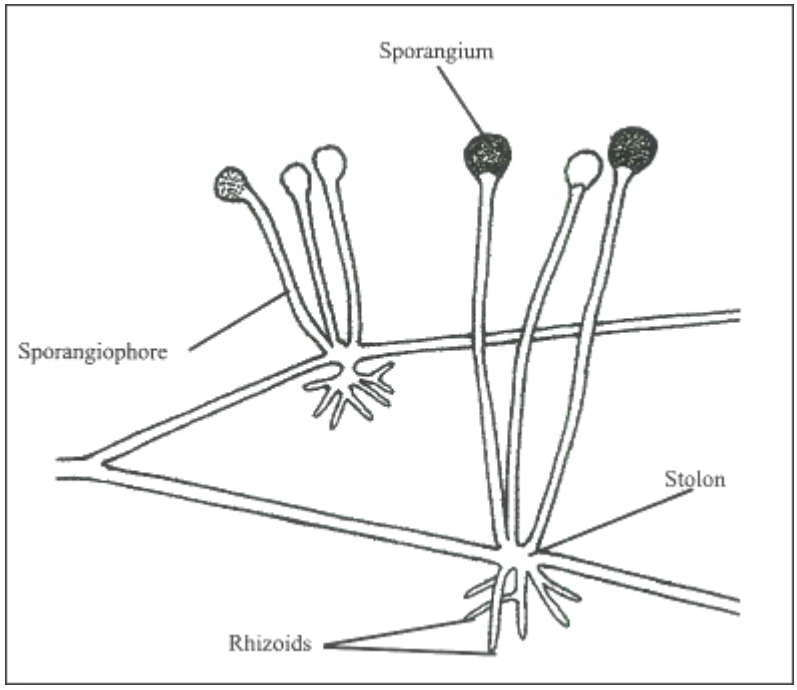

Fig. 4.6 Rhizopus

(a) Sporangiophore, which carries the reproductive part, sporangium.
(b) stolon, which helps the plant to grow and
(c) rhizoids, which helps the plant to feed. *(Fig. 4.6).*

Rhizopus feeds by sending rhizoids into the substrate. The rhizoids secrete digestive enzymes which change insoluble substances (e.g. starch) into soluble and absorbable substances (.e.g. sugar).

Mushroom

This is another saprophytic fungus. The mycelium is a tangle of hyphae hidden in the substrate on which the fungus is feeding (decaying matter in the soil). See *Fig. 4.7*.

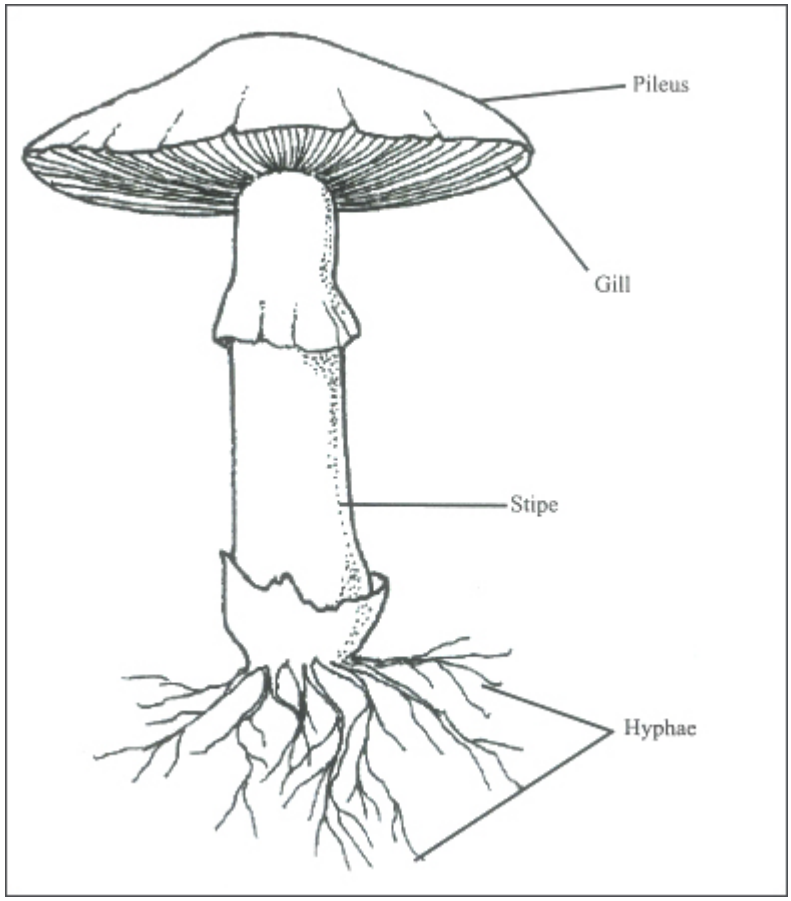

Fig. 4.7 A mushroom

The fully-developed fruiting body is an umbrella-shaped structure which consists of a stalk or **stipe** and an expanded cap or **pileus**. Both are made up of closely interwoven hyphae. Radiating from the stipe on the underside of the pileus are a number of gills. Nutrition is the same as in *Rhizopus.*

Carnivorous Plants

These are several hundreds of species of plants which are able to trap, digest and absorb nutritive compounds from the bodies of insects. This method of obtaining nutrients is common to plants found in areas with soils highly deficient in nitrogen and is an addition to the normal photosynthetic process since these plants possess chlorophyll. The mechanisms by which the prey is captured and subsequently treated show some variation and are among the most fascinating of plant adaptations.

Examples of carnivorous plants are sundew *(Drosera)* the bladder-wort *(Utricularia),* the butterwort *(Pinguicula),* the Venus fly trap *(Dionaea)* and the pitcher plants *(Nepenthes* and *Senacenia).*

The sundew (Drosera)

The plant has a rosette habit. Each leaf forms an organ by which the insect is trapped and digested. Its upper surface bears a number of multicellular glandular hairs or tentacles which are long at the leaf margins and shorter in the centre *(Fig. 4.8).* The whole leaf surface is

always sticky due to secretory activity of other smaller glands. The knob-like glandular ends of the tentacles secrete proteolytic enzymes capable of digesting the animalâ€™s body. The same glands function also to absorb the decomposition products. The reaction of the leaf on being stimulated by the presence of an insect is to bring about the curvature of all the outer tentacles inwards, towards the leaf centre, so that the insect is completely enmeshed. All the glands then vigorously secrete to form a large drop of fluid in which the animal is submerged.

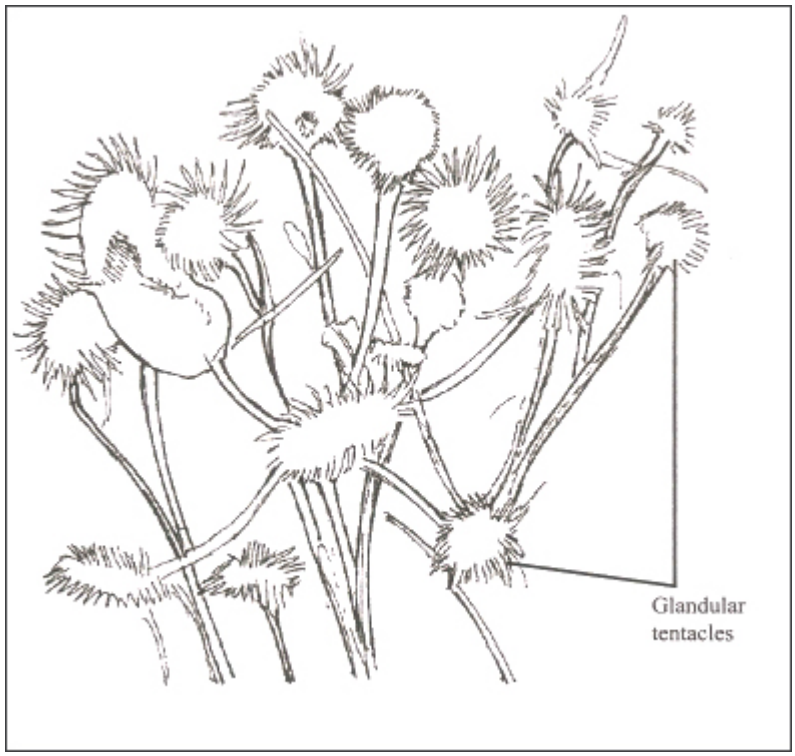

Fig. 4.8 Leaf of sundew (Drosera) upper surface.

Suggested Practicals

1. *Examination of endoparasites*

(a) Collect some lizards.
(b) Dissect each lizard to show the abdominal organs.
(c) Use your forceps to search for worms inside the abdomen.
(d) Collect the worms, and preserve in a bottle.
(e) Your teacher will help you to identify the different types of worms.

Note: These worms are parasites living in the gut of the lizard.

2. *Study of saprophytes*

(a) Moisten a piece of bread. Rub it on a dusty surface and seal in a tin. Leave it until the whole surface is covered with mould.
(b) Remove a tiny amount of the mould. Mount in water and examine under the microscope.
(c) Look for the different parts of the *Rhizopus.*

(d) Collect some mushroom and examine the different parts. Look for the pileus, stipe, gills and hyphae.

(e) Draw and label the *Rhizopus* and the mushroom.

Summary

1. Organisms exhibit different modes of nutrition which can be grouped as autotrophic nutrition and heterotrophic nutrition.
2. Autotrophic nutrition involves (a) photosynthesis which is the use of light energy to produce food, with the aid of carbon(IV) oxide, water, chlorophyll and enzymes, (b) chemosynthesis in which carbon(IV) oxide, ammonia, water or nitrates are oxidized to produce food.
3. Heterotrophic nutrition is carried out by all animals and certain plants that lack chlorophyll to manufacture their own food.
4. Heterotrophic nutrition results in different types of associations among different animals and plants.
5. Holozoic nutrition involves the ingestion of solid, complex food substances, and then changing them into simple soluble forms during digestion. Man carries out this type of nutrition.
6. Parasitic nutrition involves two organisms, in which one, the parasite lives and feeds on the other, the host. Examples include pork tapeworm, *Taenia* and *Cassytha.*
7. Symbiotic nutrition involves two organisms living together and obtaining their nourishment from each other. Examples include lichen, hermit crab and sea anemone.
8. Saprophytic nutrition involves an organism feeding on dead or decaying organic matter. Examples include *Rhizopus*, mushroom.
9. Carnivorous nutrition in plants involves several species of plants which are able to trap, digest and absorb nutritive compounds from the bodies of insects. Examples include sundew, bladder-wort, butterwort, Venus fly trap, and pitcher plant.

Objective Questions

1. The special absorbing organ in a parasitic plant is known as
   A. rhizome
   B. rhizoid
   C. root
   D. haustorium
   E. rostellum
2. Organisms which feed on dead or decaying organic matter are called
   A. parasites.
   B. symbionts.
   C. saprophytes
   D. commensals
   E. carnivorous plants

3. A lichen consists of an alga and a fungus living together. The alga provides the fungus with photosynthetic products and the fungus provides the alga with water, protection and anchorage. This is an example of
   A. commensalism
   B. saprophytism
   C. parasitism
   D. competition
   E. symbiosis.

4. Which of the following terms describes a mode of nutrition in which the organisms synthesize their food from simple inorganic substances?
   A. heterotrophic nutrition.
   B. autotrophic nutrition
   C. parasitic nutrition
   D. saprophytic nutrition
   E. symbiotic nutrition

5. An example of a carnivorous plant is
   A. mushroom
   B. sundew.
   C. *Cassytha.*
   D. *Nitrobacter*.
   E. lichen.

Essay Questions.

1(a) All plant and animal life depend on one essential natural biochemical process for food. Name and define this process. Briefly mention and describe the nutritional mode adopted by

(i) *Spirogyra.*

(ii) *Rhizopus.*

(iii) Man.

so as to benefit directly or indirectly from the process defined.

2(a) Give three characteristics of parasites and two characteristics of saprophytes associated with their nutritional processes.

(b) Describe briefly how *Rhizopus* obtains its food.

3. Explain what is meant by the following terms

(a) saprophytism;
(b) parasitism;
(c) symbiosis.

Give two examples each of the organisms that have these types of association.

4(a) Draw a fully labelled diagram of a pork tapeworm.

(b) What are the uses of its hooks and suckers?
(c) Describe how the sundew *Drosera* traps and digests insects.