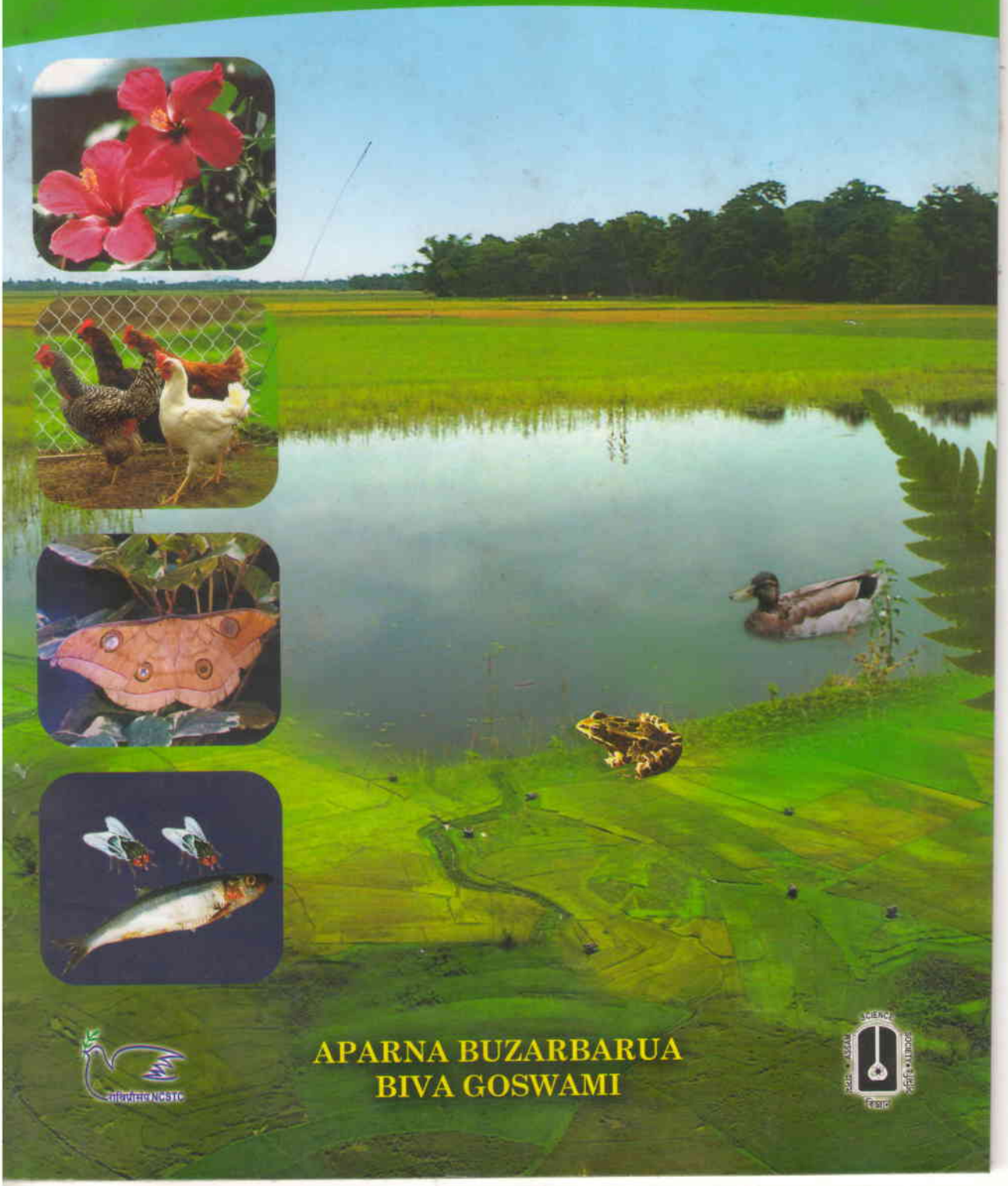
ACTIVITY MANUAL FOR LEARNING BIOLOGY



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ACTIVITY MANUAL
FOR LEARNING BIOLOGY

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Assam Science Society

ACTIVITY MANUAL FOR LEARNING BIOLOGY : A manual brought out to help the school students for studying Biology, written by Dr. Aparna Buzarbarua and Ms. Biva Goswami, catalysed and supported by RVPSP, Department of Science & Technology, Government of India, New Delhi.

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Activity Manual for Learning Biology

A manual brought out to help school students for studying Biology which describes all the materials and methods required for performing the experiments included in the low cost biology kit.

Catalysed and supported by

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ASSAM SCIENCE SOCIETY — A KEY PLAYER OF MASS AWARENESS / EDUCATION PROGRAMMES THROUGH POPULARIZATION OF SCIENCE

Established in 1953 with Head Office at Guwahati, the Assam Science Society is a non-political, pioneering organization having over 120 branches all over Assam. Since inception, the society has been devoting to science popularization through the all round development of Assamese science literature, holding seminar, exhibition, organizing teachers training camp, science talent search examination, etc.

Some of the major publications of the society :

The Society has been regularly publishing the Assamese bi-monthly science magazine **Bigyan Jeuti** since 1961. Some other outstanding scientific literary output of the Society are **Glossary of Scientific Terms** (in Assamese), **Childrens' Science Encyclopedia** (in five volumes), **Explanatory Science Dictionary** (in Assamese, published in two volumes), **Axomiya Manuhar Nribaigyanik Parichay** (Anthropological identity of Assamese people), **Axomor Gos-Gosoni, Vol. I,** (Trees of Assam), **Axomor Chorai** (Birds of Assam), **Bigyan Lekha : Kar Babe, Kenekoi Likhiba** etc. Besides the Society has published more than 160 nos. of popular science books. **The Journal of Assam Science Society** (published in English) has also contributed significantly in creating an environment of research and scientific studies.

FOREWORD

It is a great privilege for me to thank Dr. D. K. Pandey, Scientist 'E', Rashtriya Vigyan Evam Pradyogiki Sanchar Parishad (RVPSP), Department of Science & Technology, Ministry of Science and Technology, Government of India, New Delhi for Catalyzing and Supporting the project entitled "Development of low cost Biology Kit for school students."

Assam Science Society has been working for a long time to create science awareness among the people of the state and particularly the school children. For popularization of science in the state the society has published more than 160 books in Assamese.

The infrastructure facility for science teaching in the schools of our state is not yet developed as expected. For the upliftment of the science education in the secondary level, the society has developed kits along with manuals in Physics, Chemistry, Mathematics and Biology which are proved to be of immense help for the science teachers.

The manual and kit on biology have been designed in such a way that these could be useful and enjoyable for both the teachers and students. The manual has covered 44 nos. of experiments on biology, prepared and designed by experienced teachers of high profile college.

The society will remain grateful to the Project Director Dr. Aparna Buzarbarua, Retd. Professor and Head, Department of Botany, Cotton College, Guwahati. Dr. Biva Goswami, Selection Grade Lecturer, Department of Zoology, Nowgong College, is also credited for her active association in publishing the manual.

Dhireswar Kalita
General Secretary
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The following resource persons participated in the "Brain Storming Workshop on Development of Low Cost Biology Kit for School Students" held in the Department of Botany, Cotton College on 11th and 12th May, 2006.

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AUTHORS' NOTE

Biology is the branch of natural science which deals with the study of structure, behaviour and different physiological activities of plants and animals existing in this universe. Plants and animals can live in a suitable environment enriched with some essential abiotic factors like soil, air, water, light, humidity, etc. Soil is the source of various minerals necessary for plants. The roots of land plants absorb water from the soil which helps in various physiological activities of the plants. Light is indispensable for brining about photosynthesis in plants during which food substances are produced. The life of animals depends directly or indirectly on the foods prepared by the plants. Light also controls the growth and movement of some plants and animals.

Students will learn a concept more easily if they can study it by doing some experiments themselves. This will also generate interest among the students for learning the subject. Keeping this fact in mind, an attempt has been made to give the students a preliminary idea about the biological world by developing the low cost **'BIOLOGY KIT'.**

The kit contains an '**Activity Manual',** a few glass and plasticware, a few stains and chemicals and some other materials which are required for performing the experiments. In the manual, we have tried to discuss the effect of different abiotic factors on the life of organisms and the various physiological activities of plants and animals with some simple experiments. The experiments have been prepared strictly in accordance with the school syllabus. The manual includes 44 (forty four) experiments which are designed in such a way so that the students can perform them easily in the classroom with the help of the kit without any well equiped laboratory. The students of the schools of interior areas where there is no laboratory will be much benefitted with this kit.

In spite of our continuous and sincere efforts there may have some errors in the manual which may need correction. Any suggestion regarding the improvement of the kit will be highly appreciated.

The authors are grateful to Dr. Bharati Sarma, Head of the department of Botany, Cotton College, Guwahati for translating some experiments of the **Section II** into English from the Assamese version of our book **'Jiva Bigyanar Sahaj Pariksha'.**

We are specially thankful to Dr. Saibal Sengupta, Lecturer, Department of Zoology, Arya Vidyapith College, Guwahati for his significant contribution and suggestion in preparing the manual. Thanks are also due to Dr. Aditi Bhuyan, Lecturer, Department of Zoology, Handique Girls' College for her active co-operation in the project.

We are also thankful to Shri Manash Lochan Das (Lecturer, Dudhnoi College) convenor of the **'Brain storming Session' held on 11th and 12th of May 2006** and Dr. Bimal Kar (Reader, Department of Geography, Gauhati University) for smoothly and gracefully arranging the workshop.

The authors are grateful to all the Resource Persons for their valuable comments and suggestions for the improvement of the Biology Kit and the manual.

Our sincere thanks are due to Dr. Barindra Kumar Sarma and Dr. Dhireswar Kalita, present president and general secretary of the society respectively for their valuable suggestions. We are also thankful to Dr. Mohan Chandra Kalita (Professor & Head, Department of Biotechnology, Gauhati University), Dr. Hiranya Kumar Chowdhury (Lecturer, Department of Chemistry, Handique Girls' College) and Dr. Saranga Ranjan Patgiri (Lecturer, Department of Botany, Cotton College) the ex-general secretaries of the Assam Science Society for their valuable help.

We are greatly indebted to the Assam Science Society for entrusting us the responsibility for the development of the Biology Kit.

Aparna Buzarbarua
Biva Goswami

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INTRODUCTION

What is Biology ?

Biology is the science that deals with the study of living organisms (Gr. 'bios'=life, 'logos'=science) and hence it is also called **Life Science**. Jean Lamark (1744 – 1829), a French Scientist introduced in 1801 this branch of science. It is considered to be one of the oldest branch of science about living things. Biology includes the study of both plants and animals. The branch which deals with the study of plants is called Botany (Gr. 'botane'=herb) and that which deals with the study of animals is termed zoology ('zoon' = animal). At present due to sincere hard work of scientists now Biology can be studied under various branches like, morphology, histology, physiology, anatomy, cytology, embryology, genetics, ecology, taxonomy, etc.

In the 'Biology Kit' some simple experiments are included in accordance with the syllabus recommended by the Assam Higher Secondary Education Council & SEBA for Secondary and Higher Secondary School Level students only.

The activity guide prepared for carrying out the experiments has been designed into **two main** sections. The **section I** includes some simple experiments which will help the students to acquire thorough knowledge for performing some simple experiments on 'living organisms' (both plant and animal kingdom). This study is based on the five kingdom system of classification given by R. H. Whittaker (1969) as all living organisms are best thought of today as being members of one of the five kingdoms (Fig-1). The five kingdoms are stated as follows :

1. **The Kingdom Monera** (Prokaryotes, bacteria) : It includes all the prokaryotic organisms, like, bacteria, blue green algae, etc. The cells are microscopic (1 to a few microns in length) and do not contain nucleus. The mode of nutrition may be heterotrophic or autotrophic.

2. **The Kingdom protista** (Eukaryotes) : It includes primitive and unicellular eukaryotes, e.g. unicellular algae, protozoa, slime moulds, etc. The mode of nutrition may be photosynthetic, parasitic or saprophytic or holozoic (animal like).

3. **The kingdom Fungi** (Eukaryotes) : It includes unicellular or multicellular organisms without any chlorophyll and the cell wall is made up of chitin. The mode of nutrition is heterotrophic (parasitic or saprophytic). Examples are mushrooms, moulds, puffballs, Penicillium, etc.

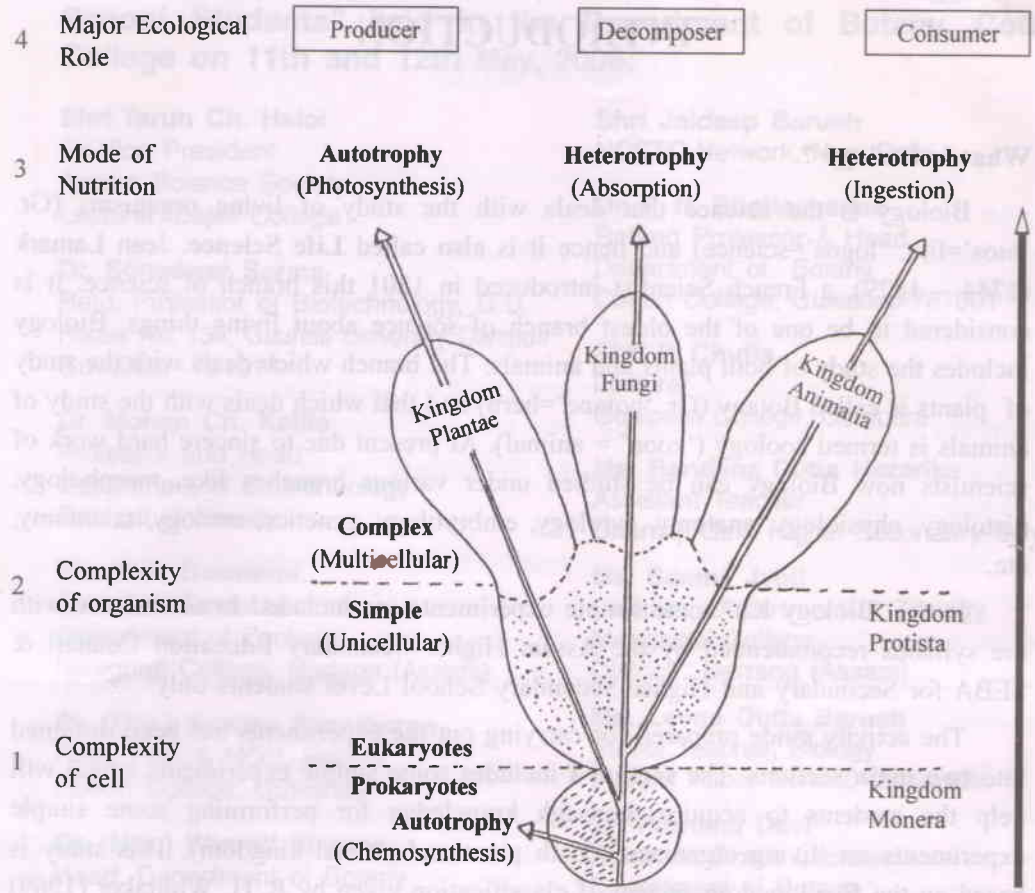


Fig. 1. Five kingdom classification of Biological World (Whittaker, 1969).

4. **The Kingdom plantae** (Eukaryotes): It includes multicellular organisms with photosynthetic pigment, chlorophyll. The cell wall is made up of cellulose. They are autotrophic. Examples are sea weeds (brown & red algae), mosses, ferns and seed plants.

5. **The Kingdom animalia** (Eukaryotes): In includes those organisms which lack chlorophyll. They are heterotrophic, Sponges, nematodes, arthropods, mammals, birds, fishes, reptiles, are all included in this kingdom.

The first three kingdoms (i.e. Monera, Protista and Fungi) are studied in microbiology as the organisms included in these groups are too small to be seen with a naked eye (less than 1 mm in diameter). They can be studied only under the microscope. Therefore, they are said to be as microorganisms.

Some simple experiments are given in the activity guide to study the microorganisms. As it is a low cost 'Kit', the inclusion of microscope in the 'kit' is not possible. Therefore, only a few experiments are included in the activity guide so that the students may have got some idea about the microorganisms. It is assumed that these experiments they can study under the microscope which is available in their school.

The Section II is comprised of study of cells and some important metabolic processes of plants and animals. In this section only those experiments are described which can be performed by the students successfully in the class room with the help of "Kit".

SECTION - I

Preamble : Microscopic living organisms are included under the plant kingdoms Monera, Protista and Fungi. The size of these organisms is 0.1 mm or less in diameter. Their mode of nutrition is either autotrophic (unicellular plants and photosynthetic bacteria) or heterotrophic (bacteria, fungi and animals).

The light microscope is a two-lens system in which the lens nearest to the object is known as the objective lens and that nearest the eye is called **ocular lens**. Visible light rays are projected with the help of the mirror through the condenser which directed the light to the objective lens to form a magnified image (real image). This image now becomes an object for the ocular lens and the light rays are magnified for a second time creating a virtual image which is visible at the eye piece lens. Eye pieces normally range in magnification from 5 X to 15 X.

Magnification of an object is equal to the magnifying power of an eye piece lens multiplied by the magnifying power of an objective lens. For example, if the eye piece lens is 10 X and objective lens is of 10 X then the total magnification of the object viewed through the eye piece will be $10 \times 10 = 100$ times.

Expt. 1. : Study of microscopic living organisms under light microscope (compound)

Requirements : Compound microscope (light), glass slides, cover glass, dropper, blotting paper, needle, forceps, a little dirty water from drain, ditch or pond.

Procedure : Take a drop of dirty water with the help of a dropper on a slide. With the help of a needle or a forceps spread apart the dirty particles. Then cover with a clean cover glass. During placing the cover glass over the material care should be taken so that no air bubbles are left inside the cover glass. For this, hold the cover glass at approximately a 45^0 angle to the slide and gently lower down it with a dissecting needle until it covers the material. After placing the cover glass properly wipe away the extra water with the help of blotting paper (Fig. 2). Now the slide is ready for observation under the microscope.

You are likely to observe variety of microorganisms under the microscope. Make a list of living & non-living components, and try to identity the organisms with the help of your teacher.

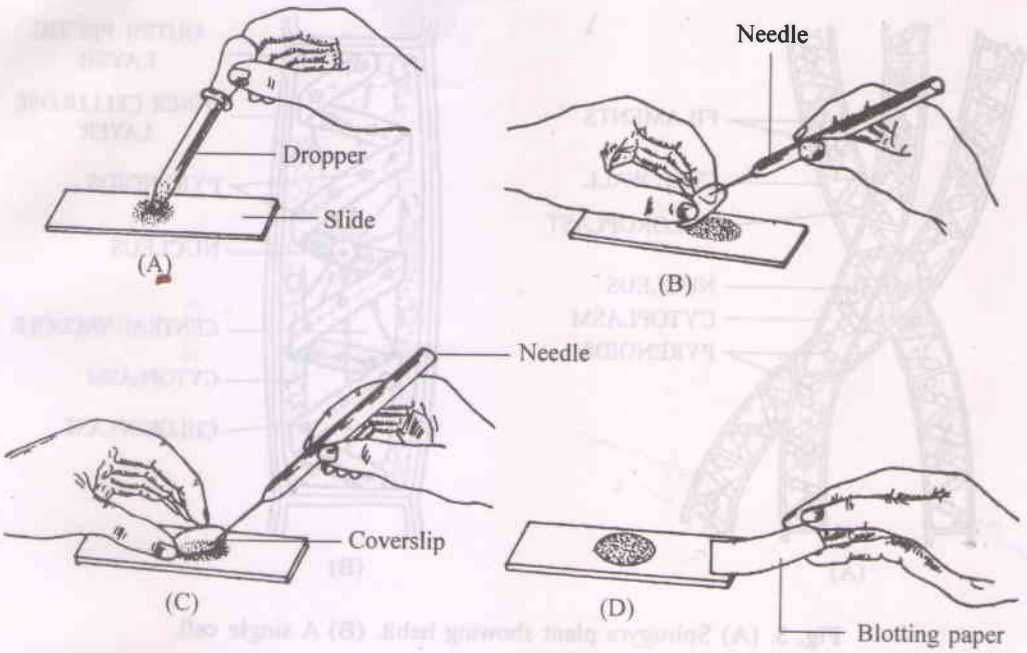


Fig. 2. Preparation of a slide (A-D).

Expt. 2. : Study of Green algae

Preamble : Algae may be defined as chlorophyll bearing autotrophic thallophytes (the plant body is not differentiated). They may vary in size from unicells (0.5 microns in diameter) to huge sea weeds reaching upto a length of 100 feet or more, e.g. *Macrocystis pyrifera*. The cell wall is made up of cellulose. Some algae are fresh water and some are marine. They reproduce by vegetative, sexual and asexual method.

Requirements : Compound microscope (light), slide, cover glass, blotting paper, needle, watch glass, brush, green scum from pond, ditches or pools.

Procedure : Take a little green scum on a watch glass and wash the scum in clear water with the brush to remove any dirt particles present. Then mount the scum on the middle of a slide in a drop of clear water. Cover it with a cover glass carefully as described in the expt.1. Then observe the slide under the compound microscope.

Observation : You may observe some unicellular green algae and some filamentous algae like Spirogyra. (Fig. 3) You may also take your teacher's help for identifying the algae.

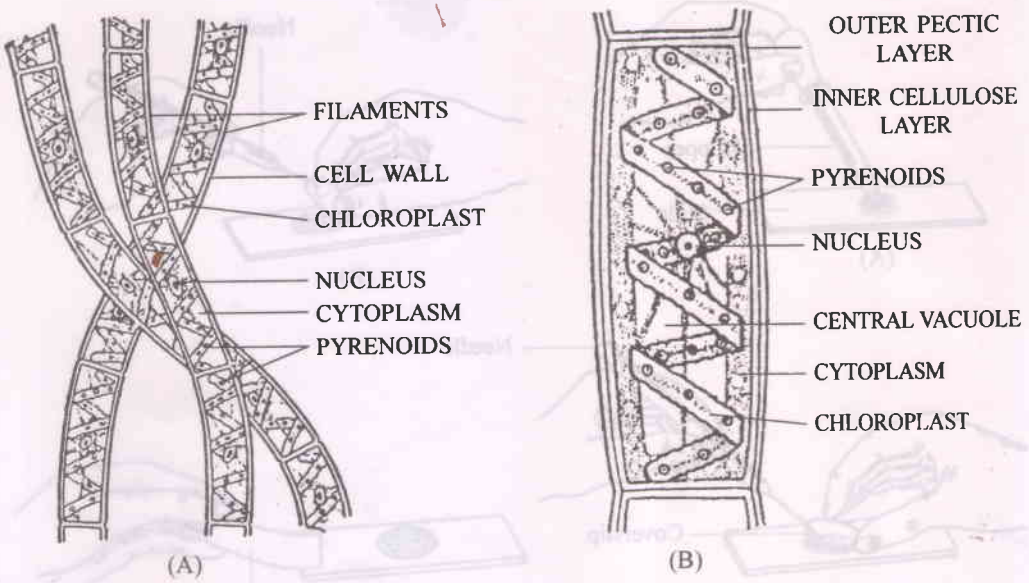


Fig. 3. (A) Spirogyra plant showing habit. (B) A single cell.

Expt. 3. : Study of Fungi (bread mould) under the compound microscope (light)

Preamble : Fungi are thallophytes without any chlorophyll pigments. Due to the absence of chlorophyll they live heterotrophically for their supply of nutrition either parasitically (on living organism) or saprophytically (on dead organic matter). The thallus consists of many interwoven mass of filaments, i.e. mycelium, the unit of which is called 'hypha'. Fungi reproduces mostly by vegetative and asexual methods and also sometimes by sexual methods. The cell wall of fungus cell is made up of 'chitin'.

Requirements : Compound microscope, slide, cover glass, blotting paper, needle, brush, watch glass, 'bread mould', Cotton blue.

Procedure : (i) For culturing 'bread mould'.

It can be cultured easily by placing a moistened piece of bread in an uncovered petridish for few days at room temperature. Bread mould will appear as white cottony patches over the bread.

(ii) **Preparation of Slide :** Take a portion of white cottony outgrowth from the bread with the help of forceps on a slide. Then stain it with a drop of cotton blue for 1 or 2 minutes and cover with a cover slip following the same procedure as in expt. 1.

Observation : While observing under the microscope you will find the mycelia and spore producing organs of the fungus as shown in the Fig. 4. The botanical names of **'Bread mould'** are **Rhizopus sp & Mucor sp.**

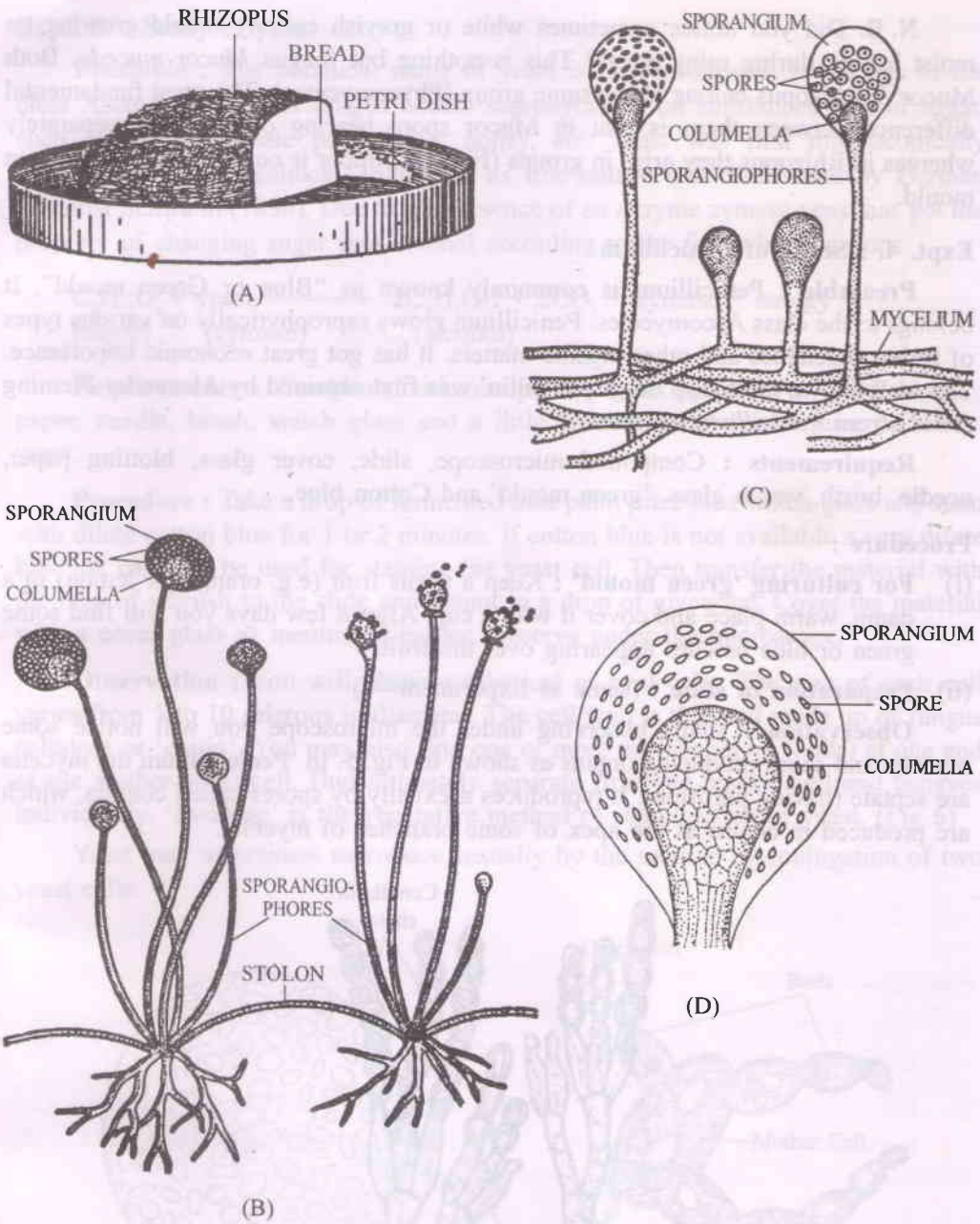


Fig. 4. (A) Rhizopus on moistened bread.
(B) Rhizopus, mycelium with sporangia.
(C) Mucor, mycelium bearing sporangia.
(D) A sporangium under high magnification.

N. B. Did you notice sometimes white or grayish cottony mould growing on moist leather during rainy days ? This is nothing but fungus *Mucor mucedo*. Both Mucor & Rhizopus belong to the same group (Phycomycetes). The most fundamental difference between them is that in Mucor spore bearing organs arise separately whereas in Rhizopus they arise in groups (Fig. 4.). Mucor is commonly known as pin mould.

Expt. 4. : Study of Penicillium

Preamble : Penicillium is commonly known as "Blue or Green mould". It belongs to the class Ascomycetes. Penicillium grows saprophytically on various types of fruits, vegetables and other organic matters. It has got great economic importance. The well known antibiotic drug 'penicillin' was first obtained by Alexander Fleming (1942) from *Penicillium notatum*.

Requirements : Compound microscope, slide, cover glass, blotting paper, needle, brush, watch glass, 'green mould' and Cotton blue.

Procedure :

(i) **For culturing 'green mould' :** Keep a citrus fruit (e.g. orange, or lemon) in a damp, warm place and cover it with a cup. After a few days you will find some green or blue patches appearing over the fruit.

(ii) **Preparation of slide :** (same as Experiment - 4)

Observation : While observing under the microscope you will notice some mycelia and spore producing organs as shown in Fig. 5. In Penicicillium the mycelia are septate (having partition). It reproduces asexually by spores called conidia, which are produced in chains at the apex of some branches of mycelia.

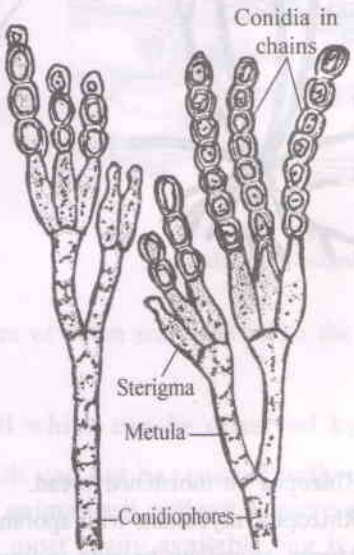


Fig. 5. Penicillium showing spore producing organs conidia in chains.

Expt. 5. : Study of yeast

Preamble : The botanical name of yeast is Saccharomyces. It belongs to the class Ascomycetes. This fungus occurs saprohytically on substances rich in sugar, such as molasses, date palm juice, honey, etc. Yeast was first microscopically examined by Leeuwenhock (1680) but its true nature was discovered by German Scientist Schwann (1836). Due to the presence of an enzyme zymase yeast has got the property of changing sugar into alcohol according to the following reactions.

$$\underset{\text{(sugar)}}{C_6H_{12}O_6} + \underset{\text{(zymase)}}{\text{yeast}} \longrightarrow \underset{\text{(alcohol)}}{2C_2H_5OH} + 2CO_2 + \text{zymase} + \text{energy}$$

Requirements : Compound microscope, slide, dropper, cover glass, blotting paper, needle, brush, watch glass and a little fermented date palm juice or bakers yeast.

Procedure : Take a drop of fermented date palm juice on a watch glass and stain with dilute cotton blue for 1 or 2 minutes. If cotton blue is not available a very dilute blue ink can also be used for staining the yeast cell. Then transfer the material with the help of a brush to the slide and mount in a drop of glycerine. Cover the material with a cover glass as mentioned earlier. Observe under the microscope.

Observation : You will observe spherical or oval cells. The size of each cell varies from 5 to 10 microns in diameter. The cell wall is thin and made up of fungus cellulose or 'chitin'. You may also find one or more protuberances (buds) at one end of the mother yeast cell. Bud ultimately separate from the mother cell and behaves individually. 'Budding' is the vegetative method of reproduction of yeast. (Fig 6)

Yeast may sometimes reproduce sexually by the method of conjugation of two yeast cells.

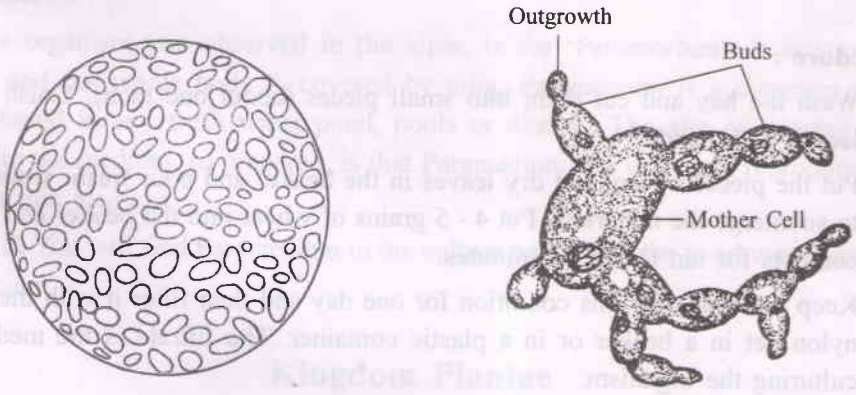


Fig. 6. (A) Yeast cells as seen under the microscope. (Low magnification)
(B) Budding of yeast. (Under high magnification)

N. B. Yeasts are sold in the market as dried yeast cakes. Therefore, yeast can also be cultured in the laboratory by placing a few grains of yeasts in a solution of sugar for one or 2 days. Millions of yeast cells will appear in the solution.

Expt. 6. : Study of an unicellular animal

Preamble : The unicellular organisms belong to the group called 'protista'. This group includes various types of organisms like free living, solitary, colonial, parasitic etc. Students can study a free living solitary microorganism by culturing it by a simple method.

Requirements : Pond water

1. A beaker (medium size) or a plastic container
2. A little bit of hay and dry leaves
3. A few grains of wheat
4. Scissors
5. Slide
6. Dropper
7. Glycerine
8. Nylon net, blotting paper
9. Filter paper
10. A beaker or any container, where you can warm water
11. Microscope.
12. Pond water.

Procedure :

1. Wash the hay and cut them into small pieces (about one inch). Crush the dry leaves with hand.
2. Put the pieces of hay and dry leaves in the beaker and pour fresh water into it to submerge the materials. Put 4 - 5 grains of wheat into the beaker and boil the contents for ten to fifteen minutes.
3. Keep the beaker in this condition for one day and then filter it with the help of nylon net in a beaker or in a plastic container. The filtrate is the medium for culturing the organism.
4. Now collect pond water and filter it. Pour some amount of filtered pond water to the filtrate in the beaker. Keep it in such condition for 2 - 3 days.
5. After 2 - 3 days, take a few drops of water from the beaker on a clean slide and observe under the microscope.

Have you seen a small organism, whitish in colour, moving about very fast? Your careful observation is required. If you find it, soak the water with a blotting paper from a corner and then put a drop of glycerine over the material and observe again under the microscope and compare the shape with the diagram (Fig. 7).

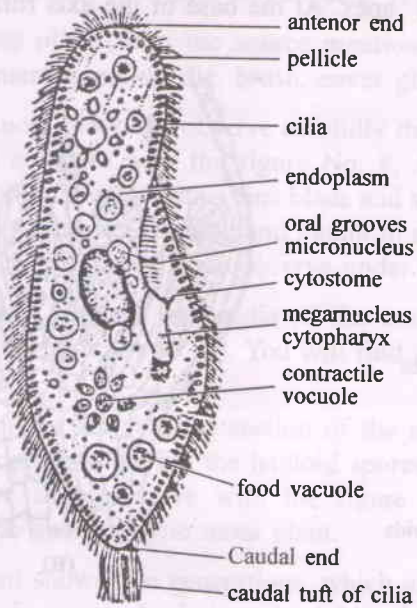


Fig. 7. Paramecium.

To be noted :

The organism you observed in the slide, is the 'Paramecium'. It is slipper – shaped, and the whole body is covered by cilia. Paramecium is a common ciliate animal found in any fresh water pond, pools or ditches. The aim of pouring pond water into the medium, so prepared, is that Paramecium can grow and reproduce very easily in this medium.

N. B. You will find Paramecium in the culture only when the pond water contains Paramecium.

Kingdom Plantae

This kingdom includes multicellular autotrophic plants. Here, some examples of mosses, ferns and seed plants will be described so that students will acquire some knowledge about the body structure of these types of plants.

Expt. 7. : Study of Mosses

Preamble : Mosses are represented by 14,500 species. They commonly grow on old damp walls, tree trunks, and on damp ground during rainy days forming soft velvet like, green carpet. Moss plant is small, about an inch or so in height, consists of a short axis (stem) with spirally arranged minute green leaves (Fig. 8). The leaves are crowded towards the apex. At the base of the axis rhizoids (root like structure) are present.

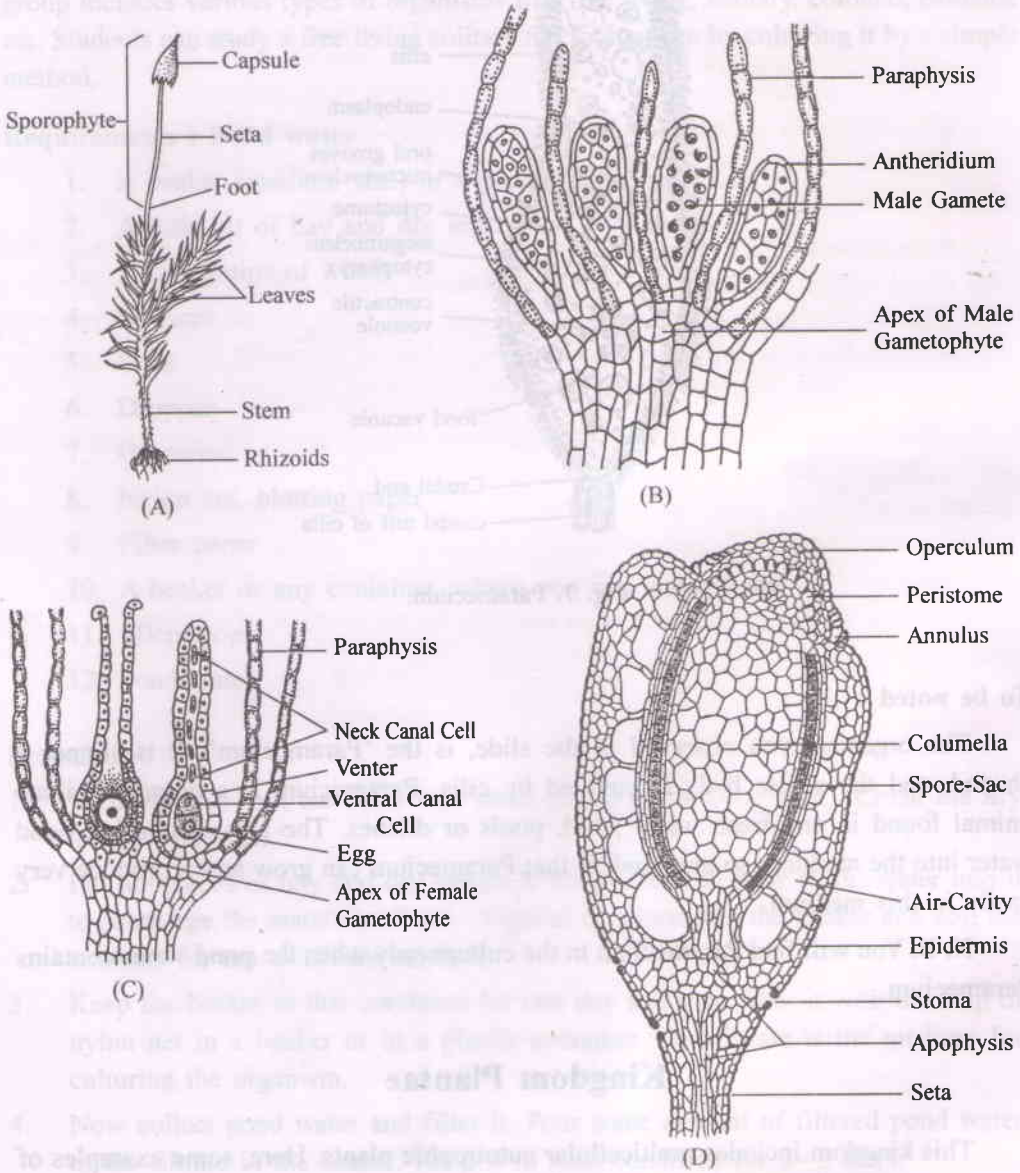


Fig. 8. (A) A Moss plant. (B) L. S. of Antheridial Head of Moss plant. (C) L. S. of Archegonial Head of Moss plant. (D) Longitudinal Section of Moss capsule.

Sexual reproduction takes place by the formation of sex organs, which are called antheridia (male) and archegonia (female). They develop generally on two different branches of the same plant. The moss plant is a gametophyte. After fertilization (takes place due to the fusion of male gametes produced in the antheridium and the female gamete or egg developed in the archegonium) the zygote (2n) develops into the sporophytic plant, which contains foot, seta and capsule. (Fig. 8)

Requirements : Moss plant (from the source mentioned above); blade, slide, safranin, blotting paper, microscope, needle, brush, cover glass, magnifying glass.

Procedure : Take a moss plant and observe carefully the entire plant body with the magnifying glass and compare with the figure No. 8, A. Then carefully cut a section of the moss apex longitudinally with a fine blade and stain the cut portion with dilute safranin. Wash with water after staining and mount in a drop of clean water on a slide and after covering with a cover glass observe under the microscope.

Observation : You will find the antheridia (if the section is a good one and properly cut). Compare with the figure (8. B). You will find the archegonia if the cut apex is a female branch (Fig. 8 C).

Similarly, you can cut the longitudinal section of the capsule and observe the section under the microscope for studying the haploid spores of mosses, which will be found inside the spore sac (compare with the figure 8, D). The spores on germination give rise to the gametophytic moss plant.

Inference : Moss plant shows two generations, which are alternating with each other. The main plant body is gametophytic (n or haploid) which bears antheridia and arechegonia. The zygote (2n or diploid) after fertilization develops into the sporophytic plant which produces capsule (2n). Within the capsule reduction division of sporogenous cells takes place which gives rise to the haploid (n) spores. The spores on germination give rise to the moss plant. In this way, the life cycle of moss plant is completed.

Expt. 8. : Study of Ferns

Preamble : Ferns are widely distributed all over the world. They grow abundantly in cool, shady, moist places, both in the hills and in the plains. The main plant body is the sporophyte.

Requirements : Microscope, magnifying glass, blade, slide, safranin, blotting paper, needle, brush, cover glass and a fern plant, (You will find it in any shady places of your home or in the garden of your school).

Procedure and Observation : Observe the plant carefully and compare with the Fig. 9. A. You will find the following characteristics of the plant—

1. Leaves are pinnately compound
2. Younger leaves are coiled (Circinate vernation)
3. The stem is rhizome which bears rhizoids

4. Leaflets on the under surface contain "Sori" (sing 'sorus'). Each sorus consists of a large number of sporangia which contain spores. Note the position of the sorus on the veins with the help of magnifying glass.

Cut a transverse section of the leaflet with the help of a blade passing through the sorus. You will find the sporangia & spores as in Fig. 9. B.

The spores are haploid (n) which on germination gives rise to the fern prothallus (n). The prothallus is a heart-shaped body on which antheridium (male) and archegonium (female) will develop (Fig. 9. C). The zygote develops after fertilization between male and female gamete gives rise to the sporophyte. (i.e. the embryo) at the apex of the prothallus. From the sporophyte ultimately the fern plant will develop.

Inference : Unlike moss plant, the fern plant is a sporophyte which bears spores within the sorus. The spores on germination gives rise to the gametophytic prothallus where fertilization between the male and female gamete takes place. After fertilization the zygote develops into the sporophyte giving rise to the fern plant. In fern, the sporophytic generation is more pronounced than in Moss where gametophytic generation is significant.

In fern also the life cycle is completed with the regular alternation of sporophytic and gametophytic generations.

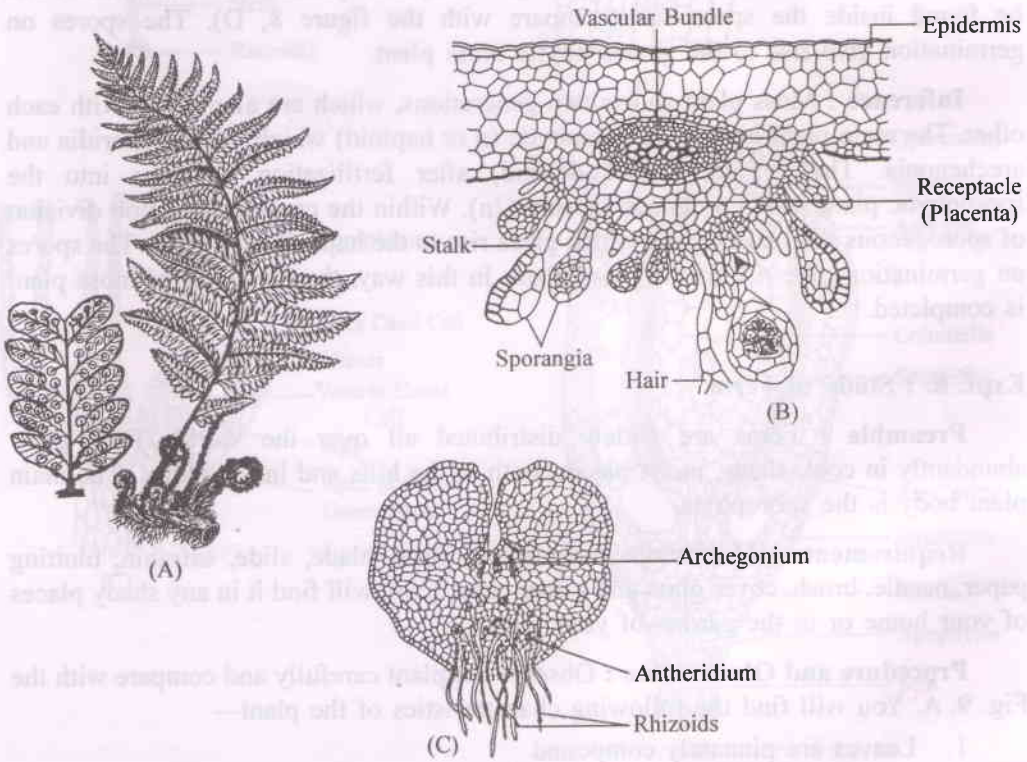


Fig. 9. (A) A fern plant and a portion of a pinna with sori (left). (B) A transverse section of a fern leaf passing through a sorus. (C) Prothallus of fern.

Study of Angiosperms

Preamble : The angiosperms (Gr.angeion, a case; sperma, seed) are **closed seeded** plants, which include the most recent, and well organized flowering plants that have colonized the earth. They are represented by diverse types of plants as herbs, shrubs, trees and climbers. Though they are autotrophic in the mode of nutrition some parasitic forms like dodder (**Cuscuta,** a stem parasite) and **Rafflesia** (a root parasite which bears the largest flower in the world) are also noticed among the angiosperms. All angiosperms produce true flowers which are the reproductive organs of the plants. They have well developed stems, leaves and fruits. The flower contains the reproductive organs : stamens (male) and carpels (female). The main plant body is the sporophyte (2n) which is more prominent in the life cycle of a plant than the gametophytic (n) generation. The gametophytic generation is represented by male gametophyte (developed in the pollen grain produced by the stamen) and the female gametophyte (developed in the ovule of the ovary of the carpel). There are two main classes of angiosperms :

(a) Dicotyledons (di=two) : The embryo of the seed bears two cotyledons (seed leaves)eg. Mango, gram, guava, cotton, orange, sunflower, etc.

(b) Monocotyledons; (monos = single) : The embryo of the seed bears only one cotyledon eg. Rice, wheat, maize, onion, orchids, etc.

The above mentioned things will be clear to you when you study and describe a common angiospermic plant available in your locality. Two examples of such common plants are described below to give you a clear picture of angiospermic plant.

Expt.9. : Study of common dicotyledonous flower

Preamble : A typical dicotyledonous flower consists of four whorls or circles of floral leaves which are arranged on a short axis called thalamus. **Calyx** is the first or lowermost whorl, the individual member of which is known as sepal which are generally green in colour. The second or next upper whorl is the **corolla** and consists of a number of usually brightly coloured leaf termed as petals. The next upper whorl is the **androecium** which contains the stamens (male part). **Gynoecium** is the topmost whorl which include the carpels (female part). Out of these four whorls,stamens and carpels are the reproductive whorls which take part in reproduction and the calyx and corolla are the accessory whorls which helps in pollination and provide protection to the flower in bud condition. Flower is said to be a complete one when all these four whorls are present. Sometimes in some flowers another leafy structure is found, termed as **bracts** the function of which is generally to provide protection to the floral bud.

(A) Study of China Rose Plant

Requirements : A portion of a branch of China rose with a flower, dissecting needle, slide, blade, magnifying glass.

Procedure : At first examine the habit of the plant and the flower very minutely and draw the complete flower with a portion of the branch at the top position of the book (as shown in the figure). Label every whorl. Then dissect every whorl of the flower starting from the first whorl i.e. calyx with the help of a needle. Label every parts of the whorl. (in the China rose flower you will get epicalyx; so it is to be arranged at the lowermost position as shown in the Fig. 10). Draw and arrange each whorl from bottom to top. After completion of the dissection and drawing cut the transverse section of the ovary and observe the arrangement of the ovule within the ovary (i.e. placentation), with the help of a magnifying glass. Different flowers have different types of arrangement of ovules. While dissecting the flowers, the morphological characters you have noticed are to be described.

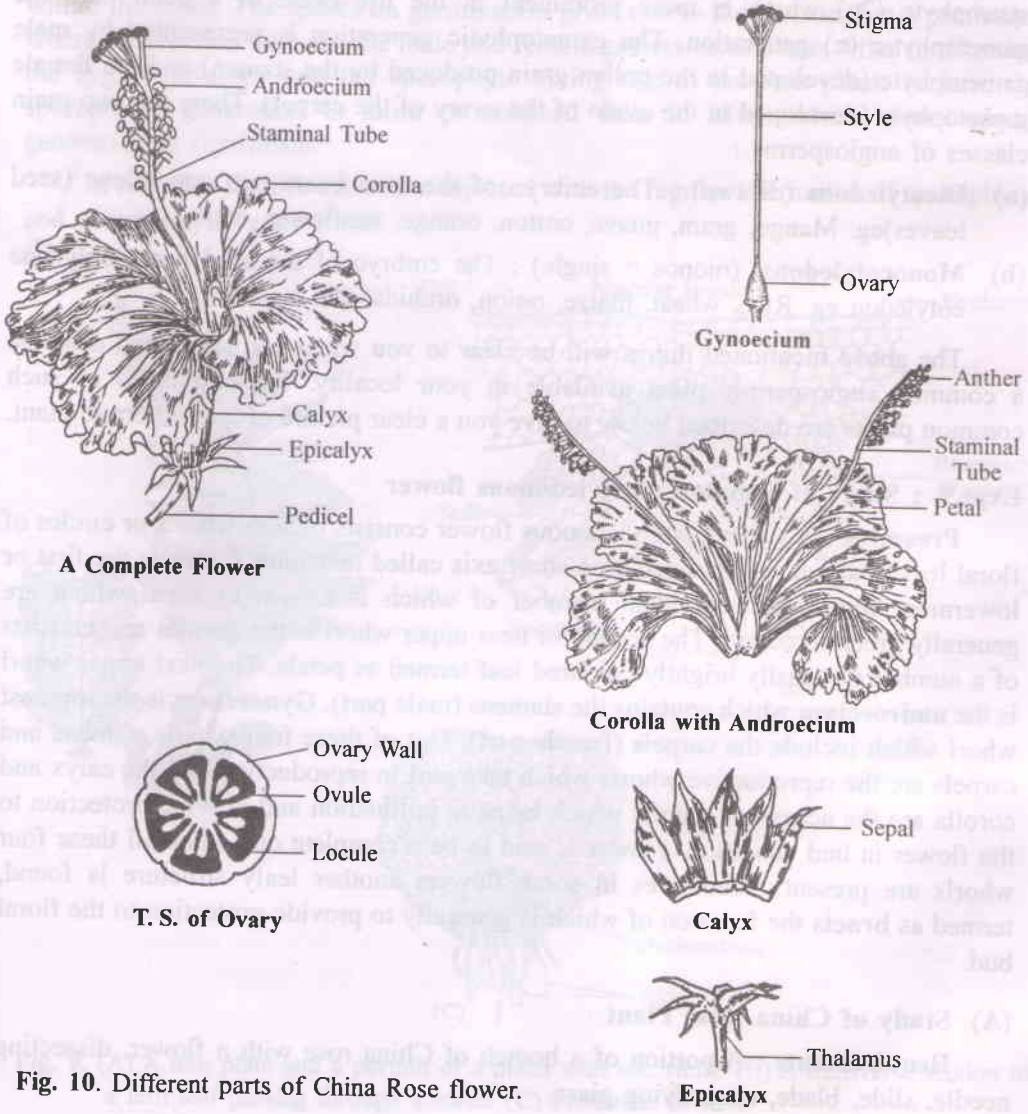


Fig. 10. Different parts of China Rose flower.

In the case of China rose, the description should be as mentioned below :

Scientific names of the plant : Hibiscus rosa-sinensis.

Family : Malvaceae.

Habit of the plant : An ornamental evergreen shrub.

Root : Tap root system.

Stem : Aerial, erect, woody, cylindrical & branched.

Leaf : Stipulate, Petiolate, simple, alternate, ovate, acute, glabrous and venation reticulate.

Flower : Solitary, axillary, complete, bisexual, pentamerous, red in colour.

Epicalyx : 6 - 10 in number, lanceolate, green in colour.

Calyx : Sepals 5, gamosepalous, tubular, persistent, aestivation valvate, green in colour.

Corolla : Petals 5, polypetalous, slightly united at the base with the staminal column, aestivation twisted, red in colour.

Androecium : Stamens many, monadelphous, epipetalous, filaments united to form a hollow staminal tube the lower portion of which is fused with the corolla; anthers are free, reniform, basifixed.

Gynoecium : Carpels 5, syncarpous, ovary superior, five chambered, placentation axile, ovules two in each chamber, style long and passes through the staminal tube, stigma 5, free, capitate, coloured.

Fruit : a Capsule

Glossary for the technical words mentioned above.

1. **Shrub :** Medium sized plants with hard & woody stem the branches of which arise profusely from near the ground.
2. **Aerial :** Above the ground
3. **Stipulate :** When a leafy appendage present at the leaf base.
4. **Petiole :** When stalk of the leaf is present.
5. **Glabrous :** hairless.
6. **Venation :** Arrangement of the veins on the leaf blade or lamina.
7. **Reticulate :** Net like arrangement of the veins.
8. **Axillary :** Position between the leaf and the stem.
9. **Hypogynous :** When ovary occupies the topmost position on the thalamus.
10. **Bisexual :** When both the sexes are present.

11. **Pentamerous :** Having parts or members in fives.
12. **Lanceolate :** Tapering toward both ends: shaped like a lance-head.
13. **Gamosepalous :** When the sepals are united.
14. **Aestivation :** The mode of arrangement of sepals and petals relatively to one another in the bud condition.
15. **Valvate :** When the petals or sepals are in contact with each other by their margins.
16. **Polypetalous :** When the petals are free.
17. **Monadelphous :** When the filaments are united together into a single bundle.
18. **Epipetalous :** When the stamens adhere to the corolla.
19. **Reniform :** Kidney shaped.
20. **Basifixed :** When the filament is attached to the base of the anther.
21. **Syncarpous :** When all the carpels are united together.
22. **Placentation :** The mode of arrangement of placentae in the cavity of the ovary.
23. **Axile :** The placentae bearing the ovules arise from the axis.
24. **Capitate :** Having a head or knob.
25. **Placenta (Pl. Placentae) :** A parenchyma tissue outgrowth in the cavity of the ovary to which the ovules remain attached.
26. **Capsule :** It is a many seeded dehiscent fruit developed from a syncarpous ovary.
27. **Parenchyma :** A simple kind of living tissue composed of thin walled similar cells.

(B) Study of Butterfly Pea Plant and the Flower (Dicotyledonous)

Requirement : Dissecting needle, slide, blade & magnifying glass.

Procedure : Same as China rose flower

Scientific name : Clitoria ternatea

Family : Fabaceae (or Papilionaceae).

Habit : A Climbing ornamental herb.

Root : Branched tap root with nitrogen fixing nodules in the roots.

Stem : Aerial, weak, branched, climbing, green & glabrous.

Leaf : Petiolate, stipulate, compound, unipinnate, each leaflet is opposite, imparipinnate, leaflet sessile, ovate, entire and acute.

Flower : Solitary, bracteate (Bract – 2) pedicellate, complete, bisexual, pentamerous, hypogynous, zygomorphic, blue or white.

Calyx : Sepals 5, gamosepalous, campanulate, persistent, aestivation imbricate (Fig. 11).

Corolla : Petals 5, Papilionaceous, zygomorphic, unequal, free, the outermost is the largest called 'standard' or 'vexillum' which encloses the two free lateral petals known as 'wings' or 'alae' which again encloses two innermost smallest petals called 'keel' or 'carina' (Fig. 11). Aestivation vexillary, bright blue or white in colour.

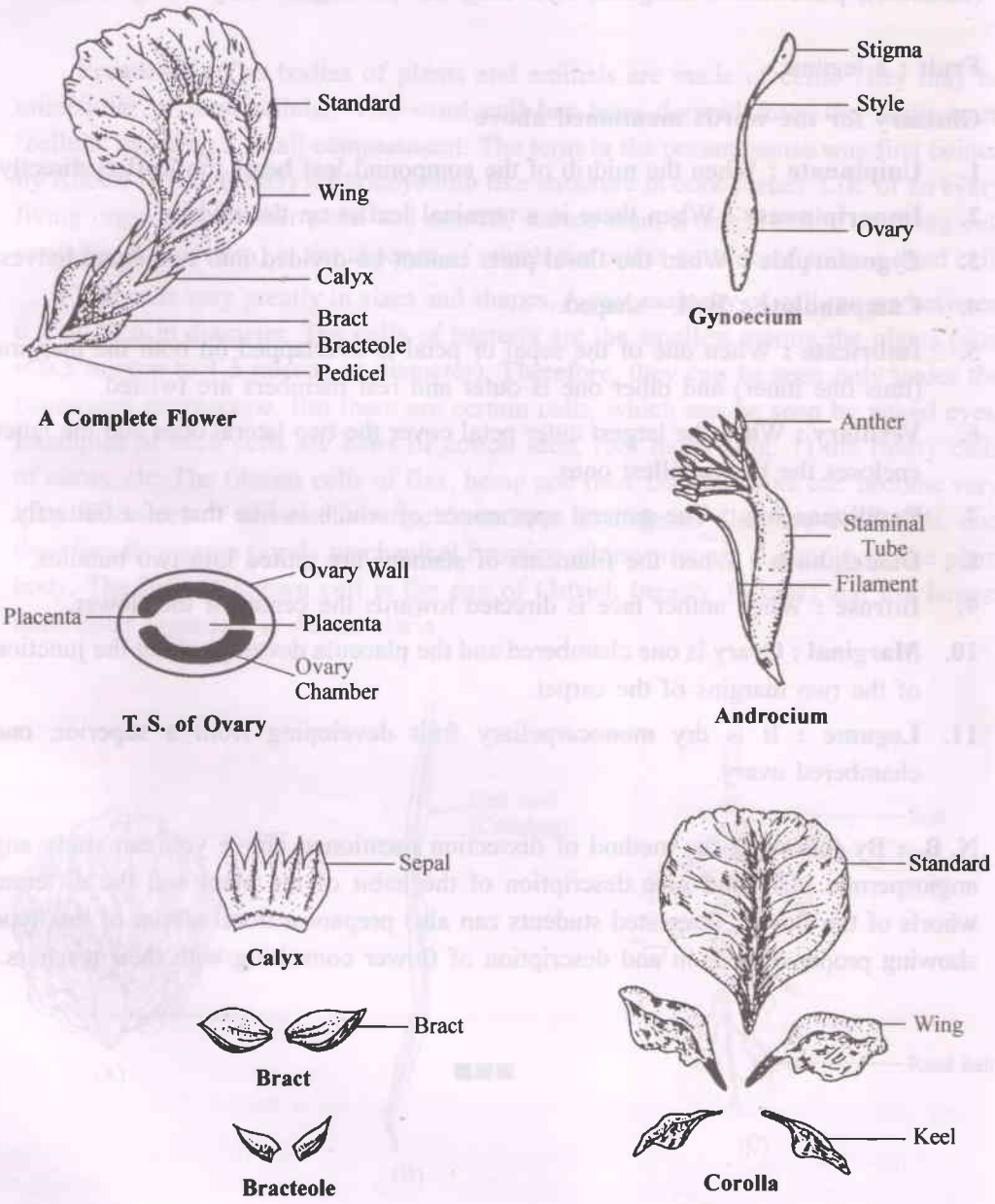


Fig. 11. Different parts of a Butterfly Pea flower.

Androecium : Stamens 10, diadelphous (9) +1; nine filaments are united to form a hollow staminal tube and one remains free. The filaments are long and anthers basifixed, introse.

Gynoecium : Carpel 1, ovary superior, unilocular with many ovules in the loculus (chamber); placentation marginal, style long curved, stigma hairy & capitate.

Fruit : a legume.

Glossary for the words mentioned above

1. **Unipinnate :** When the midrib of the compound leaf bears the leaflets directly.
2. **Imparipinnate :** When there is a terminal leaflet on the midrib.
3. **Zygomorphic :** When the floral parts cannot be divided into two equal halves.
4. **Campanulate :** Bell – shaped.
5. **Imbricate :** When one of the sepal or petal is overlapped on both the margins (thus one inner) and other one is outer and rest members are twisted.
6. **Vexillary :** When the largest outer petal cover the two lateral ones and the latter encloses the two smallest ones.
7. **Papilionaceous :** The general appearance of which is like that of a butterfly.
8. **Diadelphous :** When the filaments of stamens are united into two bundles.
9. **Introse :** When anther face is directed towards the center of the flower.
10. **Marginal :** Ovary is one chambered and the placenta develops along the junction of the two margins of the carpel.
11. **Legume :** It is dry monocarpellary fruit developing from a superior, one chambered ovary.

N. B. : By following the method of dissection mentioned above you can study any angiospermic plant and give description of the habit of the plant and the different whorls of the flower. Interested students can also prepare a floral album of this type showing proper dissection and description of flower consulting with their teachers.

■■■

Section - II

1. Living Bodies are composed of Cells

Preamble : The bodies of plants and animals are made of cells. They may be unicellular or multicellular. The word cell has been derived from the Latin word 'cellula' meaning a small compartment. The term in the present sense was first coined by Robert Hooke (1665) for honeycomb like structure in cork-pieces. Life of an every living organism whether plant and animal, started from a single cell. The living cell contains 'Protoplasm' in the absence of which the cell is considered to be a dead cell.

The cells vary greatly in sizes and shapes. A vast majority of cell ranges between 0.5 to 20 μ in diameter. The cells of bacteria are the smallest among the plants (size = 0.5 micron to 1.5 micron in diameter). Therefore, they can be seen only under the compound microscope. But there are certain cells, which can be seen by naked eyes. Examples of such cells are hairs of cotton seed, root hairs, (Fig. 1) the fleshy cells of citrus, etc. The fibrous cells of flax, hemp and rhea, coconut, Jute etc. become very long. The sizes of these cells range from 2mm to 550mm. They are dead cells, and therefore they serve purely mechanical function giving strength & rigidity to the plant body. The biggest known cell is the egg of Ostrich (nearly 15 cms) and the largest unicellular organism is Acetabularia.

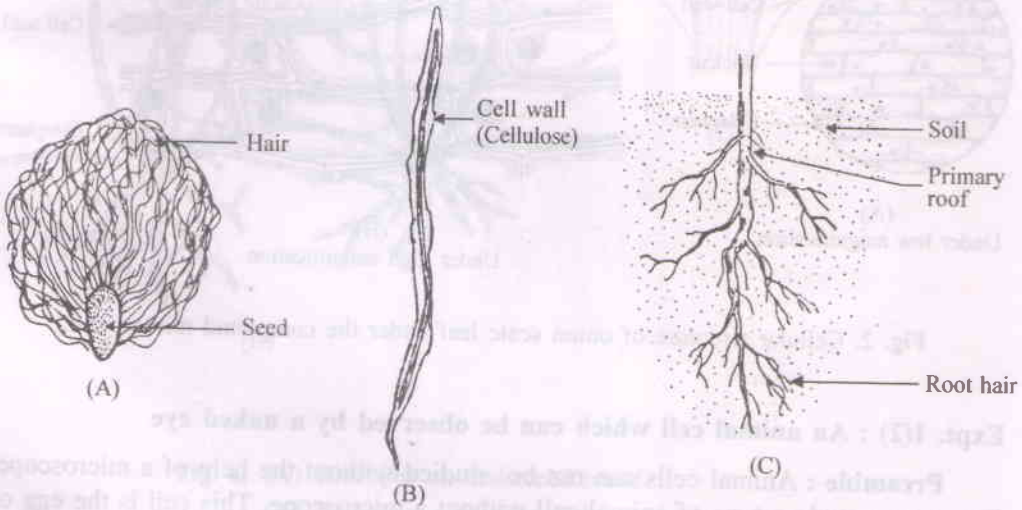


Fig. 1. (A-B) Fibrous cells of cotton. (C) Root hairs.

The following are some experiments for the study of cells under the compound microscope.

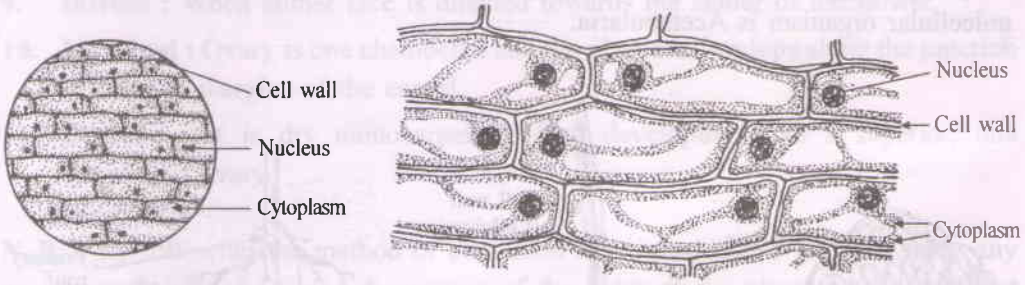
Expt. 1. (1) : Study of the plant cells

Specimen : Fleshy scale leaf of onion.

Requirements : Compound microscope, blade, needle, forceps, brush, safranin solution, slide, cover slip, watch glass, blotting paper.

Procedure : Hold tightly a piece of fleshy scale leaf of onion over the index finger of left hand with the help of thumb so that the inner surface faces upward. Now, with the help of a forceps peel off the skin of fleshy leaf of onion scale. Cut the skin into a small square or rectangular piece. Then place the skin on a watch glass containing a drop of dilute safranin for about 4-5 mins. Wash the skin with clean water properly to remove the extra stain. Then mount in a drop of water on a clean slide. Now cover the skin with the help of cover slip in such a way that there should not be any air bubble inside the cover slip. Remove extra water outside the cover slip with the help of blotting paper. Examine the slide under the compound microscope.

Observation : Under the microscope you will find rectangular cells, cell walls, and a single dot like prominent nucleus located inside the cell (Fig. 2) Observe the colour of cell wall, cytoplasm and the nucleus. You may also see some cavities called vacuoles of varying sizes in the cytoplasm.



(A)
Under low magnification.

(B)
Under high magnification.

Fig. 2. Cellular structure of onion scale leaf under the compound microscope.

Expt. 1(2) : An animal cell which can be observed by a naked eye

Preamble : Animal cells can not be studied without the help of a microscope. But we can study a type of animal cell without a microscope. This cell is the egg of any bird or reptile. But the most easily available egg is that of a hen or of a duck.

Requirements : 1. An egg, 2. one petridish or any plate.

Procedure : Examine the egg in front of a source of bright light. This can be done by holding the egg against the sunlight during daytime. At night, the egg can be examined against an illuminated electric bulb. You will see the egg cell either reddish or opaque. If it is reddish then you examine the egg with a magnifying glass. You will see many pores on the surface of the shell of the egg. These are the pores through which oxygen and carbon dioxide gases are exchanged between the egg cell and the surrounding air.

Now break open the egg shell and pour the contents in a petridish or any glass plate very cautiously so that the yolk is not broken.

Things to be Observed :

1. The middle portion of the egg is completely yellow. It is called the egg 'yolk' which is made up of fats or lipids. There is a thin membrane around the yolk which is called the **'vitelline membrane'.**
2. The jelly like white portion surrounding the yolk is called the egg **'albumin'.** It is the protein part of the egg, which is solidified and forms the white part of the egg while heating.
3. The small whitish spot on top of the yolk is the cell's **nucleus.** Since the greater part of the cell is occupied by albumin and yolk, the position of the nucleus is shifted to the upper portion instead of lying in the center.
4. Observe the different parts of the egg cell and compare them with the figure 3. Have you noticed two spiral thread like structures on either side of the yolk ? They are called the **'chalaza'** which are formed due to the rolling of the egg down the oviduct. The chalaza is not so prominent but can be seen when observed carefully. One end of the egg cell is broader than the other end. The inner portion of this broader end is filled up with air.

'Note' While examining the egg against a source of light if you find the egg opaque, you will know that the embryo is already formed inside the egg cell.

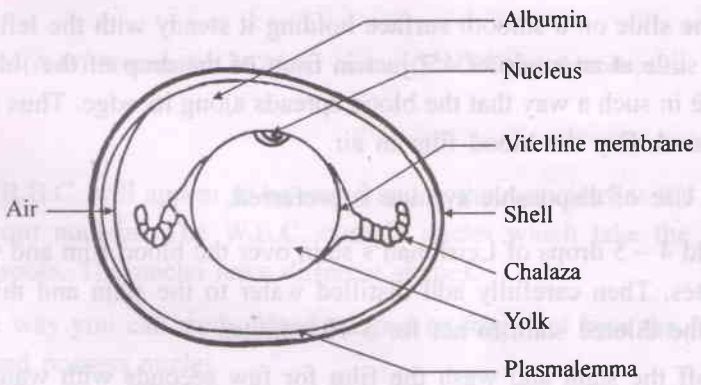


Fig. 3. Different parts of an egg cell.

Expt. 1 (3) : Study of Human Blood Cells

Preamble : Blood is a liquid connective tissue. It is a tissue because different types of cells are found in blood. The liquid part of the blood is called plasma where lies the cells. The cells are of three types. They are :

1. Red blood corpuscle (RBC) or erythrocyte
2. White blood corpuscle (WBC) or leucocyte
3. Blood platelets or thrombocyte.

The R.B.C. contains an iron pigment called haemoglobin which is red in colour. The total number of R.B.C. is more than the other two types of cells and hence the colour of blood is red.

By preparing a smear of blood on a slide the different cell can be studied under a microscope.

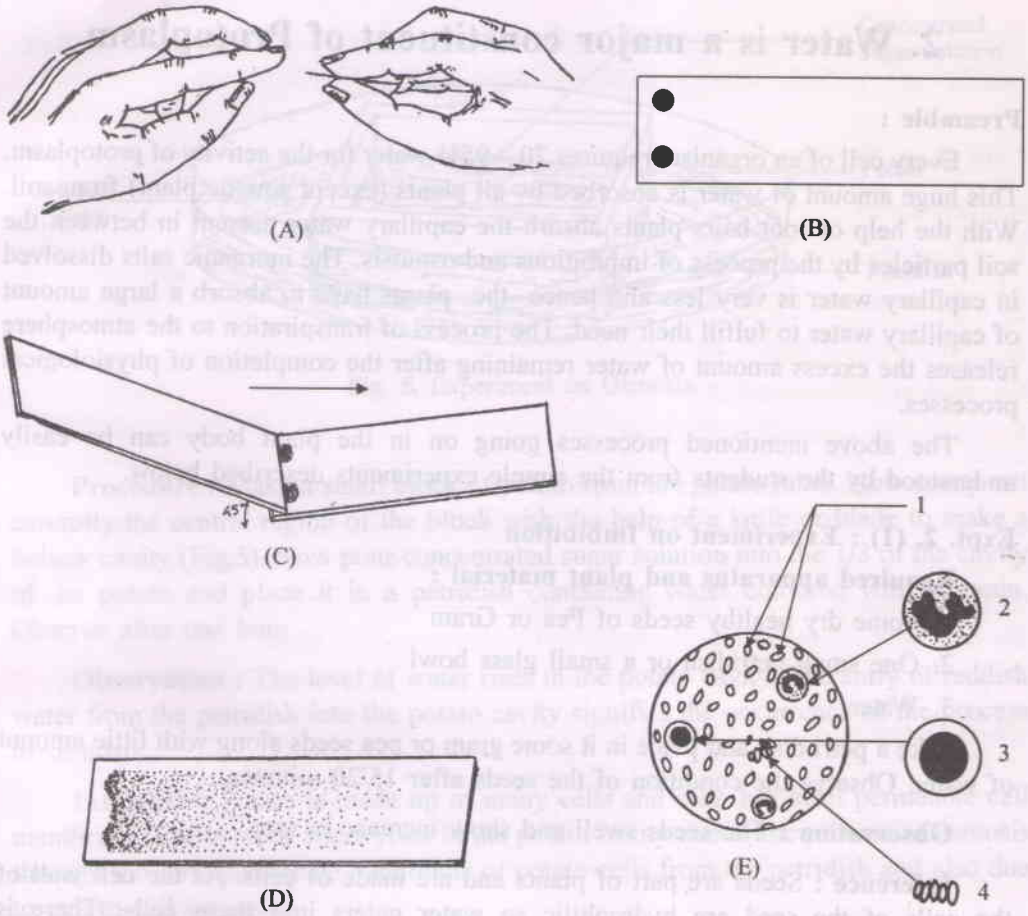
Requirements :

1. A Sterilised needle, (2) Cotton, (3) Two slides, (4) Leishman's stain, (5) One dropper, (6) Clean Water, (7) Rectified spirit, (8) Microscpope.

Procedure :

1. Take two clean slides and make them completely dry. Sterilize the needle by heating & smearing with rectified spirit.
2. Clean the tip of the fore finger of your left hand with cotton soaked in either alcohol or rectified spirit.
3. Now press the fore finger with your thumb (as shown in the fig. 4. A.) and prick the tip of the finger with a sterilized needle. Take two drops of blood on one end of a slide. (as shown in the fig. 4. B.).
4. Place the slide on a smooth surface holding it steady with the left hand. Hold a second slide at an angle of 45^0 just in front of the drop of the blood and draw the slide in such a way that the blood spreads along its edge. Thus a blood smear is prepared. Dry the blood film in air.

   N. B. : Use of disposable syringe is preferred.
5. Now add 4 – 5 drops of Leishman's stain over the blood film and wait for about 2 minutes. Then carefully add distilled water to the stain and mix thoroughly. Allow the diluted stain to act for 5-10 minutes.
6. Drain off the stain and wash the film for few seconds with water. The colour should come pink. If it is too purple, then it should be washed again.
7. Dry the slide and observe under the microscope.



1. Red blood corpuscles (R.B.C)
2, 3. White blood corpuscles (W.B.C)
4. Blood platelets

Fig. 4. (A-D) Preparation of blood smear. (E) Different blood cells.

Note : The R.B.C. will appear to be round and without nucleus as the R.B.C. of mammal is without nucleus. The W.B.C. contain nuclei which take the stain and appears as dark spots. The nuclei have different shapes.

In the same way you can study blood of toad or frog. But here the R.B.C. are spindle shaped and possess nuclei.

Precaution to be taken : Make the blood film immediately after taking the drop of blood otherwise blood will clot and it will be difficult to make a film.

2. Water is a major constituent of Protoplasm

Preamble :

Every cell of an organism requires 70 – 95% water for the activity of protoplasm. This huge amount of water is absorbed by all plants (except aquatic plant) from soil. With the help of root hairs plants absorb the capillary water present in between the soil particles by the process of imbibitions and osmosis. The inorganic salts dissolved in capillary water is very less and hence the plants have to absorb a large amount of capillary water to fulfill their need. The process of transpiration to the atmosphere releases the excess amount of water remaining after the completion of physiological processes.

The above mentioned processes going on in the plant body can be easily understood by the students from the simple experiments described below.

Expt. 2. (1) : Experiment on Imbibition

Required apparatus and plant material :

1. Some dry healthy seeds of Pea or Gram
2. One small petridish or a small glass bowl
3. Water.

Take a petri dish and place in it some gram or pea seeds along with little amount of water. Observe the condition of the seeds after 15/20 minutes.

Observation : The seeds swell and show increase in size.

Inference : Seeds are part of plants and are made of cells. As the cell wall of the cells of the seed are hydrophilic so water enters into these cells. There is absolutely no water in the dry seeds. Water continues to enter till an equilibrium is reached between the diffusion pressure of water in the petri dish and the water pressure in the cells of the seeds.

N. B. : Imbibition pressure exerts pressure on the seed coat due to which bursting of the seed coat takes place and the radicle comes out through the micropyle causing germination of seed.

Expt. 2. (2) : Process of Osmosis in Plants

What is Osmosis ? When two solutions of different concentrations are separated by a semi permeable membrane, solvent from the lower concentration diffuses to the higher concentration solution. And this process is known as osmosis. The pressure that is generated in the solution of low concentration is known as osmotic pressure. Though osmosis is a physical process, the root hairs absorb water and mineral salts from the soil by this process. Water enters from one living cell to another by this process.

(1) One petridish.
(2) Concentrated sugar or salt solution.
(3) One knife or blade.
(4) One large potato.
(5) Dilute safranin.

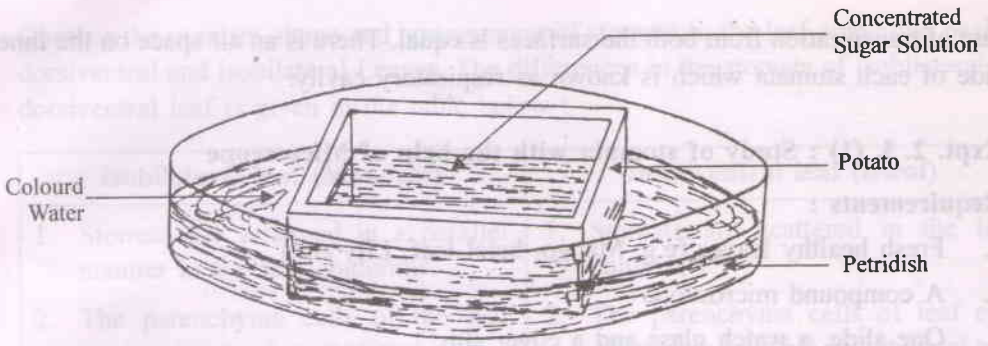


Fig. 5. Experiment on Osmosis.

Procedure : Make a small block of potato from the potato tuber. Now scoop out carefully the central region of the block with the help of a knife or blade to make a hollow cavity (Fig.5). Now pour concentrated sugar solution into the 1/3 of the cavity of the potato and place it in a petridish containing water coloured with safranin. Observe after one hour.

Observation : The level of water rises in the potato cavity. The entry of reddish water from the petridish into the potato cavity signifies the occurrence of the process of osmosis.

Inference : Potato is made up of many cells and each has semi permeable cell membrane. The level of water rises in the potato cavity due to the process of osmosis through the semi permeable membrane of potato cells from the petridish and also due to cell-to-cell osmosis.

Expt. 2. (3) : Experiments on Transpiration

Preamble : Transpiration is a process in which the excess water remaining after the completion of all physiological processes in the plants is released in the form of water vapour. This water vapour is released mainly through the stomata. Sometimes transpiration also occurs through the cuticle of the leaf epidermis or lenticels of woody plants.

What is Stomata ?

Stomata are some minute pores present in the leaf epidermis. Generally the stomata remain open during daytime and closed at night. Stomata are surrounded by a pair of special cells of the epidermis. This pair of cells is known as guard cells. (Fig. 6). Due to the presence of large number of stomata on the lower surface of **dorsiventral leaf,** the rate of transpiration is more on the lower surface in comparision to the upper surface of the leaf. In **isobilateral leaf** (the leaves in which both the surfaces are equally illuminated by sunlight e.g. leaves of Monocotyledonous plant) due to the presence of equal number of stomata on both the surfaces of the leaf, the

rate of transpiration from both the surfaces is equal. There is an air space on the inner side of each stomata which is known as respiratory cavity.

Expt. 2. 3. (1) : Study of stomata with the help of Microscope

Requirements :

1. Fresh healthy leaves (e.g. Mango, betel leaf, Lily etc.)
2. A compound microscope
3. One slide, a watch glass and a cover slip
4. Forceps, blade and brush
5. Safranin solution and water.

Procedure : Take dilute solution of safranin in a watch glass. With the help of a blade or forceps make a peel of the leaf epidermis and keep it in the watch glass. After two to three minutes wash the peel in clean water with the help of a brush. Mount the washed peel in the center of a clean slide containing a drop of water. Cover the peel with the cover slip (Care should be taken so that no air bubbles are trapped inside the cover slip). Now observe the slide under the compound microscope.

Observation :

1. Have you observed the stomata surrounded by guard cells ?
2. Observe the nucleus and chloroplast of the guard cells.

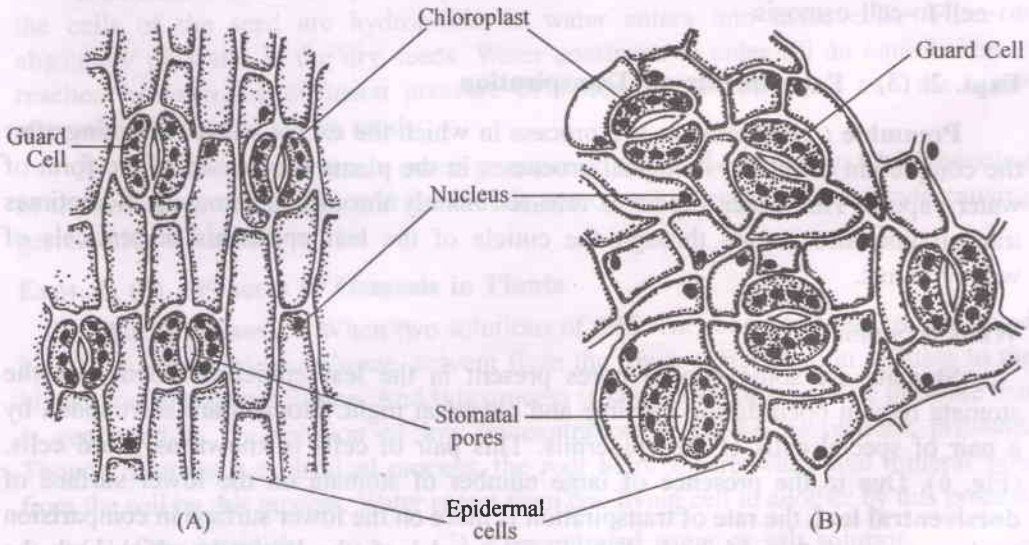


Fig. 6. Stomata in epidermal layer.
(A) Monocotyledonous leaf. (B) Dicotyledonous leaf.

Observe the number, shape and arrangement of stomata in the leaf epidermal peels of dorsiventral and isobilateral Leaves. The differences in the stomata of isobilateral and dorsiventral leaf is given in the table below :

Isobilateral leaf (Monocot)	Dorsiventral leaf (Dicot)
1. Stomata are arranged in a parallel manner in the leaf epidermis.	1. Stomata are scattered in the leaf epidermis.
2. The parenchyma cells of the leaf epidermis are elongated and almost equal. e.g. Canna, lily etc.	2. The parenchyma cells of leaf epidermis are long but of not equal size e.g. Betel leaf, Mango, Jack fruit and Madar etc.

Expt. 2. 3. (2) : To study the release of water vapour in Transpiration

Requirements :

(1) One bottle, (2) A small branch of healthy plant or a large healthy leaf with long stalk, (3) A small polythene bag, (4) Small quantity of mustard oil and water, (5) Little thread.

Procedure : Fill ¾ of the bottle with water. Remove the dust particles from the branch or the leaf and immerse it in the bottle. Pour some mustard oil on the water surface of the bottle to prevent evaporation. Cover the branch with a polythene bag as shown in the diagram (Fig.7). Tie the lower end of the polythene bag with a thread tightly with the mouth of the bottle to prevent entry of air. Keep the whole apparatus in the sunlight for half an hour.

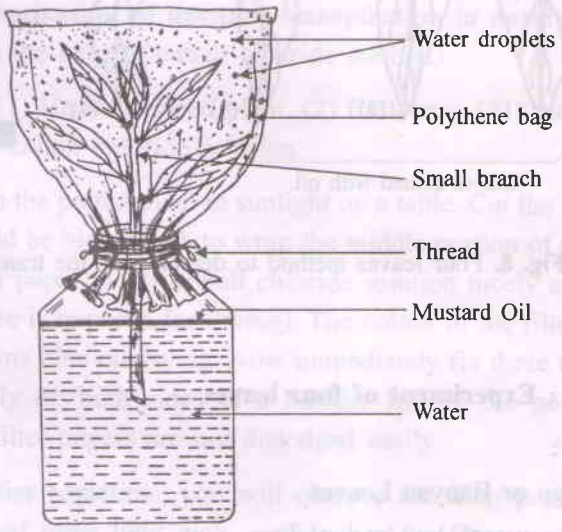


Fig. 7. Experiment to show that water vapour is released during transpiration.

Observation : After the stipulated time water droplets are seen on the inner side of the polythene bag.

Conclusion : The water droplets are formed due to condensation of water vapour released from the stomata of the leaves of the branch. This experiment proves that plants release water in the form of water vapour by the process of transpiration.

Expt. 2. 4. : To Study the Unequal Transpiration in Dorsiventral Leaf.

Those leaves arranged on the stem which get unequal amount of sunlight on both the surfaces are known as **dorsiventral leaf** e.g.Mango, Jack fruit, Banyan, Madar etc. In dorsiventral leaf generally the number of stomata is comparatively less on the upper surface of the leaf. Therefore, cuticular transpiration takesplace from this surface. On the other hand as the number of stomata is more on the lower surface of the leaf, so the amount of transpiration from this surface is more as compared to the upper surface of the leaf.

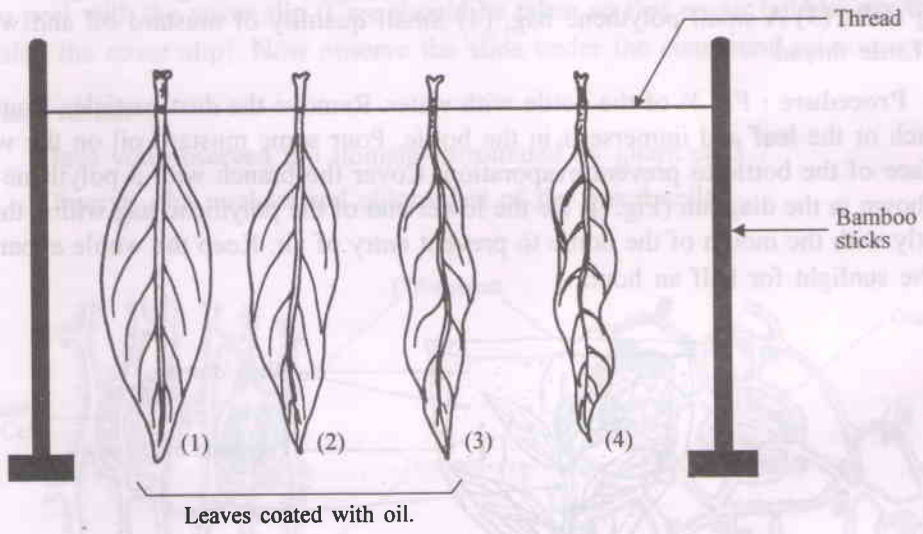


Fig. 8. Four leaves method to demonstrate the transpiration.

Expt. 2. 4. (1) : Experiment of four leaves

Requirements :

1. Four Mango or Banyan Leaves
2. Two small, smooth bamboo sticks.
3. Thread and mustard oil

Procedure : Take four leaves of equal size and smear mustard oil on both the surfaces of the first leaf, only on lower surface of second leaf and upper surface of third leaf. The fourth leaf should not be smeared with oil. Now hang all the four leaves as shown in (Fig. 8). Observe the changes in the leaves after 2 – 3 hrs.

Observation : You will observe that the leaves gradually start drying up. Tabulate the time taken for complete drying of the differentially treated leaves as shown below :

Leaf	Condition of the leaf	Wilting / Drying time
1.		
2.		
3.		
4.		

Other Observations :

1. Did all the four leaves dry up at the same time.
2. If all the leaves did not dry up at the same time, find out the causes and ask your teacher to explain the experiment.

Expt. 2. 4. (2) : Determination of unequal transpiration in dorsiventral leaf
(With the help of cobalt chloride method)

Requirements : (1) Healthy potted plant, (2) Cellotape, (3) One filter paper or blotting paper, (4) 3% cobalt chloride solution.

Procedure : Keep the potted plant in sunlight on a table. Cut the filter paper into two squares, size should be big enough to wrap the middle portion of a leaf. Now dip the two pieces of filter paper in 3% cobalt chloride solution nicely and later air dry them (slight temperature is required for drying). The colour of the filter paper is light pink when wet and turns blue on drying. Now immediately fix these two blue pieces of filter paper carefully on both sides of a healthy leaf of the potted plant with cellotape, so that the filter papers are not dislodged easily.

Observation : After sometime, you will observe the filter paper fixed on the lower surface of the leaf turns light pink earlier than the filter paper fixed on the upper surface of the leaf.

Inference : As the leaf was not allowed to come in contact with air due to the fixation by cellotape, the water vapour evolved in transpiration turned the cobalt chloride paper pink. It has already been mentioned that blue cobalt chloride paper turns pink when come in contact with water. Explain why did the cobalt chloride paper fixed on the lower surface of the leaf turned pink earlier than the cobalt chloride paper fixed on the upper surface of the leaf.

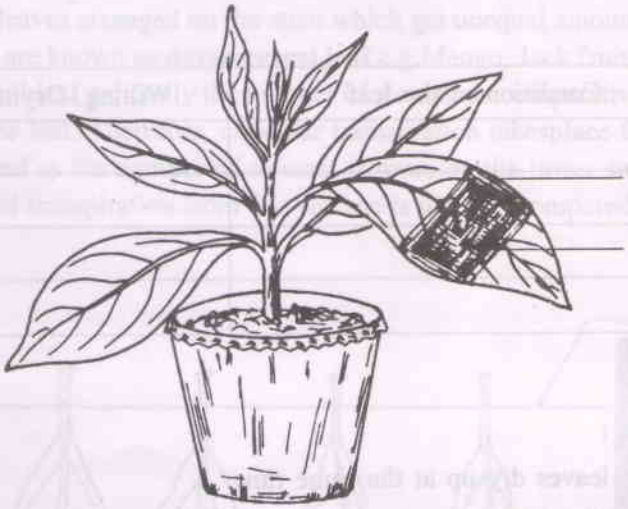


Fig. 9. Showing unequal transpiration from the two surfaces of a dorsiventral leaf with the help of cobalt chloride.

Expt. 3. : Food is essential for the nutrition of organisms

Preamble : All organisms obtain their nutrition from food. Starch, Protein and fatty substances are essential for the nutrition of a living cell. All green plants can prepare all these three kinds of food themselves. All animals have to depend directly or indirectly on plants for food. The existence of above mentioned nutritional food substances in different organs of the living organisms can be proved by the following simple experiments.

Expt. 3. (1) : To prove the existence of starch in the food obtained from different parts of plant

Preamble : Starch is a carbohydrate which is predominantly found in plants and is abundant in vegetative tissues. It is insoluble in water and produces a typical blue colour when treated with iodine solution.

Experiments	Observation	Inference
1. Add few drops of iodine solution to a small bottle containing rice powder or flour dissolved in water.	The mixture turns blue.	This experiment proves the presence of starch in flour or rice powder as iodine turns starch bluish black in colour.
2. Add a drop of iodine to a slice of potato.	Same as above.	Same as above.

Thus the presence of starch can be established in different fruits & vegetables by adding iodine solution to small pieces of brinjal, French bean, cauliflower, cucumber, banana, apple and other vegetables, etc. The change of colour to dark blue will confirm presence of starch.

Expt. 3. (2) : Presence of protein in living cell

Preamble : Protein is one of the most important constituents of protoplasm. Therefore, all types of cells contain protein in more or less amount. In case of plants protein is stored in the seeds. Proteins are very complex organic nitrogenous compounds.

Expt. 3. (2)(1) : Existence of protein in animal cell

Requirements :

1. An egg of any bird which is easily available e.g. Egg. of a hen or duck
2. A candle
3. A transparent small bottle or test tube
4. Test tube holder
5. 10% sodium hydroxide (NaoH)
6. 5% copper sulphate ($CuSo_4$) solution

Experiments	Observation	Inference
1. Break the egg and take out the albumin very carefully. Mix it with water thoroughly and filter it. Take 3 ml (less than one tea spoonful) of the filtrate in the test tube and heat it in the flame of the candle.	The content in the test tube coagulate.	The sample is protein. Because it is the nature of most of the proteins which coagulates on heating.
2. Take equal amount of the filtrate and 10% NaoH in a test tube or bottle and mix them thoroughly. Now add a few drops of 5% $CuSO_4$ solution to the mixture.	The colour of the mixture turns yellowish and then changes to violet.	Presence of protein will be confirmed.

Conclusion : Animal's egg is a single cell. This cell also contains protein like any other cell.

Expt. 3. 2. (2) : Existence of Protein in plant cell

Requirements : (1) Seeds of pea, maize, lentil, gram etc., (2) Two small bottles or test tubes, (3) Filter paper, (4) Funnel, (5) Forceps, (6) 10% Sodium hydroxide, (7) 5% Copper sulphate, (8) Water, candle and dropper.

Procedure : Soak few seeds in water. (In case of pea, remove the outer seed coat after seeds have become soft). Now, grind the seeds separately and mix with water thoroughly. Filter the mixure after two or three minutes. Perform the experiments described below with the filtrate.

Experiment : Take a little of the filtrate in a bottle and add equal amount of 10% sodium hydroxide to it. Then add few drops of 5% copper sulphate to the mixture and mix thoroughly.

Observation : The mixture will turn blue.

Conclusion : Existence of protein is proved in seeds of pea, maize etc. which are important organs of the plants and are made up of cells. This test of protein is known as **biuret test.**

Thus, perform the test for protein in the different parts of the plant and fill up the following table :

Seed/Stem	Colour of the mixture blue / pink / violet	Protein present	Name of the Protein
1. Pea (seed)			Legumin
2. Green gram (seed)			Legumin
3. Maize (grain)			Zein
4. Potato (stem)			Tuberin
5. Barley (grain)			Hordein
6. Rice (grain)			Oryzanin

Appearance of blue / pink and violet colour signifies presence of protein. By this experiment existence of almost all proteins (excepting few proteins) can be proved.

Expt. 3. (3) : To prove the existence of fatty substances in different food materials.

Preamble : Fatty substances are present as stored food in different plant seeds and some fruits. The amount of carbohydrates is less in those organs where amount of fatty and oily substances are more. Different types of commercial oils are manufactured from fatty substances. Fatty substances are refered to as fats when solid and oils when in liquid form.

Expt. 3. 3. (1) : To prove the existence of fatty substances in plant

Requirements : (1) powder of mustard seeds or groundnut, (2) a test tube or a small bottle, (3) Forceps, (4) Candle, (5) 10% sodium hydroxide, (6) Filter Paper, (7) Funnel.

Experiments	Observation	Inference
Grind finely few seeds of mustard or groundnut and mix with 2 ml of sodium hydroxide. Filter the mixture with the help of filter paper. Warm the filtrate over a candle flame.	The mixture will froth like a soapy solution.	Existence of fatty substances in pants is proved.

Expt. 3. (3) (2) : To prove the existence of fats in different types of seeds

Requirements : (1) Different types of seeds e.g. – Groundnut, Mustard, Gram, Pea, Fruit of Coconut, (2) One white paper & (3) any equipment for grinding the seeds.

Procedure : Grind the above mentioned seeds separately and rub the powder on the paper one by one at different spots.

Observation : Now, observe the paper against light. Transparency of the spots on the paper will prove the presence of fats and opaqueness of the spots on the paper will prove absence of fats. Tabulate your results in the table below.

Seed	Transparent/opaque	Fats present/absent
1. Groundnut		
2. Mustard		
3. Gram		
4. Pea		
5. Small piece of coconut		
6. Lentil		

Expt. 4. : Respiration

Preamble : Respiration is an important character of living organisms. It is essentially an oxidation process. Energy is released during oxidation of food substances by oxygen inhaled during the process of respiration. This energy so obtained helps the organism to carry out its activities.

Expt. 4. (1) : Respiration in plants

Requirements : (1) One clean bottle with a cover, (2) Germinated seeds of gram or pea, (3) One incense stick (Dhupkathi).

Procedure : Take ten germinated seeds in a bottle and cover it tightly. Keep the bottle in a dark room or wrap the bottle with carbon paper to prevent entry of light (Fig. 10). Observe the bottle after two or three days.

Observation : After the stipulated time uncover the bottle carefully and insert a burning incense stick inside it. The burning incense stick gets extinguished.

Inference : The seeds have utilized oxygen gas from the air trapped in the bottle during respiration and release carbon dioxide gas. The carbon dioxide gas is thus stored in the bottle as it can not go out from the tightly corked bottle. This Co_2 gas extinguishes the burning incense stick (oxygen is required for burning).

This type of experiment can be done with different plant parts like flower buds, young leaves and young roots (in case of roots soil particles should be removed and washed cleanly by water).

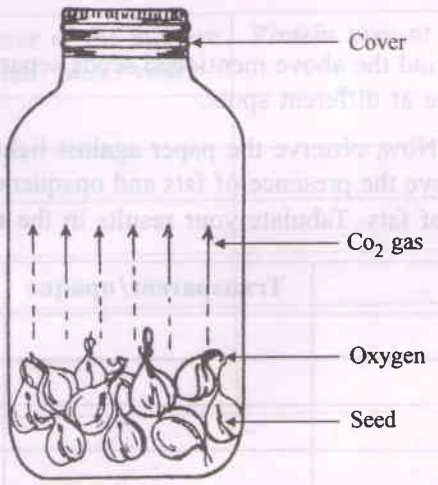


Fig. 10. Showing respiration in germinating seeds.

Expt. 4. (2) : Respiration in animal

Preamble : Different types of respiratory organs are seen among animals. The aquatic animals, like the fish, respire by means of gills whereas the terrestrial animals use lungs for respiration. Some animals also use their moist skin for this purpose. During respiration animals take in oxygen and give out carbon dioxide from their body. The air breathing animals take in oxygen through their nostrils. On the other hand the aquatic animals like fish take in water through their mouth and utilize the oxygen dissolved in water. This can be studied with a simple experiment with a fish.

Experiment 4 (2) (1) : Respiration in fish

Requirements :

1. A wide mouthed bottle filled with water
2. A live fish
3. A small fine stick around 6″ (inches) long
4. Watch to keep time
5. Magnifying glass and forceps.

Procedure :

1. Put the fish in the bottle filled with water
2. Observe whether the fish has taken water through the mouth and given out by lifting the operculum (gill covering).
3. Count how many times the fish take in and give out water per minute
4. Take out the fish and insert the stick through the operculum and push it. See whether the stick comes out through the mouth or not
5. Take out the gills and place them in a petridish. Observe the structure with the help of a magnifying glass. Compare the different parts of the gills with the help of the diagram (Fig. 11). The gills are covered by slime. Count the number of gill arches. There are gaps between gill filaments for movement of water. There are teeth like structures in the gill arches which are called 'gill rackers'. They donot allow the food particles to enter the gill chamber and go out along with water. The gill filaments are full of blood capillaries which help in the exchange of gases.

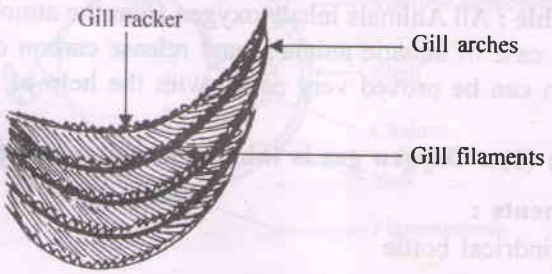


Fig. 11. Gill of fish.

To be noted :

When the gills are bathed by water, oxygen dissolved in the water enter the blood capillaries by diffusion and carbon dioxide is exhaled in to the water. In otherwords exchange of gases takes place.

Expt. 4. (2) (2) : Respiration in Toad

Requirements :

1. A wide transparent mouthed bottle
2. A live toad
3. A watch

Procedure :

1. Put the toad in the bottle and cover the mouth of the bottle with a net and tie it with a rubber band. When the toad is in resting state, observe whether the muscle of the lower jaw moves up and down or not. This movement of muscles of lower jaw indicates respiration.
2. If the toad is doing so, count how many times it does per minute. At the same time you notice whether the mouth is closed or not. Do you find any difference from that of the fish which you have already observed ?

To be noted :

When the toad lowers the muscles of the lower jaw the air goes in to the mouth cavity (buccal cavity) through the nostrils. Again, when the muscle is raised pressure is exerted on the air already accumulated from the lungs and from the surrounding tissue of the buccal cavity carrying Co_2, and the air goes out through the nostrils. In normal condition, toad performes buccal respiration. But in active condition (jumping and in other activities) it inhales more air into the buccal cavity and forces the air to the lungs and performs pulmonary respiration. Fish also posses nostrils but these openings are not respiratory in function. They act as olfactory organ.

Expt. 4. (3) : The gases exchanged during the process of respiration

Preamble : All Animals inhale oxygen from the atmosphere or oxygen dissolved in water (in case of aquatic animals) and release carbon dioxide from the body. The phenomenon can be proved very easily with the help of some simple experiments.

Expt. 4. (3) (1) : Oxygen gas is inhaled during respiration

Requiremments :

1. One cylindrical bottle
2. Match box
3. Incense stick

Procedure :

1. Put the mouth of the bottle in your mouth in such a way that the air cannot enter the bottle from out side. Now, close your nostrils with the fingers and respire through the mouth. In doing so, you will find it difficult to respire after sometime.
2. Now, remove your mouth from the bottle and immediately cover the mouth of the bottle with your palm tightly so that air cannot enter the bottle from outside.
3. Now ignite an incense stick and insert it to the bottle slowly. What do you observe ? is the stick still burning ? Observe the inner side of the bottle, can you see water droplets in the wall of the bottle ? After the above experiment you can come to the following conclusion :
    1. You feel difficult to respire because the oxygen present in the bottle was gradually decreasing.
    2. The concentration of carbon dioxide increases in the bottle which was given out by you during respiration and as a result, the ignited stick is extinguished. Because carbon dioxide does not help in ignition.
    3. Again, during expiration water vapour comes out and this vapour when touches the wall of the bottle it is transformed to water droplets.

Expt. 4. (3) (2) : Carbon dioxide gas is given out during respiration

Requirements :

1. A test tube or a beaker or a transparent plastic bottle.
2. One cup of clear lime water
3. One straw (usually used to take fruit juice)

Procedure :

1. Take some amount of clear lime water in a test tube or in a beaker.
2. Now blow air into the lime water through the straw. You will see that the clear lime water gradually turns turbid.

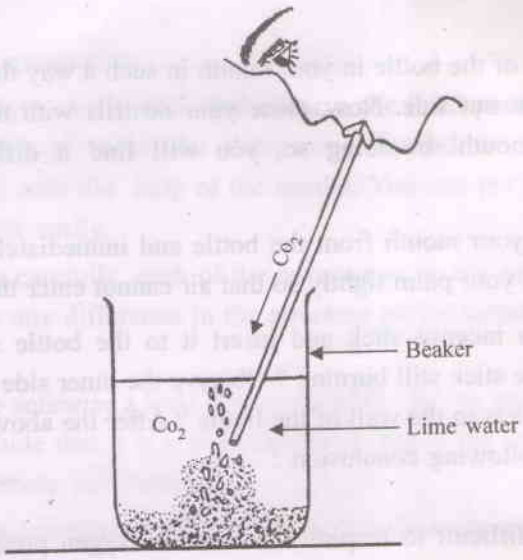


Fig. 12. Expt. to show that Co_2 is given out during respiration.

The above experiment has proved that carbon dioxide is given out during respiration. Because when carbon dioxide reacts with lime water, then a compound is formed, called "calcium carbonate". The calcium carbonate is insoluble in water and hence the clear water becomes turbid.

$$\underset{\text{Lime water}}{Ca(OH)_2} + CO_2 \longrightarrow \underset{\substack{\text{insoluble} \\ \text{calcium carbonate}}}{CaCO_3} + H_2O$$

Expt. 5. : Assimilation of carbon dioxide in plants

Preamble : Green plants produce starch in the presence of sunlight with the help of chlorophyll, water and carbon dioxide absorbed from air. Assimilation of carbon dioxide by plants is known as photosynthesis. This reaction is shown below :

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

The oxygen is evolved during the process. Thus the photosynthetic phenomenon is one of the most remarkable metabolic process for providing food supply to the biological world and purifying the atmospheric air by consuming carbon dioxide and evolving oxygen. The evolution of oxygen and requirement of chlorophyll in photosynthesis can be easily proved by the experiments described below.

Starch is produced due to the action of specific enzymes on glucose synthesized during photosynthesis. Animals can not produce starch due to the absence of chlorophyll.

Expt. 5. (1) : Chlorophyll is essential for photosynthesis

Requirements : (1) One variegated leaf of coleus, croton etc. (or any other leaf with white and green patches), (2) Alcohol (90%) and iodine solution, (3) One petridish or any other small bowl.

Procedure : Take a variegated leaf and cut out the green and non-green portions separately. Now dip the green coloured portions of the leaf in alcohol taken in a petri plate. After sometime the chlorophyll will get dissolved in alcohol. The portions of the leaf (which had chlorophyll) will turn blackish blue, on adding iodine solution (Fig. 13.) Repeat the same procedure with the non-green portions of the leaf. These portions will not turn blackish blue on addition of iodine as there is no starch. Because only starch turns blackish blue on addition of iodine. Absence of starch is attributed to the absence of chlorophyll in these leaf portions (non-green portion). Thereby proving that chlorophyll is essential for photosynthesis.

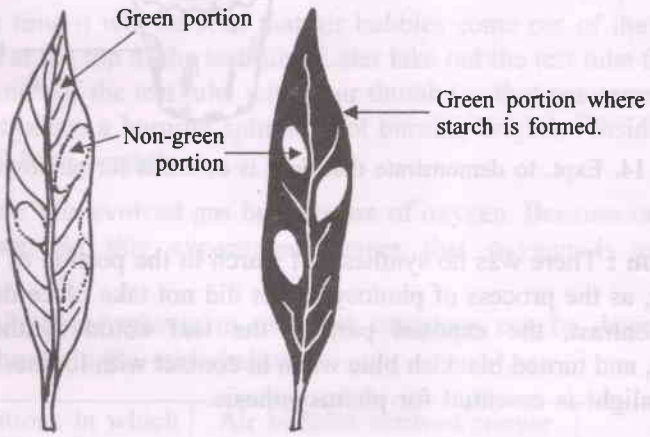


Fig. 13. Chlorophyll is essential for Photosynthesis.

Expt. 5. (2) : Light is essential for photosynthesis

Requirements : (1) A potted plant, (2) Iodine and alcohol (90%), (3) Black Paper, (4) Cellotape and (5) Petri dish.

Procedure : Keep a potted plant in a dark room for 2 to 3 days. Pluck one leaf from this plant and dip in alcohol in a petridish till leaf becomes colourless. The leaf will turn white due to dissolution of the chlorophyll in alcohol. Now, immerse this leaf in iodine solution taken in a petridish. If the colour of the leaf does not turn blackish blue, then absence of starch in the leaf is proved.

Next, fix the black paper on both sides in the middle portion of a leaf of the potted plant with cellotape in such a way that no sunlight can enter this covered portion of the leaf. Keep the potted plant in sunlight for a day (Fig. 14).

Observation : Remove the black paper carefully in the evening after 5 – 6 hours of sunlight exposure. Immerse the whole leaf in alcohol to remove the chlorophyll first. Later dip this leaf in iodine solution (Take iodine in a petri dish). You will observe that except the covered portion of the leaf the other parts of the leaf will turn blackish blue.

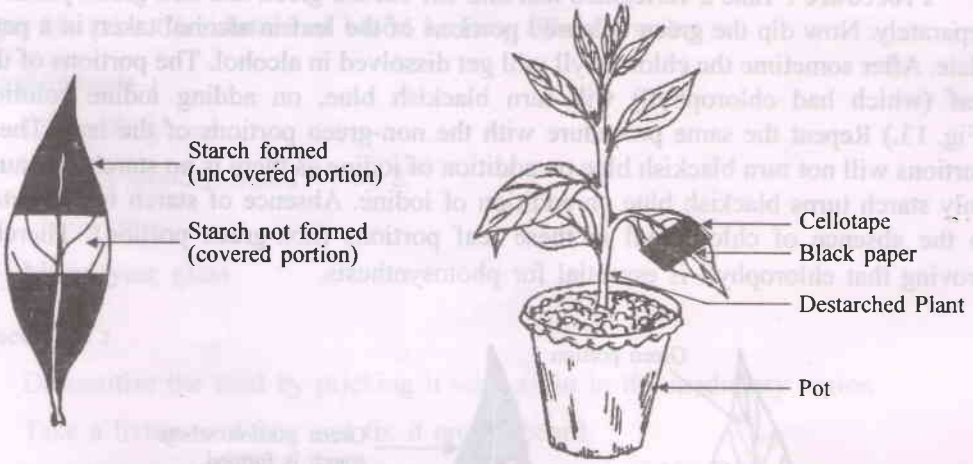


Fig. 14. Expt. to demonstrate that light is essential for photosynthesis.

Conclusion : There was no synthesis of starch in the portion of the leaf covered by black paper, as the process of photosynthesis did not take place due to absence of sunlight. In contrast, the exposed part of the leaf could synthesize starch by photosynthesis, and turned blackish blue when in contact with iodine. This experiment proves that sunlight is essential for photosynthesis.

Expt. 5. 3. : Oxygen is evolved during photosynthesis

Requirements : (1) One beaker or a plastic container or any vessel of same kind, (2) Funnel with short stem, (3) One test tube, (4) Aquatic plant (hydrilla, vallisneria or any other small aquatic plant, (5) sodium bicarbonate ($NaHCO_3$).

Procedure : First fill two third portion of the beaker (or container provided in the kit) with 0.1% sodium bicarbonate. Now, take Hydrilla plant or parts of some other aquatic plant and cut their ends while immersed in water and place them at the bottom of the beaker. Cover the plants with an inverted funnel in such a way so that the end of the funnel remains under water. Now, a test tube filled with water is to be inverted over the stem of the funnel (Fig. 15). Keep the whole experimental set up in sunlight and observe.

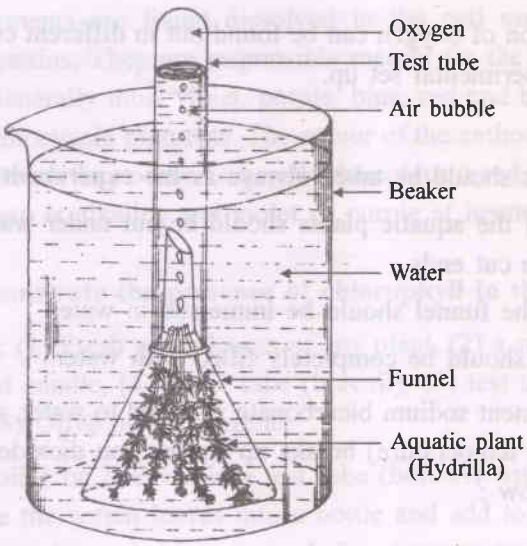


Fig. 15. Expt. to show evolution of oxygen during photosynthesis.

After some time it will be seen that air bubbles come out of the cut end of the plant and collect at the top of the test tube. Later take out the test tube from the beaker and press the mouth of the test tube with your thumb (so that gas cannot escape from the tube) and introduce a burning splinter (not burning brightly) inside the test tube. The splinter will burn brightly.

Conclusion : The evolved gas bubbles are of oxygen. Because only oxygen gas helps in burning. So this experiment proves that oxygen is evolved during photosynthesis.

The rate of photosynthesis in different situations can be determined by this experiment as shown in the table below.

Different conditions in which apparatus is kept.	Air bubbles evolved/minute	Mean
In dark	1. 2. 3.	
In sunlight	1. 2. 3.	
In light by increasing the conc. of Co_2 in water (2% or (3%)	1. 2. 3.	

The rate of evolution of oxygen can be found out in different conditions by using the similar type of experimental set up.

Precautions :

1. Aquatic plants should be taken always as the experiment is done under water.
2. The branch of the aquatic plants should be cut under water, otherwise air will enter in to the cut ends.
3. The stem of the funnel should be immersed in water.
4. The test tube should be completely filled with water.

In this experiment sodium bicarbonate is added to water, as sodium bicarbonate when heated (solar temperature) breaks up and carbon dioxide is released as shown in the reaction below :

$$2NaHCO_3 \xrightarrow{\text{Heat}} Na_2CO_3 + CO_2 + H_2O$$

The carbon dioxide so evolved is used in photosynthesis.

Expt. 6. : Experiment on plant pigments

Preamble : Plant pigments are intensely coloured substances which give colour to the various parts of the plant. The chlorophyll is one of the most important green pigment found in plants. These pigments occur in the chloroplastids which are disc like or spherical living bodies found in the cytoplasm. The chlorophylls occur abundantly in green leaves and many other aerial parts of the plant such as young stems and fruits and sepals of flowers. Chlorophyll is a mixture of different pigments as follows —

Chlorophylls	Chemical composition	Distribution in plant kingdom
1. Chlorophyll a	$C_{55}H_{72}O_5N_4Mg$	Found in all green plants.
2. Chlorophyll b	$C_{55}H_{70}O_6N_4Mg$	Higher plants and green algae
3. Carotene	$C_{40}H_{56}$	In algae and higher plants
4. Xanthophyll	$C_{40}H_{56}O_2$	Higher plants, algae, mosses and ferns.

Some plant pigments are found dissolved in the cell sap. Examples of sap pigments are anthocyanins. They are responsible mainly for the bright colour of the flowers and fruits. Generally most violet, purple, blue, red and brown colours of the flowers are due to anthocyanin pigments. The colour of the anthocyanin depends upon the pH of the sap in which they occur. Generally the colour is red when the sap is acid, it is blue when the sap is alkaline and violet or purple at neutral pH values.

Expt. 6.1. : To demonstrate the presence of chlorophyll in the green leaves

Requirements : (1) Fresh green leaves of any plant, (2) a small colourless glass bottle, (3) Match and candle, (4) a test tube (borosil), (5) test tube holder, (6) 95% alcohol, (7) Water, (8) Olive oil or benzene.

Procedure : Boil 1 or 2 leaves in a test tube (borosil) with about 25ml water. After boiling remove the soften leaves into a bottle and add to it about 25ml. 95% alcohol. Keep this experimental set up as such for about an hour and observe.

Observation : You will find the alcohol in the bottle turned green. This is the chlorophyll mixture which contains chlorophylls a, b, carotene and xanthophylls.

Now to the green solution add a little olive oil, ether or benzene and shake well. You will find the separation of two layers as follows –

1. Upper layer (green) is the benzene or olive oil layer which contains chlorophylls.
2. Lower layer (yellow) is the alcohol layer which contains carotene and xanthophylls.

Note : Chlorophyll is not soluble in water even after prolonged boiling. The leaves when boiled in water it breaks the cell walls & the tissues of the leaf which made easy extraction of the chlorophyll pigments present within the chloroplastids.

Expt. 6. 2. : To demonstrate the presence of anthocyanins in the flowers

Requirements :

1. Petals of a china rose flower (Red).
2. One test tube (borosil) and test tube holder.
3. A small beaker.
4. Water.
5. Match and candle.
6. Lemon juice.
7. Sodium bicarbonate or any alkali.
8. pH indicator paper.

Procedure : Take the petals of a china rose flower and boil with about 25ml water taken in a test tube. Decant the coloured solution in a small beaker. Note the colour of the solution.

To the solution perform the following tests and observe the colour change and note the pH value with the help of indicator paper.

Experiments	Change in colour	pH value
1. Take a little of the solution in a test tube and add a few drops of lemon juice.	Green colour changes to red or pink.	
2. To the same mixture add a little sodium bicarbonate.	Red colour changes to blue or green.	
3. Add more lemon juice.	Red colour reappears.	The presence of anthocyanins confirms.

This experiment you can carry out for different types of coloured flowers (blue, violet or purple coloured flowers).

N. B. (1) Lemon juice contains citric acid which is an organic acid.

(2) On addition of sodium bicarbonate you will find effervescence. This is nothing but the evolution of CO_2 gas evolved from bicarbonate (as shown in the expt.5.3.)

Expt. 7. : Experiment on Growth

Preamble : All living organisms can grow. Nutrition leads to growth in the body of living organisms. Growth brings about an irreversible internal change and this change is permanent. Growth is an important characteristic of a living object. Food substances synthesized by the plant during photosynthesis is utilized in building up of new tissues. Thus dry weight of the plant increases due to growth.

Experiment to show germination of seed and early seedling growth

Requirements : (1) One pair of petridish or any other covered vessel of same type, (2) Filter paper, (3) Water, (4) Scale, (5) Pea, gram or groundnut seeds.

Procedure : Place two pieces of filter paper at the base of petridish as shown in the diagram (Fig.16). Pour water on the filter paper so that the papers become wet. Now, take ten clean and healthy seeds of gram and place them at equal distance in the

petridish. Now, cover this petridish. Keep this set up on a table in a dark corner of a room for 5 – 6 days. Observe daily for germination & seedling growth. Measure the length of plumule & radicle after stipulated time and fill up the table given below.

It is expected that all the seeds will germinate within a week.

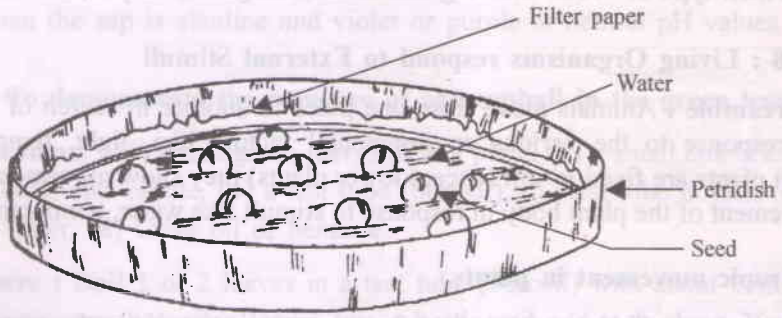


Fig. 16. Experimental set up for seed genrmination and early seedling growth.

Name of seed	Total No. of seeds taken	Number of germinated seeds	No. of days required for germination	Percentage of germination (%)	Average length of radicle (in mm)	Average length of plumule (in mm.)
Gram						
Pea						
Castor						
Groundnut						
Rice (grain)						
Soyabean						

Conclusion : After completion of the experiment you can determine the seeds having more percentage of germination with rapid growth capacity.

1. Which seeds germinate first ?
2. Which type of seed showing more percentage of germination ?
3. Which type of seeds showing maximum elongation of plumule & radicle ?

Expt. 8 : Living Organisms respond to External Stimuli

Preamble : Animals move from one place to another in search of food, shelter or in response to the various environmental factors like, light, temperature, etc. Though plants are fixed in soil (except lower plants) they show movement of an organ or movement of the plant body in response to stimuli like water, temperature, light etc.

Phototropic movement in plants

Procedure : Take a potted plant for this experiment. Keep the potted plant near a window in such a way so that the plant gets light only from the window side. After some days it will be observed that the plant bends towards the window i.e. towards the source of light (Fig. 17).

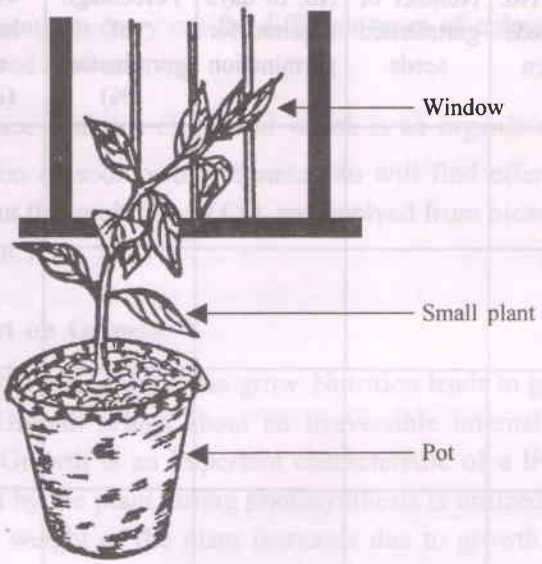


Fig. 17. Experiment to show phototropic movement in plant.

Conclusion : Growth hormone accumulates in the part of the plant which is opposite to the direction of light exposure. Accumulation of growth hormone increases the rate of growth of the cells on that side. So the portion away from light show more growth. As a result the plant bends and moves towards light.

This experiment proves the effect of light on movement.

Expt. 9 : Reproduction in animal for continuation of its race

Preamble : Reproduction in animal is an important feature for continuation of its race. In some animals the young one resembles completely its parents in appearance. But in some cases the young does not resemble its parents in form or in activity just after birth. In this case the eggs laid by the female hatched into a stage called the 'larva' which is the feeding stage of the animal. The larva gradually grows, after two, three or four stages depending on the type of insects into a non-feeding stage, called the 'pupa'. The pupa hides itself inside a covering made by the pupa itself. Examples of this type of reproduction are flies, mosquitoes, butterflies and moths etc. We can observe the life cycle of flies, mosquito or butterfly with a simple experiment.

Expt. 9 (1) : Study of reproduction and life cycle of house fly.

Requirements : (1) Wide mouthed bottle, (2) a piece of meat, (3) Magnifying glass, (4) a piece of net, (5) Rubber band or thread.

Procedure :

1. Keep a small piece of meat wrapped in a paper for one day. Next day take out the meat and keep it in a small wide mouthed transparent colourless bottle (or any other small transparent container which can be observed from outside.) After some time you will see that the smell of the meat has attracted flies to it.
2. Observe the activities of the flies with the help of the magnifying glass. Have you noticed the flies laying eggs ?
3. Next day, again observe the meat. Can you see some small white larvae without legs (grubs) on the piece of the meat ? If you have seen, observe them on the next day also. What do you notice ? Is there any change in their shape and size? Observe whether they have gone inside the piece of meat or not.
4. Now you cover the mouth of the bottle with a piece of net and tie with a rubber band or with a thread. On 4^{th} day , when you examine the larvae, notice carefully with the magnifying glass if some of them have become bigger in size and have taken the shape of a barrel. The barrel shaped stage is the 'pupa'. Have you observed any adult fly ? Have you noticed the size of the meat ?

   It is most likely that adult flies have appeared and size of the meat is reduced.

Things to be noted

1. The flies lay eggs on the meat on the first day.
2. The eggs hatch into larvae on first day and the larvae grow gradually after moulting (shedding of skin) and metamorphosed (change in structure and shape) into adult flies. The larvae grow by eating the rotten meat.

3. Flies can lay eggs on any wound or bruise on the skin of animal. So any type of wound should be kept covered.

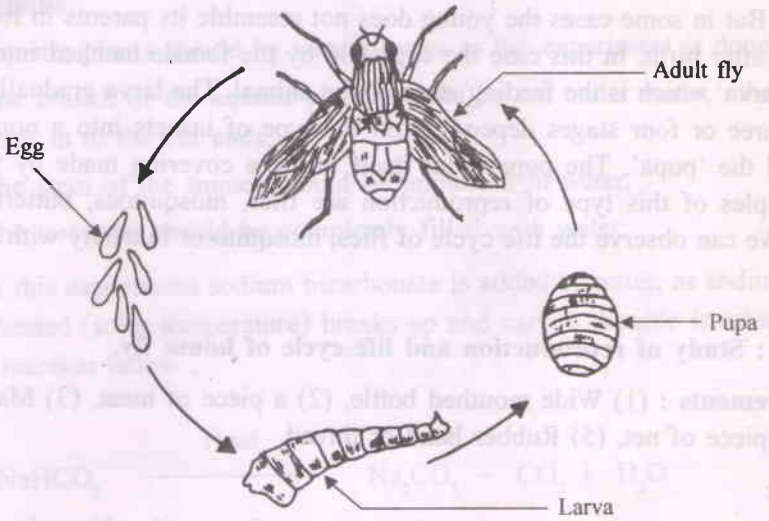


Fig. 18. Life cycle of House fly.

Expt. 9. (2) : Study of reproduction and life-cycle of mosquito

Requirements :

1. Coconut shell or any earthen pot or any plastic or metallic containers.
2. Rotten leaf, twigs etc.
3. A piece of blotting paper or filter paper
4. A dropper
5. Magnifying glass
6. A piece of fine cloth.

Procedure and Observation :

1. Put the rotten leaf and twigs etc. in the container and fill it with water. Keep it in a place away from the sun and rain water.
2. After 8 – 10 days shake the container and observe carefully. Have you seen any animalcule moving about? If not keep the set up for some more days and examine periodically until you see some animalcules.
3. If you could find any, collect with the help of the dropper and release on the blotting or filter paper. The water will be absorbed leaving only the animalcules.

4. Now observe minutely with the help of the magnifying glass. The animalcule are nothing but larvae of mosquito of different sizes. They will feed on the rotten organic substance in the container and will grow gradually. You may find some of them in the shape of a 'coma' (,). This is the pupa of the mosquito. It is very fragile and will ultimately be transformed into adult mosquito (Fig. 19).

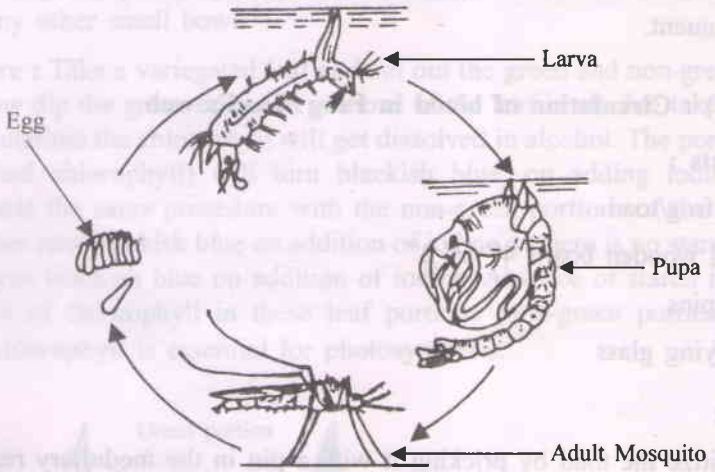


Fig. 19. Life cycle of mosquito.

5. Keep a little amount of water from the container along with the larvae in a bottle and cover the mouth with a piece of muslin cloth and tie with a rubber band. You will see adult mosquitoes after a few days.

The things you can learn from the above experiment :

1. Mosquitoes lay eggs in ditches, drains or in stagnant water.
2. The larvae feed on rotten organic substances.

N. B. : You can also study the different stages of development in case of silkworms (Mulberry, Muga, Tasar and Eri). The study of eri silkworm is very simple. It can be reared easily as it feeds on any variety of castor leaves. You can collect the eggs from a rearer or from a nearby sericulture farm. When the eggs hatch they are to be provided with tender leaves. When they grow bigger after moulting (shedding of skin) they are to be supplied with matured leaves.

Eriworm completes its life cycle in 30-40 days. Of course, it takes more time during winter than summer season. The larvae moults four times to change into the pupa.

Expt. 10. : Circulation of blood

Preamble : Due to regular contraction and expansion of the heart in man and in other vertebrates blood is circulated to different parts of the body supplying oxygen and nutrients. When the heart contracts, blood flows through the different arteries to different cells and tissues and when the heart expands the blood flows back through veins to the heart. The flow of blood in the body can be examined without the help of any instrument.

Expt. 10. (1) : Circulation of blood in Frog / Toad's web

Requirements :

1. Living frog/toad
2. A small wooden board 4″ by 2″
3. Fixing pins
4. Magnifying glass

Procedure :

1. Desensitize the toad by pricking it with a pin in the medullary region.
2. Take a living toad/frog and fix it on the board.
3. Stretch the web and pin the digits properly.
4. Observe the stretched web with the help of magnifying glass.

Observation : You will see the flow of blood through capillaries in the web.

Expt.10.(2) Circulation of blood in the vertebrates

Requirements :

1. Pencil / Pen
2. A sheet of paper
3. Watch to note time

Procedure :

1. Prepare a table with rows and columns (as shown below)
2. Now, slowly press the lower side of the wrist of your left hand in the direction of the thumb with the three fingers, (second finger, middle finger and the ring finger) of your right hand (as shown in the fig. 20). Can you feel a rhythmic wave in the area ? This wave is called the 'pulse'. You can feel it due to flow of blood at regular intervals from the heart.

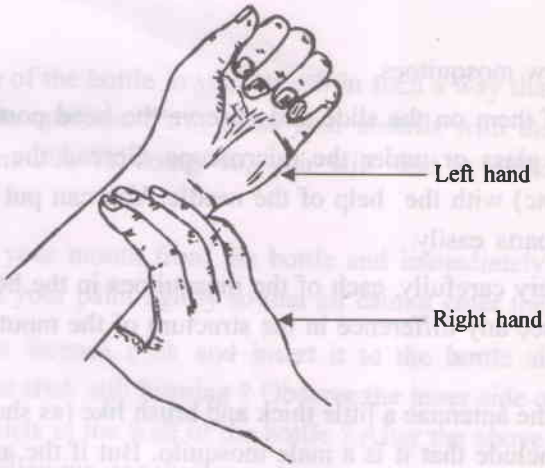


Fig. 20. Showing how to examine pulse rate.

Table for calculation of pulse rate

Sl. No.	Pulse rate/minute	Average pulse rate
1.		
2.		
3.		
4.		
5.		

3. You count the number of waves per minute. Put the record in the table. Repeat at least for three times at different times of the day and take the average value. Record the pulse rate of some of your classmates and compare the values.

   N. B. : Pulse rate may vary during different activities or when you are sick.

Expt. 11 : Identification of male and female mosquitoes

Requirements :

1. One clean slide.
2. One needle.
3. Magnifying glass/microscope.
4. Alcohol (If necessary).
5. Glycerine.

Procedure :

1. Collect a few mosquitoes.
2. Take one of them on the slide and observe the head portion with the help of a magnifying glass or under the microscope. Spread the mouthparts (antennae, proboscis, etc) with the help of the needle. You can put a drop of glycerine to spread the parts easily.
3. Examine, very carefully, each of the mosquitoes in the head region and observe if you can see any difference in the structure of the mouthparts regarding shape an size.
4. If you find the antennae a little thick and brush like (as shown in the fig. 21) then you can conclude that it is a male mosquito. But if the antennae are thread like then it is a female mosquito.

   Thus, you can identify the male and the female mosquitoes simply by looking at the mouthparts.

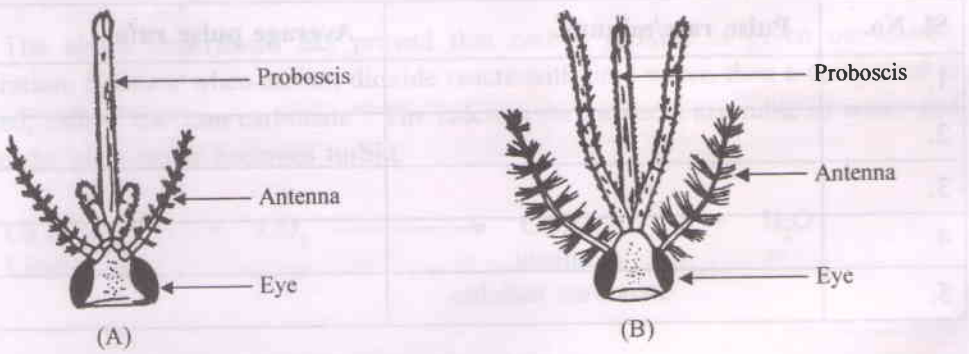


Fig. 21. Mouth parts of mosquito.
(A) Female, (B) Male.

To be noted :

1. The female mosquito sucks blood of the vertebrate animals for development of their reproductive organs. But the male mosquito sucks the sap of plants for the same purpose.
2. **Anopheles mosquitoes** carry a parasite (an unicellular parasite called – **Plasmodium**), which causes **'malaria'**. Since only the female mosquitoes suck blood, they are the carrier of the disease.

3. The mouthparts of the mosquito are modified to bear a proboscis to suck liquid food.

   Here, identification of sex is only discussed regarding mosquito, because it is related to a chapter in the text. Students can identify the male and female cockroach and many other related insects and also some other animals with the help of their respective teachers.

Expt. 12 : Genus and species in animals

Preamble : The animals which are similar in their morphological characters belong to the same category. The animals which are very closely similar and breed among themselves belong to a single group called the **'species'**. More than one species , all similar in some characters belong to a bigger group called – the **'genus'**. Again, more than one genus, having some common characters, belong to a still bigger group, the **'order'** then **'class'** and ultimately the biggest group, including all the animals is called the **'kingdom'**. Here, a simple example is cited from which students can have some idea of how groupings are made in the animal kingdom.

Procedure :

1. Collect one of each type of the following fish :
   (a) Rohu Fish (labeo rohita)
   (b) Mali fish (Labeo calbasu)
   (c) Kurhi fish (Labeo gonius)
2. Observe the different parts of the body of the each fish very carefully i.e. the shape and size of their heads, lips, number and size of the barbels, size and colour of the scales, size, position and shape of the fins and match the characters with those given in the table. Then you can identify the fish with the help of the Fig. 22. You can see one common character in the three types of fish, is their fleshy lips. This is their main external character for which they belong to the same genus group, called the **'labeo'**. The name originates from the latin word – 'Labium' which means 'lips' . But they can not be included in the same species because of differences in other characters e.g. – size and shape of the head , dorsal fins, colour of the scales, size of the barbels etc. Difference in characters means difference in their genes.

Parts of the body	Rohu fish	Kurhi fish	Mali fish
Shape & size of the head.	Head is Triangular.	Triangular but smaller in size.	The head is smaller and pointed.
Shape of the lips.	Lips are fleshy.	Lips fleshy and folded.	More fleshy than Rohu fish.
Length of barbels.	Barbels are not prominent.	Barbels are not prominent.	Barbels are prominent.
Difference in their fins.	The dorsal fin is bigger than the other two pairs of fins.	Dorsal fin is bigger than rohu fish and slightly concave.	Dorsal fin is fan like, upper part is bigger than the lower part. Tail fin with unequal lobes.
Shape of the scales.	Scales are bigger in comparision to the other two types.	The scales are very small and very dense and compact.	The scales are smaller but not so dense.
Colour of the fish.	The scales, fins and ventral part of the body reddish in colour. Dorsal side slightly blakish in colour.	The belly is white but the dorsal side is grey in colour.	The fins, scales and head black in colour. The dorsal side is more black in colour.

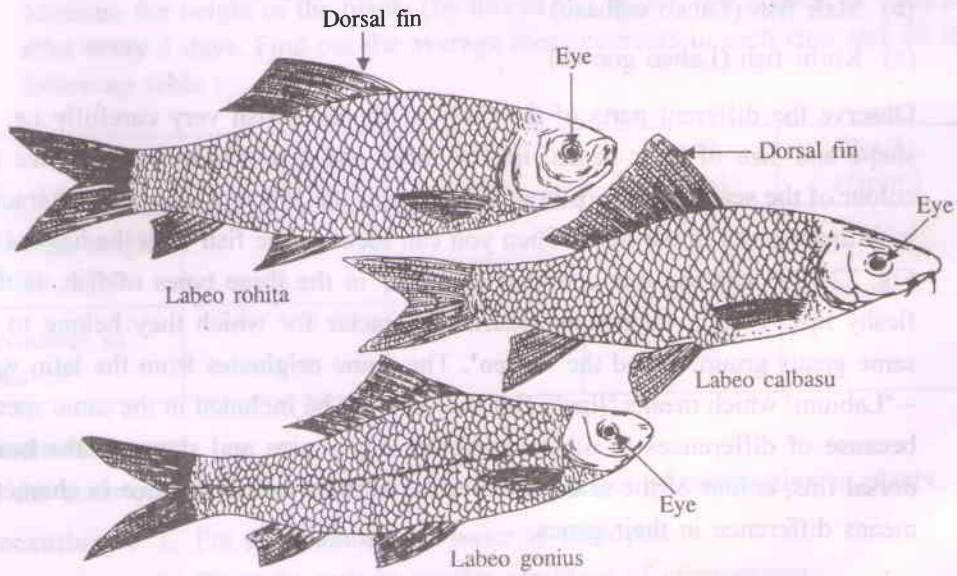


Fig. 22. Three different species of 'labeo'.

To be noted :

The aquatic animals having stream lined body paired or unpaired fins with fin-rays and gills for respiration belong to a single class called 'fish' or 'pisces' and this group is called 'class' which includes all the different types of fish. But some of them bear naked skins and others posses scales of different shape and size. Again in some fins are different.

The students can collect different types of fish from their own locality and should try to observe the variations in their external characters. This will help them to know the diversity in a group.

Expt. 13 : Population survey to identify human phenotypic character – 'ear lobe'.

The External characters which can be observed are called phenotypic characters. The phenotypic characters are determined by the genes. The genetic composition of an organism is called genotype.

In a cell 2 sets of chromosomes (human 2 sets = 46 nos. chromosomes) are present. All the genes contained in a single set of chromosome is called genome. Each parent contributes his / her genome to the son / daughter through gametes. This character of the ear lobes is a heritable character.

Two types of ear lobes are found in human – free and attached.

Procedure :

1. Survey a large random population sample, examining the earlobe. Prepare a table (as indicated below) and fill it up.
2. Find out which ear lobe trait is dominant ?
3. Express the ratio of dominant and recessive trait.

Total No. of individuals examined	Number of individuals with free ear lobes	Number of individuals with attached ear lobes	Percentage of individuals with free ear lobes	Percentage of individuals with attached ear lobes

Expt. 14 : Competition among organisms

The living being produce large number of offsprings, survival of which depends upon availability of food, water, oxygen, space etc. Since all these factors are found always in limited and more or less in fixed amount, a continuous struggle or competition between the living organisms occurs. It is because of this struggle or competition that the population of various species more or less remains the same.

Requirement : Three pots with garden soil , seeds of pea and gram, thread, scale.

Procedure : Take three pots with garden soil and marked them as A. B. and C. Sow 5 seeds of pea in pot A, 5 seeds of pea and 5 seeds of gram in pot B, and 5 seeds of gram in pot C. Place them in same place and water them regularly.

Observation :

(1) Note the date germination of

1. Pea seeds in pot A.
2. Pea seeds in pot B.
3. Gram seeds in pot B.
4. Gram seeds in pot C.

(2) Delay in germination, if any, in pot B of

1. Pea seeds (Number).
2. Gram seeds (Number).

(3) Number of plants which could not survive after germination in the pots (A), (B) and (C).

Measure the height of the plants (by thread and scale), leaf number in each pot after every 5 days. Find out the average measurements in each case and fill the following table :

	Pot A (Pea)	Pot B (Pea)	Pot B (Gram)	Pot C (Gram)
Average height of the plants				
Number of leaves				

Conclusion :

On the basis of observation you can express the effect of competition in plants.

Precautions : 1. Put same amount of water to each pot.
2. Place the pots in similar condition of environment.

■■■