Training of KRP's of Western Region on the use of Secondary Stage-II (Classes XI and XII) Kit of Biology

Programme Report

2024-2025

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Concept paper

Kits of various levels and classes have been brought out by NCERT to facilitate teachers and students in studying the Sciences at all levels including the senior secondary stage i.e. Physics, Chemistry and Biology. The states were continuously asking for training in the KITs at Senior Secondary stage as the kits are distributed / purchased by various states including western regions. However in the paucity of training on the Educational Kits, the Kit boxes are lying unopened in many schools of various states and thereby adversely affecting the learning of Sciences, including the crucial learning and career forming Senior Secondary stages. In many places proper laboratories are either not presents or if present is underutilized, hence the training on educational kits is of utmost importance.

The present training is a state demand programme. The kits come with a manual which not only illustrates its content but also describe the items usage for the smooth conduct of the practical. The items present are self sustaining for the required practical and can be replaced with; if it gets exhausted. The unique feature of the kit is all items are replaceable. The teachers can inculcate scientific temper, provides hands on experience using activity or demonstration method. This led the students to think and explore which may not be possible in theoretical studies only. Of course this requires keen interest and proper planning on the part of the teachers along with proper time in hand. Hopefully the teachers will make maximum usage of the kit and the manual after getting the required training to make Science / Biology more interesting, inspiring and futuristic in their career at the end. The present training is designed especially keeping these points in minds. The teachers feel incompetent that they can't fulfill the required practical hands to the pupils in their crucial learning stages. Hence a practical exposure to the kits and its content at Senior Secondary Biology level will facilitate teachers in feeling confident to conduct various experiments at plus two level using senior secondary biology kits. The teachers have hands on experience but are masters in either Botany or Zoology, hence feels slightly discomfort in conducting experiments in other subject, thus it will brush their knowledge with the required skills to handle the experiments at their level in the Biology at the school.

The success of this training programme will be ensured by how far the teachers can motivate their pupils to use the kit items rather than a mere demonstrable box to be opened occasionally.

Hopefully the programme does justice to the intent with which it is designed in a meticulous manner giving equal weightage to both the components of Biology namely, Botany and Zoology.

Dr. Daksha M.Parmar,
Programme Coordinator

Training of KRP's of Western Region on the use of Secondary Stage-II (Classes XI and XII) Kit of Biology

Kits of various levels and classes have been brought out by NCERT to facilitate teachers and students in studying the Sciences at all levels including the senior secondary stage i.e. Physics, Chemistry and Biology. The states were continuously asking for training in the KITs at Senior Secondary stage as the kits are distributed / purchased by various states including western regions. However in the paucity of training on the Educational Kits, the Kit boxes are lying unopened in many schools of various states and thereby adversely affecting the learning of Sciences, including the crucial learning and career forming Senior Secondary stages. In many places proper laboratories are either not present or if present is underutilized, hence the educational kits are of utmost importance. The teachers feel incompetent that they can't fulfill the required practical hands to the pupils in their crucial learning stages. The present training is designed especially keeping these points in minds. Hence a practical exposure to the kits and its content at Senior Secondary Biology level will facilitate teachers in feeling confident to conduct various experiments at plus two level using senior secondary biology kits. The teachers have hands on experience but are masters in either Botany or Zoology, hence feels slightly discomfort in conducting experiments in other subject, thus it will brush their knowledge with the required skills to handle the experiments at their level in the Biology at the school.

Laboratory is a place where theoretical ideas and concepts can be tested through experiments. Biology laboratory thus provides the learners an environment where the process of learning is facilitated by hands-on experiments. Biology laboratory provides a unique learning opportunities and environment where learners inculcate scientific temper, develop relevant skills and get exposed to realms of techniques and methodologies of scientific investigations. Biology discipline is based on experimental work and therefore practical forms an integral part of learning. Knowledge in the field of Biology can be acquired or constructed only on the basis of correct observations and experimentally verifiable processes. Like any other discipline of science, Biology is a unique discipline in the sense that it does not merely deal with the study of morphology, anatomy, physiology and reproduction of the living organisms; rather, understanding of the subject requires understanding of a number of interdisciplinary areas and approaches.

On one hand, a biologist needs to be sufficiently skilled in handling the enormous diversity of the living organisms, be it plants, animals, fungi or even microscopic bacteria, while on the other hand, a biologist should be able to understand the biochemical, molecular, physiological, behavioural, genetic and many other phenomena pertaining to the living organisms. The study of intricate relationship of different types of organisms among themselves and also with its environment is an important concern of a biologist. Thus, experiments and exercises in Biology train a learner about skills of observations, manipulation of the organisms for the study of

internal details, biochemical as well as molecular composition and processes, investigation of the abiotic environment and even analysis of phenomena like inheritance and evolution. As far as the study of the living organism is concerned, correctness of the method is very important. Such a study may be very simple, e.g., study of habit, habitat and external features of the plants or animals, or, it may involve certain manipulations like dissection and section cutting of the plant parts to study the minutest details. Very often observation and study of the magnified image of the minute parts under a microscope provides a better insight about the features of the organisms. However, microscopic study involves certain specific skills depending on type of the organisms/ tissues/cells to be studied. It involves specific preparations (peeling, section cutting, fixation, staining, dehydration, mounting, etc.) so that microscopic examination reveals the expected details. As histological and cytological observations gives us only static pictures of the continuous processes, analysis of biochemical, physiological and ecological aspects need certain other kinds of skills such as preparation of chemicals and reagents, designing and performing an experiment, observation and recording of data and ultimately interpretation and drawing conclusions.

Laboratory investigations in Biology increase the reasoning abilities, bring scientific attitude in a learner and also help in acquisition of skills of scientific processes. Also, observation of nature and the living organisms found in it is no less important for the understanding of many aspects of the subject especially the diversity of the living organisms, their systematic study, and their relationships among themselves and with the environment.

While performing experiments, honesty in recording of data and its correct presentation is very important as it is not only useful in the logical interpretation but also helps in the identification of errors.

In order to perform experiments successfully, a learner needs to go to the Biology laboratory well prepared. This includes the following: 1. Laboratory Record Book: For maintaining all the information including recording of data and its interpretation. 2. Dissection Box: A dissection box is required in the Biology laboratory for various purposes like handling and manipulation of living materials, performing experiments, preparation of slide, etc. A dissection box should contain scissors (two pairs, one small with fine tip and one larger), scalpels (one small and one medium sized), forceps (two, one small with sharp fine tips and the other medium sized with blunt tips), dissecting needles (two), razor, hand lens, dropper, fine brush, etc. 3. Laboratory Manual 4. A Laboratory Coat or Apron 5. A Hand Towel

While in the laboratory a student should be very careful and methodical. One should listen carefully to the instructions given by the teacher/ instructor before performing an experiment. In the biology laboratory a student has to handle a number of sharp objects and hence necessary precaution and care should always be taken while handling objects like scissors, forceps, needles, scalpel, razor, etc. It is also very

important to follow the safety instructions mentioned on the instruments and/or on the label of the reagent/chemical. Students should also be aware about the use of the First-aid Box so that in case of any accident or injury the preliminary aid can be provided to the affected person. While describing the experiment students are expected to follow a pattern in which the aim of the experiment, its principle, list of the materials to be used, procedure, observation table (if required), inference and discussion should be given. Necessary precautions to be taken should also be mentioned appropriately in the procedure or at the end. There are a few experiments in which field visit is essentially required. For this all the necessary preparations (materials, equipments, reagents and chemicals) should be made in advance. Drawing of illustrations is also an important component of the practical in Biology.

Students are expected to follow certain fundamental rules while drawing the illustrations so that it reflects their observations correctly.

- Make your illustrations using pencil only and always use white drawing sheet. Illustration should be in the centre of the page.
- Drawing of an object (plant, animal or experimental set-up) should be proportionate in size.
- Draw your illustrations keeping the object before you.
- Drawing must be clear with simple outlines.
- Appropriately label your drawing. Parts of the drawing should be indicated by straight horizontal line or arrow. Two lines or arrow should never cross each other. As far as possible, labeling should be done on the right side of the drawing. An appropriate legend or heading of the drawing should also be given below it.

The main objective of the training of the teachers/ KRPs on the Secondary Biology Kit is they are already dealing with the practicals in their own way but due to certain restrictions like that of their busy schedule, unavailability of certain chemicals/ glass wares or otherwise manual is to introduce the students of higher secondary stage to the fascinating world of plants, animals and microbes and their complex biological phenomena. The manual covers a complete description of the experiments and exercises. The suggested experiments cover almost all the units/topics including those on diversity in living world, plant, animal and human physiology, genetics, bio-technology and human welfare and environment. Using a standard format to describe each experiment was expected from students which include:

- ***Aim****:* It is a brief title of the experiment under investigation.
- ***Principle*****:** It is a very brief introduction of the experiment under investigation and explains the biological phenomenon involved. It gives brief but comprehensive ideas about the design of the experiment and explains the significance of the phenomenon being studied.
- ***Materials required*****:** This includes the names of plants/animals to be used as 'samples', the type of apparatus, the type and quantity of glass wares required, reagents, chemicals and solutions needed their concentration and other specifications, method of preparations of solutions and reagents. If a particular

material/chemical/glassware is not available, sufficient alternatives can be made and used.

- ***Procedure*:** This section includes full details of experimental procedure explained stepwise, including special precautions necessary to be taken while the experiment is being conducted. Drawings of the samples, apparatus and the experimental setup, wherever found necessary, have been included to facilitate the students to perform the experiment as accurately as possible.
- ***Observation and Results*:** This section deals with the recording of all observations made during the experiment. Students are advised to consider the entire data. Data can be represented in the form of tables, graphs and histograms wherever possible. Use of units in which various quantities are measured has been indicated in the manual.
- ***Discussion*:** Included in this heading is a statement of the conclusions drawn from the experimental results and compared thesis (wherever possible) with any comparable data from other sources. The relevance of the conclusions drawn from the experimental results to the various processes under investigation and to the life of plant, animal and microbes has been prompted out.
- *Precaution*: This section contains all the necessary precautions to be taken during experimentation to obtain results free of errors.

- It is essential that the teacher should properly explain each experiment so that inexperienced students will also be able to obtain accurate results within a reasonable time. Teachers are also expected to help students in identifying errors and mistakes committed during experiments and ways for correcting them. It is possible that some of the students may undoubtedly be capable of doing more sophisticated work than that represented in the manual. But introductory course of this sort has been designed to help all students for some useful and joyful experience by conducting the experiments of their own. The manual also aims that students and teachers not be discouraged by either incomplete experiments or experiments which yield apparently meaningless results. With the objectives of inculcating scientific temper among learners and providing them an opportunity to undertake independent scientific investigation, Investigatory Project Work has been included as an integral part of the practical curriculum of Class XII. Such investigatory projects are expected to provide thrill in the learning process. It is also expected to serve the real purpose of practicals, i.e., developing an ability to hypothesize and design experiments to address certain problems, to make observations methodically and to draw conclusions out of the experimental data. A comprehensive idea about undertaking investigatory project has been given in the book with a list of a few problems on which investigatory project work can be undertaken. However, the list is only suggestive and considering the wider scope students can undertake any kind of investigatory project work depending on their region, its climatic condition, availability of resources, etc.

- The programme was designed in a way that there were morning and evening session divided in Botany and Zoology subject so that the other department gets enough time for the preparation of reagents, chemicals, seeking materials required for the practical in hand and other preparations.

Identify and study the morphology of different plant groups

Dr. Daksha M. Parmar
Asst. Prof. Botany

Aim: To identify and study the morphology of representative types of bacteria, fungi and different plant groups.

***Principle*:** Morphology is the study of the characteristic features of the species. It could be a study of external or internal features. Morphological studies help in identification and classification of organisms. Requirement: Permanent slides, hand section/photograph of bacteria, Oscillatoria, Spirogyra, Rhizopus, Yeast, preserved/fresh specimens of mushroom, lichens, Funaria, Marchantia, Dryopteris/fern, Pinus, angiospermic plants (one monocotyledonous plant like maize plant and one dicotyledonous plant like pea/sun flower).

Procedure

Procedures for the study of organisms vary from one organism to the other depending upon their shape and size. • Microscopic organisms like bacteria, algae, fungi can be studied with the help of microscope only. Observe the permanent slides under a microscope and note down the characters. • Large-sized specimen (fresh or preserved) can be examined directly with naked eye or with the help of a hand lens. • Compare your observations with the characteristics given below.

Observation

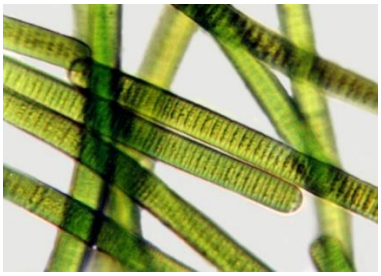
BACTERIA (i) Bacteria (sing.: bacterium) are unicellular (Fig.). (ii) Cell wall is present. (iii) Absence of membrane bound organelles like mitochondria, nucleus, golgi bodies, plastids, etc. (iv) Mesosomes are present. (v) Bacteria exist in different shapes like globular (coccus), rod-shaped (bacillus), spiral (spirullum) and comma-shaped (vibrio).

Systematic position

Kingdom – Monera
Class – Eubacteria

OSCILLATORIA the features given below are useful in identifying *Oscillatoria* (Fig).

(i) It is blue - green algae of fresh water bodies.
(ii) Thallus is filamentous, unbranched, multicellular.
(iii) The cells are arranged one above the other like a pack of cards.
(iv) Each cell has a definite cell wall.
(v) Some cells of the filament may be dead and appear as blank spaces in the filament.
(vi) Fresh specimen of the filaments show oscillatory movements and hence the name Oscillatoria.

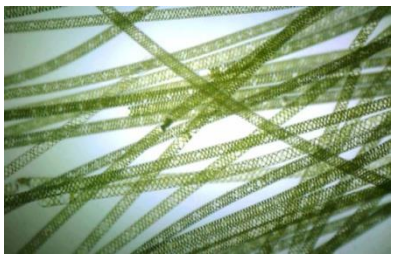


Systematic position

Kingdom – Monera
Division – Cyanobacteria
Class – Cyanophyceae

SPIROGYRA Observe the following features:

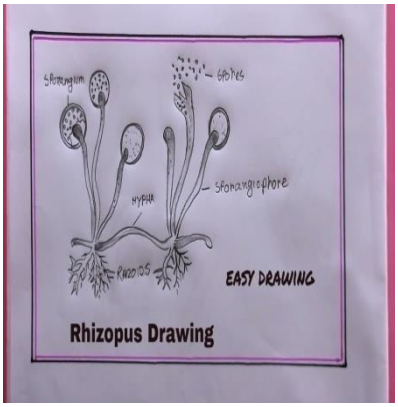
(i) Spirogyra is a green-coloured algae commonly found in stagnant fresh water bodies.
(ii) It is unbranched, filamentous and slimy to touch.
(iii) The filament is composed of large number of long, cylindrical cells placed one above the other in a single row.
(iv) The cells are characterised by long spiral ribbon-shaped chloroplasts with several pyrenoids
(v) There is a single large vacuole in each cell.



(vi) Conjugation tubes formed between the cells of two different filaments may also be found when in reproductive phase.

Systematic position

Kingdom – Plantae
Division – Thallophyta
Class – Chlorophyceae



Agaricus Stipe Gills Annulus Pileus RHIZOPUS Observe the following features:

(i) Thallus is an interwoven mass of hyphae called mycelium.
(ii) Hyphae are tubular, multinucleate and without any septa (coenocytic).
(iii) Some hyphae are horizontal and grow parallel on the surface of the substratum. These are called stoloniferous hyphae. Some hyphae grow down into the substratum, and are called rhizoidal hyphae. Erect vertically growing hyphae are called sporangiophores. • Sporangiophore bears the capsule or sporangium, which is globular in outline. • A dome-shaped columella is found inside the cavity of sporangium. • Numerous black spores fill the cavity between columella and the sporangial wall.

DICOTYLEDONOUS PLANT

(i) Plant body is differentiated into roots, stems and leaves (Fig).
(ii) Taproot system.
(iii) Leaves simple or compound, with reticulate venation.
(iv) Flowers tetramerous or pentamerous, either solitary or in clusters forming inflorescence.
(v) Reproductive organs are stamens and carpels. Within the carpels ovules are present.
(vi) Seeds have two cotyledons. Example: Hibiscus, pea, gram, lady's finger, ground nut.

Systematic position

Kingdom – Plantae
Division – Angiosperm
Class – Dicotyledonae

MONOCOTYLEDONOUS PLANT

(i) Plant body differentiated into roots, stems, and leaves (Fig).
(ii) Fibrous root system.
(iii) Leaves simple or compound with parallel venation.
(iv) Flower trimerous.
(v) Ovules situated inside the carpels.
(vi) Seed has one cotyledon Example: maize, wheat, sugarcane, paddy

Systematic position

Kingdom – Plantae
Division – Angiosperm Class – Monocotyledonae

Study of the mitosis

Dr. Kusum
Assistan Professor, Zoology

***Aim*:** To study the mitosis in onion root tip cells.

I. Skill required for the experiment:

1. Laboratory Skills: It involves the ability to work with instruments and staining techniques, including using a compound microscope.
2. Sample Sensitivity: Ability to recognize and collect the correct onion root tip sample, and its sensitivity during the procedure, pressing it gently and effectively without damaging the cells.
3. Technical Competence: Understanding and following the steps of sample collection, staining, tissue fixation, and then critical observation of the prepared slides.
4. Mental Focus: Managing mental elements like concentration, time management, and maintaining calmness during the experiment.
5. Teamwork: If performed in a group, teamwork is crucial to complete the process efficiently and collaboratively.

Concept behind the Experiment

Mitosis can be observed from onion (*Allium cepa*) root tips. The roots are easy to grow in large numbers and can be grown by keeping the root region of an onion immersed in water for a few days. The cells at the tip of the root are actively dividing; hence many cells will be in stages of mitosis.

Each cell of an onion has 8 chromosomes and it has the following stages:

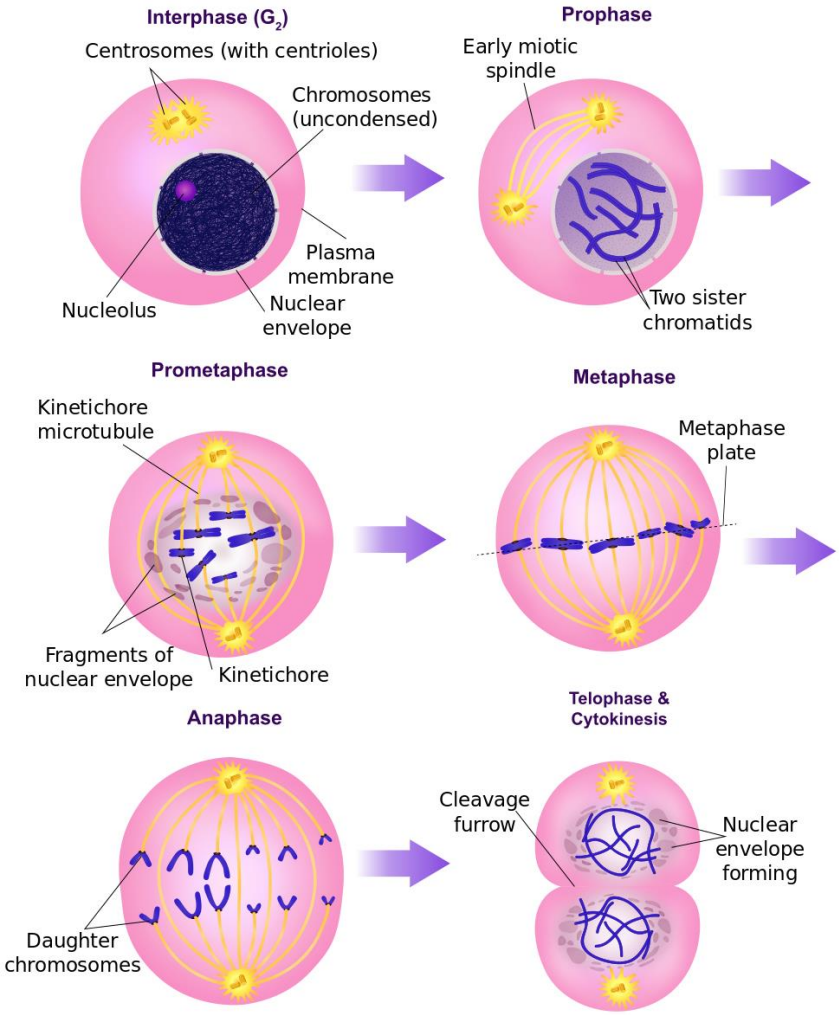
Interphase – Nucleus appeared more or less uniformly stained and chromatin or chromosomes were not clearly visible. A nuclear membrane was present.

Prophase – Chromosomes were visible inside the nucleus and the nuclear membrane was present.

Metaphase – Chromosomes appeared as thicker (more densely condensed) than in prophase, and were arranged along the central portion of the cell.

Anaphase – Chromosomes were divided into two groups which appeared to be moving away from each other towards the opposite ends of the cell.

Telophase – Chromosomes were decondensed, forming chromatin, and the nuclear membranes were partly or fully present. A cell wall was also present between the two daughter cells. The length of each daughter cell was approximately half of the cell observed in the preceding earlier stages.



Materials required

1. Rooted onion
2. Sharp blade
3. Slide
4. Cover slip
5. Microscope
6. 70% ethyl alcohol
7. 1:3 Acetic alcohol (1-part acetic acid and 3-parts methanol) fixative
8. HCl (dilute)
9. Acetocarmine solution

Principle

Somatic growth in plants and animals takes place by the increase in the number of cells. A cell divides mitotically to form two daughter cells wherein the number of chromosomes remains the same (i.e., unchanged) as in the mother cell. In plants, such divisions rapidly take

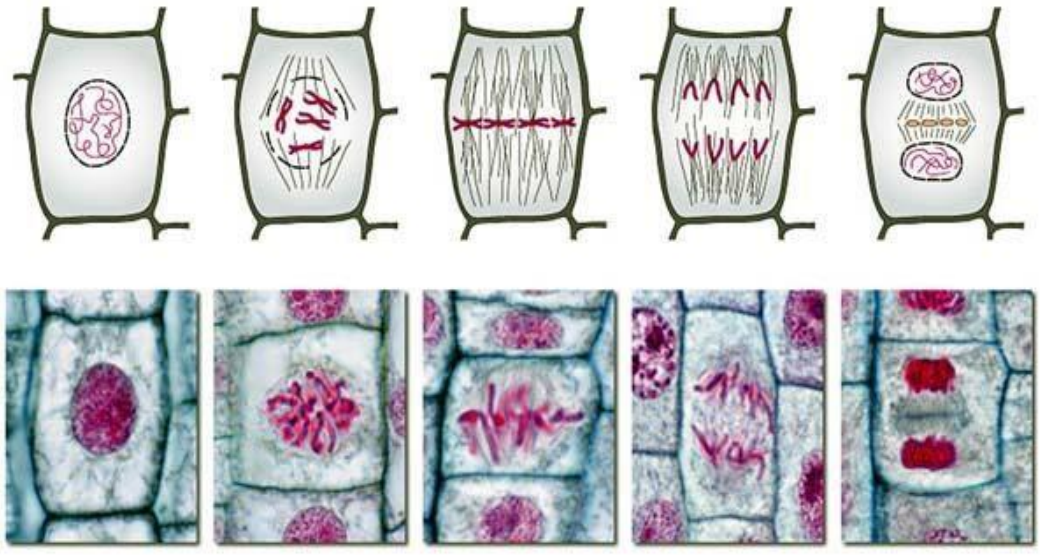
place in meristematic tissues of root and shoot apices, where the stages of mitosis can be easily observed. In animals, mitotically dividing cells can be easily viewed in the bone marrow tissue of a vertebrate, epithelial cells from gills in fishes and the tail of growing tadpole larvae of frog.

Procedure

I. Trim the old roots from the base of a medium sized onion bulb.
II. Place the base of the onion bulb on the mouth of a conical flask full of water.
III. Keep the conical flask in dark for three to four days till the root tips come out.
IV. Cut the root tips with the help of a sharp blade and immediately fix in the acetic alcohol (1:3) for one hour (Root tips can be kept in fixative for 12 hours to several weeks. For longer storage transfer the root tips directly to 70% alcohol).
V. Remove from fixative and place the root tips in equal parts of 95% alcohol and dilute HCl for 5-10 min.
VI. Cut small pieces (0.5 mm) from root tips and place them on a clean glass slide.
VII. Add 2-3 drops of acetocarmine solution over it and wait for 5-10 min.
VIII. Place a cover slip on the drop and apply gentle pressure (for spreading of cells).
IX. Heat the slide gently over a spirit lamp without allowing acetocarmine to boil.
X. Place a blotting paper on the cover slip to remove excess of stain.

Observations

The slides were observed under the microscope, and respective mitotic stages were observed as Interphase (A) and stages of mitosis (B - E)



A. Interphase B. Prophase C. Metaphase D. Anaphase

Result & Discussion

The stages of mitosis can be broadly categorised into two parts: karyokinesis (division of nucleus) and cytokinesis (division of cytoplasm, and ultimately of the cell). Those cells, which are not in the phases of cell division are considered to be in interphase, while those cells which were dividing can be categorized in to respective mitotic stages.

Discussion

During Interphase, nucleus appears more or less uniformly stained, chromosomes are not visible and nuclear membrane is present. At prophase, the nuclear membrane disintegrates and the spindle fibres attach to the centromere of each pair of sister chromatids and they begin to move toward the center of the cell. During metaphase the chromosomes rest along the center plane of the cell. During anaphase, the centromeres split and the sister chromatids begin to migrate toward the opposite poles of the cell. During telophase, the chromosomes at either end of the cell begin to cluster together, and the formation of new nuclear membrane starts. Cytokinesis also occurs during telophase, giving rise to two separate daughter cells. Cell plate appears between the two daughter cells – this is the new cell wall forming between the two cells.

Precautions

1. Only sharp tip of the root be taken.
2. Root tip must be pressed gently.
3. Extra stain must be removed by blotting sheet.

Evaluation Questions

1. Did you follow the correct technique during the experiment?
2. Did you adhere to the correct staining protocol and pay special attention?
3. Were there any staining errors or irregularities during the experiment?
4. Are your results similar to the given results?
5. Did you analyze the results wisely?
6. Have you found the correct reason behind the variations?

Reproductive parts of a Flower

Dr. Daksha M. Parmar
Asst. Prof. Botany

***Aim*:** To study the reproductive parts of commonly available flowers

***Principle*:** The male reproductive parts of a flower are the stamens collectively called androecium and the female reproductive parts are the carpels/pistils collectively called gynoecium. The individual units of stamen consist of a filament, which supports the anther lobes. Gynoecium consists of stigma, style and ovary. Many variations are found in different characteristics of both the stamens and carpels. We shall try to study these variations in the reproductive parts of flowers in the exercise.

***Requirements*:** Commonly available flowers, needles, forceps, razor/scalpel blade, brush, slides, cover slip, watch glass, magnifying lens, dissecting microscope, compound microscope, etc.

Procedure (i) Familiarize with the terms to describe the reproductive parts of flowers (ii) Observe the flower with the naked eye, hand lens or under a dissecting microscope. Study their reproductive parts and count the number of stamens and record their cohesive and adhesive features. (iii) Cut L.S. of the flower and place it on a slide to observe the following characters: (a) Placement of anthers (b) Position of the ovary: epigynous/perigynous/hypogynous. (iv) Mount one stamen on a slide and study the following characters: (a) Attachment of filament to anther (b) Dehiscence pattern of the anther lobes for discharge of pollen. (v) Cut T.S. of anther lobe to observe the number of pollen sacs. (vi) Mount the pistil on a slide and study style, stigma and ovary. Record the number of stigma and nature of pistil. (vii) Cut T.S. of ovary, mount it on a slide and observe (a) Number of locules in the ovary (b) Type of placentation (c) Number of ovules per locules (viii) Draw labelled figures of your preparation and observations.

Questions

1. Name the most common type of placentation observed.
2. What is the most common type of dehisence pattern in anthers?
3. Name a few unisexual flower-bearing plants studied by you.
4. “Flower is a modified shoot.” Justify the statement based on your observation.

Difference in rate of transpiration between two surfaces of leaf

Ms. Manisha Pande
Asst. Prof Botany

Aim: To demonstrate difference in rate of transpiration between two surfaces of leaf.

Principle: A plant does not use most of the water that it absorbs. About 97.99% of the water is lost through transpiration. Transpiration is defined as the physiological loss of water in the form of water vapour from leaves and other ariel parts of the plant. 85% of transpiration takes place through stomata of leaves.

There are 3 main types of transpiration, based on where the process occurs:

1. **Stomatal transpiration**: Stomata make up only 3% of leaf surface area but most water loss happens through these openings.
2. **Cuticular transpiration**: The leaf surface has a waxy cuticle through which water vapour can evaporate. Here water loss is lower as compared to stomatal transpiration.
3. **Lenticular transpiration**: Lenticels, small openings in plants bark, are another area from where the water is lost. This is responsible for lowest amount of water loss.

❖ **Stomatal> Cuticular > Lenticular**

Rate of transpiration depends upon several factors like light, temperature and also on the size, type, number and distribution of stomata on leaves. The distribution of stomata varies on both the surface of leaves, especially in dorsiventral leaves:

❖ **Stomata** $_{\text{lower surface}}$ **> Stomata** $_{\text{upper surface}}$

There are 2 methods to demonstrate the rate of transpiration:

1. Cobalt chloride test
2. Vaseline test

Requirements:

I. For method I:

A herbaceous plant (broad leaved plant), filter paper, 5% cobalt chloride solution, hot plate/oven, wire gauze, cellotape, slides, rubber bands.

II. For method II:

4 leaves of a healthy plant Bouganviella, Catharanthus etc., Vaseline petroleum jelly, thread, stand.

Procedure:

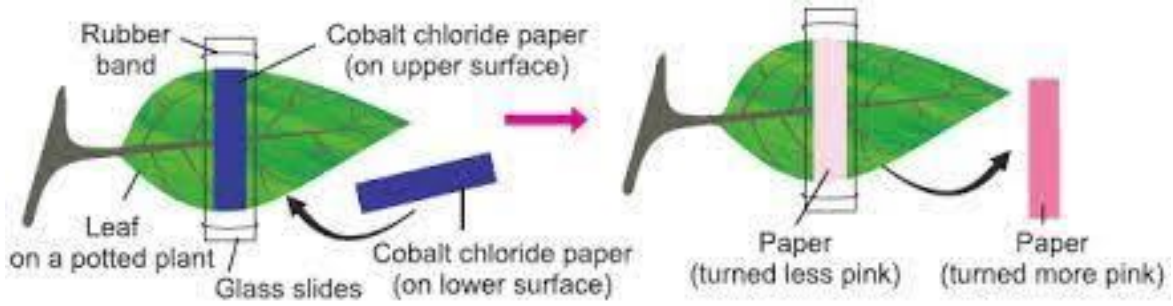
A. For cobalt chloride method:

- Prepare 100 mL of 5% cobalt chloride solution by dissolving 5g of cobalt chloride in 100 mL distilled water.

- Cut filter paper into small rectangular strips and immerse them in cobalt chloride solution in a petridish for 3-5 minutes.
- Take out the strip from the solution and dry them in air.
- Here we can see that:

  - Anhydrous cobalt chloride
    Dry ↓
    Blue in color
  - Cobalt chloride paper
    Water (from transpiration) ↓
    Pink in color

- Select a healthy plant leaf and cover the upper and lower surface of leaf with a small strip of filter paper soaked in cobalt chloride solution.
- The filter paper can be held in place with the help of 2 clips and rubber bands.
- Place the plant in sunlight for some time.



Observation:

- Observe the change in colour of the filter paper.
- Record the time required for the color change.

Name of the plant	**Time taken for change in color from blue to pink (in minutes)**							
		2	**4**	**6**	**8**	**10**	**12**	**14**
	Upper epidermis							
	Lower epidermis							

Inference:

- It will be observed that the filter paper attached to the lower surface turns pink much faster than the strip on the upper surface.

❖ **Time for upper surface> Time for lower surface**

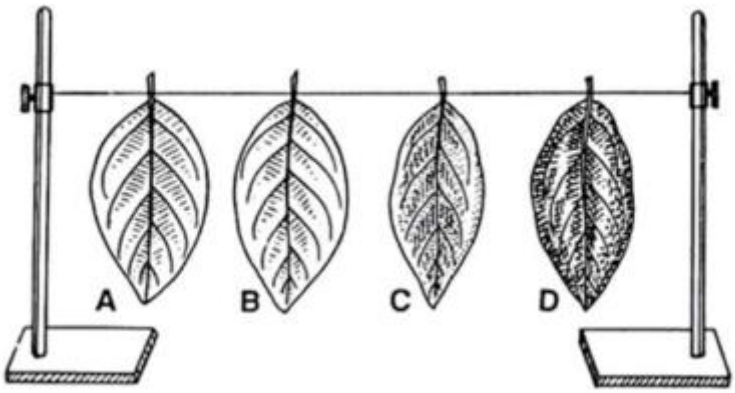
- Reason for this is that since more stomata are present on lower surface, more transpiration will take place from lower surface and hence filter paper will change color to pink in less time.
- On the upper surface due to the presence of fewer stomata, rate of transpiration will be less and hence filter paper will take more time to change color to pink.
- Hence rate of transpiration will be more on the lower surface.
- This is because the number of stomata are generally more in the lower epidermis than in the upper surface. As a result, the amount of water vapour lost by transpiration from the lower surface is more than the upper surface.

B. For Vaseline method/ 4 leaf experiment:

- Take 4 leaves of same size from healthy plant (Bouganviella, Catharanthus).
- Dry them completely and wipe them so that there is no dust present on the leaf surface.
- Spread the leaf on a white sheet and apply Vaseline/petroleum jelly/grease on leaf surface as follows:

Leaf no.	Vaseline application
A	On both surfaces
B	On lower surface
C	On upper surface
D	No vaseline

- Tie the leaves to a thread and tie the thread to the stand so that leaves are exposed to air.
- Record your observations after some time.



Leaf no.	Appearance of wilting
A	No wilting
B	Small amount of wilting
C	Considerable wilting
D	Complete wilting

Observation:

- We can observe that the leaves show varying amount of wilting depending upon the surface on which Vaseline is applied.

1. Leaf A shows no wilting due to application of Vaseline on both surfaces.
2. Leaf B shows slight wilting due to application of Vaseline on lower surface.
3. Leaf C shows considerable slight wilting due to application of Vaseline on upper surface.
4. Leaf D shows complete wilting due to not application of Vaseline on any surface.

Inference:

- From the above experiment we can conclude that:

1. For leaf A Vaseline covered both surfaces so transpiration could not occur and hence leaf remained fresh.
2. For leaf B Vaseline covered stomata present on lower surface and hence much transpiration could not occur so slight wilting.
3. For leaf C Vaseline covered stomata on upper surface and hence more transpiration occurred from lower surface so considerable wilting could be seen.
4. For leaf D both the surfaces were exposed to sunlight and hence transpiration occurred from both surfaces so leaf wilted completely.

Result-

- From both the experiments, we can see that see that more transpiration occurs form lower surface and hence numbers of stomata are more on the lower surface than the upper surface.

Questions:

1. What property of cobalt chloride makes it useful for the experiment?
2. What will be the result of cobalt chloride experiment if it is carried out in dark?
3. What time of day is suitable for carrying out the transpiration experiment and why?
4. Do all the leaves possess stomata?
5. What is an amphistomatic leaf? Give some examples of plants containing amphistomatic leaf.
6. What is a bifacial leaf? Give examples.
7. What is the difference between stomata of monocot (grasses) and dicot plants?

Pollen germination percentage

Dr. Daksha M. Parmar
Asst. Prof. Botany

***Aim*:** To calculate percentage of pollen germination

Principle: In nature, pollen grains germinate on the compatible stigmas of the carpel. Pollen grains can also be induced to germinate in a synthetic medium. During germination, intine (inner wall) of pollen grain emerges out as pollen tube through one of the germ pores in exine (outer wall).

***Requirement*:** Calcium nitrate, boric acid, sucrose, distilled water, petridish, slides, coverslips, brush, needle, microscope, and mature pollen grains of Tradescantia/balsam/ Jasmine/lily/pomegranate/grass/Vinca/China rose/Petunia.

Procedure (i) Prepare the pollen germination medium by dissolving 10g sucrose, 30mg calcium nitrate and 10mg boric acid in 100ml of distilled water. Alternatively 10% sucrose solution can also be used. (ii) Take a drop of medium or 10% sucrose solution on a cover slip and sprinkle mature pollen grains on the drop. (iii) Invert the cover glass on to a slide (iv) After 10 minutes, observe the slide under microscope. (v) Count (a) total number of pollen grains seen in the microscope field, and (b) the number of pollen grains that have germinated.

Observation

Several pollen grains germinate and put forth pollen tubes.
Count the total number of pollen grains and the number of germinated pollen grains in 3-5 different microscope fields.
Tabulate your observations and calculate the percentage of pollen germination.

S.No.	Total Number of Pollen (N)	Total Number of Germinated Pollen (n)	Percentage of Germination =n/Nx100

Discussion

Although pollen grains of many species germinate in this medium, the percentage of germinations and the time taken for germination varies in different species. Draw a germinating pollen grain and label.

Pollen Tube Growth

Dr.Daksha M.Parmar
Asst. Prof. Botany

Aim*:* To study pollen tube growth on stigma

Principle**:** Pollen grains germinate and form pollen tubes after they get deposited by the process of pollination on compatible stigma. Pollen tube, made up of cellulose, is an extension of the inner wall of pollen grain (intine). It emerges through one of the germ pore and passes through tissues of stigma and style to reach the ovule. The growing pollen tube is observed by staining with cotton blue. Requirement: 5–6 excised styles with stigma of Petunia/grass/maize/sunflower/Abelmoschus (Lady's finger), beaker, water, slides, cover slips, cotton blue stain, microscope, brushes, and needles.

Procedure: Place the stigmas in boiling water in a beaker for softening the tissues for 5–10 minutes. (ii) Stain with cotton blue for 3–5 minutes and wash with water to remove excess stain. (iii) Mount one stigma in a drop of glycerine on a slide. Place a cover slip on the stigma and gently press the cover slip on the material. Observe the slide under a microscope. (iv) If you fail to observe pollen tubes mount another stigma

Observation**:** Look for long blue-coloured tubular structures traversing through the tissues of stigma and style

Discussion**:** Pollen tubes are seen amidst the stylar tissue. Many pollen tubes may be seen. Trace the origin of pollen tubes to the pollen grains present around the surface of the stigma

Mitosis in Onion root Tips

Dr. Daksha M. Parmar
Asst. Prof. Botany

Aim: Preparation and study of mitosis in onion root tips

***Principle*:** Somatic growth in plants and animals takes place by the increase in the number of cells. A cell divides mitotically to form two daughter cells wherein the number of chromosomes remains the same (i.e., unchanged) as in the mother cell. In plants, such divisions rapidly take place in meristematic tissues of root and shoot apices, where the stages of mitosis can be easily observed. In animals, mitotically dividing cells can be easily viewed in the bone marrow tissue of a vertebrate, epithelial cell from gills in fishes and the tail of growing tadpole larvae of frog.

***Requirement*:** Onion bulbs, wide mouth glass tubes/jar/bottle, glacial acetic acid, ethanol 2-4% acetocarmine/acetoorcein stain, N/10 HCl, spirit lamp/hot plate, slide, cover slips, blotting paper, molten wax/nail polish and compound microscope

***Procedure*:**

Growing of root tips

Select a few medium-sized onion bulbs. Carefully remove the dry roots present. Grow root tips by placing the bulbs on glass tubes (of about 3–4 cm. diameter) filled with water. Care should be taken so that the stem portion of the bulb (basal part) just touches the water. A few drops of water may be added periodically to compensate evaporation losses. New roots may take 3–6 days to grow. Cut 2–3 cm long freshly grown roots and transfer them to freshly prepared fixative, i.e., aceto-alcohol (1:3: glacial acetic acid: ethanol). Keep the root tips in the fixative for 24 hours and then transfer them to 70% ethanol (for preservation and use in future). Onion root-tip cells have a cell cycle of approximately 24-hour duration, i.e., they divide once in 24 hours, and this division usually takes place about two hours after sunrise. Therefore, roots grown on water should be cut only at that time to score maximum number of dividing cells.

***Preparation of slide*:** Take one or two preserved roots, wash them in water on a clean and greasefree slide. Place one drop of N/10 HCl on the root tip followed by 2–3 drops of aceto-carmine or aceto-orcein stain on it. Leave the slide for 5–10 minutes on a hot plate (or warm it slightly on spirit lamp). Care should be taken that the stain is not dried up. Carefully blot the excess stain using blotting paper. Now cut the comparatively more stained (2–3 mm) tip portion of the root and retain it on the slide and discard the remaining portion. After (10–20 seconds) put one or two drops of water and blot them carefully using blotting paper. Again put a drop of water on the root tip and mount a cover slip on it avoiding air bubbles. Place the slide in between the folds of blotting paper using the fingers in such a way that the cover slip mounted on the slide is properly held. Now slowly tap the cover slip using the blunt end of a

pencil so that the meristematic tissue of the root tip below the cover slip is properly squashed and spread as a thin layer of cells. Carefully seal the margins of the cover slip using molten paraffin wax or nail polish. This preparation of onion root tips cells is now ready for the study of mitosis.

***Study of slide*:** Place the slide on the stage of a good quality compound microscope. First observe it under the lower magnification (10 X objective) to search for the area having a few dividing cells. Examine the dividing cells under higher magnification of the microscope to observe the detailed features of mitosis.

***Observation*:** The stages of mitosis can be broadly categorised into two parts: karyokinesis (division of nucleus) followed by cytokinesis (division of cytoplasm, and ultimately of the cell). Those cells, which are not in the phases of cell division are considered to be in interphase. You may observe that most of the cells in a microscope field are in interphase

***Interphase*:** The cells are mostly rectangular, oval or even circular in shape, with almost centrally situated densely stained nucleus. The chromatic (coloured) material of the nucleus is homogeneous and looks granular. The boundary of the nucleus is distinct. One or few nucleoli (sing: nucleolus) can also be observed inside the nucleus

Stages of Mitosis

Prophase Intact nuclear outline is seen. The chromatin (seen as a homogeneous material in the nucleus at interphase) appears as a network of fine threads (chromosomes). Nucleoli may or may not be visible. If the cell under observation is in the early stage of prophase then the chromatin fibres (chromosomes) are very thin. However, in the cells at late prophase, comparatively thicker chromatin fibres would be visible. Besides this, in the late prophase the nuclear membrane may not be noticed.

(a) **Metaphase** The nuclear membrane disappears. Chromosomes are thick and are seen arranged at the equatorial plane of the cell. Each chromosome at this stage has two chromatids joined together at the centromere, which can be seen by changing the resolution of the microscope. Nucleolus is not observed during metaphase.

(b) **Anaphase** This stage shows the separation of the chromatids of each chromosome. The chromatids separate due to the splitting of the centromere. Each chromatid now represents a separate chromosome as it has its own centromere. The chromosomes are found as if they have moved towards the two poles of the cell. The chromosomes at this stage may look like the shape of alphabets 'V', 'J' or 'I' depending upon the position of centromere in them. Different anaphase cells show different stages of movement of chromosomes to opposite poles, and they are designated to represent early, mid and late anaphase

(c) **Telophase** Chromosomes reach the opposite poles, lose their individuality, and look like a mass of chromatin. Nuclear membrane appears to form the nuclei of the two future daughter cells.

(d) **Cytokinesis** In plants, a cell plate is formed in the middle after telophase. The plate can be seen to extend outwards to ultimately reach the margin of the cell and divide the cell into two. Such cell plates are characteristic of plant cells. However, in an animal cell, the two sides of the cell show in-pushing or constrictions formed from the peripheral region in the middle of the cell, which grow inward and meet to divide the cell into two daughter cells. Draw labelled diagrams of all the phases of mitosis.

Discussion

Mitotic index (MI) is defined as a ratio of the total number of dividing cells (n) and the total number of cells (N) in a particular focus chosen randomly under the microscope and is calculated as MI = ×100 n N . By randomly selecting 5 to 10 such foci, one can estimate the mitotic index for a given type.

Study of stages of meiosis using permanent slides

Dr. Daksha M.Parmar
Asst. Prof. Botany

***Aim*:** Study of stages of meiosis using permanent slides

***Principle*:** Meiosis is a type of cell division in which the number of chromosomes is halved (from diploid to haploid) in the daughter cells, i.e., the gametes. The division is completed in two phases, meiosis I and meiosis II. Meiosis I is a reductional division in which the chromosomes of homologous pairs separate from each other. Meiosis II is equational division resulting in the formation of four daughter cells. Stages of meiosis can be observed in a cytological preparation of the cells of testis tubules or in the pollen mother cells of the anthers of flower buds.

***Requirement*:** Permanent slides of meiosis and compound microscope.

***Procedure*:** Place the slide on the stage of the microscope and search for the dividing cells using lower magnification. When dividing cells are located observe them under higher magnification.

***Observation*:** Observe various stages of meiosis and identify them on the basis of the specific features. A significant number of cells will be in the Interphase. These cells have a centrally positioned densely stained nucleus.

Meiosis I	
Prophase I	Unlike the prophase of mitosis, it is a comparatively complex phase characterised by a number of events. Five sub-phases can be identified in it. **(a) Leptotene (leptos = slender tene = band or thread)** (i) The nuclear membrane and nucleolus are not distinctly observable. (ii) Fine network of thin threads are seen uniformly distributed in the nucleus. These are chromatin threads, which may be observed as more prominent structures in the later stages. **(b) Zygotene (Zygon = paired)** This stage is characterised by the pairing of the homologous chromosomes, which can be seen as paired chromatin threads (bivalents). **(c) Pachytene (pachy = thick)** The chromatin threads get condensed and appear shortened and thick. Pairs of homologous chromosomes can be seen. Each chromosome has two chromatids and thus each bivalent consists of four chromatids. This configuration is called tetrad. **(d) Diplotene (diplos = double)** The homologous chromosomes (each made up of two chromatids) show distinct separation from each other except at few regions where

	attachments are seen. These are chiasmata (sing. chiasma) representing the site of exchange of the parts between two homologous chromosomes (i.e. crossing over). **(e) Diakinesis (Dia = opposite; kinesis= separation or movement)** (i) The homologous pair of chromosomes appear more shortened, thick and prominent. (ii) Chiasmata can be still observed. (iii) All the homologous pairs appear scattered in the cell.
Metaphase I	Homologous chromosomes are still in pairs, and are arranged along the equatorial plane of the cell. At this stage, the number of bivalents can be counted. Chiasmata may still be seen in a few bivalents.
Anaphase I	The chromosome pairs appear to have moved towards the two opposite poles of the cell. At the later stage, the anaphase – I may show the assembly of chromosomes at two poles. This results into the reduction of number of chromosomes to half. This stage can be identified by the presence of two chromatids in each chromosome.
Telophase I	The chromosomes present at the two poles appear decondensed and form two distinct nuclei. Note: After the telophase I stage there may or may not be cytokinesis. Thereafter the cell enters into the second meiotic division.
Meiosis II	
Prophase II	(i) Distinct thread- like chromatin fibres or rod- shaped chromosome are see
Metaphase II	This phase is similar to that of mitotic division (i) The chromosomes having two chromatids attached at the centromere are observed arranged at the equatorial plane of the cell. Note: Metaphase II of meiosis can be differentiated from metaphase-I on the basis of the following features: (ii) Each chromosome of metaphase II has two chromatid whereas in metaphase I these are paired homologous chromosomes each having two chromatids thus forming tetrad. (iii) In the metaphase I of meiosis, a few chiasmata are observed, where as no chiasmata are observed during metaphase II.
Anaphase II	The two chromatids of each chromosome after separation appear to lie at the two poles of the cell.
Telophase II	Note: Anaphase II can also be distinguished from the anaphase I of meiotic division on the basis of chromatids: In anaphase I, each chromosome has two distinct chromatids, but in anaphase II, each chromosome is represented by one chromatid only. The separated chromosomes appear decondensed and form nuclei

Mendel's Law of Independent Assortment

Dr. Daksha M.Parmar
Asst. Prof. Botany

***Aim*:** To verify the Mendel's Law of Independent Assortment

***Principle*:** In a dihybrid cross, the segregation of one gene pair is independent of the segregation of the other pair. It means that genes of two different traits assort independently to give a probability ratio equal to segregation probability ratio of one allele pair X segregation probability ratio of other allele pair, which comes to, (3:1) X (3:1) = 9:3:3:1

***Requirement*:** Plastic beakers; 64 plastic beads each of yellow, green, red and white to represent, yellow and green colour of seed coat and red and white flowers respectively and napkin/hand towel.

***Procedure*:** Students are to work in pair. The following steps are to be followed sequentially: (i) Place 64 beads of each colour in four separate beakers. (ii) Put the beakers containing the yellow and red beads on your left side, and those containing the green and white beads on your right side. The beakers on your left side represent plants bearing yellow seed and red flower (dominant character YY, RR). Beakers on the right side represent plants bearing green seeds and white flowers (recessive character yy, rr). These are the two parental types having contrasting forms of two different characters. (iii) Stir the beads in each beaker with a pencil/pen. Each bead now represents alleles in the male and female gametes. (iv) Pick up one yellow, one green, one red and one white bead, and put them together on the napkin spread on the table. (v) Continue picking up and putting together of the beads of all colours as mentioned in the previous step, till all the beads are utilised. (vi) Note that in all, 64 such 4-bead clusters are obtained representing the F1 individuals. Ascertain their genotype and phenotype. (vii) Next step is to cross these F1 individuals to raise the F2 generation. Let us suppose half of the 4-bead clusters (32 clusters) represent the male parents and the remaining half (32 clusters) the female parents. Now put the 32 red and 32 white beads together in one beaker (numberedI), and similarly put 32 yellow and 32 green beads together in other 36 beaker (numbered-II). These two beakers represent F1 female. Similarly put remaining 32 red + 32 white beads in beaker numbered-III, and 32 yellow and 32 green one in beaker numbered-IV to represent the F1 male. The arrangement can be presented as below

Female F1	Male F1
32 red + 32 white (Beaker I)	32 red+32 white (Beaker III)
32 yellow + 32 green (Beaker II)	32 yellow + 32 green (Beaker IV)

Stir the beads in each beaker with a pencil. In order to raise the F2 generation, pick up (with eyes closed) one bead from the beaker-I of female and one bead from the beaker-III of the male, and put into the palm of the partner student. Similarly, pick up one bead each from the

beaker-II of female and beaker IV of male to put in the palm of the partner. This partner would now keep all the four beads together (to represent the F2 individual). Continue this process till all beads are utilised. At the end, 64 F2 individuals (each represented by a 4-bead cluster) are obtained. (ix) Determine the genotype and phenotype of each of the 64 F2 individuals and write down the number of individuals of different genotypes and phenotypes in the tabular form (given below), remembering that Y (yellow seed colour) is dominant over y (green seed) and R (red flower) is dominant over r (white flower). (x) Repeat the whole procedure (steps i to ix) six times, and tabulate your results.

Observation Tabulate the results as follow: Symbol (-) indicates the presence of corresponding dominant or recessive allele e.g. Y or y and R or r. Summarise your results (adding together the data of all the six repeats)

F1 Generation

(a) Total number of individuals: _____

(b) Phenotype (s) _____

(c) Genotype (s) _____

Generation & repeat No.	Total No. of off springs	Genotype				Phenotype			
F1 1. 2. 3. 4. 5. 6. Total F2 1. 2. 3. 4. 5. 6. Total		Y-R	Y-rr	yyR	yyrr	Yellow	Yellow	Green	Green

F2 Generation

(a) Total number of individuals _____

(b) Phenotypes _____

(c) Number of individuals in each phenotypic class:

Number	Phenotype
_____	_____
_____	_____
_____	_____

(d) Phenotypic ratio _____

(e) Genotypic ratio _____

Number of individuals of each genotypic class:

Number	Genotype
_____	
_____	
_____	
_____	
_____	
_____	
_____	
_____	
_____	
_____	

(e) Genotypic Ratio _____

***Discussion*:** The four phenotypic classes in the F2 generation are in ratio of 9:3:3:1 as expected from the Law of Independent Assortment. The genotypic ratio would be (1:2:4:2): (2:1) :(2:1):1.

Study of Human Skeleton

Dr. Kusum
Assistant Professor
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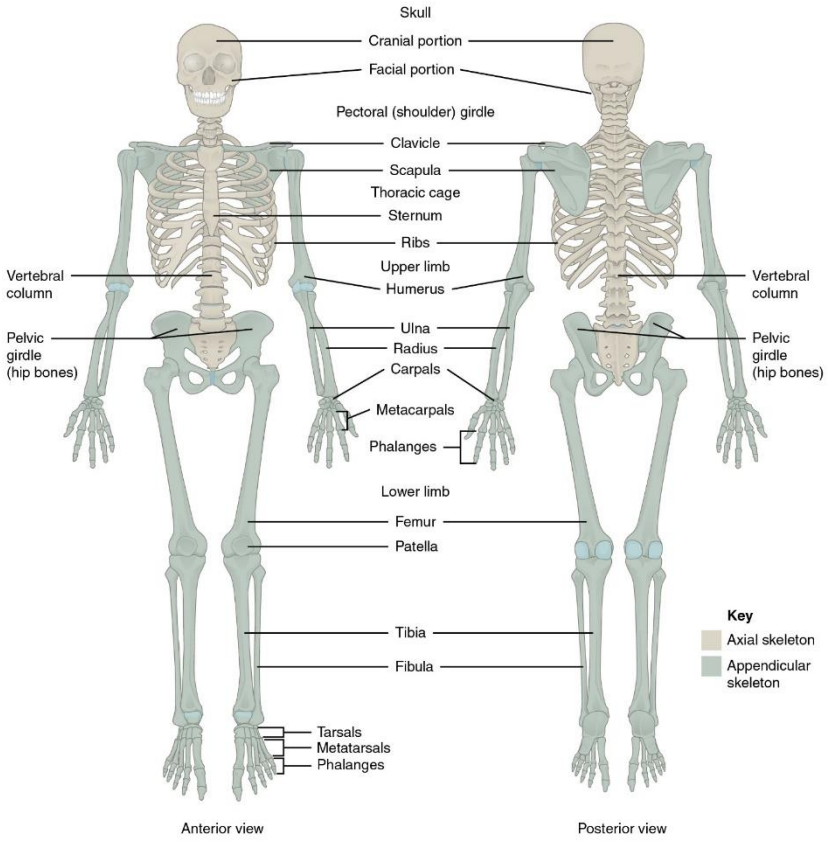
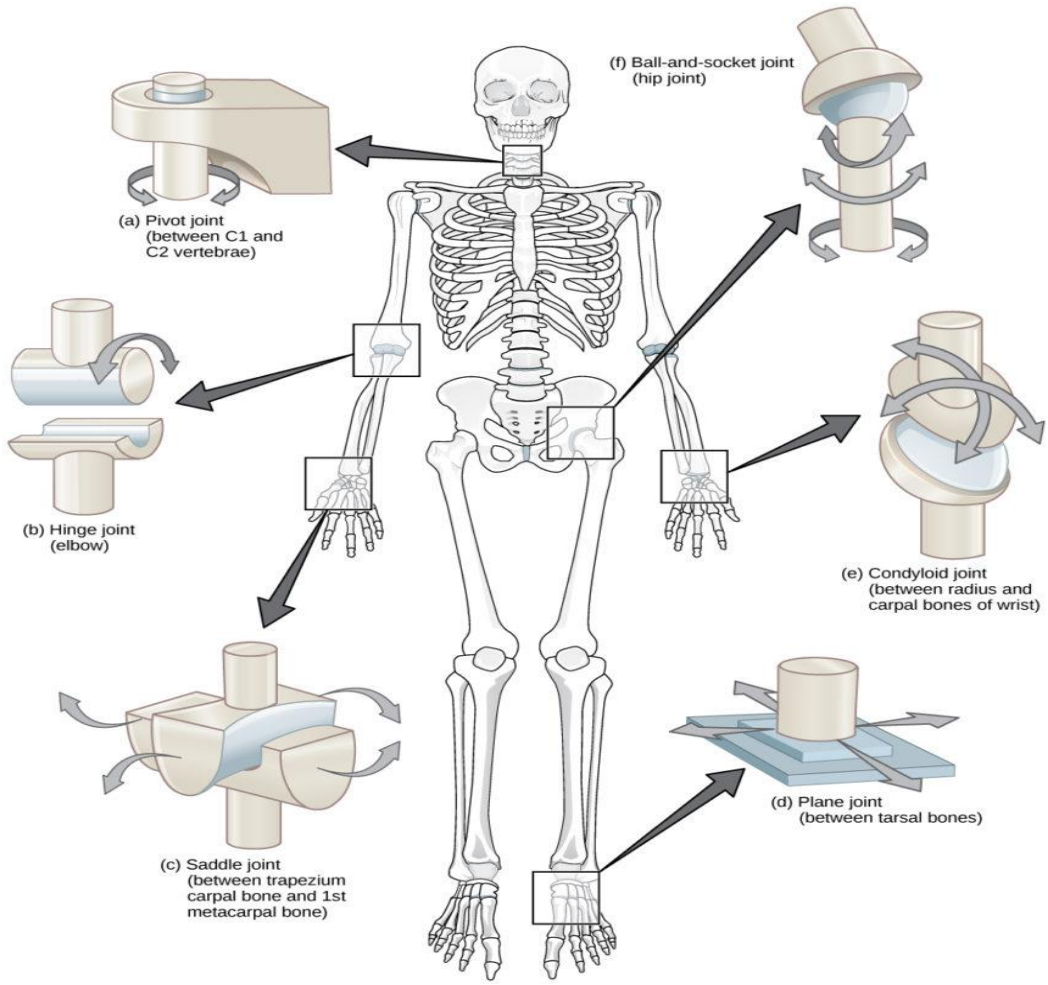
Aim : To study the human skeleton and different types of joints.

Skill:

1. Laboratory Skills: It involves the ability to work with laboratory models, including using a human skeleton.
2. Sensitivity of model/chart: Ability to recognize the skeleton system & joints of humans, its types, movement, importance, and effectiveness.
3. Technical Competence: Understanding and following the steps during the experimental demonstration via model to understand the human skeleton system.
4. Mental Focus: Managing mental elements like concentration, focusing on the concepts of joints in the human skeleton system, and maintaining calmness during the demonstration.
5. Teamwork: If performed in a group, teamwork is crucial to complete the process efficiently and collaboratively.

I. Concept behind the experiment:





I. **Axial skeleton-80 bones distributed along the main axis of the body. It includes skull, vertebral column, sternum and ribs.**

Skull is composed of two sets of bones – cranial and facial (22 bones).

Cranial bones-8 and it form the hard protective outer covering, cranium for the brain.

Facial region -14 and form the front part of the skull.

Hyoid bone-A single U-shaped bone, present at the base of the buccal cavity.

Middle ear contains tiny bones – Malleus, Incus and Stapes (Ear Ossicles).

Vertebral column-26 serially arranged units called vertebrae (dorsally) placed.

First vertebra-atlas and it articulates with the occipital condyles.

Vertebral column has-cervical (7), thoracic (12), lumbar (5), sacral (1-fused) and coccygeal (1-fused) Sternum-a flat bone on the ventral midline of thorax,

Ribs-12 pairs, thin flat bones connected dorsally to vertebral column and ventrally to the sternum

II. ***Appendicular skeleton-*** limb bones and girdles and each limb is made of 30 bones

Hand bones (fore limb)-humerus, radius and ulna, carpals (wrist bones – 8 in number), metacarpals (palm bones – 5 in number) and phalanges (digits – 14 in number)

Leg bones (hind limbs)- Femur (thigh bone – the longest bone), tibia and fibula, tarsals (ankle bones – 7 in number), metatarsals (5 in number) and phalanges (digits – 14 in number)
Knee cap-A cup shaped bone called patella cover the knee ventrally
Pectoral and Pelvic girdle bones-help in the articulation of the upper and the lower limbs respectively Scapula-a large triangular flat bone situated in the dorsal part of the thorax between the second and the seventh ribs.
Clavicle (collar bone)-is a long slender bone with two curvatures
Pelvic girdle-consists of two coxal bones. Each coxal bone is formed by the fusion of three bones – ilium, ischium and pubis.

III. Human joints

Fibrous joints-do not allow any movement. This type of joint is shown by the flat skull bones which fuse end-to-end with the help of dense fibrous connective tissues in the form of sutures, to form the cranium.
Cartilaginous joints- the bones involved are joined together with the help of cartilages. The joint between the adjacent vertebrae in the vertebral column is of this pattern and it permits limited movements.
Synovial joints- characterised by the presence of a fluid filled synovial cavity between the articulating surfaces of the two bones. Such an arrangement allows considerable movement. These joints help in locomotion and many other movements.
Ball and socket joint- present between humerus and pectoral girdle
Hisnge joint- knee joint
Pivot joint- between atlas and axis
Gliding joint-between the carpals
Saddle joint- between carpal and metacarpal of thumb

II. Materials required:

1.Human skeleton
2.Notebook
3.Pen/pencil

III. Principle:

Human skeletal system consists of a framework of bones and a few cartilages. This system has a significant role in movement shown by the body. In human beings, the skeleton system comprises 206 bones and a few cartilages. It is grouped into two principal divisions – the axial and the appendicular skeleton.

IV. Axial skeleton- 80 bones distributed along the main axis of the body. It includes skull, vertebral column, sternum and ribs.

V. Appendicular skeleton- limb bones and girdles and each limb is made of 30 bones

Human Joints are essential for all types of movements involving the bony parts of the body. Locomotory movements are no exception to this. Joints are points of contact between bones, or between bones and cartilages. Force generated by the muscles is used to carry out movement through joints, where the joint acts as a fulcrum. The movability at these joints

vary depending on different factors. Joints have been classified into three major structural forms, namely, fibrous, cartilaginous and synovial.

V. *Procedure:*

1. Human skeleton was taken out and observed carefully with the detailed overview.
2. The different types of human were studied by the skeleton model.

VI. Observations:

The human skeleton was observed carefully and different joints were noted down.

VII. Result & Discussion:

VIII. Precautions:

1. Human skeleton must be observed very carefully.
2. Everything observation must be noted down in notebook.

IX. *Evaluation Questions*

1. Did you follow the correct instructions during the experiment?
2. Did you adhere to the correct explanation of the concept and pay special attention?
3. Was there any query regarding the understanding of the experiment?
4. Are your understanding/ concept have enhanced?

Preparation of Pedigree Charts of genetic traits

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Aim: To prepare pedigree charts of genetic traits such as rolling of tongue, blood groups, widow's peak, colour blindness.

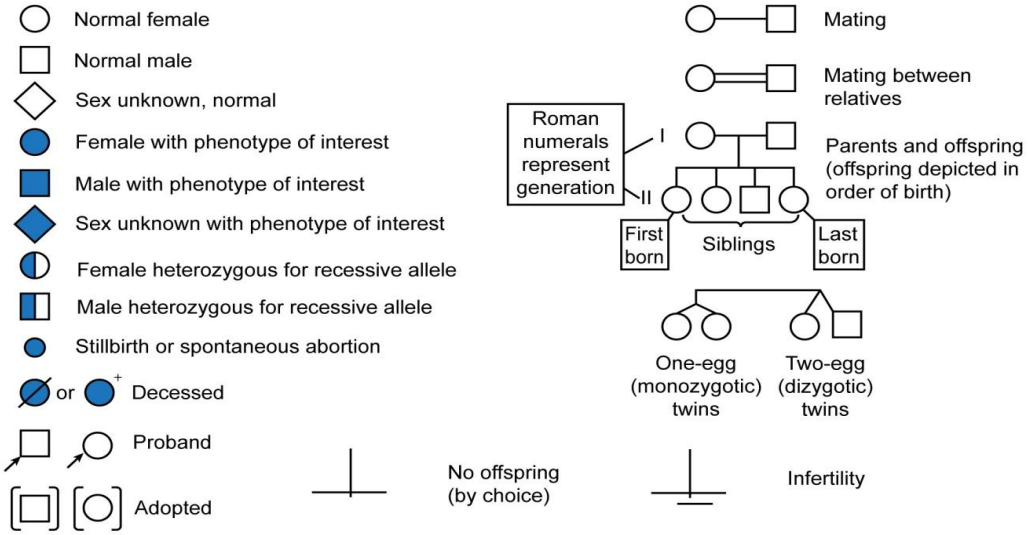
I. Skills:

1. Laboratory Skills: This involves the ability to work with instruments and techniques, including using a sphygmomanometer or digital blood pressure measuring device.
2. Sensitivity and understanding: Ability to recognize the pedigree & sensitivity during the explanation, communicating effectively, and taking care of diagram analysis.
3. Technical Competence: Understanding and folloing the steps of genetic traits analysis, problem-solving, and making appropriate decisions.
4. Mental Focus: Managing mental elements like concentration, time management, and maintaining calmness during the experiment.
5. Teamwork: If performed in a group, teamwork is crucial to complete the process efficiently and collaboratively.

I.Concept for the Experiment

Pedigree analysis, is a pictorial representation of a family tree outlining the inheritance of one or more characteristics. The person from whom the pedigree is initiated is called the proband and is usually designated by an arrow.

The symbols commonly used in depicting pedigrees are summarized here:



Dominant traits:

If a trait is dominant, at least one parent must have the trait and it will not skip a generation. Brachydactyly, polydactyly, dimple in the cheek are some of the common traits of this type.

Recessive traits:

If a trait is recessive, neither parent needs to have the trait because they could be heterozygous.

X-linked traits:

In X-linked pedigrees, fathers who have the trait may have daughters who don't, ruling out Y-linkage.

Example of X-linked dominant traits: Oral-facial-digital syndrome (Duchene Muscular Dystrophy), which results in absence of teeth, cleft (bifid) tongue associated with mental retardation.

Example of X-linked recessive diseases: Red-green colour blindness and hemophilia

Y-linked traits:

Such as hypertrichosis of the ear, only appear in males because females don't have Y-chromosomes.

Material Required:

1. Pedigree chart
2. Notebook
3. Pen/pencil

Principle:

The study of human heredity has been one of the major focuses of geneticists, one who seek to understand the pattern of transmission of traits and their prevalence in different ethnic groups. Parents pass on characteristics, or traits to their children through genes.

These characteristics are present in genes on chromosomes and it is transmitted via both mother and father (having only a single copy of genes from them).

Pedigree analysis is interesting as it can be used to find paternity/ maternity of a child and are often used to study the genetics of inherited diseases. Pedigree analysis is done to determine if the mode of inheritance is recessive, autosomal, mitochondrial or sex-linked.

For example, pedigrees can be analyzed to determine the mode of transmission for a genetic disease:

1. Dominance - whether the disease alleles are dominant or recessive
2. Linkage - whether the disease alleles are X-linked (on the X chromosome) or autosomal

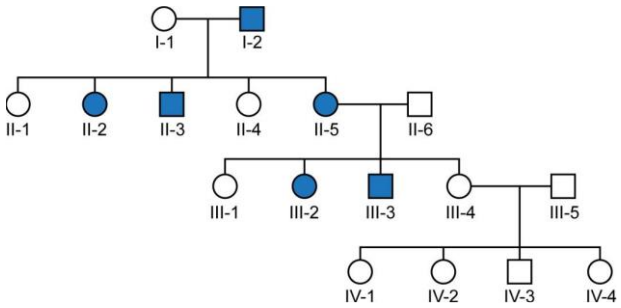
Procedure:

1. A family will be selected from the participants in which any one of the monogenic traits such as tongue rolling, widow's peak, blood groups', red-green colour blindness, dimple in the cheek, hypertrichosis of ear, hitch-hiker's thumb, etc., is found.
2. Then the person will be asked to exhibit the trait to tell in which of his/her parents, grandparents (both maternal and paternal), their children and grandchildren the trait in question is present.
3. Among surviving individuals, the trait must also be examined.
4. Based on available information preparation of pedigree chart must be done using the appropriate symbols.

5. A careful examination of the pedigree chart would suggest whether the gene for the character is autosome linked dominant or recessive, X - chromosome linked dominant or recessive, Y- chromosome linked or not.

Observations:

Let us take an example of a human autosomal dominant trait.
Example: neurofibromatosis (tumour-like growths on the body), familial hypercholesterolemia, phenylthiocarbamide (PTC) tasting, Marfan syndrome and brachydactyly (short fingers).



Result and Discussion

The given pedigree chart shows that -
I-2: Father is diseased
1^{st} generation progenies
II-2: 1^{st} generation child (female) is affected
II-3: 1^{st} generation child (male) is affected
II-5: 1^{st} generation child (female) is affected
2^{nd} generation progenies
III-2: 2^{nd} generation child (female) is affected
III-3: 2^{nd} generation child (male) is affected

Discussion

These are the traits whose encoding gene is present on any one of the autosomes, and the wildtype allele is recessive to its mutant allele, i.e., the mutant allele is dominant.

Precautions:

1. Data collection must be done carefully for pedigree chart preparation.
2. Analysis of the pedigree chart must be done critically.

Evaluation Questions:

1. Did you adhere to the correct pedigree analysis protocol and pay special attention?
3. Did you follow the correct guidelines for knowing the genetic traits of a character?
4. Were there any errors or irregularities during the genetic analysis?
5. Are your results similar to as described for the genetic trait?
6. Did you analyze the results wisely and thoughtfully?

Determining the blood pressure using a sphygmomanometer and stethoscope

Dr. Kusum, Assistant Professor, Zoology

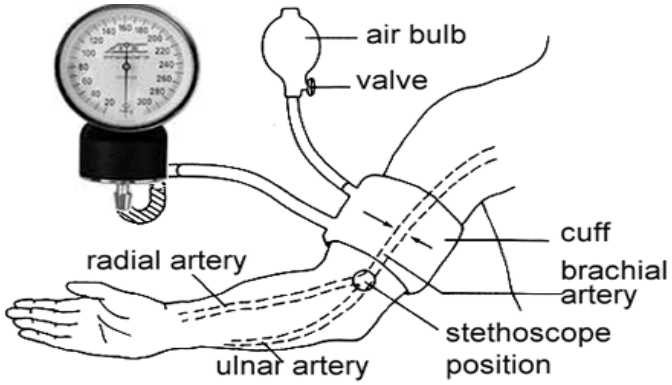
***Aim*:** To determine the blood pressure using a sphygmomanometer and stethoscope.

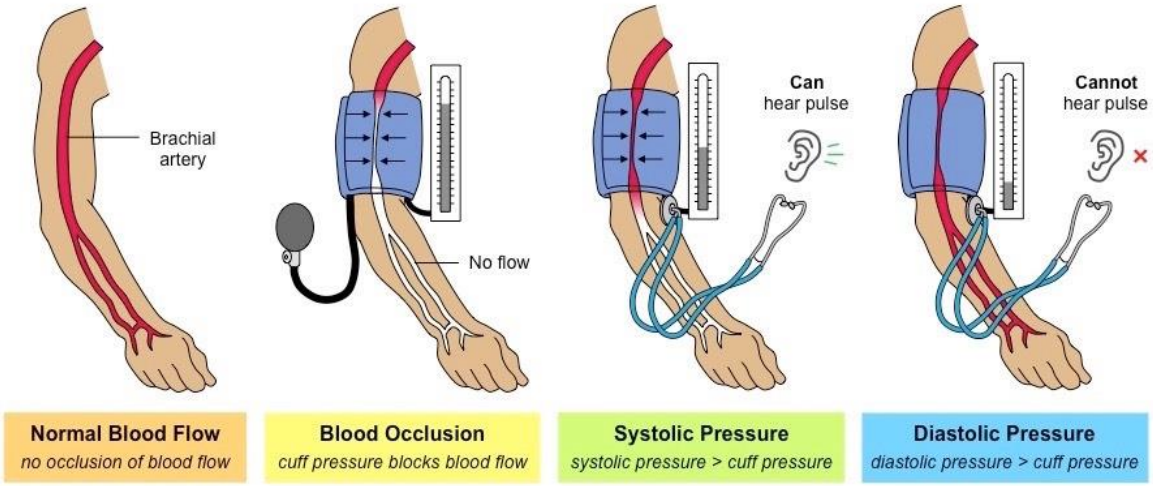
***Skills* :**

1. Laboratory Skills: This involves the ability to work with instruments and techniques, including using a sphygmomanometer or digital blood pressure measuring device.
2. Patient Sensitivity: Ability to recognize the patient & sensitivity during the procedure, communicating effectively, and taking care of their comfort.
3. Technical Competence: Understanding and following the steps of the blood pressure measurement process, problem-solving, and making appropriate decisions.
4. Mental Focus: Managing mental elements like concentration, time management, and maintaining calmness during the experiment.
5. Teamwork: If performed in a group, teamwork is crucial to complete the process efficiently and collaboratively.

Concepts behind this Experiment :

1. Blood Pressure: It is a measure indicating the force exerted by blood on artery walls as the heart pumps blood through the body. It is measured in millimeters of mercury (mmHg) and consists of systolic pressure (when the heart beats) and diastolic pressure (when the heart is at rest).
2. Sphygmomanometer: A device used to measure blood pressure. It involves a cuff that is gradually inflated and deflated around the arm, leg, or other parts of the body.
3. Systolic Pressure: The pressure in the arteries when the heart contracts and pumps blood out.
4. Diastolic Pressure: The pressure in the arteries when the heart is at rest between beats.
5. Hypertension (High Blood Pressure): A medical condition where the blood pressure is above the normal range, possibly due to an unhealthy lifestyle, stress, poor diet, or other factors.
6. Hypotension (Low Blood Pressure): A medical condition where the blood pressure is below the normal range, which could lead to fatigue, dizziness, or other health problems.





Materials Required for this Experiment

1. Blood Pressure Measuring Device (sphygmomanometer or digital blood pressure monitor)
2. Arterial Band/Cuff
3. Measurement Protocol or Chart
4. Comfortable Chair or Surface for the patient to sit
5. Pen or Pencil
6. Calibrated Measurement Equipment (if necessary)
7. Notebook or Paper for recording results

Principle

The principle of this experiment involves measuring blood pressure by recording the force of the heart pumping and the resistance of the arteries. Blood pressure is expressed in two figures: systolic (pressure when the heart contracts) and diastolic (pressure when the heart rests between beats).

Procedure

1. Allow the person to sit comfortably with their arms bent at heart level.

2. Wrap the sphygmomanometer cuff around the appropriate part of the body with moderate tightness.
3. Ensure the device is calibrated correctly and secure it.
4. Place the device on the correct spot and, if using a digital monitor, press the button to get the readings.
5. For accurate measurement, ensure the person is in a relaxed state, and avoid taking readings after consuming alcohol, tea, or coffee.

Observation Table

No.	Systolic Pressure (mmHg)	Diastolic Pressure (mmHg)	Comments
1.			
2.			

Results and Discussion

- Systolic Pressure: The highest pressure recorded when the heart contracts.
- Diastolic Pressure: The lowest pressure recorded when the heart is at rest.
- Additional Results: Can include measurement errors, irregular pressures, and conditions like hypertension or hypotension

Discussion:

Analyze the health condition of the person based on the readings, understanding factors like diet, exercise, and stress that can influence blood pressure.

Precautions

1. Use the correct equipment and ensure it is calibrated.
2. Apply the cuff correctly on the artery.
3. Ensure the person is relaxed and the environment is quiet.
4. Follow established measurement protocols.
5. Take at least three measurements and calculate the average.

Evaluation Questions

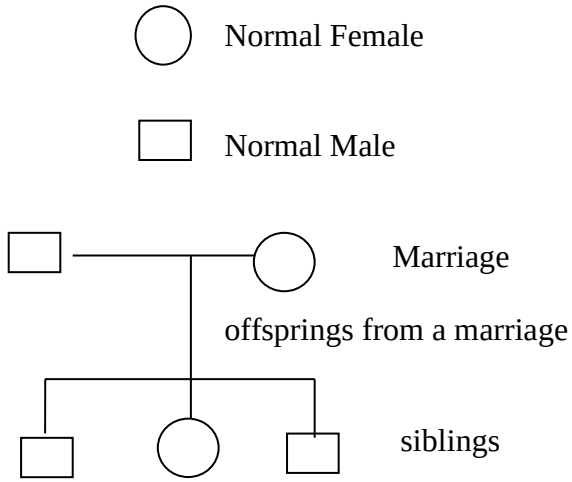
1. Did you follow the correct technique during the experiment?
2. Did you adhere to the correct measurement protocol and pay special attention?
3. Were there any errors or irregularities during the experiment?
4. Are your results within the normal range, or is there any abnormality present?
5. Did you analyze the results wisely and thoughtfully?

Preparation and analysis of Pedigree Charts

Dr.Daksha M.Parmar
Asst. Prof. Botany

***Aim*:** Preparation and analysis of Pedigree Charts

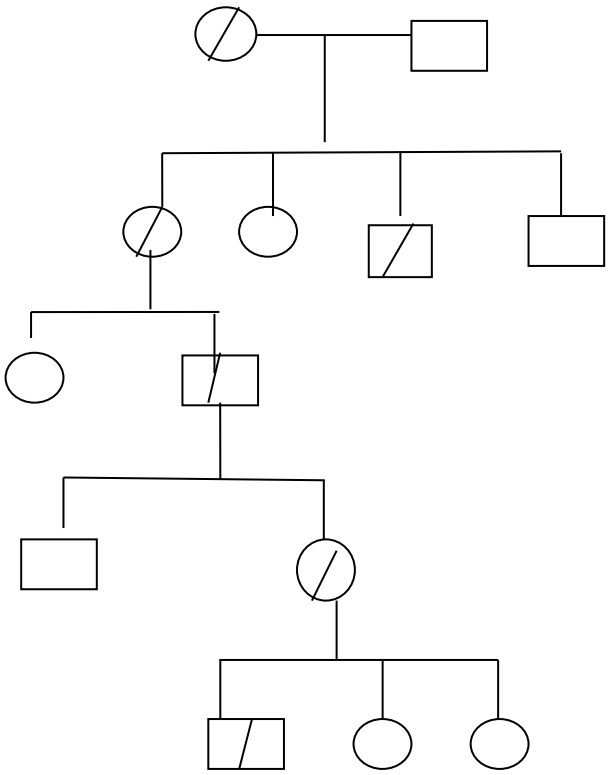
***Principle*:** The Mendelian concept of dominance and segregation can also be studied in humans by preparing and then analysing the pedigree charts. The internationally approved symbols for indicating males and females, marriages, various generations (I, II, III), etc., are given below.



Requirement: Information about characters/traits in a family for more than one generation Procedure Select a family in which any one of the monogenic traits such as tongue rolling, widow's peak, blood groups', red-green colour blindness, dimple in the cheek, hypertrichosis of ear, hitch-hiker's thumb, etc., is found. Ask the person exhibiting the trait to tell in which of his/her parents, grandparents (both maternal and paternal), their children and grand children the trait in question is present. Among surviving individuals the trait may also be examined. The information made available is the basis for the preparation of pedigree chart using the appropriate symbols. A careful examination of the pedigree chart would suggest whether the gene for the character is autosome linked dominant or recessive, X - chromosome linked dominant or recessive, Y- chromosome linked or not.

Explanation

1. **Autosome Linked Dominant traits**: These are the traits whose encoding gene is present on any one of the autosomes, and the wild type allele is recessive to its mutant allele, i.e., the mutant allele is dominant. The pedigree-chart can be of the undernoted pattern, where the female being interviewed is exhibiting the trait, and is indicated by an arrow-mark in the chart.



Inheritance of Autosome linked Dominant Traits

The characteristic features of inheritance of such type of traits are: (a) Transmission of traits occurs from parents of either sex. (b) Males and females are equally affected. (c) The pedigree is vertical, i.e., the trait is marked to be present in each of the generations. (d) Multiple generations are characteristically affected. Brachydactyly, polydactyly, dimple in the cheek are some of the common traits of this type.

Study of Compound Microscope

Dr Ramesh Sethy
Asst. Prof. Zoology

Background

Compound microscope is optical scientific equipment used to magnify and view smaller structures which cannot be seen with naked eyes by using two or more number of lenses. The compound microscope is used commonly used in biological experiments. It provides high magnification (enlargement of the appearance or image of the object) as well as fair resolution (differentiation of neighbouring points as separate entities).

Requirement

A compound microscope

Theory

Parts of Microscope:

The compound microscope has four sets of parts-

1. The stand or the support system
2. The optics or the magnification system
3. The mechanical adjustment system
4. The illumination system

1.) The support system: This system consists of –

- Tube: It supports the objectives and eyepiece.
- The arm or limb: It is the curved metallic structure which is required to hold and move the microscope. It gives correct height and angulation to the body tube.
- The revolving nose piece: It holds the objective at place while we are observing the sample. It is the objective changer.
- Stage: It is the flat square shaped surface attached superiorly to the lower end of the arm on which we put our slide. It possess pair of spring clips which hold the slide in place.
- The foot: It is the heavy metallic bottom part which supports all the other parts of the microscope. It may be oval, tripod or horseshoe shaped.

2.) The optics or magnification system: This consists of a system of lenses. The lenses of the microscope are divided into two groups-

- The first group of lenses present just above the preparation under examination that is the object, is called the objective. The objective comes with its magnification labelled on it such as 10X (low power), 45X (medium power), 100X (high power). Along with the magnification, numerical aperture (NA) is also engraved on the objective (0.30 onthe 10X objective, 0.65 on the 45X objective, 1.30 on the 100X objective). Thegreater the NA, greater is the resolution. The working distance of an objective is the distance between the front lens of the objective and the object slide. The greater the magnification of the objective, smaller is the working

distance. For 10X, 45X and 100X objectives, the working distance is 5-6mm, 0.5-1.5mm and 0.15-0.20mm respectively.

- The second group of lenses is present where the microscopist applies his eyes and is called the eyepiece or ocular. It may be labelled with its magnification such as 5X or 10X.

3.) The adjustment system: This system comprises of-

- The coarse adjustment knob: It is the large knob used to adjust the position of the body tube allowing us to quickly bring the sample into view.
- The fine adjustment knob: It is the small knob used to change the position of body tube by slowly making small adjustment. It is used to bring the object into perfect focus.
- Condenser adjustment knob: It is the sub-stage adjustment knob used to move the condenser up and down to increase the illumination or to reduce the illumination.
- Iris diaphragm lever: This lever is fixed on the condenser and is generally used for aperture adjustment. It is used to close and open the diaphragm for either reducingor increasing the intensity of light.

4.) The illumination system: It comprises of-

- Light source: Both electric light and daylight can be used as source of light. Electric light is more preferred as it is easier to adjust. An external source of illumination that is 60 watt electric lamp placed 18 inch away from the microscope can be used for routine purpose. Nowadays many microscopes are provided with built-in lamps beneath the stage. Otherwise daylight can be used. Use of direct sunlight is bad both for the microscope and eyes. It is best to use reflected sunlight of a dull white background.
- Mirror: It is located beneath the condenser and can be turned in any direction. andit is used to increase the amount of light shining through our sample or slide. It reflects the rays from the light source on to the object. It has two mirrors mounted back to back. One is flat and the other is concave. Flat mirror is used in presence of condenser and the concave mirror is used in absence of the condenser.
- Condenser: Beneath the stage, there is presence of condenser having standard diameter of 39.5mm which collects and concentrates the light that passes through the sample or brings the rays of light to a common focus on the object to be examined. There may be two or more lenses.

FIGURE: Showing Different Parts of Compound Microscope

Instructions

1) Always keep the microscope in vertical direction.
2) Don't make the use of direct sunlight.
3) Don't keep the microscope near the edge of the table.
4) The object to be examined should be mounted in mounting medium and should becovered with cover slip before observation.
5) Don't use excess mounting medium.
6) Always keep the microscope clean, dust free and covered.
7) Concave mirror is used while using low power lens whereas plane mirror is used while using high power or oil immersion lens. To obtain maximum and even illumination the mirror must be adjusted accordingly.
8) After placing the slide over the stage the low power lens is to be brought down using coarse adjustment knob. Bend by the side of the tube and bring your eyes at the level of slide while bringing it down. Never bring down the objective with coarse adjustment knob while looking through the eye-piece of the microscope.

Bring itdown to the extent that it is just near to the slide but not touching it.

9) Slowly the objective is to be raised while looking through the eye-piece of the microscope using coarse adjustment knob till the object is seen. The image of the object is made clear using the fine adjustment knob.
10) To use high power lens, the objective is to be raised again. Change the lens and then bring it down looking from the side. The objective is again raised while looking through the eye-piece till the object is seen.
11) Remove the eye-piece for a while and adjust the position of condenser to get better results.
12) Adjust the iris-diaphragm.
13) After adjusting the condenser and iris, replace the eye-piece and observe again. The object will be very clear.
14) While using oil immersion lens, a drop of cedarwood oil is placed on the slide. Cedarwood oil is preferred to other oils because its refractive index is nearer to that of glass. The oil on the objective should be removed using dry,soft cloth and then with a little xylol. Use of excess xylol is to be avoided.
15) Never unscrew any part of microscope. Do not clean any lens of the microscope with alcohol as the cementing material for the fixation of lens is soluble in alcohol.

Identification of Living Organisms in Water samples using Compound Microscope

Dr Ramesh Sethy
Asst. Prof. Zoology

Aim:

To identify and study the living organisms (Phyto and Zooplankton/Protists) in a water sample, making students aware of microorganisms, food chains, and useful organisms in water.

Skills Required:

1. **Understanding of Laboratory Rules**: It is essential to be aware of the rules of the laboratory for conducting the experiment safely.
2. **Sample Collection and Preservation**: Skill is required to properly collect and preserve the sample. This includes cleaning the sample, preparing it according to the correct protocol, and preserving it properly.
3. **Use of Microscope**: The ability to use a microscope to examine organisms is required. This includes proper handling and operation of the microscope.
4. **Identification of Organisms**: Knowledge and skills are required to identify organisms in the water sample. This involves careful observation and identification using the microscope.
5. **Analysis and Interpretation of Results**: The ability to analyze the results from a scientific perspective and draw appropriate conclusions is needed. This includes understanding the results, presenting them in an organized manner, and summarizing them appropriately.

Concepts:

1. **Water Sample Collection**: Collect the water sample using the specified method. Be careful during the collection process.
2. **Preservation of Collected Water Sample**: Preserve the collected water sample according to the correct protocol.
3. **Microscopy**: Use a microscope to examine the organisms. Be prepared for proper use of the microscope.
4. **Identification of Organisms**: Identify organisms using the microscope. Observe carefully and identify useful organisms.
5. **Counting of Organisms**: Count the different types of organisms. You can even count the organisms individually.
6. **Analysis of Results**: Analyze the results, focusing on the dominance and quantity of organisms.

7. **Reporting**: Report the results of the experiment, including details, observations, and conclusions.

Materials Required:

1. Water Sample (from sources like rivers, ponds, pools, water taps, etc.)
2. Beaker
3. Small vials or test tubes
4. Slides and cover slips
5. Watch glasses
6. Dropper
7. Preservation solution (5% FAA) (Formalin: Acetic Acid: Ethanol)
8. Compound Microscope
9. Haemocytometer**.**

Principle:

The evaluation of the number and type of organisms (both microscopic and macroscopic) present in a water body determines the productivity and food chain of the water mass. A water body with a high density of phytoplankton typically has high productivity and is often turbid with higher levels of nutrients and dissolved oxygen. Regular assessments of such water bodies help monitor ecological balance and detect pollution, as some organisms are indicators of environmental pollution.

Procedure:

1. Collect about one litre of water sample from a nearby water source (pond, reservoir, river, etc.).
2. To preserve the organisms in each sample, add about 5 ml of FAA (Formalin, Acetic Acid, Ethanol).
3. In the laboratory, transfer the water sample to a one-liter graduated container.
4. Let the water sample stand undisturbed for 48-72 hours.
5. Separate the water, leaving behind concentrated sediment at the bottom of the container.
6. Transfer the sediment to a small vial or test tube, cover, and label it for future use.
7. Using a dropper, transfer a few drops of the sediment onto a watch glass. If the sediment is too concentrated, dilute it with water.
8. Place a drop from the watch glass onto a slide, mount it, and observe it under a microscope.
9. Prepare a few more slides from each water sample and observe them first under low magnification, then under higher magnification.

Observation and Conclusion:

1. Record the presence of different types of organisms.
2. Count the number of organisms under the microscope.
3. Common organisms found in water bodies include Euglena, Paramecium, Ceratium, etc.

Result and Discussion:

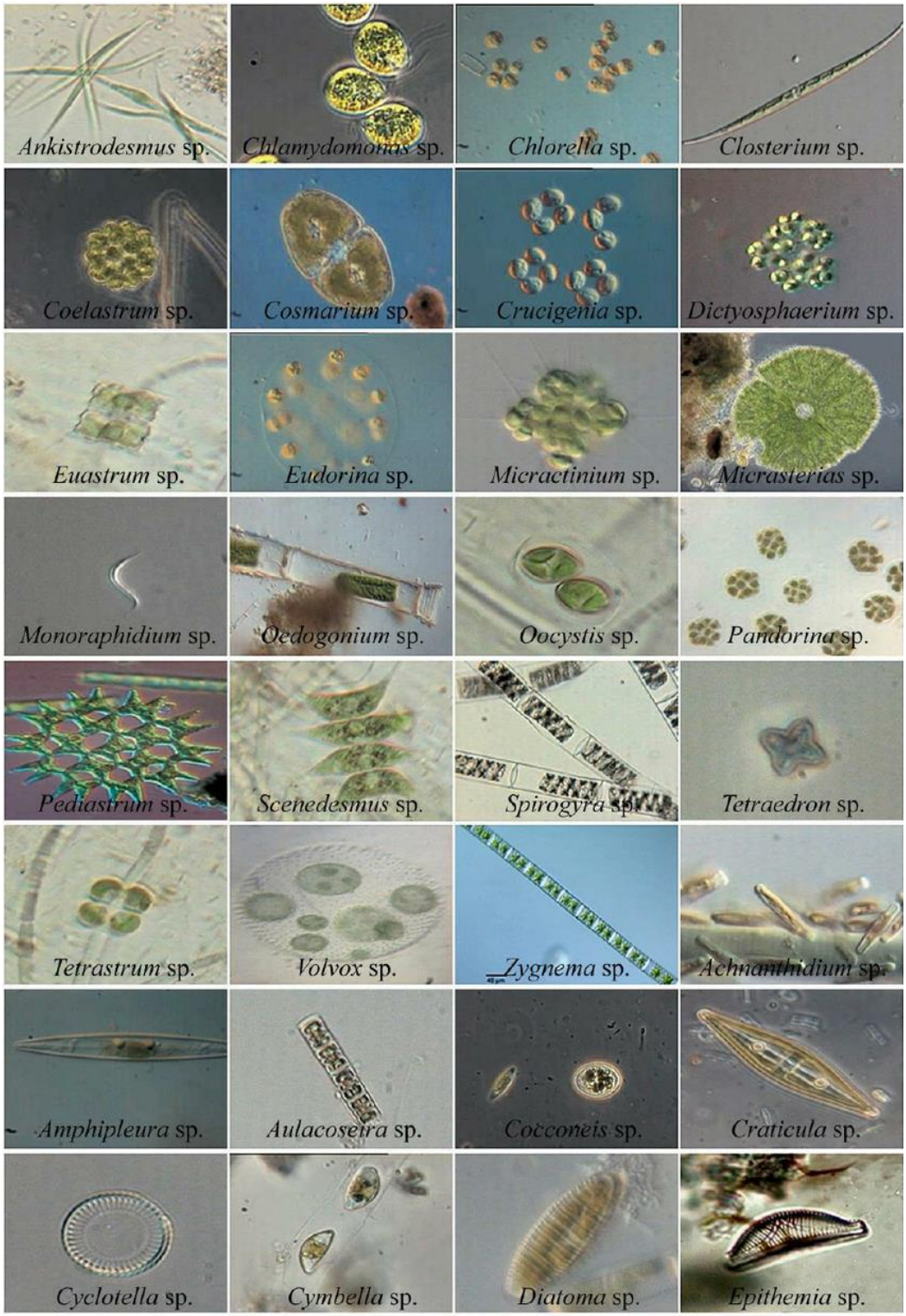
Based on this experiment, we can determine the presence of living organisms in the water sample. Using the microscope, we observed various microorganisms and estimated the severity of water pollution. This experiment helps us understand the structure and importance of organisms and their contribution to water and environmental health.

Precautions:

1. Ensure that you follow all safety precautions during the experiment.
2. Avoid contact with any hazardous reagents, use them carefully, and store them in a safe place.
3. If any environmental hazards occur during the experiment, report them to the appropriate authorities.

Related Questions:

1. Why do polluted waters typically have fewer types of organisms but higher density?
2. After collecting water samples, why is FAA (Formalin, Acetic Acid, Ethanol) added for preservation?
3. Name at least one phytoplankton and zooplankton typically found in polluted water.


Ankistrodesmus sp.
Chlamydomonas sp.
Chlorella sp.
Closterium sp.
Coelastrum sp.
Cosmarium sp.
Crucigenia sp.
Dictyosphaerium sp.
Euastrum sp.
Eudorina sp.
Micractinium sp.
Micrasterias sp.
Monoraphidium sp.
Oedogonium sp.
Oocystis sp.
Pandorina sp.
Pediastrum sp.
Scenedesmus sp.
Spirogyra sp.
Tetraedron sp.
Tetrastrum sp.
Volvox sp.
Zygnema sp.
Achnanthidium sp.
Amphipleura sp.
Aulacoseira sp.
Cocconeis sp.
Craticula sp.
Cyclotella sp.
Cymbella sp.
Diatoma sp.
Epithemia sp.

Emasculation, Bagging and Tagging for controlled pollination.

Dr. Rahul Soni
Asst. Prof. Botany

Aim: - To perform emasculation, bagging and tagging for controlled pollination.

Principle: - Emasculation is the process of artificial hybridization in which the stamens from the female flowers are removed from bisexual flowers in order to prevent self-fertilization. This process is carried out long before the anthers mature. Removal of anther from the bisexual flowers before the anthers mature is known as emasculation. The emasculated flower is then bagged to prevent any unwanted pollination. This process helps in the production of flowers with desired characteristics. For this, it is essential to have knowledge of the flower structure, fertilization, physiology of flowers and fertilization.

Requirement: - Ornamental plants/ wild plants bearing large bisexual flower, magnifying lens, tweezers, small sharp scissors, brush, alcohol, rubber bands, paper bags, paper clips and tags.

Procedure

1. A bud of flower was selected and its stamens are removed. This is **emasculation**. It was marked as female parent plant.

Fig.- 1 Showing emasculation of a flower

2. The flower is then covered with a plastic bag to prevent unwanted pollination. It is called as **bagging.**

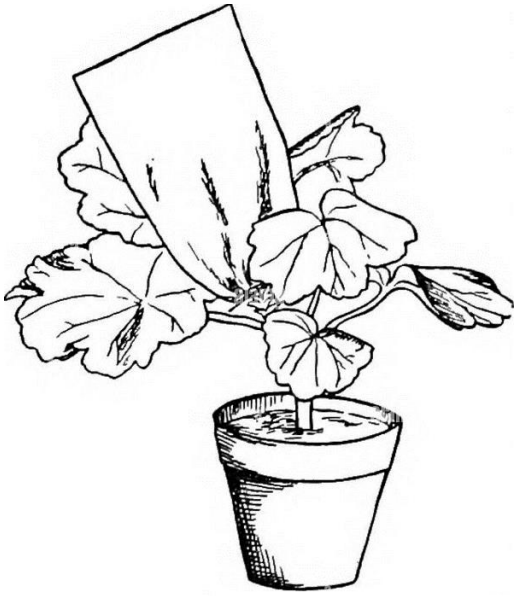


Fig.- 2 Bagging of an emasculated flower

3. The anther of male plant with desired characteristics were brought in contact with this after temporarily removing the bag and its pollen grains were dusted on the surface of the stigma.

Fig.- 3 Transfer of pollen grain with brush

4. This artificially pollinated flower is immediately covered with a polythene bag and tag was attached with requisite information.

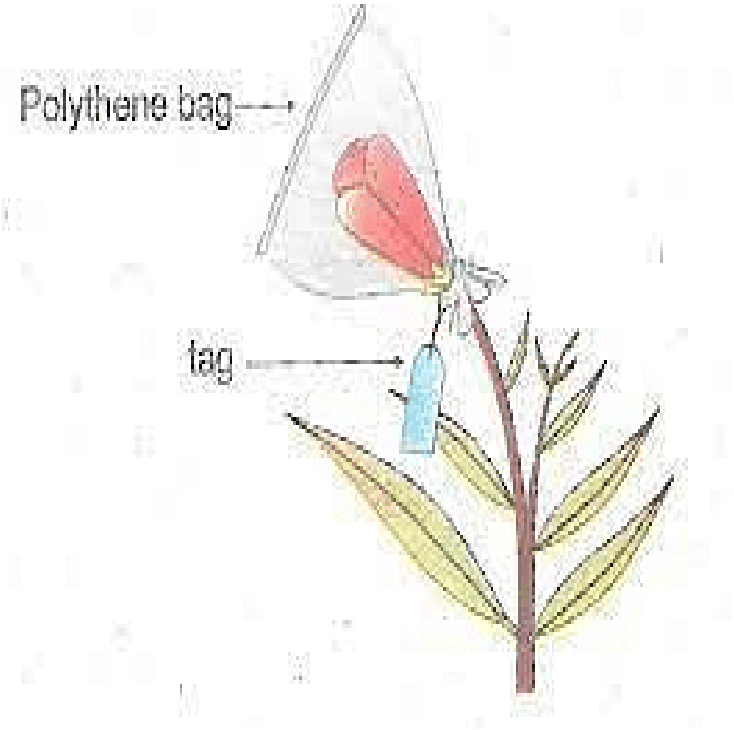


Fig. - 3 Tagging of flower bud

Precautions-

(i) Procedure should be carefully done during emasculation.
(ii) Desired characteristics of male plant should be pre-decided.

Preparation of herbarium Sheets of flowering plants

Dr. Rahul Soni
Asst.Prof. Botany

***Aim:* -** Preparation of herbarium sheets of flowering plants

***Principle:* -** Taxonomists preserve plant specimen in dry state by mounting it on a thick sheet of paper 42 × 29cm size. An Herbarium is defined as a collection of plants that usually have been dried, pressed, preserved on sheets and arranged according to any accepted system of classification for future reference and study.

***Requirement:* -** A sharp knife, blotting sheets or old newspapers, 2% formalin solution, tray, forceps, thick white card sheets cut to 41 × 29cm size, gloves, field press, rope, gum/quick fix/needle and thread.

***Procedure:* -** The preparation of a herbarium involves-

- **Field visits and specimen collection: -** A complete specimen should possess all parts including root system, flowers and fruits. Therefore, regular field visits are necessary to obtain information at every stage of growth and reproduction of a plant species. In the fields, the tools required are mainly trowel (digger) for digging roots, scissors and knife for cutting twigs, a stick with a hook for collection of parts of tall trees, a field note book, polythene bag, old newspaper and magazines. To avoid damage during transportation and preservation many replicates of the specimens should be collected. The collected specimen must be tagged with a field number and necessary information should be recorded in a field note book.
- **Pressing and drying: -** The specimens are spread out between the folds of old newspapers or blotting sheets avoiding overlapping of parts. The larger specimen may' folded in 'N' or' W' or 'V' shapes. The blotting sheets with plant specimen should be placed in the plant press for drying. After 24 to 48 hrs the press is opened.
- **Mounting: -** The dried specimens are mounted on herbarium sheets of standard size (41 x 29 cm). Mounting is done with die help of glue, adhesive or cello-tape. The bulky plant parts like dry fruits seeds, cones etc. are dried without pressing and are put in small envelops called fragment packets. Succulent plants are not mounted on herbarium sheets but are collected in 4% formalin or FAA (Formalin Acetic Alcohol).
- **Preservation: -** The mounted specimens are sprayed with fungicides like 2% solution of mercuric chloride.
- **Labelling: -** A label is pasted or printed on the lower right hand corner. The label should indicate the information about the locality, altitude, habit, date and lime of collection, name of collector, common name, complete scientific name etc.
- **Storage: -** Properly dried, pressed and identified plant specimens are placed in thin paper folds (specimen covers) which are kept together in thicker paper folders genus

overs), and finally they are incorporated into the herbarium cupboards in their proper position according to a well-known system of classification. In India Bentham and Hooker's system of classification is used for' his purpose. Type specimens are generally stored in separate and safe places.

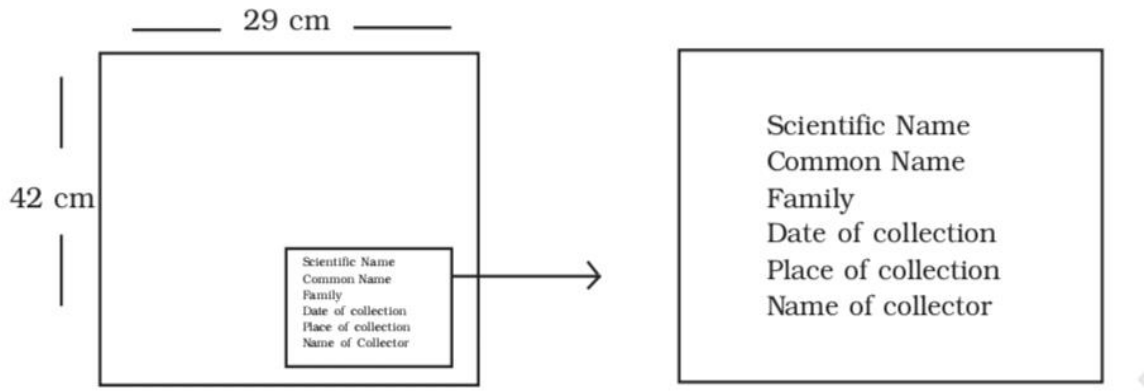


Fig. 1- herbarium sheet with labelling

Prepare the following data of the plants you have collected:

No.	Local name	Botanical name	Family	Session and place	Economic uses
1.					
2.					
3.					
4.					
5.					
6.					
7.					

Questions:

1. Write any three importance of herbarium.
2. Write a note on herbarium.

Study of homologous and analogous organs in plants

Dr. Rahul Soni
Asst. Prof. Botany

Aim: Study of homologous and analogous organs in plants.

Principle: Homologous organs are organs that have a similar structure but different functions. The homologous structures are similar anatomically because they were inherited from a common ancestor. Analogous organs are the opposite of homologous organs, which are similar in function but possess different structural properties.

***Requirement*:** Plant specimens showing tendrils, thorns, etc., as given in the text or any other locally available plants, a plant with normal stem, potato and onion bulb, prickly pear, specimens of phylloclade, cladode and wings of bird.

Observations: -

1. Homologous Organs in Plants

- **Tendrils of passion flower and thorns of pomegranate**: - Tendrils of passion fruit and thorns of pomegranate are structurally and functionally different but they have similar origin i.e. they arise from axillary bud.

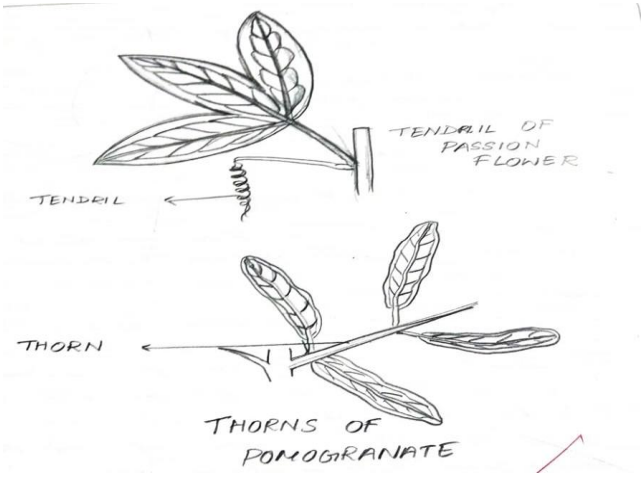
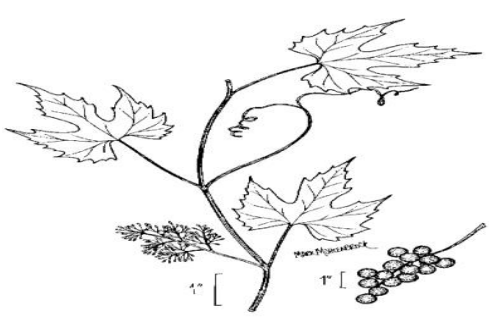


Fig. 1- Tendrils of passion flower and thorns of pomegranate

- **Tendrils of *Vitis* and thorns of *Carissa:* -** Tendrils of *Vitis* and thorns of *Carissa* originate from the terminal bud, but they are functionally different.



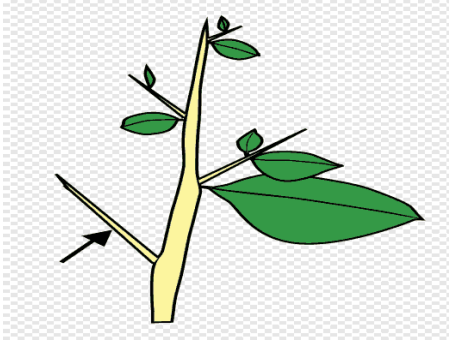


Fig. 2- Tendrils of *Vitis* and thorns of *Carissa*

- **Tendrils of balloon vine (*Cardiospermum*) and bulbils of Agave: -** Both are modifications of floral bud, but they perform different functions. Tendrils help in climbing but bulbils are meant for reproduction.

Fig. 3- Tendrils of baloon vine (*Cardiospermum*) and bulbils of Agave

- **Scale leaves of onion and spines of prickly pear (*Opuntia*): -** Both the scale leaves and spines are modifications of leaves but are structurally and functionally different. Scale leaves of onion are thick and fleshy and store food. On the other hand, spines of cactus are defensive organs.

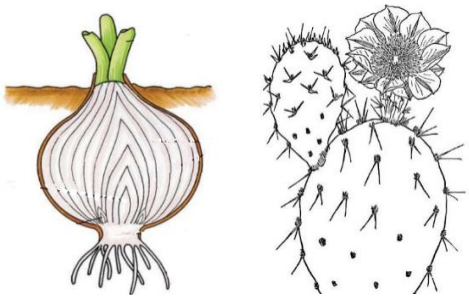


Fig. 4- Scale leaves of onion and spines of prickly pear (*Opuntia*)

2. Analogous Organs in Plants

- **Stem tendrils and leaf tendrils: -** All tendrils are analogous with one another, being structurally and functionally similar, irrespective of their origin.
  Example: Tendrils of pea and tendrils of *Vitis.* Tendrils of pea are modification of leaf and in *Vitis* it is the modification of terminal bud.

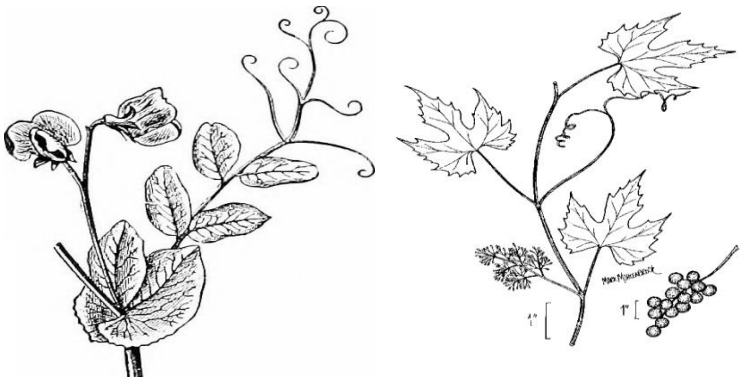


Fig. 5- Tendrils of pea and tendrils of *Vitis*

- **Thorns and spines: -** Thorns and spines are analogous structures being defensive in function. Thorns are modifications of axillary or terminal buds, and spines are modifications of leaves. e.g.: Thorns of pomegranate and spines of prickly pear.

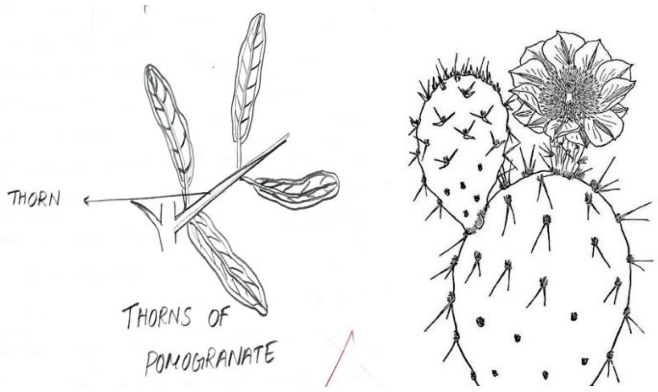


Fig. 6- Thorns of pomegranate and spines of prickly pear

- **Modified underground stems and modified roots: -** Modified stems (rhizome, corm, tuber) are analogous to modified roots (carrot, radish) as they perform similar function of storage of food but their origin is different. Rhizome of ginger, potato tuber, Colocasia are stems and beetroot, radish etc. are roots.

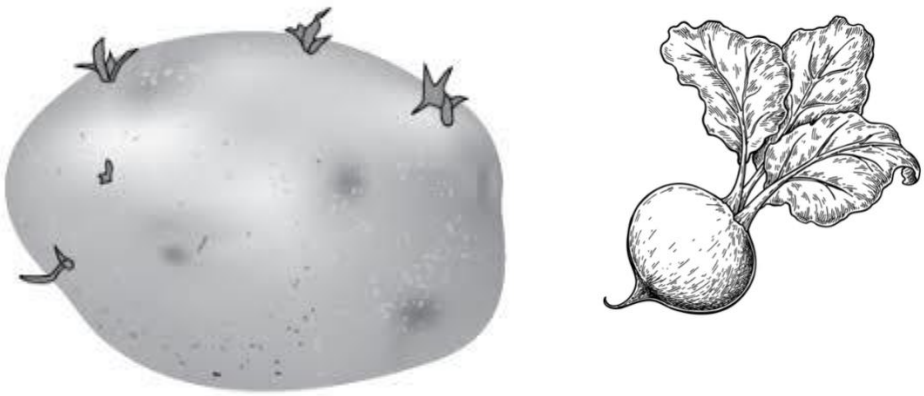


Fig. 7- Potato tuber and Beetroot

- **Phylloclade, cladode and leaves: -** They perform the same function i.e. they photosynthesise but phylloclade and cladode are modifications of stem. Phylloclade of Opuntia, Parkinsonia, Asparagus and leaves of any local plant like mango are analogous organs

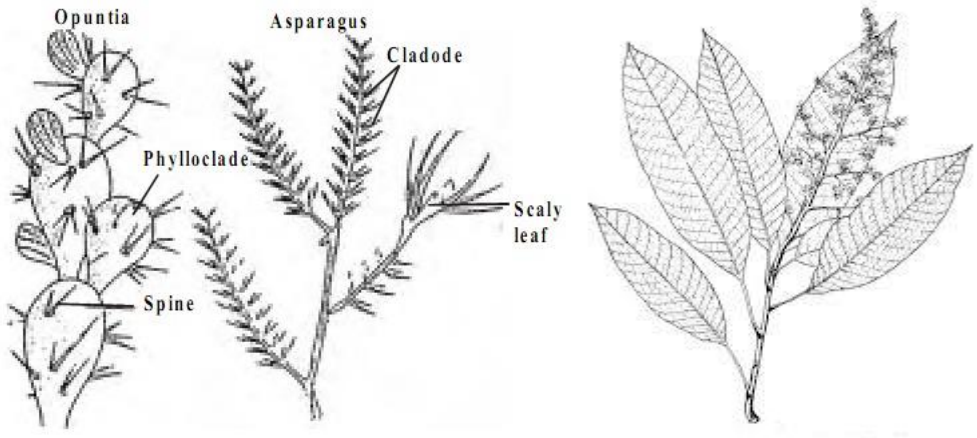


Fig. 7- Phylloclade of Opuntia, cladode of Asparagus and leaves of Mango

Modification of Root, Stem and Leaf

Dr. Rahul Soni
Asst. Prof. Botany

Aim - To study modification of root, stem and leaf.

Principle- Roots, stems, and leaves undergo modification to perform additional functions in plants. Each of these parts has separate functions to perform. The main job of the roots is to absorb and transport water. However, at special times, roots may undergo modification to store food, help in respiration and provide support. Similarly, the primary function of the stem is to produce and support lateral add-ons and conduct food and minerals. However, it gets modified to perform additional tasks like storage of food, and protection. Leaves are mainly involved in photosynthesis. Besides photosynthesis and transpiration, they can provide support to managing water loss by reducing transpiration.

Materials Required - specimen or locally available root, stem and leaf material showing modification.

Procedure - 1. Carefully observe the shape and external morphology of each specimen.
2. Draw diagrams and observe the morphological differences between the samples.

Observations-

(A) Roots modification: -

1. For storage of food-

- **Conical roots: -** Conical roots are modified into roughly cone-shaped structures. They are broad at the top and go on decreasing at the other end. Example: Carrot.
- **Fusiform roots: -** Fusiform roots are a little swollen in the middle when compared to both ends. Example: Radish.
- **Napiform roots: -** Napiform roots are swollen at the anterior end and suddenly taper to a pointy end at the posterior end. Example: Beetroot.
- **Tuberous roots**: - Tuberous root is on enlarged fleshy root modification as a storage organ with shoots produced at one end and roots produced at the other end. Tuberous roots don't have buds on them. Example: Sweet potato.

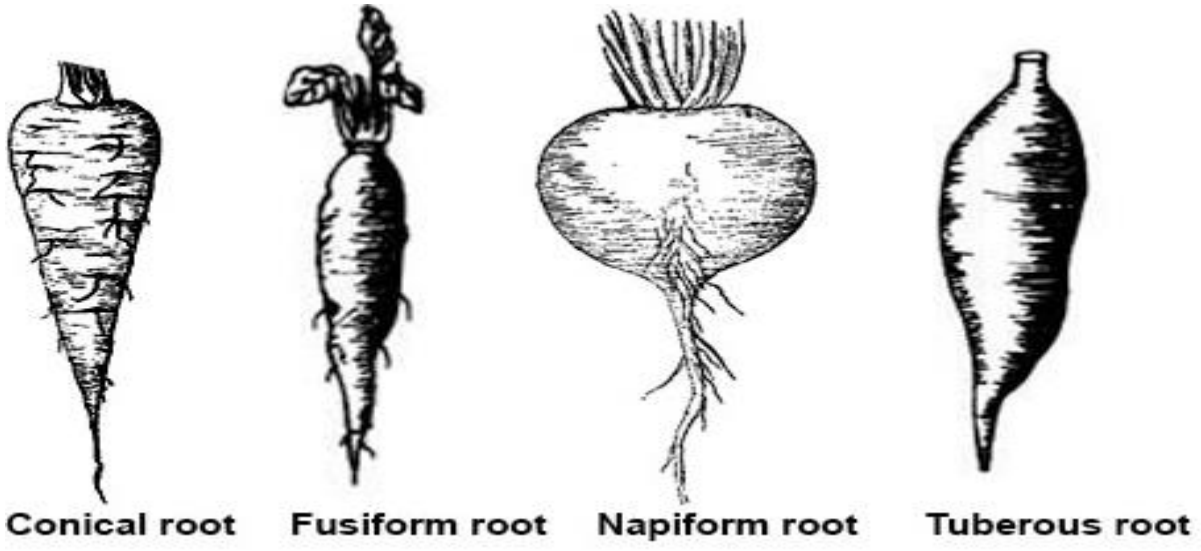


Fig. 1- Root modification for storage of food

2. For Nitrogen fixation: - Nodulated roots are knob-like structures that form on the roots of plants, especially legumes, as a result of a symbiotic association by nitrogen-fixing Rhizobium bacteria. They fix nitrogen. An active nodule is pink in color.

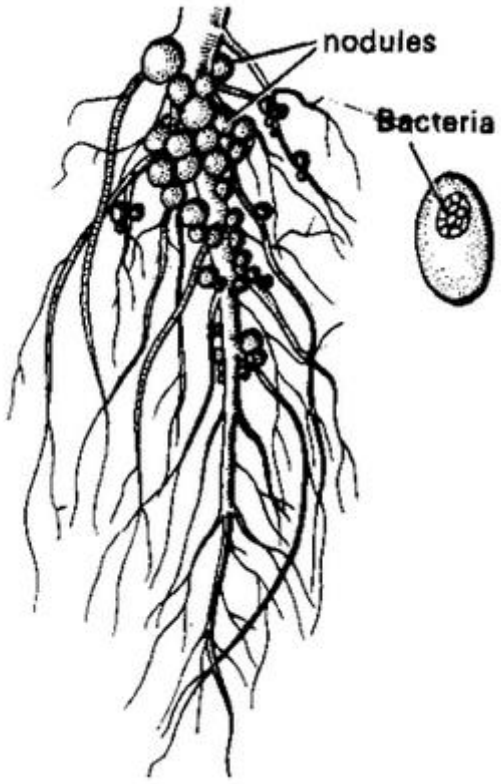


Fig. 2- Root modification for Nitrogen Fixation

3. For mechanical support: -

- **Prop root:** - Few trees develop strong roots that emerge from under their branches, grow downwards into the soil, and strengthen their enormous branches. These are called prop roots. Example: Banyan tree.

- **Stilt root**: - Some plants have also developed some roots from their base, just above the soil, and anchor the plant or the tree to the soil which is known as the Stilt roots. Example: Maize

- **Climbing root: -** Some plants don't use tendrils or twine around their support like other climbers. These plants have Climbing roots at the nodes that hold to the surface firmly, helping the climbers climb huge trees in the rainforests. Example: Araceae

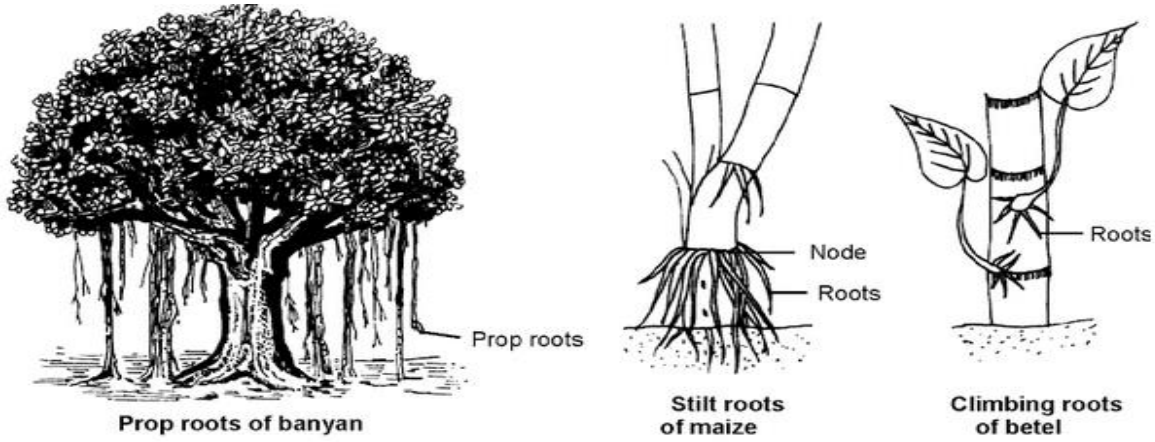


Fig. 3- Root modification for Mechenical support

4. For gaseous exchange: - Pneumatophores or breathing roots are found in plants growing in mangroves or swamps with saline water for exchange of gases. They are erect peg like structures with numerous pores through which air circulates e.g., *Rhizosphere mangle, Heritiera fomes.*

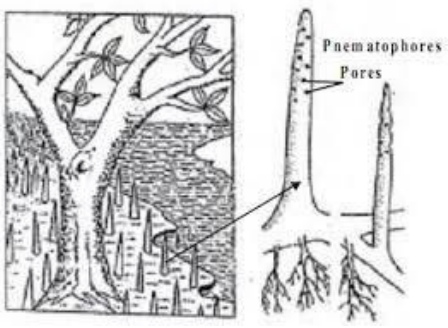


Fig. 4- Root modification for gaseous exchange

(B) Stems modification

1. Underground Stem Modification: -

- **Rhizome: -** The rhizome is a non-green, fleshy underground stem with nodes and internodes. The adventitious roots basically arise from the lower sides. Root-stock rhizome refers to the rhizome stem that grows obliquely and when they grow horizontally they are known as straggling rhizomes. Example: Ginger.

- **Bulb: -** Bulb modification is a type of modified stem that looks like a highly condensed discoid stem. Usually, there are many adventitious roots present at the base of the bulb. These bulbs can be scaly or tunicated. A dry membranous scale leaves called a tunic covers the tunicated bulb. Example: Onion

- **Corn: -** The corm is a condensed rhizome that grows in a vertical form. It has a flattening base and is almost spherical in shape. The nodes have scale leaves and axillary buds and the adventitious roots are located at the base or all over the body area. Example: Colocasia.

- **Tuber: -** Tubers are modified stems that may store starch, as seen in the potato. Tubers arise as swollen ends of stolons, and contain many adventitious or unusual buds (familiar to us as the "eyes" on potatoes). Each eye is a node and has one or more buds subtended by a leaf scar. Example: Potato

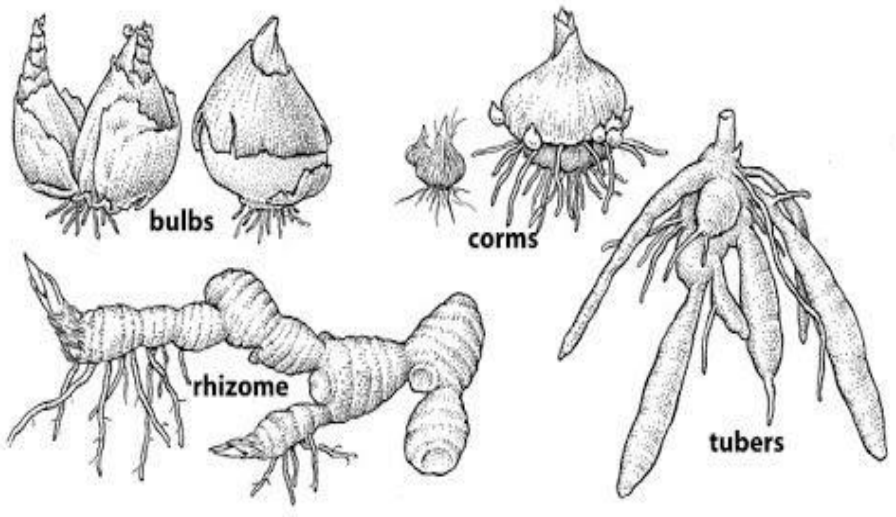


Fig. 5- Underground Stem Modification

2. Sub-aerial Modification of Stem

- **Runner: -** Runners can be defined as a type of creeping stem with long internodes that usually run horizontally on the soil surface and bear scale leaves, adventitious roots, and scale leaves. This type of steam arises from an axillary bud. Example: Wood sorrel

- **Sucker**: - Sucker stem basically rises from the basal underground part of the main stem and they grow horizontally for a distance below the soil and then grow upwards obliquely. The stem develops a leafy shoot and adventitious roots before they separate from the mother plant. Example: Pudina

- **Stolon**: - A stolon is a weak lateral stem that rises from the main stem base. After growing erect for a while it bends downwards to touch the ground. Example: Jasmine

- **Offset**: - Offset is defined as a short runner with one lone internode. The offset basically develops from a leaf axil. It, then, grows as a short horizontal branch and produces a rosette of leaves above and adventitious roots below. Example: *Pistia*

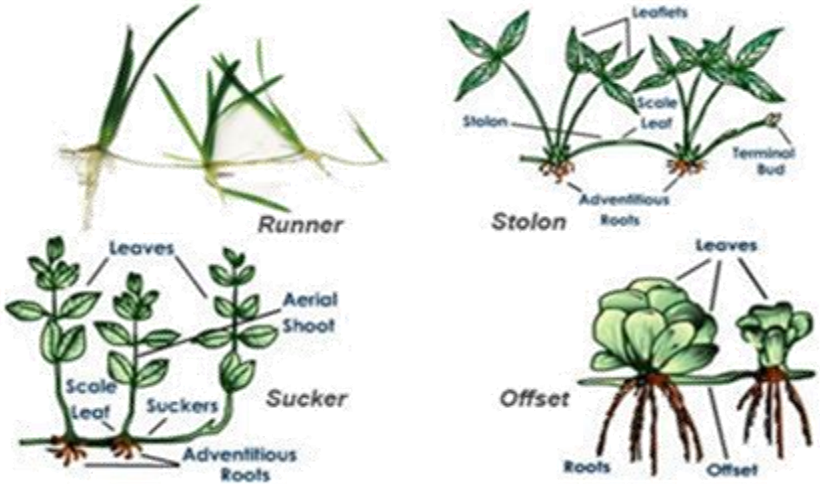


Fig. 6- Sub-aerial Modification of Stem

3. Aerial Stem Modifications

- **Tendril: -** Tendrils are the green thread-like leafless structures that are formed when the stem of the plant or the branches are modified and are used for climbing. Example: Antigonon.

- **Thorns**: - Thorns are pointed, hard, or woody structures and sometimes bear leaves and flowers. They can also be branched. Thorns are used for defense or climbing. They also regulate respiration.

- **Phylloclade's: -** Phylloclades are fleshy in nature and are flattened or cylindrical branches. The leaves transform into spines or scales and they also regulate transpiration. Example: *Euphorbia.*

- **Bulbul**: - Bulbil is modified floral or vegetative buds with stored food for the plant body. They are meant for vegetative propagation. Bulbils detach to become new plants. Example: *Dioscorea*

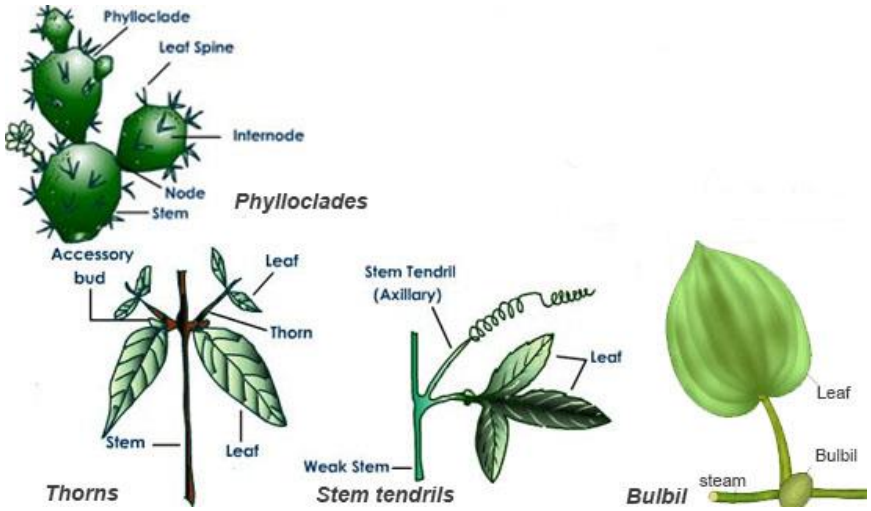


Fig. 7- Aerial Modification of Stem

(C) Leaf modification

1. **Storage Leaves: -** Some xerophytic plants and Crassulaceae plants generally have highly thickened and succulent leaves with tissues to store water. This kind of adaptation helps plants to conserve a very limited supply of water and resists drying up.

2. Leaf Tendrils: - In plants with weak stems, leaves or a part of the leaf gets modified into green thread-like structures called tendrils which help in climbing around the support. Example: Wild pea.

3. Leaf-spines: - Leaves of certain plants become wholly or partially modified for defensive purposes into sharp, pointed structures known as spines. Example: Aloe

4. Scale-leaves: - Scale leaves are typically thin, dry, stalk less, membranous structures, that are usually brownish in color or sometimes colorless. They protect the axillary bud that they bear in their axil. Example: Asparagus.

5. Leaflet Hooks: - In *Bignonia unguis cati* the three terminal leaflets of the leaf get modified into claw-like hooks which help them in climbing.

6. **Leaf Roots**: - In the case of Salvinia, three leaves are present at one node. Out of these, two leaves are normal and the third gets modified into adventitious roots which help in floating over the surface of the water.

7. Phyllode: - In a few plants, the petiole or any part of the rachis becomes flattened or winged taking the shape of the leaf and turning green in color. This winged petiole or rachis is referred to as the phyllode. Example: Australian Acacia.

8. Insect Catching Leaves: - In insectivorous plants, the leaves are specially adapted to catch and digest insects to fulfill their nitrogen requirement. Example: Venus fly trap.

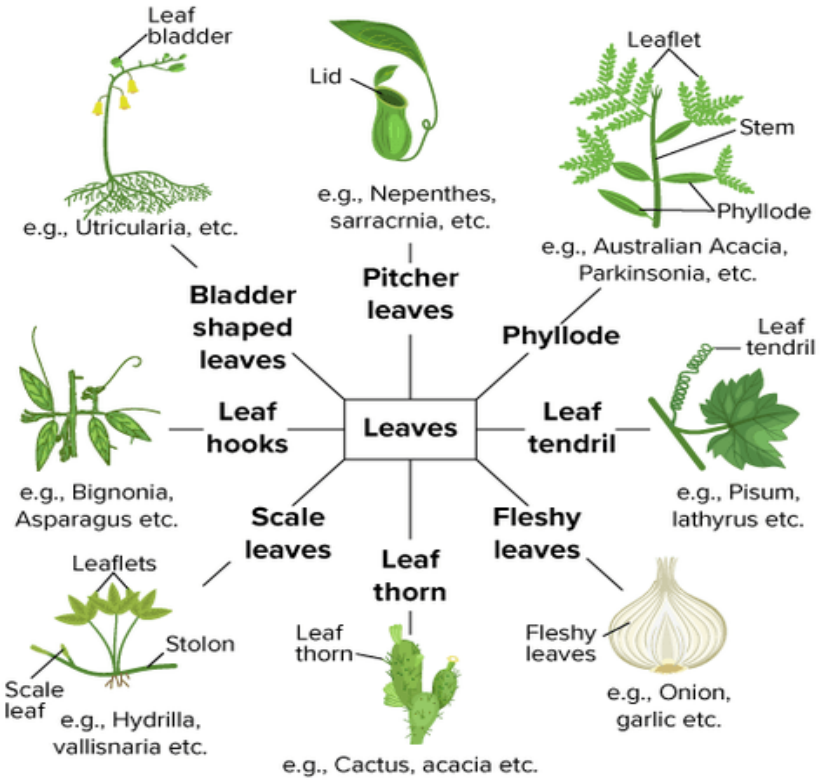


Fig. 8- Leaf Modification

Questions:

Ques. Why are stems modified?
Ques. What are modified leaves?
Ques. What is the modification of parts of plants?
Ques. Why is onion a modified stem?
Ques. Is a flower a modified leaf?
Ques. Are potatoes a root or stem?
Ques. Is carrot a modified stem?
Ques. Is garlic a root?
Ques. Is the bulb a modified leaf?
Ques. Are petals modified leaves?

Water-holding capacity of soils

Dr.Daksha M.Parmar
Asst. Prof. Botany

***Aim*:** To determine the water-holding capacity of soils

Principle: Water holding capacity of the soil is the amount of water retained in the capillary spaces of the soil after the percolation of gravitational water into the deeper layers. Water holding capacity depends upon the capillary pore spaces in the soil. Sandy soil has very low water holding capacity, whereas clayey soils have very high water holding capacity. Requirement: Soil samples from different sites (garden, road side, bank of river, paddy field etc.), Gooch crucible (china clay crucible with perforated bottom), filter-paper, pestle and mortar, petridish, beaker, glass rod, balance and blotting paper

Procedure:

(i) Dig a small pit about 10cm x 10cm x 10cm, Scoop 100–300 g of soil from the pit and collect it in a small polythene bag.
(ii) Remove the pebbles and large lumps from the soil sample.
(iii) Pass the soil through a coarse sieve to remove small lumps and dead decaying leaves and twigs.
(iv) Spread the soil into a thin layer on a sheet of blotting paper or old newspaper and sundry it for 2–3 hours or dry it in a pan kept on stove. Alternatively dry the soil sample in oven at 1080C for 1 hour.
(v) With the help of pestle and mortar grind the sample into fine powder.
(vi) Put a small disc of blotting paper at the base of the Gooch crucible. Weigh the crucible along with the blotting paper and note its weight.
(vii) Transfer the soil sample into the crucible. Tap the rim of the crucible gently several times with the help of glass rod so that soil is compactly filled and forms a uniform layer at the top. Add more soil if necessary.
(viii) Weigh the crucible along with soil sample and note its weight.
(ix) Fill the petridish with water and place two small glass rods in it parallel to and at a small distance from each other.
(x) Place the crucible on the two glass rods in such a manner that its bottom is in contact with water.
(xi) Leave the set up undisturbed till water appears at the upper surface of the soil. Wait till entire soil surface is wet.
(xii) Remove the crucible and allow all the gravitational water to flow out from the bottom. When no more water percolates, wipe the bottom dry with the blotting paper.
(xiii) Weigh the crucible and note its weight.

***Observation* :** Record your observation in the following table. Calculate the % water holding capacity of the soil as follows. Weight of crucible + blotting paper: A g Weight

of crucible + blotting paper + soil sample before experiment: B g Weight of dry soil: B - A= Cg Weight of crucible + blotting paper + wet soil sample after experiment: D g Weight of wet soil after the experiment: D - A= Eg Mass of water absorbed by soil: E - C= Ng

Sample No.	Wt. of the crucible +Blotting Paper (A)	Wt. of the crucible +Blotting Paper + Soil Sample (B)	Wt of the soil sample (B-A) =(C)	Wt. of the crucible +Blotting Paper+ Wet soil (D)	Wt. of Wet soil (D-A) = E	Amt of Water absorbed (E-C) =N	% Water holding capacity N/Cx100
A. Garden Soil							
B. Road side Soil							
C…….							
D…….							

***Discussion*:** Compare % water holding capacity of soil collected from different habitat conditions. The variation in water holding capacity is due to varying proportion of sand, silt and clay in the soil of different habitats. Soil with very high proportion of sand have very low water holding capacity due to large pore spaces between the particles which enables the water to percolate freely into deeper layers leaving upper layers practically dry. In clay soil, due to very small size of the pore spaces (fine capillaries) the water is retained in the capillary spaces as capillary water. In these soils the water does not percolate freely. Soil with more or less equal proportion of sand, silt and clay (loam soil) combines the properties of sand and clay and therefore has optimum water holding capacity and optimum soil-air for root growth.

Questions

1. What are heavy soil and light soil?
2. Give examples of a plant seen in heavy soil and light soil.
3. How does pore space determine the % water holding capacity of soil?
4. Why is clay soil often referred to as physiologically dry soil?
5. Which type of soil is suitable for cultivation of crop plants?
6. How can water-holding capacity of soil be improved?
7. Dead decomposed organic matter is usually added in the fields before the cultivation of crops. Apart from providing the mineral nutrients, what additional role does organic matter play in the cultivation of crop plants?

Understanding the concept of blood grouping

Dr. Kusum, Assistant Professor Zoology

Aim: To understand the concept of blood grouping of different ABO blood group systems and to determine our blood group type.

Skill:

Laboratory Skills: It involves the ability to work with laboratory chemicals and techniques, including the use of ABO blood group kit.

Patient Sensitivity: Ability to recognize the patient & sensitivity during the procedure, communicating effectively, and taking care of their comfort.

Technical Competence: Understanding and following the steps of the blood sample collection by piercing, use of ABO kit reagents effectively and correctly, and mixing the samples appropriately.

Mental Focus: Managing mental elements like concentration, time management, and maintaining calmness during the experiment.

Teamwork: If performed in a group, teamwork is crucial to complete the process efficiently and collaboratively.

Concept for the Experiment

There are four major blood groups and eight types collectively called the ABO blood group system. The grouping of blood types is done based on the presence or absence of specific antigens and antibodies i.e., Anti-A and Anti-B

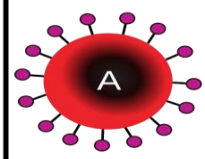
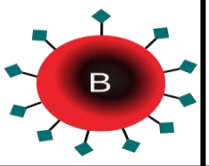
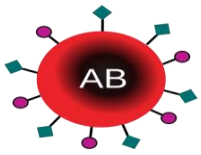
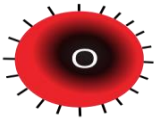
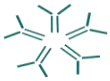
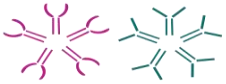
Blood groups include –

Group A – Antigen A and Antibody B

Group B – Antigen B and Antibody A

Group AB – Both Antigen A and B and no Antibody.

Group O – No Antigens and Both A and B Antibodies.

	Group A	Group B	Group AB	Group O
Red blood cell type				
Antibodies in plasma	 Anti-B	 Anti-A	None	 Anti-A and Anti-B
Antigens in red blood cell	 A antigen	 B antigen	 A and B antigens	None

Based on the presence of the third kind of Antigen, the RH factor, the above four blood groups are classified into eight different blood groups.

A positive – Presence of RH+

A negative – Presence of RH-

B positive – Presence of RH+

B negative – Presence of RH-

AB positive – Presence of RH+

AB negative – Presence of RH-

O positive – Presence of RH+

O negative – Presence of RH-

Materials required

Toothpicks

Clean glass slide

Alcohol swabs

Sterile cotton balls

Blood sample

Lancet

Biohazard disposal container

Antibodies (Anti-A, B, and D).

Principle:

Blood is the most vital fluid in human body. The loss of **blood**, during an accident or injury, can lead to a variety of conditions, and in extreme cases, it might even prove to be fatal. Hence, the knowledge about our blood groups might prove to be life-saving for a person in case of blood transfusions.

Human beings mainly have four types of blood groups: A, B, AB, and O. The system for differentiating the blood group was given by Karl Landsteiner, an Austrian biologist in the year 1901. Human blood consists of red blood cells, **white blood cells**, and **platelets** which play a vital role in the transportation and regulation of blood. The type of blood group a person has is mainly determined by the presence or absence of the antibodies and the antigens on the surface of **Erythrocytes**, also known as red blood cells.

Landsteiner's law states that if an antigen is present on a patient's red blood cell, the corresponding antibody will not be present in the patient`s **plasma** under normal conditions.

Procedure:

Take a clean glass slide and on this slide, draw three circles.

Open the monoclonal antibody kit to add antibodies in the circles drawn on the slide.

In the first circle, add Anti-A, to the second circle, put Anti-B, and in the third circle, add Anti-D using a dropper.

Put the slide containing the antibodies in a safe place without disturbing it.

After that, wipe the ring finger and gently rub near the fingertip, where the blood sample will be collected.

Wipe off the first drop of blood by pricking the fingertip with the lancet.

Gently press the fingertip and allow the blood to fall on the three circles on the slide.

Use a cotton ball to stop the blood flow if required.

Take a toothpick and mix the blood sample gently and wait for a minute to observe the result.

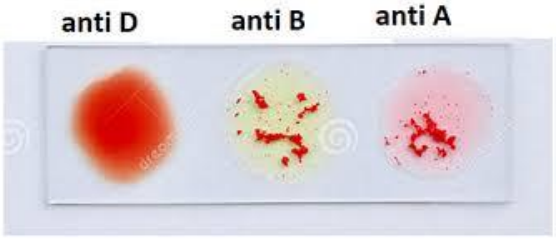
Observations

Experimental slide was observed carefully and the following result was found

A. No agglutination

B. Agglutination

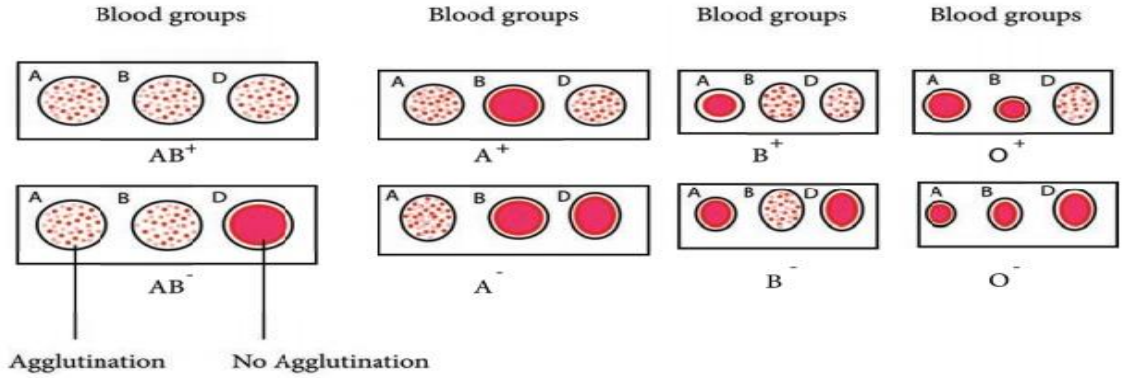
C. Agglutination



A. **B.** **C.**

Result and Discussion

The patient's blood group is AB-, as it has antigen A and antigen B. The interpretation of the result can be done easily by the given chart.



Discussion

If agglutination on A side the blood group is A.
If agglutination seen on B side the blood group is B.
If Agglutination on both A and B side the blood group is AB.
If No agglutination on A and B side the blood group is O.
If agglutination is seen on D side the blood group is Rh(D) positive.
If No agglutination on D side the blood group is Rh(D) negative.

Precautions

Hand must be wiped with 70% alcohol before starting the experiment.
Piercing must be done gently.
Cotton must be discarded carefully in the specific dustbin.
Tip of the reagent bottles must not be touched with blood samples.
After experimenting, the slides must be discarded in bleaching.

Evaluation Questions

Did you follow the correct technique during the experiment?
Did you adhere to the correct observation protocol and pay special attention?
Were there any errors or irregularities during the experiment?
Are your results the same as described in the figure, or is there any variation?
Did you analyze the results wisely and thoughtfully?

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11. Ms. Ronika V. Patel
12. Yogesh T. Kachure, Silvassa, DNH
13. Mr. Bhavesh S.Modi Banaskatha, Gujarat
14. Mr. Kusho Ram Yadav, Chattisgarh
15. Mr. Kejha Ram Nishad Chattisgarh
16. Mr. Ganga Prasad Barle Chattisgarh
17. Mr. Subodh Tiwari Chattisgarh
18. Mr. Satish Malviya Chattisgarh