केंद्रीय विद्यालय संगठन , नई दिल्ली

Kendriya Vidyalaya Sangathan, New Delhi

शिक्षा एवं प्रशिक्षण का आंचलिक संस्थान , चंडीगढ़

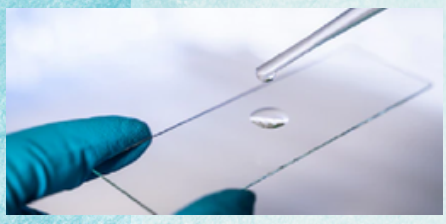
Zonal Institute of Education & Training, Chandigarh

तत् त्वं पूषन् अपावृणु
केन्द्रीय विद्यालय संगठन

PRACTICAL BOOK

CLASS- XI

BIOLOGY

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प्रस्तावना

चंडीगढ़ यह बहुत खुशी और उत्साह के साथ है कि केंद्रीय विद्यालय संगठन, शिक्षा एवं प्रशिक्षण का आंचलिक संस्थान, चंडीगढ़ शिक्षकों एवं विद्यार्थियों के लिए कक्षा 11वीं , जीव विज्ञान हेतु प्रयोगात्मक पुस्तक प्रस्तुत कर रहा है, जो उभरते शैक्षिक परिदृश्य के अनुरूप समग्र और प्रगतिशील शिक्षा प्रदान करने की हमारी प्रतिबद्धता में एक महत्वपूर्ण पड़ाव केंद्रीय विद्यालय संगठन और राष्ट्रीय शिक्षा नीति 2020 द्वारा निर्धारित दिशानिर्देशों पर दृढ़ता से ध्यान देने के साथ, यह पुस्तक न केवल व्यावहारिक कौशल को बढ़ाने बल्कि जीव विज्ञान की गहरी समझ को विकसित करने के लिए तैयार की गई है। माइक्रोस्कोप के तहत सेलुलर संरचनाओं का अध्ययन करने से लेकर पारिस्थितिक सर्वेक्षण करने तक, प्रत्येक प्रयोग को नवीनतम सी.बी.एस.ई. पाठ्यक्रम के साथ संरेखित करने और NEP 2020 में उल्लिखित प्रमुख दक्षताओं को बढ़ावा देने के लिए सोच-समझकर बनाया गया है।

के. वि. सं. और राष्ट्रीय शिक्षा नीति 2020 अनुभवात्मक शिक्षा, महत्वपूर्ण सोच और कौशल विकास के महत्व पर जोर देते हैं। यह पुस्तक इन्ही सिद्धांतों पर आधारित, जो प्रयोगों का एक संग्रह पेश करती है, जो रटने से परे है और विषय वस्तु के साथ सक्रिय जुड़ाव को प्रोत्साहित करती है। इस पुस्तक में, आपको विविध प्रकार के प्रयोग मिलेंगे जो जीव विज्ञान के प्रमुख विषयों को समाहित करते हैं।

मुझे विश्वास है कि पुस्तक न केवल बेहतर परीक्षा तैयारी की सुविधा प्रदान करेगी बल्कि वैज्ञानिक खोज के लिए जुनून भी जगाएगी।

शुभकामनाओं सहित

(**मुकेश कुमार**)
उपायुक्त एवं निदेशक
शिक्षा एवं प्रशिक्षण का आंचलिक केंद्र
चंडीगढ़

PRACTICALS
CLASS XI

Time: 03 Hours **Max. Marks: 30**

Evaluation Scheme		Marks
One Major Experiment Part A (Experiment No- 1,3,7,8)		5 Marks
One Minor Experiment Part A (Experiment No- 6,9,10,11,12,13)		4 Marks
Slide Preparation Part A (Experiment No- 2,4,5)		5 Marks
Spotting Part B		7 Marks
Practical Record + Viva Voce	(Credit to the student's work over the academic session may be given)	4 Marks
Project Record + Viva Voce		5 Marks
Total		30Marks

A: List of Experiments

1. Study and describe locally available common flowering plants, from the family Solanaceae (Poaceae, Asteraceae or Brassicaceae can be substituted in case of particular geographical location) including dissection and display of floral whorls, anther and ovary to show a number of chambers (floral formulae and floral diagrams), type of root (tap and adventitious); type of stem (herbaceous and woody); leaf (arrangement, shape, venation, simple and compound).

2. Preparation and study of T.S. of dicot and monocot roots and stems (primary).

3. Study of osmosis by potato osmometer.

4. Study of plasmolysis in epidermal peels (e.g. Rhoeo/lily leaves or flashy scale leaves of onion bulb).

5. Study of distribution of stomata on the upper and lower surfaces of leaves.

6. Comparative study of the rates of transpiration in the upper and lower surfaces of leaves.

7. Test for the presence of sugar, starch, proteins and fats in suitable plant and animal materials.

8. Separation of plant pigments through paper chromatography.

9. Study of the rate of respiration in flower buds/leaf tissue and germinating seeds.

10. Test for the presence of urea in urine.

11. Test for the presence of sugar in the urine.

12. Test for the presence of albumin in urine.

13. Test for the presence of bile salts in urine.

B. Study and Observe the following (spotting):

1. Parts of a compound microscope.

2. Specimens/slides/models and identification with reasons - Bacteria, Oscillatoria, Spirogyra, Rhizopus, mushroom, yeast, liverwort, moss, fern, pine, one monocotyledonous plant, one dicotyledonous plant and one lichen.

3. Virtual specimens/slides/models and identifying features of - Amoeba, Hydra, liver fluke, Ascaris, leech, earthworm, prawn, silkworm, honey bee, snail, starfish, shark, rohu, frog, lizard, pigeon and rabbit.

4. Mitosis in onion root tip cells and animal cells (grasshopper) from permanent slides.

5. Different types of inflorescences (cymose and racemose).

6. Human skeleton and different types of joints with the help of virtual images/models only

PART – A

1. *Study and describe locally available common flowering plants, from the family Solanaceae (Poaceae, Asteraceae or Brassicaceae can be substituted in case of particular geographical location) including dissection and display of floral whorls, anther and ovary to show a number of chambers (floral formulae and floral diagrams), type of root (tap and adventitious); type of stem (herbaceous and woody); leaf (arrangement, shape, venation, simple and compound).*

Aim: Study and describe flowering plants of families Solanaceae, Fabaceae and Liliaceae

Theory

Taxonomy deals with the identification, nomenclature and classification of organisms. Bentham and Hooker's system of classification is universally used for the classification of plants. The description of a plant can be done on the basis of morphological features and floral characters. In flowering plants (angiosperms), a flower is indeed a modified shoot. A shoot is a part of the plant that includes the stem, leaves, and any developing buds. The flower is a specialized reproductive structure that has evolved from a modified shoot. It contains all the necessary structures for sexual reproduction, including male and female reproductive organs.

Requirements

To perform the experiment locally available plant specimens of Solanaceae, Fabaceae and Liliaceae is required. Besides that the given items are also needed- glass slides, cover glass, water, 100 ml beakers, Petridish, razor, blade, needles, brush, hand lens, dissecting microscope and compound microscope.

Procedure

- Write the features like habit, root and stem morphology in the given table.
- Count the number of calyx and corolla (tri, tetra, pentamerous) and stamens.
- Cut the Longitudinal section of the flower carefully, place them on the slide and observe the following using a dissecting microscope to study.
  - Anther and Stamen
  - Carpel
  - Ovary
- Write the Floral formula and make a Floral diagram

Observation

Compare the characters with those given in the table and identify the family to which the plant belongs to-

FEATURES		**Solanaceae**	**Poaceae**	**Brassicaceae**
Habit	Herb/ shrub/ tree			
Root	Tap/ fibrous root			
Stem	Soft/ woody/ hairs (trichomes)/ Branched/ Unbranched			

Leaf	Simple/ compound, Phyllotaxy/ Venation			
Inflorescence	Cymose/ Racemose			
Flower	Unisexual/ Bisexual, actinomorphic / Zygomorphic			
Calyx	Number of sepals / free/ united, aestivation			
Corolla	Number of petals / free/ united, aestivation			
Androecium	Number of stamens, Monadelphous/diadelphous/ polyadelphous			
Gynoecium	Number of carpels, apocarpous/ syncarpous, hypogynous/ epigynous / Perigynous ovary			
Placentation	Marginal/ axile/ parietal/ free central /basal			
Fruit	Type			
Floral formulae				

Floral Diagram

2. Aim: Preparation and study of T.S. (Transverse Section) of dicot and monocot roots and stems

Theory

Anatomy is the study of internal morphology. The plant consists of various tissues like simple tissue (parenchyma, collenchyma and sclerenchyma) and complex tissues (xylem and phloem). The tissues may be temporary (meristematic) or permanent (sclerenchyma, parenchyma, collenchyma). These tissues form different layers in the composition of stems and roots.

Requirements:

Samples of stem and root of monocotyledon and dicotyledons, stain (safranin), water, glycerine, watch glass, slide, cover slip, brush, razor, blotting paper, compound microscope.

Procedure:

- Take a sample of stem/ root.
- Carefully make a T.S. of the sample material with the help of a blade/ razor.
- Transfer the thin and uniform sections into a watch glass containing water.
- Stain the sections using safranine. Excess stains should be washed properly. By using water / dilute acid water.
- Transfer the properly stained section to the glass slide with the help of a brush.
- Transfer the section onto a clean slide containing 1 drop of glycerine.
- Place a cover slip over it avoiding air bubbles and finally, observe under the compound microscope.
- Write your observations in the following table-

Observation

Feature		**Stem**		**Root**	
		Dicot	**Monocot**	**Dicot**	**Monocot**
Cuticle	Present/ Absent				
Epidermis	Layers/ cells				
Hypodermis	Present/ Absent				
Stomata	Present/ Absent				
Cortex	Layers/ cells				
Root hairs	Unicellular / Multicellular				
Pericycle	Layers				
Vascular bundle	Open/ Close Radial/ Conjoint/ Collateral				
Xylem	Centripetal/ Centrifugal Endarch/ exarch				

Phloem	Numbers				
Caspaerian strip	Present/ Absent				
Pith	Present/ Absent				

Diagrams

Aim: Study of osmosis by potato osmometer

Theory

An osmometer is a device used to measure osmotic pressure or osmolarity in a solution. In osmosis, the solvent molecules flow via a semi-permeable membrane from an area of higher concentration to an area of lower concentration through a semipermeable membrane cell membrane). Osmosis occurs due to the difference in free energy of the solvent molecule in two regions. Pure water (solvent) has more free energy compared to the water in a solution. Therefore, during osmosis, water (solvent) moves through the semipermeable membrane from a region of its high free energy to a region of its low free energy. Osmosis helps in the distribution of nutrients and in the release of waste products.

There are two types of osmosis: Endosmosis and Exosmosis.

- Exosmosis: Solvent molecules start moving outside the cell.
- Endosmosis: Solvent molecules start moving inside the cell.

Types of Solutions

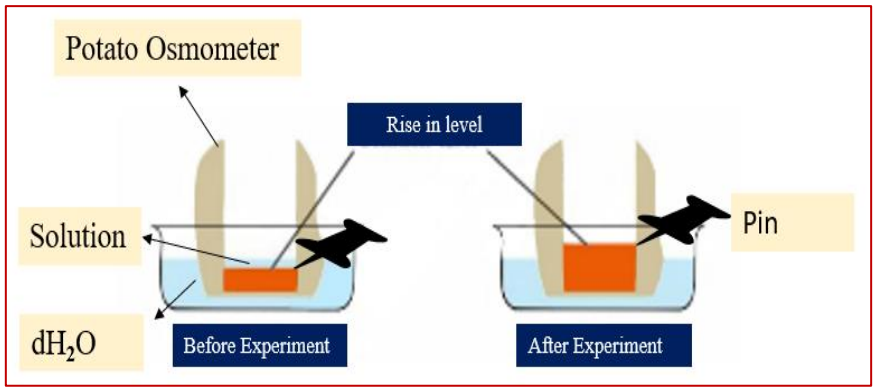
Hypotonic Solution	These are solutions with low solute levels
Hypertonic Solution	Solutions with high solute levels are known as hypertonic.
Isotonic Solution	If both solutions have the same amount of solute concentration they are then known as isotonic solutions.

Requirements

Large potato, Petridish, 20 % sugar solution, Alpins, knife, distilled water

Procedure

- Peel the potato using a knife and make a cavity carefully as shown in the diagram. This is our osmometer.
- The sides and bottoms should be flat and not very thick.
- Pour d.H_2O into the Petri dish until it is half full. Then place the potato in the Petri dish.
- Fill half the cavity made in the potato with 20% sugar solution. Mark the level of sugar solution in the cavity using a pin.
- Leave the osmometer undisturbed for about two hours.
- Observe you reading after two hours.
- Mark the rise in the level of the sugar solution in the cavity with another pin.



Observation

Perform the experiment with different situations like hypertonic, hypotonic and isotonic solutions and record your observations.

Experiment	Solution	Water level Rise/ drop/ no change	Process Endosmosis / exosmosis / no change
1	Hypertonic		
2	Hypotonic		
3	Isotonic		

Conclusion

Occurrence of Osmosis in Different Solution Types

Hypotonic Solution	If we place living cells in a hypotonic solution the water moves into the cell because of the higher concentration of water than in the cell. **(Endosmosis)**
Hypertonic Solution	If we place living cells in a hypertonic solution the water moves out of the cell because of the lower concentration of water in the cell. (**Exosmosis**)
Isotonic Solution	If we place living cells in an isotonic solution, it won't show any change because of the equal concentration of water on either side.

Aim: Study of plasmolysis in epidermal peels (e.g., Rhoeo/lily leaves or flashy scale leaves of onion bulb)

Theory

Plasmolysis is the process of shrinkage or contraction of the protoplasm of a plant cell as a result of loss of water from the cell. Through the semi-permeable cell membrane movement of water molecules takes place.

When a plant cell is placed in a hypertonic solution, exosmosis takes place i.e. water from the cell sap moves outside. Due to this, the protoplasm separates from the cell. This is known as plasmolysis.

When a plasmolyzed cell is placed in a hypotonic solution, endosmosis takes place i.e. water enters into the cell. The cell swells to become turgid. It is called deplasmolysis.

If a living cell is placed in an isotonic solution the water moves in and out of the cell and is in equilibrium.

Requirements

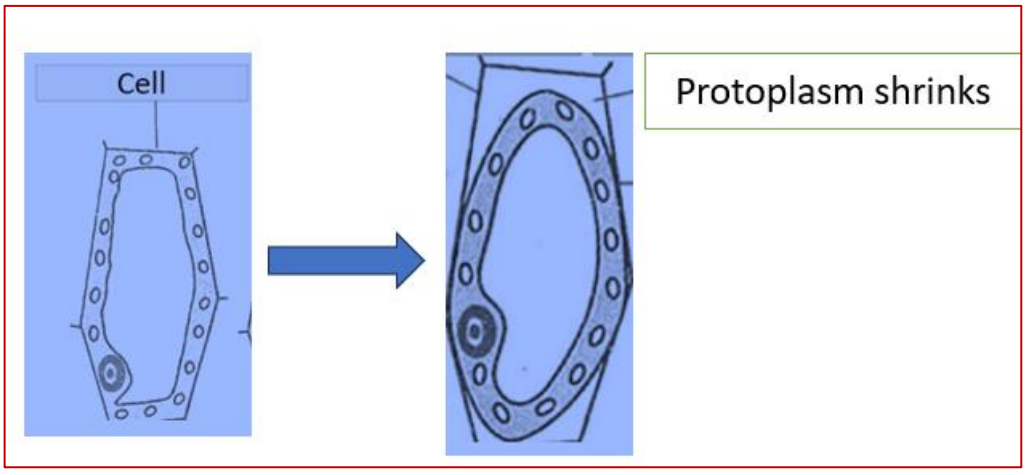
Rhoeo leaf, glass slide, coverslip, sodium chloride solution (5%), sodium chloride solution (0.1 %), compound microscope, forceps, dropper, needle

Procedure

- Tear the Rhoeo leaf along the lower side of the leaf.
- Using forceps, pull out two small segments of the thin transparent layer from the lower epidermis of the Rhoeo leaf.
- Place them on separate glass slides.
- Slide 1- Put 1 to 2 drops of sodium chloride in 0.1% solution
- Slide 2- Put 1 to 2 drops of sodium chloride 5 % solution
- Place a cover slip over the peel of both slides using a needle.
- Observe both slides under the compound microscope.

Observation

After half an hour we can observe that cells in sodium chloride 0.1% solution appear turgid, while cells in the sodium chloride 5 % solution show plasmolysis.



Slide	Solution	Plasmolysis (Yes/ No)	Conclusion
1	0.1 % NaCl		
2	5 % NaCl		

Endosmosis (water moves into the cell because of the higher concentration of water outside the cell than inside the cell). The cell then swells and becomes turgid.
Exosmosis (water moves out of the cell and the protoplasm causes shrinkage and assumes a spherical shape.

Aim: Study of distribution of stomata on the upper and lower surfaces of leaves

Theory

Stomata are microscopic pores mostly found on the epidermis of leaves. The stomata help in the transpiration process, gaseous exchange and water transport within the tissues. A stomate opens and closes in response to the internal pressure of two sausage-shaped guard cells that surround it. The inner wall of a guard cell is thicker than the outer wall. In dicot, the lower surface of the leaf has more stomata than the upper surface. In monocots, they are usually the same in number. In most of the floating plants, stomata are found only on the upper epidermis.

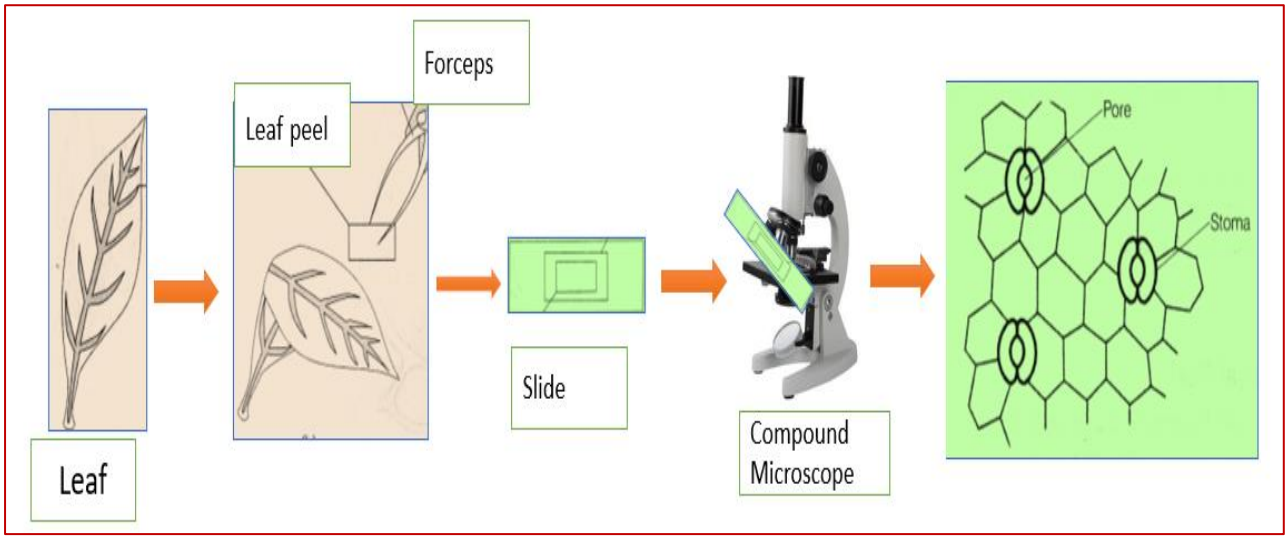
Requirement

Potted plant, safranine, forceps, needle, watch glass, slide, cover slip, brush, blade, glycerine, compound microscope

Procedure

- Take clean distilled water in the watch glasses.
- Take the peel from both the upper surface and lower surface of the leaf using the forceps.
- Place the peels in two separate watch glasses containing water.
  Watch glass I- for peel from the upper surface of the leaf
  Watch glass II- for the peel of the lower surface of the leaf
- Stain the peel of both watch glasses and after staining place them to the glass slide.
- Take a blade and cut a small rectangle or square piece from each peel.
- Take some glycerine using a dropper and put one drop of glycerine on both slides.
- Take a cover slip and place it gently on the peel with the help of a needle.
- Observe the glass slide containing stained peel under a compound microscope.
- Count the number of stomata in the peels of both the upper and lower epidermis of the leaf appearing in the microscopic field.

Observation



Watch glass	No of epidermal cell	No of stomata	Stomatal index
1			
2			

$$\text{Stomatal index} = \frac{\text{No: of Stomata}}{\text{No: of Stomata + No: of epidermal cells}} \times 100$$

Aim: Comparative study of the transpiration rates in the upper and lower surfaces of leaves.

Theory

Transpiration is the process of water movement through a plant and its evaporation from aerial parts, such as leaves, stems and flowers. The stomata perform transpiration as well as gaseous exchange. Transpiration is the biological process of removal of excess water from the aerial parts of the plants. In different plants, distribution, number, size and type of stomata vary. Various environmental factors affect the transpiration like- light, temperature, humidity and wind. Transpiration helps in the absorption of water from the soil. Transpiration helps to cool down the plant surface during evaporation.

Requirement

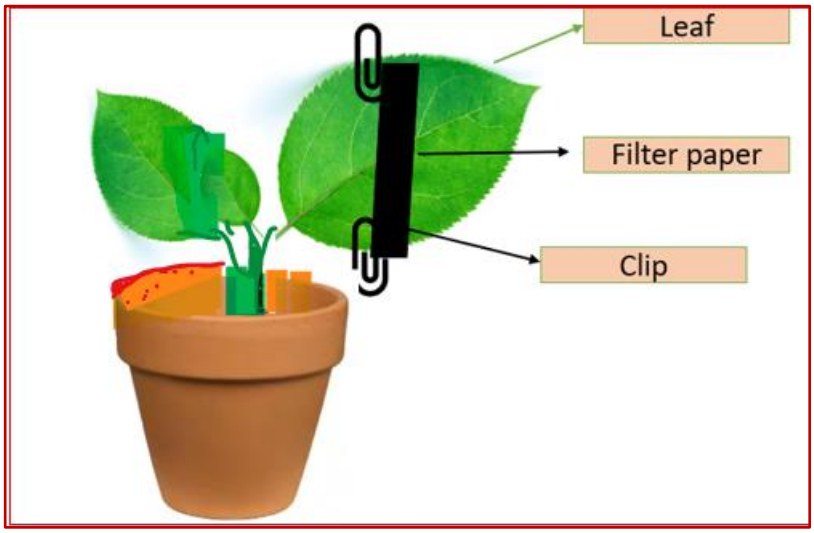
A potted plant, Forceps, Filter paper strips, Wire gauze, 3% cobalt chloride solution, Petri Dish, Binder clips, Glass Slide

Procedure

- Dip some filter paper strips into a 3 % cobalt chloride solution for 3-5 minutes. The filter papers become **pink** in colour when wet.
- Remove the strips using forceps and leave these to dry. After drying the filter paper becomes **blue** in colour.
- Clean a healthy leaf and clean both surfaces.
- Take the dry pieces of cobalt chloride paper from the wire gauze.
- Place the dried strips of cobalt chloride paper:
  a- one on the upper surface of a leaf of the potted plant.
  b- other on the lower surface of a leaf of the potted plant.
- Take two glass slides and place one over the upper and the other over the lower side of the leaf.
- Clip the slides together using binder clips.
- Note the time taken by the cobalt chloride paper to change its **blue** colour to **pink**.

Observation

The time taken to change the colour of the cobalt chloride paper from blue to pink on the lower leaf surface is less than the upper surface.



Leaf surface	Time taken (change in colour from blue to pink)
Upper	
Lower	

Conclusion

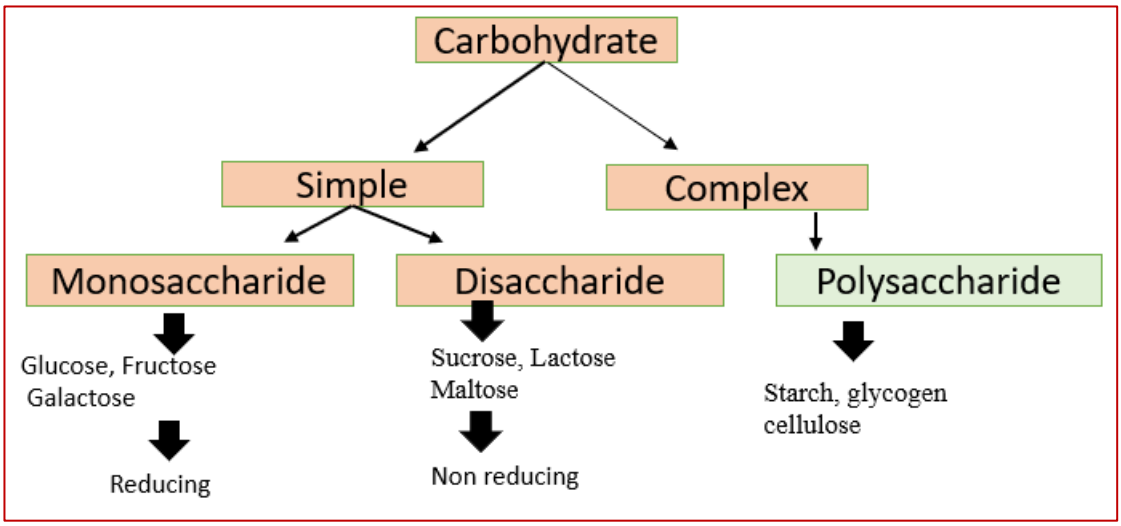
The quick change in the colour of cobalt chloride paper on the lower surfaces indicates a higher rate of loss of water vapour from this surface than the upper one

Aim: Test for the presence of sugar, starch, proteins and fats in suitable plant and animal materials

Theory

Sugar, fat, protein and starches are the main nutrients that we require for energy, growth, development etc. Food consists of both organic and inorganic substances. These are the main types of macronutrients in food (nutrients that are required daily in large quantities). Carbohydrates are Broken down into glucose, used to supply energy to cells. Extra is stored in the liver. Proteins are Broken down into amino acids, used to build muscle and to make other proteins that are essential for the body to function. Fats are Broken down into fatty acids to make cell linings and hormones. Extra is stored in fat cells.

Carbohydrates- They are composed of sugar molecules that contain carbon, hydrogen and oxygen.



Monosaccharides- These are the simplest carbohydrates. Monosaccharides can reduce cupric (Cu^{2+}) ions into cuprous (Cu^{+}) ions due to the presence of free aldehydic and ketonic groups and give positive results in Benedict's test and Fehling's test. These reduce the cupric ion present in Benedict's and Fehling's solution and form a precipitate of cuprous oxide. Depending upon the concentration of sugar, green, orange or brick red precipitates are obtained.

Disaccharides – These are composed of two monosaccharide units. When it is boiled with HCl, sucrose undergoes hydrolysis to form glucose and fructose, which gives positive results with Benedict's and Fehling's solutions.

Polysaccharides- These are made up of many monosaccharide units. Starch gives a blue-black complex with iodine.

Proteins are polypeptides in which amino acids are joined by peptide bonds. Amino acids consist of both the amino (-NH_2) group and the carboxylic group (-COOH).
The biuret test is a method used for the detection of peptide bonds in a protein molecule. In the **Biuret test**, the nitrogen atoms in the peptide chain react with copper ions in the reagent to form a violet-coloured complex.

Xanthoproteic test is used for the identification of proteins containing aromatic amino acid units. By heating with nitric acid, the benzene ring in the amino acid unit is nitrated and forms a yellow coloured compound which turns to orange colour with alkali.

Fats are made up of fatty acids and glycerol. Fats contain carbon, hydrogen and sometimes oxygen. Phosphorous, nitrogen and sulphur are also present in some fats. They are insoluble in water, but soluble in non-polar like chloroform and benzene. They are found stored in many oil seeds and some animal tissues. They produce translucent spots on paper due to the diffraction of light. They also give a pink colour with azo dye, Sudan III.

Requirement

Benedict's reagent, Fehling's solution A, Con HNO3, Ammonia solution, con HCl, CuSO4, NaOH, Million's reagent, Iodine solution, Sudan III soln, Oil dropper, test tube, burner/ spirit lamp, dropper, test tube holder, potato extract, egg albumin, Banana extract

Procedure

	Test for	Main requirement	Methodology	Observation
A	Glucose	**Benedict's reagent** Banana extract	Take a small quantity of Benedict's reagent and add this to the test tube containing banana extract. Boil the test tube for 2 minutes. Keep shaking the test tube as it is being heated.	Brick red precipitate
B		Fehling's Test (Fehling's soln. A and B) Banana extract	Add a small quantity of Fehling's solution 'A' to the test tube containing the banana extract. Add Fehling's solution B to the test tube containing the banana extract. Boil the sample for 2 minutes.	Brick red precipitate
C	Sucrose	Cnc HCl, Benedict's reagent, sugarcane extract	Add 2/ 3 drops of conc. HCl to the test tube containing sugarcane extract. Boil the sample for 2 minutes. (This hydrolyses sucrose into glucose and fructose). Now add a few drops of NaOH soln in the test tube (make the solution alkaline). Finally, add a small quantity of Benedict's reagent to the test tube and boil for 2 minutes,	The colour changes from blue to green and finally to orange or brick red
D	Starch	Potato extract Iodine solution	Add 5 drops of iodine solution to the test tube containing potato extract.	Blue-black colour
E	Protein	40% NaOH 1% CuSO4 egg albumin	Add a few drops of 40 % NaOH solution to the test tube containing egg albumin.	Violet colour

			In this test tube add 2-3 drops of 1 % CuSO4 solution. Shake the solution to mix it well.	
F		con. HNO3 Ammonia solution Egg albumin (Xanthoproteic Test)	Add 5 drops of Concentrated HNO3 to the test tube containing egg albumin. Boil the sample for 2 minutes. Yellow precipitate appears in the test tube. Add a few drops of ammonia solution to the sample. Shake the solution to mix it well.	Yellow ppt. changes to orange
G		Million's regent egg albumin	Add few drops of Million's reagent to the test tube containing egg albumin. Wait for some time.	Pink colour
H	Fat	Sudan III reagent Oil	Add few drops of Sudan III reagent to the test tube containing oil. Shake the solution to mix it well.	Pink colour
I		Peanut seed White paper	Crush the peanut seed and rub it on a piece of white paper.	Translucent spot

A- On boiling banana extract with Benedict's reagent, the cupric ion present in Benedict's reagent is reduced by the reducing agent, sugar, to form a brick-red coloured precipitate of cuprous oxide.

B- The cupric ion present in Fehling's solution is reduced on boiling by the reducing substance, sugar, to form the brick-red coloured precipitate of cuprous oxide

Aim: Separation of plant pigments through paper chromatography

Theory

The main pigments in plants are chlorophyll a (dark green), chlorophyll b (yellowish-green), xanthophylls (yellow) and carotenoids (orange). The chromatography technique is used to separate plant pigments on the basis of differences in solubility and adsorption properties. This technique involves the interaction between three components: the mixture to be separated, a solid phase and a solvent.

In paper chromatography, the mixture containing plant pigments is spotted onto the paper, dried and the solvent is allowed to flow along the sheet by capillary attraction. As the solvent slowly moves through the paper, different pigments separate into different coloured spots.

Requirement

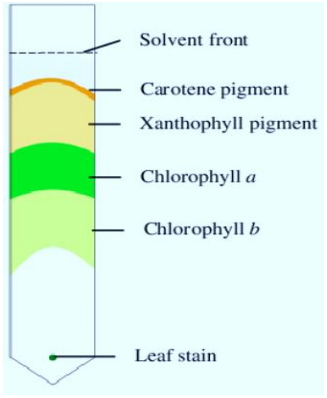
Pestle mortar, Plant material like spinach leaves, chromatographic chamber, Scissors, Whatman filter paper, Ether acetone solvent, acetone, capillary tube, pencil, spatula, watch glass, measuring cylinder, thread. etc

Procedure

- Take fresh spinach leaves and cut into small pieces. Mix these pieces with 5ml of acetone in the mortar and grind it. After grinding collect the pigment extract.
- Take a strip of filter paper having a narrow notch and at one end of the strip mark a horizontal line with a pencil about 2-3 cm away from the tip of the notch.
- Put a drop of the extract in the middle of the line with the help of a capillary tube. Dry it till four or five drops are placed on the paper.
- Take the chromatographic chamber and pour ether acetone solvent into it.
- Using a thread, hang the filter paper strip in the chromatographic chamber.
- The loading spot should remain about 1 cm above the solvent level.
- Leave the chromatographic chamber undisturbed for some time.

Observation

The dried chromatographic paper strip shows four distinct paper bands. Different pigments can be identified by their colours.



Result

Band	Pigment
Orange yellow band	Carotene
Yellowish band	Xanthophylls
Dark green band	Chlorophyll a
Yellowish green	Chlorophyll b

Aim: Study of the rate of respiration in flower buds/leaf tissue and germinating seeds.

Theory

Respiration is a catabolic process in which simple food components break down into simpler substances and release CO2 and energy. Carbohydrates, fats, and proteins are respiratory substrates. Carbohydrates are the primary substrate for respiration. The rate of respiration can be measured in terms of respiratory quotient (RQ). The RQ is the ratio of CO_2 produced to that of the O_2 consumed during respiration.

RQ = Volume of CO_2 evolved / Volume of O_2 evolved

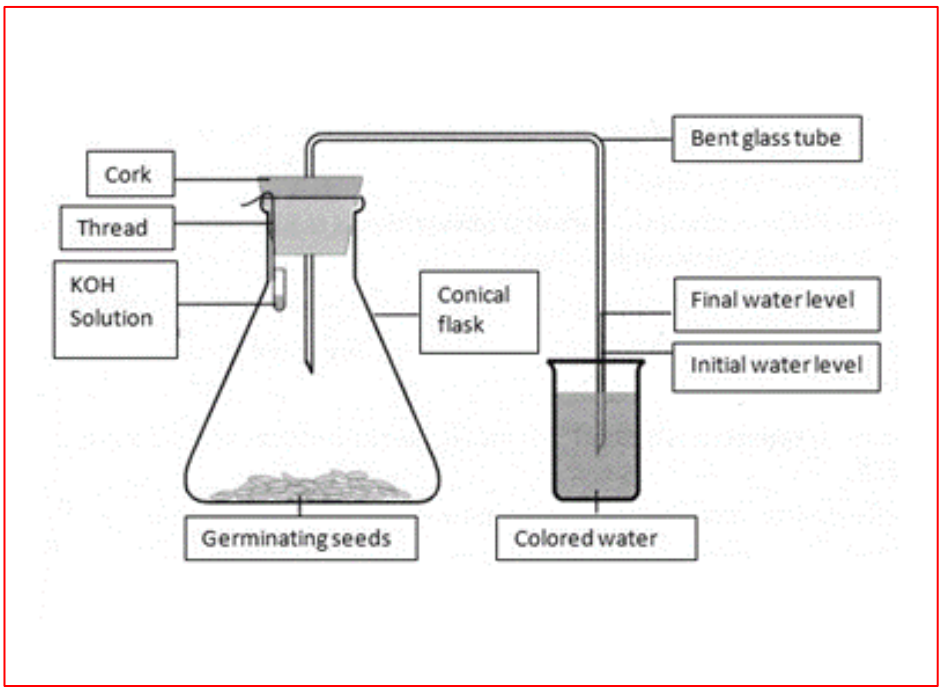
Respiration in plants can be studied in moist germinating seeds that release CO_2 during respiration. The seeds are kept in an air-tight conical flask. A small test tube containing KOH solution is placed in the flask. KOH absorbs the CO_2 released by the seeds and a partial vacuum is created in the flask as a result. This causes the water level in the delivery tube to rise. Thus, the rise in water level at the end of the delivery tube dipping in the beaker proves that germinating seeds release carbon dioxide during respiration.

Requirement

Geminating seed of wheat, KOH, test tube, cork with hole, distilled water, measuring cylinder, conical flask, bent glass tube etc.

Procedure

- Place about 30 germinating wheat seeds in a conical flask.
- Pour 4 ml of KOH solution into a small test tube.
- Tie a cotton thread around the neck of the test tube. Suspend the test tube in the conical flask above the germinating seeds.
- Close the mouth of the conical flask with a cork.
- Insert one end of a delivery tube into the conical flask through the cork and dip the other in a beaker containing water.



- Observe the position of the water level in the delivery tube. This is the initial reading of the water level in the delivery tube.
- Apply the petroleum jelly on the cork to make the apparatus airtight. Keep the apparatus undisturbed for two hours.
- Repeat the same procedure for the groundnut and wheat.

Observation

After two hours, you will see that the level of water has risen in the delivery tube at the end dipped in the beaker of water.

Conclusion

- The rise in water level at the end of the delivery tube dipped in the beaker proves that germinating seeds release carbon dioxide during respiration.
- In the case of groundnut and bean seeds, the rise in water level is relatively lesser because these seeds use fat and proteins as respiratory substrates and release a very small amount of carbon dioxide.
- But in the case of wheat grains, the rise in water level is greater because they use carbohydrates as respiratory substrate.
- When carbohydrates are used as a substrate, equal amounts of carbon dioxide and oxygen are evolved and consumed.

Aim: Test for the presence of urea in urine.

Theory

Urine is a liquid by-product of metabolism in humans and in many other animals. Urine flows from the kidneys through the ureters to the urinary bladder. Urine is produced when blood is filtered by the kidney. In humans the main excretory product is urea. Urine consists of water, urea, uric acid, trace amounts of enzymes, carbohydrates and hormones. Urea is naturally produced during the process of breakdown of proteins. The amino groups are removed from the amino acid present in the proteins and converted to NH3. The liver produces several chemicals (enzymes) that change ammonia into a form called urea. The urea passes to the kidneys and is finally excreted from the body through the urine. A healthy adult person normally excretes about 15g of nitrogen per day. Among this, about 95% of this nitrogen is excreted as urea through urine.

Requirement

Urine sample, test tube, dropper, measuring cylinder, sodium hypobromite solution etc. 2% Na_2CO_3, 1 % acetic acid, phenol red indicator, urease powder, spatula etc.

Procedure and observation

S.N.	TEST	METHOD	RESULT
1	Sodium hypobromite Test	Take a 2 ml urine sample into the test tube. Add a few drops of sodium hypobromite solution to the urine sample.	The brisk effervescence of nitrogen
2	Urease Test	Take a 5 ml urine sample into a test tube. Add 4-5 drops of phenol red indicator. Add 2 % Na2CO3 solution drop by drop until a pink colour develops in the test tube. Add 1% acetic acid to the test tube drop by drop until the pink colour disappears. Add urease powder to the test tube and shake it well.	pink or red colour

Aim: Test for the presence of sugar in the urine.

Theory

Urine consists of about 95-96% water, urea, uric acid, creatine etc. The pH of urine ranges between 4.6-8. The main inorganic constituents of urine are NaCl, KCl, sulphates and phosphates. Ordinarily, glucose (sugar) is absent in normal urine. But when the glucose level in the blood exceeds the renal threshold of glucose (160 – 180 mg /dl), glucose starts to appear in the urine. The presence of glucose in the urine is called glucosuria and is usually an indication of diabetes mellitus.

Requirement

Test-tube, test-tube holder, urine sample, measuring cylinders, Benedict's solution and burner, Fehling's solution A, Fehling's solution B

Procedure and Observation

S.N.	TEST	METHOD	RESULT
1	Benedict's Test	Take a 2 ml urine sample in a test tube and add 5 ml Benedict's reagent in it. Heat the test tube for 2 minutes and keep shaking the test tube while heating.	Yellow/ green/ red precipitate
2	Fehling's test	Take 2 ml urine sample in a test tube and add 2 ml Fehling's solution A and then 2 ml Fehling's solution B. Heat the test tube for 2 minutes and keep shaking the test tube while heating.	Gellow/ yellow/ red precipitate

Aim: Test for presence of albumin in urine.

Theory

Albumin is a protein produced by the liver. It is the most abundant circulating protein found in plasma. Its main functions are the ability to maintain intravascular oncotic pressure, meaning it keeps the fluid pressure stable within the blood vessels. It is also a carrier protein for steroids, fatty acids, and thyroid hormones in the blood. A healthy kidney does not let albumin pass into the urine. Albumin is synthesized by liver hepatocytes and rapidly excreted into the bloodstream at the rate of about 10/ 15 gm per day. In albuminuria, the level of albumin found in urine will be above the normal level. Albuminuria is an indication of kidney damage.

Requirement

Urine sample, Test-tube, test-tube holder, urine sample, measuring cylinders, Benedict's solution and burner, 30 % sulphosalicylic acid, Conc. HNO_3.

Procedure and Observation

S.N.	TEST	METHOD	RESULT
1	Sulphosalicylic Acid Test	Take a 2 ml urine sample in a test tube and pour the urine into the test tube. Add a few drops of sulphosalicylic acid to the test tube. Heat the test tube gently.	whitish or cloudy turbid solution
2	Heller's Test	Take 5 ml con. HNO3 in a test tube. Add a sample of urine by means of a dropper along the inner side of the test tube so that it forms a layer over the nitric acid.	White ring at the junction of two layers

Aim: Test for the presence of bile salts in urine.

Theory

Bile salts are one of the primary components of bile. Bile is a greenish-yellow fluid made by your liver and stored in the gallbladder. Bile contains water and organic molecules such as cholesterol, bile acids, and bilirubin. In humans, the two main functions of bile are digestion and absorption of fats and elimination of bile salts from the body by secretion into bile. Bile salts help with the digestion of fats. They also help the body absorb fat-soluble vitamins, like vitamins A, D, E, and K.

Adult humans produce around 400 to 800 ml of bile daily. The formation of bile salts starts with the breakdown of RBCs. The macrophages break down haemoglobin in the RBCs and remove iron from the heme component. The iron-free portion of heme is converted to biliverdin (green pigment), and then into bilirubin (yellow-orange pigment). The presence of bile salts in urine is an indicator of liver problems.

Requirements

Urine sample, Test-tube, test-tube holder, urine sample, measuring cylinders, Spatula, Benedict's solution and burner, Smiths reagents, Sucrose, Con. H_2SO_4.

Procedure and Observation

S.N.	TEST	METHOD	RESULT
1	Smith's Test	Take 1 ml of Smith's reagent into a test tube. Tilt the test tube and pour the urine along the side of the test tube.	A green ring is formed at the junction of two layers
2	Pettenkofer's Test	Take a 2 ml urine sample into a test tube. Add some sucrose into the test tube. Tilt the test tube and pour the 2 ml H_2SO_4 along the side of the test tube.	Red colour.

PART – B (spotting)

1- Parts of a compound microscope.

Arm - The microscope is handled or carried by the curve-shaped structure called the arm.
Body tube - The body tube separates the objective and the eyepiece of the microscope.
Foot or base - It is a U-shaped structure and supports the entire weight of the microscope.
Stage - It is the platform upon which the specimen or slide is placed for study. It has Stage clips on the stage that hold the slide and a hole through which light can pass.
Diaphragm- The diaphragm is found under the stage of the microscope and it controls the amount of light that reaches the specimen. The diaphragm can be of two types:

- Disc diaphragm
- Iris diaphragm

Nose piece - It is a circular and rotating metal part that is connected to the body tube's lower end. The nose piece has three holes wherein the objective lenses are embedded.
Fine adjustment knob- It is smaller and is used for sharp and fine focusing of the object.
Coarse adjustment knob- It is a large knob that is used for moving the body tube down and up for bringing the object to be examined under exact focus.
Light Source - The light source in the microscope is a lamp/ sunlight.
Optical Parts of Compound Microscope
Eyepiece lens or Ocular - It is present at the top. It is marked as 4X, 10X, 40X and 100 X. These indicate the magnification power.
Condenser - A condenser sits between the stage and the diaphragm. The condenser controls how much light from the light source.
Objective lenses - The objective lens gathers light from the specimen, magnifies the image of the specimen and projects the magnified image which can be observed through the eyepiece. There are three objective lenses as follows:

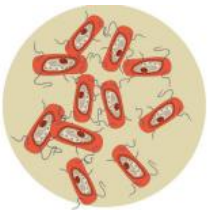
- Oil immersion objective – 100X
- High power objective – 45X
- Low power objective – 10X

Precautions

- The lenses should be cleaned with the help of silk cloth and cleaning liquid before use.
- Focus on the low power objective first and then move to high power.
- Only the fine adjustment knob should be used when the high-power objective is employed.
- A coverslip should always be used to cover preparations before observation.
- Do not dismantle the microscope.
- An oil immersion lens should never be used without the use of oil.

2- **Specimens/slides/models and identification with reasons - Bacteria, Oscillatoria, Spirogyra, Rhizopus, mushroom, yeast, liverwort, moss, fern, pine, one monocotyledonous plant, one dicotyledonous plant and one lichen.**

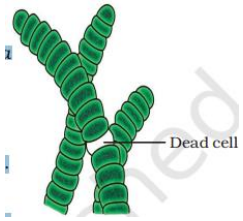
BACTERIA



Systematic position
Kingdom – Monera
Class – Eubacteria

- Bacteria (sing.: bacterium) are unicellular.
- Cell wall is present.
- Absence of membrane bound organelles like mitochondria, nucleus, Golgi bodies, plastids, etc.
- Mesosomes are present.
- Bacteria exist in different shapes like globular (coccus), rod-shaped (bacillus), spiral (spirillum) and comma-shaped (vibrio).

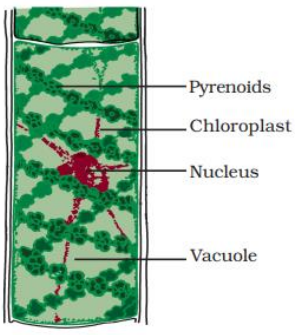
OSCILLATORIA



Systematic position
Kingdom – Monera
Division – Cyanobacteria
Class – Cyanophyceae

- It is a blue-green algae of freshwater bodies.
- Thallus is filamentous, unbranched, and multicellular.
- The cells are arranged one above the other like a pack of cards.
- Some cells of the filament may be dead and appear as blank spaces in the filament.
- Fresh specimen of the filaments shows oscillatory movements and hence the name Oscillatoria.

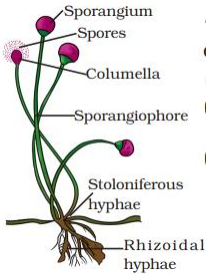
SPIROGYRA



Systematic position
Kingdom – Plantae
Division – Thallophyta
Class – Chlorophyceae

- It is a green-coloured algae commonly found in stagnant freshwater bodies.
- It is unbranched, filamentous and slimy to touch.
- The filament is composed of a large number of long, cylindrical cells placed one above the other in a single row.
- Chloroplast is long spiral ribbon-shaped. Several pyrenoids are present.
- There is a single large vacuole in each cell.

RHIZOPUS

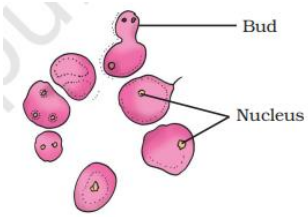


Systematic position
Kingdom – Fungi
Division – Eumycota
Class – Zygomycetes

- Thallus is an interwoven mass of hyphae called mycelium.
- Hyphae are tubular, multinucleate and without any septa (coenocytic).

- Hyphae may be stoloniferous (horizontal and grow parallel on the surface) and rhizoidal (grow down into the substratum).
- Erect vertically growing hyphae are called sporangiophores.
- Sporangiophore bears the capsule or sporangium.
- Numerous black spores fill the cavity between columella and the sporangial wall.

SACCHAROMYCES (YEAST)



Systematic position
Kingdom – Fungi
Division – Eumycota
Class – Saccharomycete

- Cells are oval or spherical in shape, and colourless.
- Cells form chains of buds that help in propagation.
- Each cell has one vacuole.
- A single nucleus is present in each cell.

LICHENS

- The body of a lichen is a thallus- Crustose, Foliose and Fruticose type.

Crustose

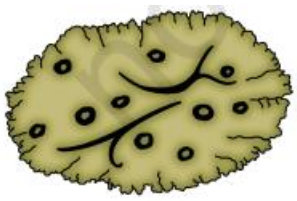
- These are composed of thin, flat, inconspicuous thallus without lobes.
- The thallus is closely attached by its whole lower surface to stones, rocks, barks of wood trees, etc.

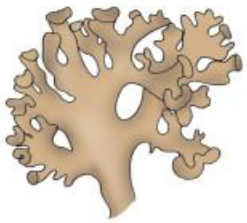
Foliose

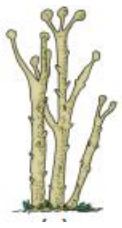
- Foliose lichens are leafy lichens with flat lobed and horizontally spreading thalli.
- These are attached to the substratum by rhizoid-like structures.

Fruticose

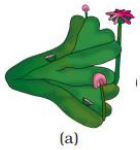
- The thallus is flat or ribbon like upright, generally branched and pendulous thalli.
- These are attached to the substratum by disc like structures at their bases.







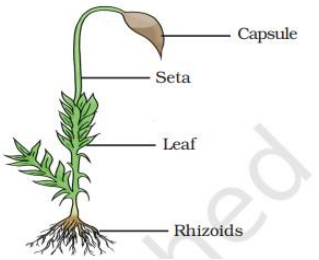
MARCHANTIA (LIVERWORT)



Systematic position
Kingdom – Plantae
Division – Bryophyta
Class – Hepaticopsida

- Thallus is dorsiventrally flattened, dichotomously lobed, with an apical notch in each lobe.
- On the dorsal side dark median furrow (mid-rib) is present.
- Vegetative propagule gemmae cups are present on the dorsal surface.
- They have rhizoids for anchorage and absorption of water.
- Reproductive organs antheridiophores and archegoniophores are arises from the apical notches of male and female thalli respectively.
- The antheridiophores and archegoniophores bears antheridia and umbrella shaped archegonia.

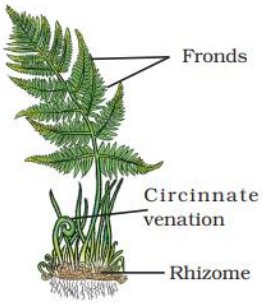
FUNARIA (MOSS)



Systematic position
Kingdom – Plantae
Division – Bryophyta
Class – Musci/Bryopsida

- The thallus has small upright, 'stem' that bears, small, green, spirally arranged leaf-like structures having no midrib.
- Rhizoids are septate.
- Reproductive organs are borne on separate branches of the same thallus.
- Antheridia is club-shaped while archegonia are flask shaped.
- A mature plant bears sporophyte on the female branches. The sporophyte consists of a capsule, seta and a foot.

DRYOPTERIS (FERN)



Systematic position
Kingdom – Plantae
Division – Pteridophyta
Class – Filicopsida

- The rhizome is short, thick and covered with scale leaves, remnants of leaf bases and a cluster of adventitious roots.
- The aerial shoot consists of large compound leaves (fronds).
- The young leaf has circinate venation.
- The petiole has a dense covering of brown hairs like ramenta.
- Leaves are long (1.0-1.5 m), compound with leaflets arranged on either side of rachis.
- Large number of sac-like structures (Sori) are present on the ventral side of the pinnule.
- Each sorus contains a cluster of sporangia-bearing spores.

PINUS

Systematic position
Kingdom – Plantae
Division – Gymnosperm
Class – Coniferopsida

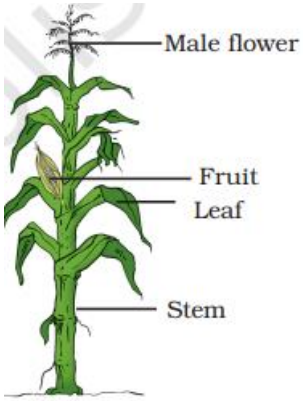
- Pinus is a cone-shaped tall tree.
- Stem- hard, woody, cylindrical, rough and branched.
- Branches-
  (a) branches of unlimited growth are 2-3 cm long and bear long, needle-like green leaves (acicular leaves)
  (b) branches of limited growth.
- Reproductive organs are borne in male and female cones in the same plant.
- Male cones are borne in large clusters (8-40). They are small, green and conical. It is surrounded by a large number of green and small microsporophylls Male cone contains pollen sacs. Pollen grains are winged.
- Female cones are large (10-30cm in length) consisting of megasporophylls. Megasporophylls has (a) bract scale and (b) ovuliferous scale which bears 2 ovules on the ventral side.

DICOTYLEDONOUS PLANT

Systematic position
Kingdom – Plantae
Division – Angiosperm
Class – Dicotyledonae

- The plant body is differentiated into roots, stems and leaves.
- Root- Taproot
- Leaf- simple or compound, with reticulate venation.
- Flower- Tetramerous or pentamerous, either solitary or in clusters forming inflorescence.
- Reproductive organs- Male stamens and female carpels. Within the carpels ovules are present.
- Seeds: two cotyledons.
- Example: Hibiscus, pea, gram, lady's finger, ground nut.

MONOCOTYLEDONOUS PLANT

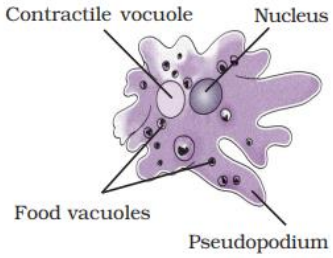


Systematic position
Kingdom – Plantae
Division – Angiosperm
Class – Monocotyledonae

- Plant body differentiated into roots, stems, and leaves
- Root- Fibrous
- Leaf- Simple or compound with parallel venation.
- Flower- trimerous.
- Ovules situated inside the carpels.
- Seed- one cotyledon
- Example: maize, wheat, sugarcane, paddy

3- **Virtual specimens/slides/models and identifying features of - Amoeba, Hydra, liver fluke, Ascaris, leech, earthworm, prawn, silkworm, honey bee, snail, starfish, shark, rohu, frog, lizard, pigeon and rabbit**.

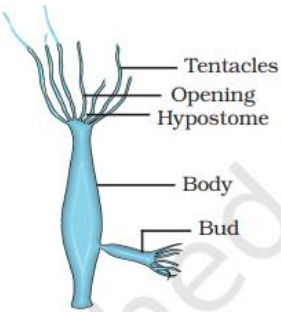
AMOEBA



Systematic position
Phylum – Protozoa
Class – Sarcodina

- Unicellular with irregular shape.
- A nucleus of an almost round shape is present.
- A contractile vacuole and several food vacuoles are present in the cytoplasm

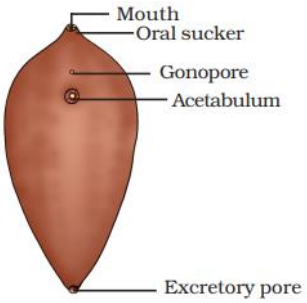
HYDRA



Systematic position
Phylum – Cnidaria
Class – Hydrozoa

- The body, called a polyp is elongated and cylindrical
- Long, slender and contractile tentacles (6-10) are present at oral end.
- The flat aboral end helps to attach to the substratum.
- Show vegetative propagation (Bud-like structures branch out from the polyp, which ultimately separate as young hydra).
- Sometimes, gonads may be seen as small bulges on the body.

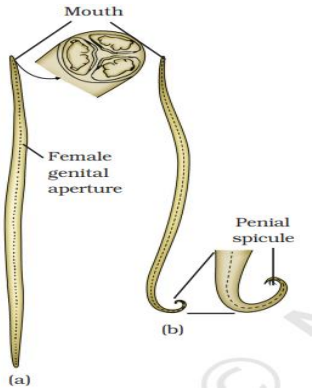
FASCIOLA (LIVER FLUKE)



Systematic position
Phylum – Platyhelminthes
Class – Trematoda

- Body- leaf-like dorso-ventrally flattened body
- The anterior part is broader with a conical end. The mouth is present at the tip and is surrounded by a muscular oral sucker.
- On the ventral surface a muscular ventral sucker (acetabulum) is situated 3-5 mm behind (posterior) the oral sucker.
- On the ventral surface genital aperture or gonopore is also situated.
- At the tip of the posterior end excretory pore is present.
- Liver fluke is bisexual.

ASCARIS (ROUND WORM)



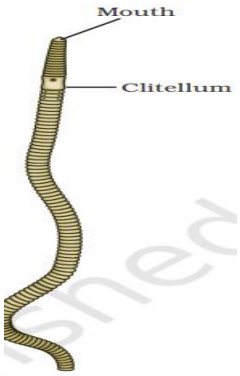
Systematic position
Phylum – Aschelminthes
Class – Nematoda

- Body - long (20 to 40 cm), cylindrical (5 to 6 mm diameter) with no segmentation
- Sexes- Separate; the females are longer than the males.
- Both ends are pointed; the posterior end of the male is ventrally curved.
- The mouth is situated at the anterior end and is surrounded by three lips, one present mid-dorsally and the other two lips situated ventrolaterally.

- All along the length of the body single longitudinal lines are present.
- Excretory pore is present on the ventral surface.
- Male has ventrally curved posterior tip, a pair of penial spicules
- In female the genital aperture is present mid-ventrally.

PHERETIMA (EARTHWORM)

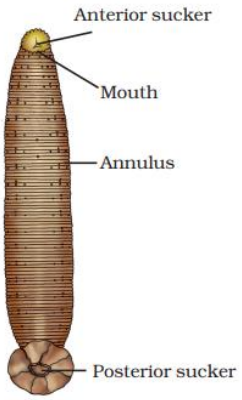
Systematic position
Phylum – Annelida
Class – Oligochaeta



- The anterior end is pointed and posterior end is slightly depressed or blunt.
- Metameric segmentation
- Skin- slimy and moist (due to the secretion of mucus from the body wall).
- The dorsal surface is darker than the ventral one.
- A mid-dorsal dark line is also visible all along the length of the body.
- The mouth is situated ventrally in the first metamere (peristomium).
- Anus is situated at the tip of the last metamere.
- The 14th - 16th segments in adults are comparatively thick, and it is called clitellum.
- Female and male genital apertures are present ventrally in the mid-ventrally (14^{th}) & ventrolateral (18^{th}) segments respectively.
- A pair of genital papillae is present ventrolaterally in the 17^{th} & 19^{th} segments just above and below the male genital apertures.
- On the ventral surface, 4 pairs of openings of spermathecae are situated ventrolaterally in the grooves between 5/6, 6/7, 7/8 and 8/9 segments.

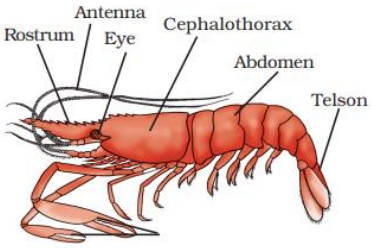
HIRUDINARIA (LEECH)

Systematic position
Phylum – Annelida
Class – Hirudinea



- Body- Elongated with convex dorsal surface (dark green) and flat ventral surface (Yellowish brown).
- Size- 6 to 10 cm in length.
- Skin- moist (due to secretion of mucus from the body wall).
- The anterior pat has a cup-shaped sucker which contains a mouth. The posterior part has a ventral sucker.
- Anus is present on the dorsal side at the junction of the last metamere and the posterior sucker.
- Hundreds of grooves or annuli are present on the body surface. There are 33 body segments each with five superficially marked annuli except the few anterior and posterior ones.
- Each of the five anterior metameres bears a pair of eyes (dark spot) on the dorsal margin.
- There are 17 pairs of ventrolaterally arranged nephridiopores present in the metameres starting from 6th to 22nd.
- The male and female genital apertures are present on the ventral side in the middle of the 10th and 11th metameres.

PALAEMON (PRAWN)



Systematic position
Phylum – Annelida
Class – Crustacea

- Body- laterally compressed body is elongated, bilateral and symmetrical.
- The body is divided into the anterior cephalothorax (fused head and thorax) and posterior abdomen.
- A pair of stalked compound eyes are present at the anterior end of the cephalothorax.
- The abdomen consists of 6 segments each with its own set of biramous appendages. At the end of the last abdominal segment, a terminally pointed structure, telson, is present.
- There are 19 pairs of jointed appendages, i.e., one pair in each segment.
- In the cephalothoracic region, there are 13 pairs of appendages of which antennules, antenna, chelate legs, and nonchelate legs are the prominent ones.
- The appendages of the five anterior abdominal segments are called the pleopods or swimming
- legs. The appendages of the last abdominal segment are broader and called uropod.

BOMBYX MORI (SILKMOTH)

Systematic position
Phylum – Arthropoda
Class – Insecta

- Body - creamy white, 25 mm in length. It is divisible into the head, thorax and abdomen.
- Head is comparatively small. Thorax is provided with three pairs of jointed legs and two pairs of wings. Abdominal segments are continuous with thoracic segments.
- The entire body as well as the wings are covered with microscopic scales.
- A pair of compound eyes and an antenna are present on the head.
- They are nocturnal.

APIS INDICA (HONEYBEE)

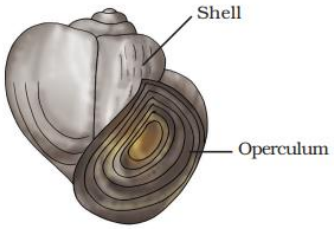
Systematic position
Phylum – Arthropoda
Class – Insecta
Order – Hymenoptera

- Honeybee is a social insect, with 3 forms- queen, workers, and drones.
- Body- is divided into three distinct regions: head, thorax and abdomen.
- Head is somewhat triangular. A pair of large compound eyes is present dorso-laterally on it. Three small ocelli are present on the dorsal surface between the two compound eyes.
- Mouthparts are present ventrally on the head.
- Thorax consists of three segments, i.e., prothorax, mesothorax and metathorax.
- One pair of jointed legs is present ventrally in each of the thoracic segments.
- Two pairs of membranous wings present dorsally in the mesothorax and the metathorax.
- Abdomen: A six-segmented abdomen is present behind the metathorax. A very narrow region in between the abdomen and thorax.

➢ **Workers** - unfertile female, smallest in size, abdominal segments bear wax glands, which are present ventrally on the four posterior abdominal segments. A sting is present at the end of the last abdominal segment. Pollen-collecting baskets are present in the thoracic legs.

- **Queen**- fertile female, largest in size (15-20 mm) in a colony of bees. The abdomen is long and tapering. Wings and legs are small. Eyes are small. Wax gland is absent in the abdominal segment.
- **Drones** – Male, larger than workers but smaller than queen in size. Eyes are very large. Wax glands are absent in the abdominal segments.
- The common Indian species of bees are: Apis dorsata, Apis indica and Apis florae. Among these species Apis dorsata is largest in size and Apis florae is smallest.

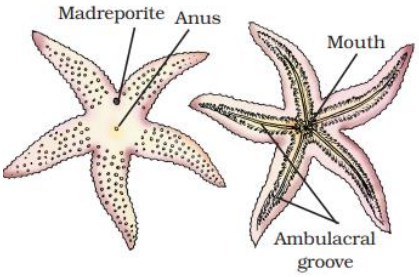
PILA GLOBOSA (APPLE SNAIL)



Systematic position
Phylum – Mollusca
Class – Gastropoda

- Body remains lodged within a hard and one-piece spirally coiled calcareous shell.
- There is a wide opening at the end of the last whorl of the shell, which remains closed by another calcareous plate called operculum.
- The body consists of four regions: head, foot, visceral mass and mantle.
- It moves with its foot.

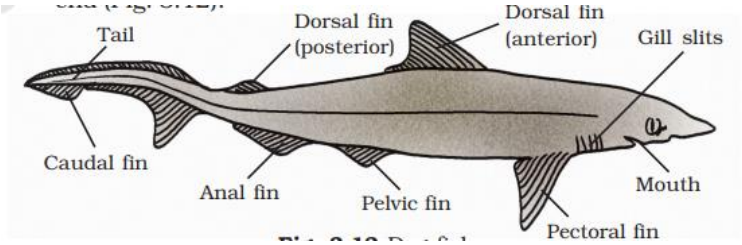
ASTERIAS (STAR FISH)



Systematic position
Phylum – Echinodermata
Class – Asteroidea

- Star-shaped pentamerous structure
- Shows radial symmetry
- Body has a central disc from which five tapering arms radiate.
- The entire body surface bears numerous small-sized blunt protuberances.
- The lower surface is called the oral surface, as mouth is situated centrally on this side
- Special organs, called tube feet, are present.
- The upper surface is called aboral surface, where anus is present

SCOLIODON (SHARK)



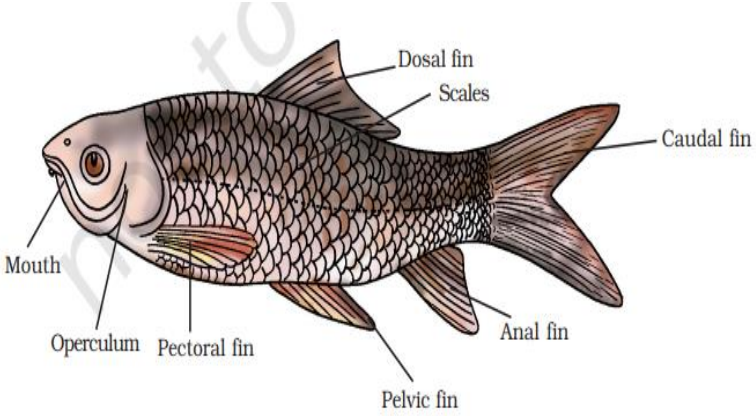
Systematic position
Phylum – Chordata
Subphylum – Vertebrata
Superclass – Pisces
Class – Chondrichthyes

- Marine fish
- Scale- minute placoid scales
- Body- head, trunk and tail.
- A crescentic mouth is present on the ventral surface of the head behind the tip. The mouth has several rows of sharp and backwardly pointed teeth on both the upper and lower jaws.
- Tail is elongated with heterocercal caudal fin (the upper and lower halves of unequal size).
- The body bears a number of unpaired and paired fins.
- Pectoral and pelvic fins are in pairs.
- Five pairs of gill slits are present laterally between mouth and pectoral fins.

- A median groove-like cloacal aperture is situated ventrally between the two pelvic fins.
- Males have midventrally situated copulatory organ.

LABEO ROHITA (ROHU)

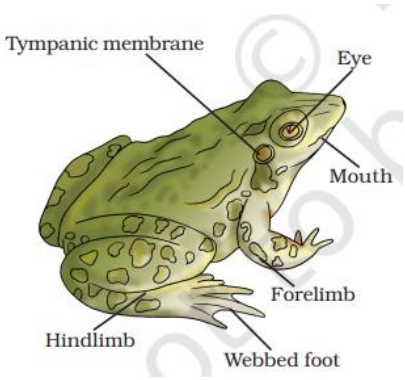
Systematic position
Phylum - Chordata
Subphylum - Vertebrata
Super Class - Pisces
Class – Osteichthyes



- Body- Streamlined and laterally compressed body, which is grey or black on the dorsal side; and silvery on the ventral surface.
- Size: Up to 1m in length
- The body is divisible into head, trunk and a tail with homocercal (dorsal and ventral lobes are of equal size) caudal fin.
- Head is extended between the snout and the posterior end of the operculum (i.e., gill cover).
- Snout is depressed and obtuse.
- The operculum is free and open along the posterior and ventral margins.
- Mouth is a transverse opening near the tip of the snout, which has fleshy lips.
- Scale- Overlapping cycloid dermal scales.
- Both unpaired (dorsal fin, a caudal fin and an anal fin) and paired (Pectoral and pelvic fins are present on its body.

RANA TIGRINA (FROG)

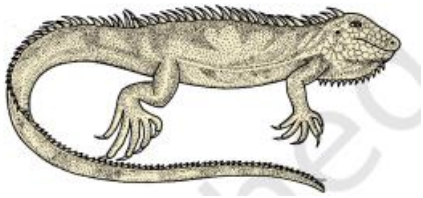
Systematic position
Phylum – Chordata
Subphylum – Vertebrata
Class – Amphibia



- The body consists of the head and trunk, the neck is absent.
- Eyes are bulging and covered by a nictitating membrane.
- The outer boundary of the middle ear is covered by a membrane, called the tympanic membrane.
- Skin is naked and slimy (secretion of mucous glands present in the skin).
- Mouth is terminal, having a bilobed tongue.
- Upper jaw has several rows of spiny teeth, lower jaw has no teeth.
- Forelimbs are smaller than the hindlimbs.
- The forelimbs have four, and hindlimbs have 5 clawless digits. An interdigital web-like membrane is present in the hind-limbs, which is used for swimming.

CALOTES (GARDEN LIZARD)

Systematic position
Phylum – Chordata
Subphylum – Vertebrata
Class – Reptilia



- The body is divided into a head, neck, trunk and elongated tail.
- Body is covered with rough epidermal scales.
- Head is triangular with a cone-shaped snout. Eyes are dorsolateral in position on the head.
- Limbs are pentadactyl (five digits) limbs; the digits are clawed.
- Shows camouflage.

COLUMBA LIVEA (PIGEON)

Systematic position
Phylum - Chordata
Subphylum - Vertebrata
Class - Aves

- Body covered with feathers.
- Streamlined body divisible into head, neck and trunk.
- A small and round head, having a beak without teeth.
- Eyes have movable eyelids and nictitating membrane.
- Forelimbs are modified into two wings for flying.
- The hindlimbs have four-clawed digits of which the first one is backwardly directed and the
- remaining three are forwardly directed.
- Cloacal aperture is situated at the posterior end of the trunk.

4- Mitosis in onion root tip cells and animal cells (grasshopper) from permanent slides.

Growing of onion root tips

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.

- Pick out a few medium-sized onion bulbs, and carefully cut away the roots.
- Grow root tips by setting bulbs in water-filled glass tubes with a diameter of 3 to 4 cm. It is important to take precautions to ensure that the bulb's base, or stem, barely touches the water.
- It could take 3-6 days for new roots to form.
- Cut roots that are 2 - 3 cm long and transfer them to a fixative, such as aceto-alcohol (1: 3:: glacial acetic acid: ethanol) for 24 hours.
- After that, move them to 70% ethanol for future usage and preservation.

Preparation of slide

- Select one or two preserved roots, give them a quick rinse, and then arrange them on a spotless slide.
- Apply 2-3 drops of aceto-carmine stain after one drop of N/10 HCl to the root tip. Leave the slide on a hot plate for 5 to 10 minutes (or briefly warm it on a spirit lamp).
- Don't dry the stain completely. Carefully blot the excess stain using blotting paper.
- Cut the tip of the root (2–3 mm), retain it on the slide and discard the remaining portion.
- After 10 to 20 seconds, add 1-2 drops of water and carefully blot them with blotting paper.
- Apply another drop of water to the root tip, then mount a cover slip on top of it without creating any air bubbles.
- Now slowly tap the coverslip using the blunt end of a pencil so that the meristematic tissue of the root tip below the coverslip is properly squashed and spread as a thin layer of cells.
- Carefully seal the margins of the coverslip using molten paraffin wax or nail polish.

Study of slide

- Using a 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 mitosis takes place in two stages- Karyokinesis (a division of the nucleus) followed by Cytokinesis (a division of cytoplasm).
- Those cells, which are not in the phases of cell division are considered to be 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

- An 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

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.

Anaphase

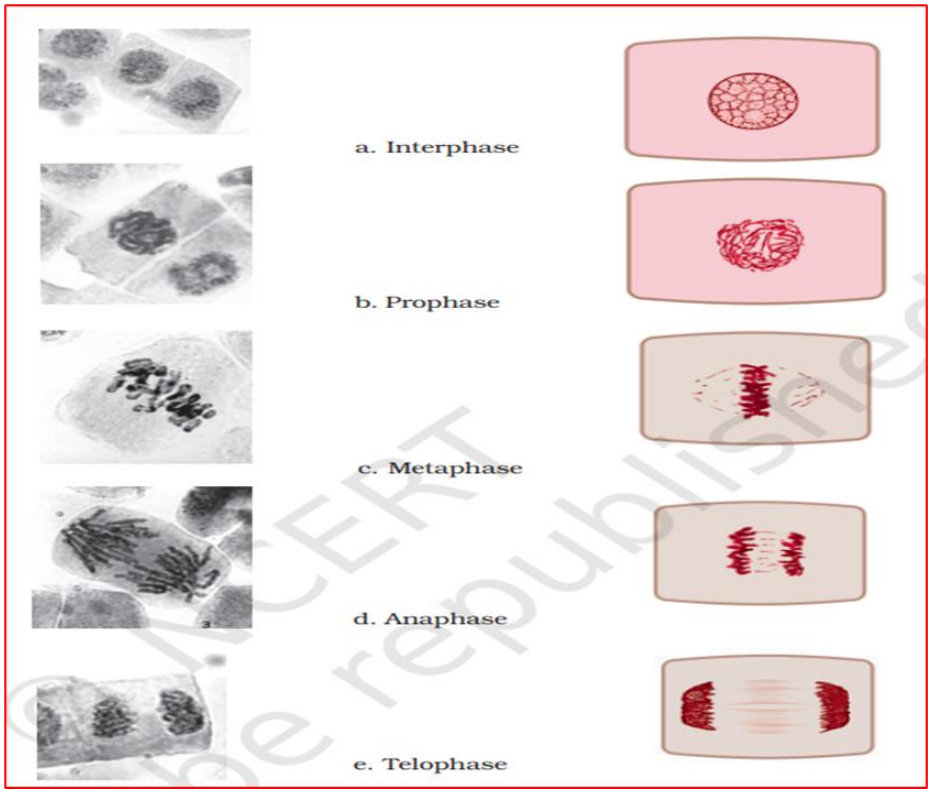
- separation of the chromatids of each chromosome.
- The chromatids separate due to the splitting of the centromere.
- Each chromatid now represents a separate chromosome as it has its own centromere.
- The chromosomes are found as if they have moved towards the two poles of the cell.
- The chromosomes at this stage may look like the shape of alphabets 'V', 'J' or 'I' depending upon the position of the 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

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.

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



Aim: To study and identify different types of inflorescences

Theory

Flowers are borne alone or in clusters in angiosperms. Single flowers are referred to as solitary flowers, and flowers that are produced in groups on a single stalk or peduncle are referred to as inflorescences. It is the reproductive branch made up of several dwarf (small-growing) shoots known as flowers. The flower's stalk is called a pedicel. Racemose and cymose are the two primary forms of inflorescences.

- **Racemose type**- In this type of inflorescence, the main axis continues to grow. It does not terminate in a flower and gives off flowers laterally in an acropetal manner (where old flowers are arranged lower side and young flowers are on the upper side).
- **Cymose type**- In this type of inflorescence, the peduncle terminates in a flower. Here, the older flowers are present at the upper portion and young buds are arranged towards the base. This arrangement is called the basipetal succession.
- Cyathium (in Euphorbia), Verticillaster (in Ocimum), and Hypanthium (in Banyan) are some special types of inflorescences.

Types of racemose inflorescence	
Raceme	When the peduncle or (main axis) is elongated and flowers are pedicellate. E.g., Radish, Mustard
Spike	Sessile flowers are borne on elongated axis Ex- amaranth, Achyranthes
Catkin	The flowers are sessile and unisexual. The peduncle is thin, long and weak. E.g., Mulberry, Oak.
Spadix	In it, the peduncle is thick, long and fleshy. The flowers are small, sessile and unisexual. Examples include Banana, Colocasia, Maize, Palms
Corymb	The peduncle is short and all flowers are present at the same level because the lower flower has a much longer pedicel than the upper one. eg. Cassia, Candytuft
Umbel	Extremely reduced main axis bearing a cluster of pedicellate flowers with more or less equal stalk E.g. Onion
Head/ Capitulum (Anthodium)	Sessile flowers are borne in a dense cluster in a common receptacle, which is the flattened main axis. E.g.- Sunflower
Types of Cymose inflorescence	
Uniparous cyme/Monochasial cyme	Single flower arises in the axil of a leaf of an ordinary shoot or the peduncle ends in a single flower. E.g., Hibiscus rosasinensis
Dichasial or biparous cyme	It consists of only three flowers, out of which the central one is the oldest and the two lateral ones arising in the axils of bracts below the older flower are youngest. E.g., Jasminum.
Multiparous cyme/Polychasial	The main axis ends in a flower with more than two branches arising from the peduncle below the terminal flower. E.g., Calotropis.

Requirement

Inflorescences of locally available plants, hand lens, beaker, water.

Procedure

- Gather inflorescences from plants that are readily available in your area and preserve them in a beaker of water.
- List the plant species and classify the inflorescences into racemose and cymose.
- Take note of the plant's inflorescence's axillary or terminal location.
- Create a labelled diagram of the inflorescence (of each type of plant you have collected) to show how the oldest and youngest flowers are arranged on the peduncle.
- Label and identify the components of each inflorescence's flower by drawing a schematic of it.
- Take note of the ovary's placement in relation to the arrangement of the other floral components (epigynous, perigynous, hypogynous).

Observation

Name of the plant	Inflorescence Type	Position of ovary

Aim: Study of Human skeleton and different types of joints

Theory

The human skeleton in adults is composed of 206 bones. It is divisible into two categories: Axial and appendicular skeleton. The axial skeleton consists of the bones of the skull, vertebral column, sternum and ribs. The appendicular skeleton consists of the bones of the limbs along with their girdles.

Requirement

Specimen of human skeleton, Model

Human Skull

- The human skull consists of 22 bones (29 including inner ear bones and hyoid bone).
- It is composed of two sets of bones - cranial and facial
- Cranial bones- occipital, parietal, frontal, temporal, sphenoid and ethmoid bones.
- The cranial bones have a strong bone case for eyes called orbit.
- Facial bones form the front part (i.e., face) of the skull.
- Hyoid bone is single, U-shaped present at the base of the buccal cavity.
- A nasal passage formed by nasal bones is present just below the orbit.
- Maxilla and pre-maxilla bones form the upper jaw, and the mandible bone forms the lower jaw. Teeth are not bones.
- The occipital bone forms the back and base of the skull and encircles the spinal cord.
- The skull is dicondylic. due to the presence of two occipital condyles in the skull. The condyles connect the skull with the Atlas (first vertebral column).

Vertebral Column

- It consists of 26 serially arranged units (vertebrae).
- The vertebra has a central hollow portion (neural canal) through which the spinal cord passes.
- In humans, the vertebral column is composed of 33 vertebrae that include 7 cervical, 12 thoracic, 5 lumbar, 5 sacral (fused), and 4 coccygeal (fused).
- A typical vertebra has- a centrum (the modified notochord), two laterally projecting transverse processes, a neural canal through which passes the spinal cord and a mid-dorsal neural spine.
- The two neighbouring vertebrae articulate with each other through their anterior and posterior zygapophyses.
- Intervertebral discs are present between the centra of two neighbouring vertebrae.

Rib Cage and Sternum

- Ribs may be grouped into thoracic ribs, and the sternal ribs.
- The sternum is a long, flat bone that forms the front of the rib cage.
- The thoracic ribs articulate with the thoracic vertebrae, and the sternal ribs do so with the sternum.
- There are 12 pairs (24) of thoracic ribs.
- Each rib is a thin flat bone and is carried ventrally from the vertebral column.
- 7 pairs of thoracic ribs are attached to the sternal ribs.
- 5 pairs of thoracic ribs do not articulate with sternal ribs, and are called false ribs.

- Among these, the last 2 pairs of false ribs are free and are called floating ribs.

Pectoral Girdle (Shoulder Girdle)

- It consists of a clavicle (collar bone) and a scapula (shoulder blade).
- Scapula is a large triangular flat bone with a slightly elevated ridge called the spine.
- The spine projects as a flat, expanded process called the acromion.
- Scapula connects humerus with clavicle.
- The clavicle or collarbone is an S-shaped bone situated at the front of your body in a horizontal position.
- It connects the pectoral girdle and axial skeleton.
- The clavicle articulates with the acromion. Below the acromion is a depression called the glenoid cavity, for articulation of the head of the humerus to form the shoulder joint

Pelvic Girdle

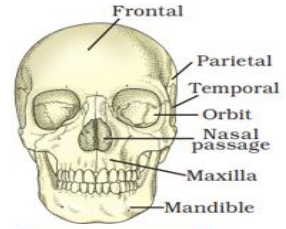
- The pelvic girdle consists of the two hip bones. The hip bones are connected to each other anteriorly at the pubic symphysis, and posteriorly to the sacrum at the sacroiliac joints to form the pelvic ring.
- Each half is formed by the fusion of three bones - ilium, ischium and pubis
- The fusion point of these three bones is a cavity (acetabulum) to which the thigh bone articulates.

Bones of the Hand or forelimb

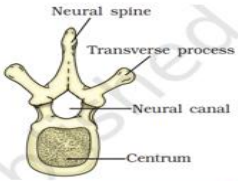
- The forelimb is located between the wrist and elbow.
- It consists of the humerus, radius and ulna, carpals (wrist bones 8 in number), metacarpals (palm bones 5 in number), and digits (digits 14 in number).
- The head of the humerus fits into the glenoid cavity of the pectoral girdle.
- Radius-ulna consists of 2 separate bones namely radius and ulna.
- Ulna is more developed and has an olecranon process which forms the elbow joint with humerus.

Bones of the Leg or Hind Limb

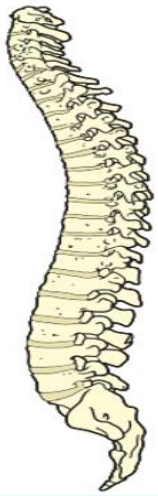
- It is made up of femur (longest bone), tibia and fibula, patella (knee cap) tarsals, metatarsals, phalanges.
- The head of femur fits into the acetabulum of the pelvic girdle.
- The distal end has two condyles which articulate with triangular shaped patella and proximal part of tibia to form knee on the ventral side.
- Tibia-fibula consists of two separate bones tibia and fibula. Tibia is more developed than fibula.
- Proximal end of tibia articulates with femur and patella and forms knee.
- One hind limb consists of 30 bones, namely: femur (1), patella (1), fibula (1), tibia (1), tarsals (7), metatarsals (5), and phalanges (14).



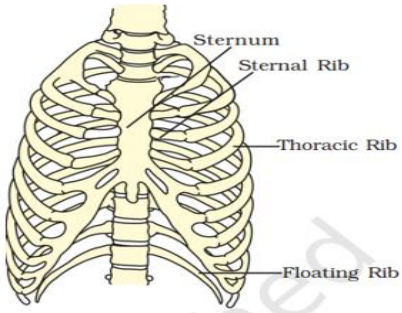
Human Skull



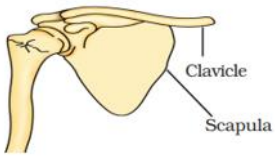
A typical vertebra



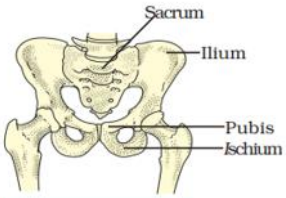
Vertebral column



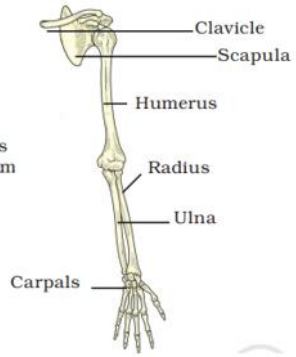
Rib cage and sternum



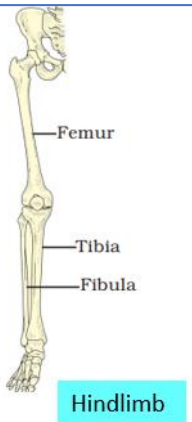
Pectoral Girdle



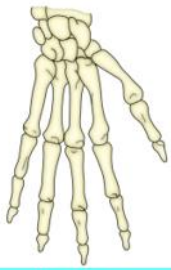
Pelvic Girdle



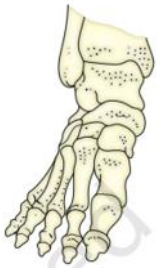
Forelimb



Hindlimb



Carpals, Metacarpals and Phalanges



Tarsals

Different types of joints

Gliding Joints

- These are flat joints, which allow back and forth or side-to-side movement of all or a few joining elements. Twisting is not possible.
- Example- lower leg to the ankle joint, forearm to the wrist joint

Pivot Joints

- These joints allow rotational movement.
- Example- head and neck

Hinge Joints

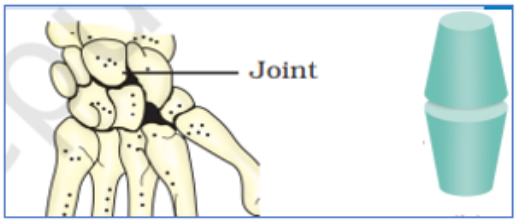
- These joints allow movement in one plane only.
- Example- fingers, toes, knees, elbows, and ankles.

Saddle Joints

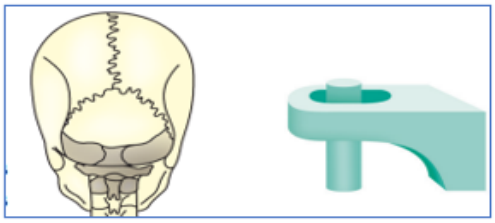
- These joints allow movement in two planes.
- Example- metacarpals and carpals of thumb, middle ear, heel

Ball and Socket Joints

- These joints allow movement in more than two planes.
- Example- humerus with pectoral girdle, femur with pelvic girdle, and maleus with incus (in ear ossicles).

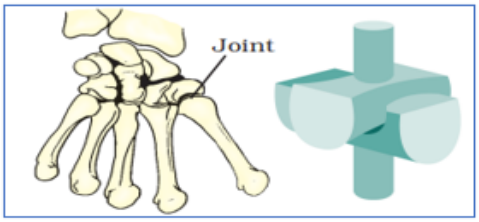


Gliding Joints- hind limb bones showing the joint



Pivot Joints- Skull and vertebral column showing the joint

Hinge Joints- elbow bone showing the joint



Saddle joint- carpals and thumb bone showing the joint

Bibliography

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