Kingdom: Animalia
Phylum: Mollusca
Class: Gastropoda
PREFACE

Biology is a natural science concerned with the study of life and living organisms, including their structure, function, growth, origin, evolution, distribution and taxonomy. It provides detailed information about the zoological as well as botanical aspects of life with intensive study of different species of plants and animals, internal structure of human body, physical and chemical functions of tissues, organs and organ systems, and many other aspects.

Practical application of biology is of utmost importance in the field of physiology, neurology, biochemistry, cardiology, zoology, pisciculture, apiculture, sericulture etc. Therefore it is necessary to have a firm grip over such an extensive subject and its practical application. Hence we bring to you “STD XI Sci. - BIOLOGY PRACTICAL HANDBOOK” a handbook which is a complete and thorough guide of different biology practicals.

This handbook written according to the needs and requirement of the board exam and helps the student to score high. It covers the entire syllabus with different sets of practicals written in a systematic and comprehensive manner. The diagrams included are neat, labelled and well drawn to provide an imagination of what they look like in real. The handbook also includes all the necessary information regarding the practical. It also includes a skeleton paper of examination.

And lastly, we would like to thank all those who have helped us in preparing this book. There is always room for improvement and hence we welcome all suggestions and regret any errors that may have occurred in the making of this book.

*A book affects eternity; one can never tell where its influence stops.*

**Best of luck to all the aspirants!**

Yours faithfully

Publisher
(A) List of Experiments

1. Study of parts of compound microscope.
2. Preparation of T.S. of dicot (sunflower) and monocot roots and stem to study different plant tissues.
3. Study and describe three locally available flowering plants from the families-Solanaceae, Fabaceae and Liliaceae with respect to types of root – (tap and adventitious), stem (herbaceous and woody), leaf (arrangement, shape, venation, simple and compound) and floral characters.
4. Study of plasmolysis in epidermal peels.
5. Study of osmosis by Potato osmometer.
7. To test the presence of sugar, starch, proteins and fats from suitable plant and animal materials.
8. To study the digestion of starch by salivary amylase under different conditions of temperature and pH.

(B) Study / Observation of the following (Spotting)

1. Study of specimens and identification with reasons:
2. comparative study of rates of transpiration in upper and lower surface of leaf.
4. Study of different modifications of stem (stem tuber, runner, and tendril).
5. Study of different modification of leaf (leaflet and stipular tendril), leaf Spines, phyllode).
7. Study and identification of different types of inflorescence.
8. Study of tissues and diversity in shapes and sizes of plant and animal cells – palisade cells, guard cells, parenchyma, collenchyma, sclerenchyma, xylem, phloem, squamous epithelium, muscle fibres, mammalian blood smear, through temporary or permanent slides.

9. Observation and comments on experimental set up on:
   a. Phototropism
   b. Suction due to transpiration
   c. Apical bud removal


11. Study of human skeleton (except skull, hand bones and foot bones) and different types of joints (synovial, cartilaginous and fibrous joint with one suitable example).

12. Study of external morphology of earthworm, cockroach and frog through models.

13. Study of mitosis in onion roots tips and animal cells (grasshopper) from permanent slides.
<table>
<thead>
<tr>
<th>No.</th>
<th>Title</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>(A) List of Experiments</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>To study the parts of a compound microscope.</td>
<td>01</td>
</tr>
<tr>
<td>2.</td>
<td>Preparation and study of transverse section of dicot (sunflower) and monocot (maize) stem and root to study different plant tissue.</td>
<td>03</td>
</tr>
<tr>
<td>3.</td>
<td>Study of flowering plants from the families – Solanaceae, Fabaceae and Liliaceae.</td>
<td>14</td>
</tr>
<tr>
<td>4.</td>
<td>Study of plasmolysis in epidermal peels.</td>
<td>26</td>
</tr>
<tr>
<td>5.</td>
<td>Study of osmosis by potato osmometer.</td>
<td>28</td>
</tr>
<tr>
<td>6.</td>
<td>To study structure and distribution of stomata in upper and lower surface of leaf.</td>
<td>29</td>
</tr>
<tr>
<td>7.</td>
<td>To test the presence of sugar, starch, proteins and fats.</td>
<td>31</td>
</tr>
<tr>
<td>8.</td>
<td>To Study the digestion of starch by salivary amylase.</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td><strong>(B) Study / Observation of the following (Spotting)</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Study of specimens and their identification.</td>
<td>41</td>
</tr>
<tr>
<td>2.</td>
<td>Comparative study of rates of transpiration in upper and lower surface of leaf.</td>
<td>51</td>
</tr>
<tr>
<td>3.</td>
<td>Study of different modifications of root(Fusiform root, parasitic root, epiphytic root and pneumatophores.).</td>
<td>52</td>
</tr>
<tr>
<td>4.</td>
<td>Study of different modifications of stem (stem tuber, runner and tendril).</td>
<td>56</td>
</tr>
<tr>
<td>5.</td>
<td>Study of different modification of leaf (leaflet and stipular tendril, leaf spines, phyllode).</td>
<td>59</td>
</tr>
<tr>
<td>6.</td>
<td>Study of imbibition of seeds/raisins.</td>
<td>61</td>
</tr>
<tr>
<td>7.</td>
<td>Study and identification of different types of inflorescence.</td>
<td>62</td>
</tr>
<tr>
<td>8.</td>
<td>To Study tissues and diversity in shapes and size of plant and animal cells.</td>
<td>64</td>
</tr>
<tr>
<td>9.</td>
<td>Observation and comments on experimental set up.</td>
<td>69</td>
</tr>
<tr>
<td>10.</td>
<td>Study of specimens and their Identification.</td>
<td>72</td>
</tr>
<tr>
<td>11.</td>
<td>Study of Human Skeleton.</td>
<td>89</td>
</tr>
<tr>
<td>12.</td>
<td>Study of External characters of Earthworm, Cockroach and Frog.</td>
<td>104</td>
</tr>
<tr>
<td>13.</td>
<td>Study of mitosis in onion root tips and animal cells.</td>
<td>107</td>
</tr>
</tbody>
</table>
Aim:
To study compound microscope and its parts.

A microscope is an instrument which magnifies or enlarges the image of extremely small object which cannot be seen with naked eyes.

The compound microscope consists of two main parts.
1. Lens systems (optical parts)
2. Mechanical parts.

1. **Lens systems (optical parts):**
   There are three types of lens systems.
   i. **Eye piece**
      Eye piece lies at the top of the body tube. It can be replaced.
      They are generally of 5X, 10X, 15X magnification.
   ii. **Objective:**
       Objectives are attached to the nose piece.
       They are of different magnifications as 10X (low power) and other of high power (45X) and 100X for oil immersion.
       The most commonly used objective is 10X.
   iii. **Mirror:**
       It is movable, detachable and fitted below the stage.
       It has one concave and one flat surface.
       It reflects light upward through the diaphragm.

2. **Mechanical parts:**
   Compound microscope is made up of following parts:
   i. **Base:**
      It is the lowermost part of microscope. It bears the weight. It is ‘U’ or triangular shaped.
      It supports the body of microscope.
   ii. **Body tube:**
       It is a body of microscope and made up of tube hence called body tube.
       It can move in vertical direction i.e. up and down movement.
       It bears two lenses viz. eye piece and objective at suitable distance.
   iii. **Inclination joint:**
       It joins the lower and upper parts of microscope. The upper part of microscope can be tilted to suit the eye-level of the observer.
iv. **Fine adjustment knob:**
   It is small-sized screw.
   It is attached to the body tube. It moves the body tube up and down and exact focussing can be made.

v. **Coarse adjustment:**
   It is attached to the body tube which can be moved up and down for focussing.

vi. **Stage with clips:**
   It is platform with circular hole in the middle on which slide is placed and fixed with clips.

vii. **Nose-piece:**
   It is a circular metallic structure attached below the body tube.
   It is revolving part for the adjustment of objectives. There are three or four objectives fitted in the nose-piece with lens.

viii. **Body arm (limb):**
   It supports the body tube. It is usually curved. It is used to hold the microscope.

ix. **Diaphragm:**
   It is fitted below the stage. It controls the amount of light incident on the condenser lens.

**Instructions / Precautions while using the microscope.**

i. Place the microscope in maximum diffused light.

ii. Fix first the low power for observation.

iii. Use concave mirror to adjust the light.

iv. Always clean the lenses or mirror with muslin cloth or soft handkerchief.

v. Slide should be clean and dry.

vi. Use diaphragm to adjust proper light.

vii. Do not touch the lens, objective, mirror or diaphragm with hands.

viii. Always observe with both eyes open.

ix. Never leave a slide on stage after use.

x. Hold the microscope with both hands.
Aim:
To prepare a temporary stained mount of transverse section of dicot (sunflower) and monocot (maize) stem and root to study different plant tissue.

Requirement:
Fresh or preserved material of sunflower stem and root, fresh or preserved material of maize stem and root, a sharp blade, microscope, slides, coverslips, watchglass, saffranin (1 gm in 100 ml of 50% ethanol), glycerine, brush, blotting paper.

Method for taking sections:
i. Hold the plant material vertically between the thumb and index finger and keep the edge of the razor at right angle to the longitudinal axis of the plant material and cut thin sections.
ii. Transfer these sections from the edge of the blade with the help of brush into a watch glass containing water.

Staining:
i. Select 3-4 good, thin and entire transverse sections and transfer them to another watch glass containing saffranin stain.
ii. Allow the sections to remain in the stain for 2 to 3 minutes.
iii. After staining, wash the sections with water repeatedly to remove the extra stain.

Mounting:
i. Take a clean slide and place stained section in the centre of the slide, and mount in glycerine or water.
ii. Place the coverslip gradually with the help of needle.
iii. Blot the excess of glycerine or water from the sides of the coverslip.
iv. While mounting care should be taken not to allow air bubbles to enter the mounting medium.

Precautions:
i. The material and the razor/blade should be flooded with water while cutting the sections.
ii. Brush should be used while handling the sections.
iii. Coverslip should be placed gently to avoid the entry of air bubbles.
iv. Remove extra glycerine with filter paper.
Section Cutting, Staining and Mounting
Aim:
To study of transverse section of dicot (sunflower) stem.
1. Sunflower is a dicot stem.
2. The outline of the stem in T.S. is circular with hairy surface.
   T.S. shows arrangement of various tissues in specific manner from periphery to centre as follows;

   **Gross anatomy of sunflower stem**

1. **Epidermis:**
   i. It is single layered outermost covering of stem.
   ii. The cells are thin walled, living, compactly arranged and covered with cuticle.
   iii. It bears multicellular hair.

**Function:** Protection.
2. Cortex
   i. The cortex region is present just below epidermis.
   ii. The region consist of
       a. Hypodermis  b. General cortex  c. Endodermis
       a. Hypodermis
          i. It lies just below epidermis.
          ii. It is made up of 4 – 5 layers of collenchymatous cells.
          iii. The cells are living, having deposition of cellulose at corners.
          iv. They may contain chloroplast and perform photosynthesis.
          **Function:** They provide mechanical support.
       b. General cortex (Parenchyma)
          i. It is present just below hypodermis.
          ii. It consists of few layers of living, thin walled cells with intercellular spaces.
          iii. They may contain chloroplast and become photosynthetic.
          iv. Some mucilagenous canals may be seen.
          **Function:** Storage of food.
       c. Endodermis
          i. It is the innermost layer of cortex which consists of single row of cells.
          ii. The cells are barrel shaped compactly arranged without intercellular spaces.
          iii. It contains starch grains.

3. Stele:
   The central core of tissue consisting of the vascular bundle is called **stele**.
   It consists of pericycle, medullary rays, vascular bundles and pith.
   a. Pericycle
      i. It lies in between endodermis and vascular bundles.
      ii. It has alternate patches of sclerenchyma and parenchyma.
      iii. Each patch of sclerenchyma lies associated with phloem of vascular bundle called hard-bast fibres.
   b. Medullary rays
      i. In between the vascular bundles, the gap is filled with thin walled, parenchymatous cells arranged in four to five radial rows.
      ii. It is called as medullary rays or pith rays.
      **Function:** Store food material. They also help in lateral conduction of food and water.
   c. Vascular bundle
      i. The vascular bundles are **conjoint, collateral and open** which are arranged in a ring.
      ii. Each bundle consist of
          1. phloem  2. cambium  3. xylem
          1. Phloem
             i. It is present towards outsides below the pericycle (sclerenchymatous patch).
             ii. It is made up of thin walled cells.
             iii. It consist of sieve tube, companion cells and phloem parenchyma.
             **Function:** Conducts food material.
2. **Cambium**  
   i. It is present between xylem and phloem.  
   ii. The cells are thin walled, rectangular, meristematic tissues which produces new cells.

3. **Xylem**  
   i. It is present towards inner side of vascular bundle.  
   ii. Large metaxylem towards periphery and smaller protoxylem towards centre, hence xylem is **endarch**.  
   iii. The cells are lignified and dead.  
   **Function:** Conduction of water and minerals.

d. **Pith**  
   i. The central region of stem which extends from below the vascular bundle to the centre.  
   ii. It is occupied by large parenchymatous cells.
Point of identification:

i. Multicellular hairs present on epidermis
ii. Collenchymatous hypodermis.
iii. Xylem endarch (metaxylem towards periphery and protoxylem towards centre)
iv. Vascular bundles conjoint, collateral and open
v. Vascular bundles are arranged in a ring
vi. Pith is present in the centre

Inference:
The given specimen is the section of dicot stem.

Aim:
To study of transverse section of dicot (sunflower) root

[T.S. of dicot (sunflower) root diagram]
T.S. of root shows the following structures;

1. **Epidermis or epiblema:**
   i. It is the outermost single layer of thin walled cells.
   ii. Cells are compactly arranged
   iii. Some cells of this layer bear thin walled tubular outgrowths called root hairs.

2. **Cortex:**
   It lies below epidermis and is made up of many layers of thin walled parenchyma cells.

3. **Endodermis:**
   The innermost layer of the cortex is called endodermis.
   It consists of barrel-shaped closely packed single layer of cells.
   The radial wall of these cells are thickened called casparian band.

4. **Pericycle:**
   It is a single layer of thin walled cells below endodermis.

5. **Vascular bundles:**
   There are 2-6 alternately arranged bundles of xylem and phloem called radial bundles.
   Xylem bundles are exarch i.e. protoxylem lies towards the outside and metaxylem towards the centre.
   Xylem vessels are polygonal in outline.

6. **Phloem bundles:**
   These consists of sieve tube, companion cells and parenchyma.

7. **Conjunctive tissue:**
   Phloem and xylem bundles are separated from each other by parenchyma cells called conjunctive tissue.

8. **Pith:** It is highly reduced or absent.

**Point of identification:**

i. Presence of unicellular hair on the epidermis
ii. Hypodermis absent
iii. Vascular bundles are radial
iv. Xylem/phloem bundles are less than 6
v. Protoxylem lies towards periphery and metaxylem lies towards centre i.e. xylem is exarch.
vi. Pith is highly reduced / absent.
Aim:
To study of transverse section of monocot (maize) stem

Gross Anatomy of a monocot stem (Maize)

T. S. of a monocot stem (Maize)
1. Maize is a monocot plant.
2. T. S. is circular and with smooth surface.
3. Vascular bundles are many and scattered in ground tissue.
4. T.S. shows arrangement of various tissues in specific manner from periphery to centre as:

1. **Epidermis**
   i. It is the single, outermost layer.
   ii. The cells are thin walled, living with a thick cuticle on the outer surface.
   iii. Epidermal hairs are totally absent but few stomata may be present here and there.
   **Function:** It protects the internal tissue.

2. **Hypodermis**
   i. It lies just below epidermis.
   ii. It is made up of two – three layers of thick walled dead sclerenchymatous cells.

3. **Ground tissue**
   i. It is present below hypodermis.
   ii. It is made up of living, thin walled parenchymatous cells.
   iii. They are loosely arranged with intercellular spaces.
   iv. It is not differentiated into cortex, endodermis, pericycle etc. as in dicotyledonous stem.

4. **Vascular bundles**
   i. There are many vascular bundles scattered in ground tissue.
   ii. They are conjoint, collateral and closed type.
   iii. The vascular bundles towards periphery are more in number and closely placed than the centre.
   iv. The V.B. towards periphery are smaller in size while central V.B. are larger in size and widely placed.
   v. Each vascular bundle is somewhat oval in shape and surrounded by sclerenchymatous bundle sheath.
   vi. Bundle sheath specially develops towards upper and lower side of V. bundle.
   vii. The vascular bundle consist of
      a. **Xylem**
      b. **Phloem**

   a. **Xylem**
      i. It is usually ‘Y’ shaped.
      ii. Two bigger vessels (Metaxylem) are at two lateral arms while two smaller vessels (protoxylem) at the base.
      iii. The lower protoxylem elements break to form a water containing cavity called lysogenous cavity.
      **Function:** It is water conducting tissue and also gives rigidity.

   b. **Phloem**
      i. It lies towards periphery and made up of living cells.
      ii. It consists of sieve tubes, companion cells and phloem parenchyma is absent.
      **Function:** It conducts food material.
Aim:
To study of transverse section of monocot (maize) root

T.S. of a monocot (maize) root

T.S. of monotoc root shows the following structures;

1. **Epidermis / piliferous layer or epiblema:**
   - It is a single outermost layer of cells without cuticle.
   - Cells are compactly arranged.
   - Some cells of it give rise to unicellular root hair.

2. **Cortex:**
   - It lies below epidermis.
   - It is quite wide and is made up of many layers of parenchyma cells.

3. **Endodermis:**
   - It is innermost layer of cortex.
   - It is made up of ring of barrel shaped cells.
   - The endodermal cells posses bands of thickening called casparian bands.
4. **Pericycle:**
   It is a single layer of parenchymatous cells and lies below the endodermis.

5. **Vascular bundles:**
   There are many (8 or more) alternate bundles of xylem and phloem called radial bundles. Xylem bundles are exarch i.e. protoxylem lies towards the outerside and metaxylem towards the centre.
   Xylem vessels are rounded or oval.
   Phloem lies just below the pericycle and consists of sieve tube, companion cells and parenchyma.

6. **Conjuctive tissue:**
   Phloem and xylem bundles are separated from each other by parenchyma tissue called conjuctive tissue.

7. **Pith:**
   It is well developed and consists of parenchyma in the central region of root.

**Point of identification:**
1. Presence of unicellular hair on the epidermis.
2. Hypodermis absent.
3. Vascular bundles are radial.
4. Xylem or phloem bundles are 8 or more than 8.
5. Pith is well developed.

**Anatomical difference between dicot and monocot stem**

<table>
<thead>
<tr>
<th></th>
<th>Dicot stem</th>
<th>Monocot stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Epidermis is with multicellular hairs.</td>
<td>It is without hairs.</td>
</tr>
<tr>
<td>2.</td>
<td>Hypodermis is collenchymatous.</td>
<td>Hypodermis is sclerenchymatous.</td>
</tr>
<tr>
<td>3.</td>
<td>Endodermis and pericycle are present.</td>
<td>Both are absent.</td>
</tr>
<tr>
<td>4.</td>
<td>Vascular bundles are few in a ring and open</td>
<td>Vascular bundles are many and scattered and closed (cambium absent).</td>
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<tr>
<td></td>
<td>(cambium present).</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Bundle sheath is absent.</td>
<td>Bundle sheath is present.</td>
</tr>
<tr>
<td>6.</td>
<td>Medullary rays and pith are present.</td>
<td>Both are absent.</td>
</tr>
<tr>
<td>7.</td>
<td>Secondary growth occurs.</td>
<td>Secondary growth is absent.</td>
</tr>
<tr>
<td>8.</td>
<td>Xylem vessels arranged in radial rows.</td>
<td>Xylem vessels arranged in V shape.</td>
</tr>
<tr>
<td>9.</td>
<td>Lysogenous cavity is absent.</td>
<td>Lysogenous cavity is present.</td>
</tr>
</tbody>
</table>

**Anatomical difference between dicot and monocot root**

<table>
<thead>
<tr>
<th></th>
<th>Dicot root</th>
<th>Monocot root</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Vascular bundles are 2-6 in numbers.</td>
<td>Vascular bundles are more than 6.</td>
</tr>
<tr>
<td>2.</td>
<td>Xylem diarch to hexarch.</td>
<td>Xylem polyarch i.e. more than 6.</td>
</tr>
<tr>
<td>3.</td>
<td>Pith is small or absent.</td>
<td>Pith is large and well developed.</td>
</tr>
</tbody>
</table>