G.C.E. (Advanced Level)

Biology

Practical Instructional Manual

(For the syllabus implemented from 2012)

Department of Science, Health and Physical Education

Faculty of Science and Technology

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1st Print - 2011

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Guidance Prof. W.M. Abeyrathne Bandara, Director General,
National Institute of Education (NIE)
Mr. Lal Wijesinhge Assistant Director General
(Curriculum Development), NIE

Direction Mr. C.M.R. Anthony, Director,
Department of Science, Health and Physical Education, NIE

Subject Coordination: Ms. H.M. Mapagunaratne , Project Officer, NIE

Resource contribution:

Internal :	Mr. C. M.R. Anthony	-	Director, Department of Science, Health & Physical Education.
	Ms. H.M. Mapagunaratne	-	Project Officer, NIE
	Ms. S.M.C.G. Wijesekara	-	Assistant Project Officer, NIE
External :	Prof. G.S. Widanapathirana	-	Senior Professor, Department of Microbiology, University of Kelaniya
	Prof. M.J.S. Wijeratne	-	Senior Professor, Department of Zoology, University of Kelaniya
	Ms. C.V. Shirani Devotta	-	Dhammissara College,Nattandiya
	Ms. H.A.S.G. Perera	-	Sirimavo Bandaranayake B. M.V., Colombo
	Ms. S.D.N. Abeykoon	-	St. Anthonys' Girls School, Kandy
	Ms. S.D.P. Bandara	-	Dharmaraja College, Kandy
	Ms. M.R.P.R. Basnayake	-	Ku/ St. Annes' College, Kurunegala
	Ms. J.A.J. Hanee	-	K/ Zahira College, Gampola
	Ms. P.H. Nishadi Kulathilaka	-	Maliyadeva Girls' School, Kurunegala
	Ms. C. R. Dias	-	St. Thomas' College,Mt. Lavinia
	Ms. B. Ganeshadas	-	Colombo Hindu College,Ratmalana
	Mr. W.G. Pathirana	-	Vijitha Central College, Dickwella
	Ms.P.A.K. Perera	-	Devi Balika Vidyalaya,Colombo

Type Setting : Ms .R.R.K. Pathirana - NIE

Web Site : www.nie.lk

Contents

PRACTICAL NO.1

Parts and functions of the microscope, and using microscope to observe specimens.

Expected Learning Outcomes

1. Recognizes the parts and understands the functions of a student microscope.
2. Uses the microscope in the correct manner.
3. Prepares wet mounts of live tissues or cells.
4. Manipulates the microscope to observe specimens.
5. Calculates the magnification of objects.
6. Draws cells according to the appropriate size and the scale.
7. Determines the actual size of cells.

Materials and Equipment

- Simple student microscope with low, medium and high power objectives
- Clean dry slides and cover slips
- Beaker and watch glasses/ Petri dishes
- Water sample from paddy field, hay infusion , pond water sample, onion epidermal peel
- Paint brush and a razor blade
- Graph paper

Instructions

- Instruct the students to follow the guidelines given below**.**
    - Identify the major parts of the microscope: The body and base, ocular tube, eyepieces (interchangeable), rotatable objective holder, low, medium and high power objectives, (which can be screwed in), focusing knobs-coarse and fine focus, stage with center circular opening, stage clips, adjustable mirror.
    - Observe the samples employing proper microscopic techniques.
    - Make thin epidermal peels of onion and place in water in a watch glass or Petri dish.
    - Transfer section of onion peel into a drop of water on the center of a clean glass slide by using a fine paint brush.
    - Hold the cover slip at the edge of the drop of water, with the help of a mounting needle, and gently lower the cover slip, supporting it with the needle onto the drop of water. Do not allow air bubbles to be trapped under the cover slip.
    - Place the slide on the stage of the microscope and move the low power objective in to position.

- Looking through the eye piece, move the slide to bring the object into position for study. Adjust the mirror to give optimum illumination to the object for clear viewing.
- Use the coarse focus knob to get the image as clear as possible.
- Study and note the structures visible.
- Rotate the objective holder and bring the medium power into position. Adjust the focus to get a sharp image.
- Bring the high power into position.
- Use the fine focus knob to make the image sharp.
- Study and record what you observe under low, medium and high power.
- Demonstrate the determination of actual size of given cell and advice them to determine the size of a cell.
- Study of other samples:
  Follow the steps given above to study a drop of water from paddy field, hay infusion, pond water and cells obtained from buccal cavity lining .
- Direct them to make notes and sketches on their observations.

PRACTICAL NO.2

Simple laboratory tests to identify starch, non –reducing sugars, reducing sugars , proteins, fats and oils.

Expected Learning Outcomes

1. Conducts tests to identify given food materials.
2. Follows laboratory procedures accordingly.
3. Conducts experiments with due care.
4. Records procedures and observations.
5. Presents the obtained results creatively.

Materials and Equipment

- pH paper
- Test tubes
- Test tube rack
- Bunsen burner
- Spatula

- $1cm^3$ syringe
- Iodine in Potassium Iodide solution
- Dilute HCl/H_2SO_4
- Sodium Hydrogen Carbonate ($NaHCO_3$)
- 1% Starch solution (corn flour is recommended)
- Benedict's reagent
- Sudan III
- 5% Potassium hydroxide solution
- 1% Copper sulphate solution
- 1% Glucose solution
- 1% Sucrose solution (Analar sucrose)
- Coconut oil or Sesame oil
- Egg albumin
- 1% lactose solution
- 1% fructose solution

Instructions

- Demonstrate simple laboratory tests to identify starch, non-reducing sugars, reducing sugars, proteins, fats and oils by using pure forms.
- Provide relevant pure forms of food materials and equipments for the students.
- Guide students wherever necessary.
- Instruct the students to record the observations

PRACTICAL NO.3

Use of electron micrographs to understand the structure of cellular components.

Expected Learning Outcomes

1. Interprets the electron micrograph.
2. Identifies the cellular components as seen by an electron micrograph.
3. Draws the cellular components accurately.
4. Determines the size of each cellular component.

Materials and Equipment

- Electron micrograph of a bacterial cell
- Electron micrograph of an animal cell
- Electron micrograph of a plant cell.

Instructions

- Allow the students to observe the electron micrograph of a bacterial cell, animal cell and a plant cell.
- Students must be able to identify /recognize components/organelles and their relative proportions.

PRACTICAL NO.4

Microscopic observation and identification of different types of plant tissues.

Expected Learning Outcomes

1. Uses the microscope to identify major plant tissues.
2. Makes suitable drawings on observed plant tissues as seen through the microscope according to the scale.
3. Differentiates the plant tissues according to the characters of each tissue.
4. Identifies parenchyma, collenchyma,sclerenchyma (sclerids,fibers),xylem elements and phloem elements

Materials and Equipment

- Microscopes
- Prepared slides of cross sections of stem, root and leaf of *Helianthus*
- Other suitable prepared slides containing major plant tissues (cross section of *Nymphea l*eaf petiole, monocot and dicot leaf epidermis, material macerated from flesh of *Guava, Annona* fruits, and wood of stem cuttings etc.)

- Wherever prepared slides are not available prepare suitable slides (wet mounts) in the classroom.
- Slides and coverslips

Instructions

- Allow students to examine the slides under low power.
- Direct them to identify the areas /zones which show the distribution of different tissues.
- Let students identify the characters of each tissue under medium and high powers.
- Provide students with other suitable prepared slides for further identification of a variety of plant tissues.
- Let students make suitable diagrams to show the observed characters of the tissue.

PRACTICAL NO.5

Microscopic observation and identification of different types of animal tissues.

Expected Learning Outcomes

1. Uses the microscope to identify major animal tissues.
2. Makes suitable drawings of observed animal tissues as seen through the microscope according to the scale.
3. Differentiates the animal tissues according to their characters.

Materials and Equipment

- Microscopes
- Prepared slides of epithelial tissues, smooth and striated muscles, cardiac muscles , connective tissues such as cartilage, bone and human blood cells

Instructions

- Allow students to examine the slides of epithelial tissues, smooth and striated muscles, cardiac muscles, connective tissues such as cartilage, bones and human blood cells under low power.
- Let students identify the characters of each tissue under medium and high powers.
- Let students make suitable drawings to show the observed characteristics of above tissues.
- Instruct the students to record highlighting the identification features of each tissue.

PRACTICAL NO.6

Identification of different stages of mitosis and meiosis using microscopic slides.

Expected Learning Outcomes

1. Identifies the major/main stages of cells in the process of mitosis and meiosis.
2. Differentiates the behavior of chromosomes during the two types of cell division.

Materials and Equipment

- Student microscope
- L.S onion root tips for study of mitosis
- T.S anther for study of meiosis
- Computer illustrations

Instructions

- Let the students observe each of the slides under low, medium and high powers of the microscope respectively.
- Ask them to identify the cells which show the main stages of mitosis and meiosis using the positions and shapes of the chromosomes.
- Direct students to draw the observed stages of mitosis and meiosis in correct sequence.
- Direct students to identify, carefully the various positions and shapes of the chromosomes and the changes that take place.
- Instruct the students to record highlighting the changes that occur in the nucleus and centrioles of cells undergoing mitosis and meiosis.

PRACTICAL NO.7

Laboratory experiment to demonstrate enzyme activity and to determine the rate of enzymatic reaction (starch - amylase)

Expected Learning Outcomes

1 Records the time taken for the reaction.
2 Tabulates the results and observations.
3 Conducts experiments by manipulating the variables.

Materials and Equipment

- Extract of crude amylase (from crushed germinating green gram seeds – germinated for 30 hours)
- 1% (w/v) starch solution
- Iodine solution (I_2 / KI)
- Stop watch
- White porcelain tile
- Thermometer
- Pipettes
- Water bath
- Boiling tubes and test tubes

Instructions

- Instruct students to set up the experiments as given below.
  - Measure definite volumes (5 ml) of amylase solution and (10 ml) of starch solution into separate test tubes.
  - Allow the solutions to attain the same temperature.
  - Mix up the two solutions and start the stop watch.
  - Test a drop of reaction mixture with a drop of Iodine solution on the white porcelain tile at 2 minute intervals.
  - Continue the test until a colour change of blue- violet will not appear.
  - Observe the time taken.
  - Tabulate the results indicating time elapsed and colour change.
  - Repeat the above procedure for different temperatures (5 ^{0}C, room temperature, 40 ^{0}C, 60 ^{0}C) (Temperature can be maintained by adding cold or hot water to the water bath).
- Let students comment on the results obtained.

PRACTICAL NO.8

Determination of rate of photosynthesis by amount of oxygen released.

Expected Learning Outcomes

1. Arranges the apparatus according to the instructions.
2. Demonstrates the release of oxygen from the aquatic plants during photosynthesis.
3. Makes accurate observations.
4. Determines the rate of photosynthesis by measuring the volume of oxygen released.
5. Conducts experiments by manipulating the variables.
6. Draws conclusions from the results obtained from the experiments.

Materials and Equipment

- Aquatic plants such *as Hydrilla* or *Elodea*
- Audus photosynthesis apparatus (micro burette)
- 0.01% solution of Sodium bicarbonate
- Test tube, glass funnel, table lamp, thermometer, stop watch, ruler

Instructions

- Direct the students to set up the Audus photosynthesis apparatus. Make sure that the micro burette is completely filled with water. Place a table lamp close to the aquatic plants to provide adequate light.
- Let them observe the oxygen bubbles released due to photosynthesis and how oxygen gets collected at the bend of micro burette.
- Instruct them to measure the volumes of oxygen released by using a syringe at definite intervals.
- Direct them to determine the rate of photosynthesis at various conditions such as changing the intensity of light, by changing the distance of the table lamp, or concentration of Bicarbonate solution.
- Direct them to record the results.

Note

- Experiment on changing the concentration of $NaHCO_3$ solution preferably should be done for two different concentrations only.

PRACTICAL NO.9

Microscopic observation of cross section of a leaf with special reference to adaptations for photosynthesis

Expected Learning Outcomes

1. Observes the arrangements of tissues in a dicot leaf with special reference for photosynthesis.
2. Develops the ability of cutting thin sections of leaves.
3. Makes accurate observations under various powers of the microscope
4. Draws the cross section of leaf as seen through microscope.

Materials and Equipment

- A fresh leaf of a dicotyledonous plant
- Slides and cover slips
- Small paint brush, razor blade
- Watch glass with water
- Microscopes

Instructions

- Instruct students to cut thin transverse sections of the leaf and transfer them to the water in watch glass.
- Make them mount the sections on a drop of water on a slide and cover with the cover slip.
- Direct students to select a part of the section which shows all the tissues clearly.
- Instruct them to observe the nature and distribution of the different types of tissues and cells.
- Ask them to draw the line diagram and detailed diagram.

PRACTICAL NO.10

Determination of rate of respiration using germinating seeds.

Expected Learning Outcomes

1. Sets up apparatus to determine the rate of respiration of germinating seeds.
2. Makes accurate observations and measurements.
3. Determines the rate of respiration by measuring the volume of oxygen intake or the volume of carbon dioxide released

Materials and Equipment

- Green gram seeds
- Two respirometers (refer the diagram given in Annex)
- KOH solution
- Ignition tube
- Stop watch
- Triple beam balance
- Water bath
- Vaseline

Instructions

- Guide the students to germinate the green gram seeds, by soaking in water for at least 8 hours and to spread it on wet paper for one day.
- Guide the students to set up two respirometers according to the diagram given in the Annex and to follow the instructions given below.
    - Add equal weights (25 g) of germinating seeds to each.
    - Insert an ignition tube with KOH solution
    - Make the apparatus airtight.
    - Keep the flask of the respirometer in a water bath.
    - Level the coloured liquid columns in A and B by using C stopper.
    - Note the initial positions of the water column in each of the tubes.
    - Start the stop watch.
    - Observe and record changes in the water column after two hours.
    - Calculate the volume of O_2 intake/ the volume of CO_2 released and determine the rate of respiration.

PRACTICAL NO.11

Observation of the characteristic features of typical Bacteria and Cyanobacteria.

Expected Learning Outcomes

1. Observes characteristic features of Bacteria using charts or diagrams.
2. Observes characteristic features of Cyanobacteria using permanent slides.
3. Distinguishes Bacteria and Cyanobacteria.
4. Makes correct recordings of the observations.

Materials and Equipment

- Charts/ Diagrams of Bacterial cells
- Permanent slides of *Nostoc, Anabaena, Lyngbia, Oscillatoria* and *Microcystis*
- Microscopes.

Instructions

- Allow students to examine the charts/ diagrams of Bacteria.
- Let students observe and identify the characteristic features of above Cyanobacteria using microscopes.
- Let students to record observations.

Note

- Prepare charts/ diagrams / large drawings to facilitate observation of micro organisms by students.

PRACTICAL NO.12

Observation of characteristic features of typical organisms of phyla Ciliophora, Rhizopoda, Bacillariophyta, Phaeophyta, Rhodophyta & Chlorophyta.

Expected Learning Outcomes

1. Observes *Paramecium, Amoeba,* Diatoms, *Sargassam, Gelidium, Chlamydomonas* Using diagrams/ slides/ specimens.
2. Lists characteristic features of the above organisms.
3. Distinguishes above mentioned organisms.
4. Makes correct records of the observations.

Materials and Equipment

- Diagrams /slides/specimens of *Paramecium, Amoeba,* Diatoms, *Sargassam, Gelidium & Chlamydomonas*
- Microscopes
- Slides and coverslips

Instructions

- Allow students to examine the diagrams/ slides/ specimens of *Paramecium, Amoeba,* Diatoms, *Sargassum, Gelidium and Chlamydomonas.*
- Let the students observe and identify characteristic features of above mentioned organisms.
- Let students record the observations.

Note

- Arrange field visits to study above specimens.

PRACTICAL NO.13

Observation of characteristic features of typical organisms of phyla Chytridiomycota, Zygomycota, Ascomycota and Basidiomycota.

Expected Learning Outcomes

- Observes *Allomyces, Mucor, Aspergillus* and *Agaricus* using diagrams/ slides / specimens.
- Lists characteristic features of above mentioned organisms.
- Distinguishes above mentioned organisms.
- Makes correct recordings of the observations.

Materials and Equipment

1. Diagrams/slides/specimens of *Allomyces, Mucor, Aspergillus* and *Agaricus*
2. Microscopes
3. Slides and coverslips

Instructions

1. Allow students to examine the diagrams/ slides/ specimens of *Allomyces, Mucor, Aspergillus* and *Agaricus.*
2. Let the students observe and identify the characteristic features of above mentioned organisms.
3. Let students record the observations.

Note

- Fungal growth rate is higher in dark places.
- Mycelia of *Mucor* can be obtained by making a thin layer on a glass slide with moistened flour or keeping moistened bread covered with a glass jar.

PRACTICAL NO.14

Observation of characteristic features of typical organisms of phyla Bryophyta, Lycophyta, Pterophyta, Cycadophyta, Coniferophyta, Anthophyta and classes Monocotyledoneae and Dicotyledoneae

Expected Learning Outcomes

1. Observes *Marchantia*, Mosses – *Pogonatum, Selaginella, Nephrolepis, Cycas*, *Pinus* and flowering plants using specimens/ diagrams.
2. Lists characteristic features of above mentioned organisms.
3. Develops the ability to identify above mentioned organisms.
4. Makes correct recordings of the observations.

Materials and Equipment

- Specimens / diagrams of *Marchantia, Pogonatum, Selaginella, Nephrolepis, Cycas, Pinus* and flowering plants-a monocot and a dicot
- Hand lenses

Instructions

- Allow students to examine the diagrams /specimens of *Marchantia, Pogonatum, Selaginella, Nephrolepis,Cycas, Pinus* and flowering plants-a monocot and a dicot.
- Let the students observe and identify the characteristic features of above mentioned organisms.
- Let students record the observations.

Note

Arrange field visits to study above specimens.

PRACTICAL NO.15

Observation of characteristic features of the phyla Coelenterata, Platyhelminthes, Nematoda, Annelida, Mollusca, Arthropoda and Echinodermata and the external features of the typical organisms belonging to the classes of each of these phyla except Nematoda.

Expected Learning Outcomes

1. Observes characteristic features relevant to the phylum.
2. Observes external characteristic features of typical organisms of major classes (specified in the Teacher's Instructional Manual) of phyla Coelenterata, Platyhelminthes, Annelida, Mollusca, Arthropoda and Echinodermata.
3. Develops the ability to identify above mentioned organisms.
4. Makes correct recordings of the observations.
5. Develops and uses dichotomous keys to distinguish animals.

Materials and Equipments

- Diagrams/ slides/ specimens of the organisms of the relevant classes
- Microscopes if necessary

Instructions

- Make the students observe the following organisms belonging to classes given below.
  - Classes of Phylum Coelenterata
    - Class Hydrozoa: *Hydra, Obelia*, Soft coral
    - Class Scyphozoa*: Aurelia* (jelly fish)
    - Class Anthozoa: Sea anemone, Hard coral
  - Classes of phylum Platyhelminthes
    - Class Turbellaria: *Planaria, Bipalium*
    - Class Trematoda: *Fasciola* (Liver fluke)
    - Class Cestoda : *Taenia* (Tape worm)
  - Classes of phylum Annelida
    - Class Polychaeta: *Nereis*
    - Class Oligochaeta: Earth worm
  - Class Hirudenia: Leech

- Classes of phylum Mollusca
  - Class Polyplacophora: *Chiton*
  - Class Bivalvia: Mussels, Oyster
  - Class Gatropoda: Snail, Slug
  - Class Cephalopoda: Squid, Octopus
- Classes of phylum Arthropoda
  - Class Crustacea: Prawn, crab
  - Class Insecta: Cockroach (any insect)
  - Class Chilopoda: Centepede
  - Class Diplopoda: Millipede
  - Class Arachnida: Scorpion, Spider
- Classes of phylum Echinodermata
  - Class Asteroidea: Star fish
  - Class Ophiuroidea: Brittle star
  - Class Echinoidea: Sea urchin, Sand dollar
  - Class Holothuroidea: Sea cucumber
  - Class Crinoidea: Sea lily
- Let the students observe and identify the characteristic features of the phyla and classes to which the above organisms belong.
- Let the students observe and record the external features of the above animals.
- Let students prepare a dichotomous key to distinguish the above animals.

Note

- Maintain a collection of biological specimens and arrange field visits

PRACTICAL NO.16

Observation of characteristic features of typical organisms of classes Osteichthyes, Chondrichthyes, Amphibia, Reptilia, Aves and Mammalia.

Expected Learning Outcomes

1. Observes shark/skate, grey mullet/ tuna/ carangids, toad/frog/ salamander/ *Ichthyophis*, lizard/cobra/crocodile, parrot/crow, a common mammal using specimens/ diagrams
2. Lists characteristic features of above mentioned organisms.
3. Develops the ability to identify above mentioned organisms.
4. Makes correct recordings of the observed organisms.

Materials and Equipment

- Specimens/ diagrams of shark/ skate, grey mullet/tuna/carangids, toad/frog/ salamander/*Ichthyophis*, lizard/ cobra /crocodile, parrot/crow, a common mammal

Instructions

- Allow students to examine the diagrams/ specimens of shark/ skate, grey mullet/tuna/ carangids, toad/frog/salamander/*Ichthyophis* ,lizard/ cobra /crocodile, parrot/crow, a common mammal
- Let the students observe and identify the characteristic features of above mentioned organisms.
- Let the students record the observations.

PRACTICAL NO.17

Study the basic histological structure of the alimentary canal of man and relates the major variations in different regions to their functions.

Expected Learning Outcomes

1. Observes the gross structure and various parts of the alimentary canal of man.
2. Observes the position of each part of the alimentary canal and their position in relation to other organs.
3. Identifies the common features of the basic histological structure of the alimentary canal.
4. Highlights the functions of each part to its structure.
5. Uses the transverse sections to study the histology of the different parts of the alimentary canal.

Materials and Equipment

- Chart / model/computer illustration showing clearly the entire alimentary canal in situ
- Chart / diagrams /computer illustrations showing gross external morphology and internal anatomy of the various parts of the alimentary canal
- Prepared slides of the T.S of stomach ,T.S. of small intestine, T.S. of liver and T.S. of large intestine
- Microscope

Instructions

- Provide students with wall charts/ models/computer illustrations to observe the major parts of the alimentary canal.
- Let students observe the position of each part of the alimentary canal with respect to other organs.
- Ask the students to observe the prepared slides and identify the four layers.
- Direct students to examine the gross external morphology and internal structure of the stomach, small intestine, large intestine and rectum.
- Let students to observe charts/slides/ models /computer illustrations of T.S of stomach, T.S of small intestine, T.S of liver and T.S of large intestine.

- Instruct students to make appropriate notes and illustrative sketches in respect of all above observations.
- Direct them to make line diagrams to show the histology of the wall of different parts of the alimentary canal of man using charts/models/microscopic slides.
- Provide students with prepared slides of the T.S of stomach , small intestine to identify four basic layers that form the wall of the stomach / small intestine.
- Guide them to identify different types of tissues that form each of the four layers.

PRACTICAL NO. 18

Study of human respiratory system using models/diagrams and observation of effects of exercise on respiratory rate and the pulse rate.

Expected Learning Outcomes

1. Observes the gross structure of the human respiratory system.
2. Describes the location of lungs in the thoracic cavity.
3. Relates the structure to its functions of major components of the respiratory system.
4. Measures pulse rate and respiratory rate.
5. Determines the effect of exercise on respiratory rate and pulse rate.

Materials and Equipment

- Models/charts/computer illustrations of the human respiratory system.
- Stop watch

Instructions

- Allow students to study the model or chart and note the relative positions and gross structure of different components of respiratory system.
- Let students observe the status of the thorax during full inspiration, full expiration and during normal uncontrolled breathing.
- Instruct the students to hold the back of their hand immediately below their nostrils to count the number of expirations during normal breathing over a period of five minutes.
- Ask them to count pulse during one minute, at rest.

- Instruct the students to stand up and step-march, to a rhythm set by the teacher for a period of three minutes.
- Direct the students to determine pulse rate over a period of one minute and breathing rate over a period of three minutes.
- Advice students to repeat at five minute intervals and determine time taken by each pupil to return to resting values.
- Ask students to tabulate and analyze the results for the entire class as well as for each individual.

PRACTICAL NO.19

Determination of solute potential of epidermal peels of *Rhoeo.*

Expected Learning Outcomes

1. Differentiates between the status of flaccid, turgid and incipient plasmolysis of cells in *Rhoeo* epidermal peels through microscopic observations.
2. Prepares solutions of known concentrations using stock solutions.
3. Determines percentage plasmolysis of the tissue by making accurate observations under microscope.
4. Plots a graph to illustrate obtained data.
5. Determines solute potential of cells in *Rhoeo* epidermal peels using values obtained by the graph.

Materials and Equipment

- Fresh leaves of *Rhoeo*
- Six Petri dishes with lids (labeled 0.15M, 0.20M, 0.25M, 0.30 M, 0.35 M, 0.40 M)
- Six test tubes (labeled 0.15M, 0.20M, 0.25M, 0.30 M, 0.35 M, 0.40 M)
- Test tube rack
- Two 10.00 ml graduated pipettes
- Beaker with distilled water
- Beaker with 1M sucrose solution
- Fine forceps, razor blade
- Microscope
- Slides and cover slips
- Graph paper

Instructions

- Instruct the students to prepare 20 ml of sucrose solutions of different concentrations as given (0.15M, 0.20M, 0.25M, 0.30 M, 0.35 M, 0.40 M) in each of the labeled test tubes by using the graduated pipettes, 1M sucrose solution and distilled water.
- Direct them to pour the prepared solutions from test tubes into Petri dishes.
- Ask students to take small fragments from the lower epidermis (purple coloured) of *Rhoeo* and place a few (2-3) fragments in each of the sucrose solutions in Petri dishes.
- Instruct them to set the Petri dishes aside with their lids closed at least for 20 minutes for the cells to achieve osmotic equilibrium.
- Direct the students to mount fragments of each of the epidermal peels on slides in a drop of the sucrose solution from which the peel is immersed.
- Let students examine under low power of microscope and select a clear field of cells and turn to mid power .
- Instruct the students to count the number of plasmolysed cells and total no. of cells within that particular field.
- Ask them to calculate percentage plasmolysis.
- Instruct the students to plot a graph of concentration of sucrose solution on X axis against percentage plasmolysis on Y axis.
- Direct students to determine the molarity of the sucrose solution that would give 50 % plasmolysis, from the graph. Calculate the solute potential of the sucrose solution from the table.
- Discuss the results obtained.

Solute potentials of given sucrose solutions at 20^0C

Concentration of sucrose solution (molarity)	Solute potential/*kPa*	Solute potential/*atm*
0.05	-130	-1.3
0.10	-260	-2.6
0.15	-410	-4.0
0.20	-540	-5.3
0.25	-680	-6.7
0.30	-820	-8.1
0.35	-970	-9.6
0.40	-1 120	-11.6
0.45	-1 280	-12.6
0.50	-1 450	-14.3
0.55	-1 620	-16.0
0.60	-1 800	-17.8
0.65	-1 980	-19.5
0.70	-2 180	-21.5
0.75	-2 370	-23.3
0.80	-2 580	-25.5
0.85	-2 790	-27.5
0.90	-3 010	-29.7
0.95	-3 250	-32.1
1.00	-3 510	-34.6
1.50	-6 670	-65.8
2.00	-11 810	-116.6

PRACTICAL NO.20

Determination of water potential of *Colocasia* petioles / Potato strips

(A) Determination of water potential of *Colocasia* petioles

Expected Learning Outcomes

1. Develops methods for measuring curvature of *Colocasia* petiole strips.
2. Plots a graph using concentrations of sucrose solutions (in X axis) against the percentage of change in curvature (in Y axis)
3. Interprets experimental results.
4. Determines the water potential of *Colocasia* petioles using the data obtained from the graph.

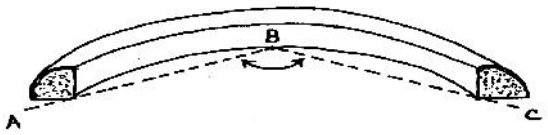
Materials and Equipment

- Fresh petioles of *Colocasia*
- Six Petri dishes with lids (labeled 0.15M, 0.20M, 0.25M, 0.30 M, 0.35 M, 0.40 M)
- Six test tubes (labeled 0.15M, 0.20M, 0.25M, 0.30 M, 0.35 M, 0.40 M)
- Test tube rack
- Two 10.00 ml graduated pipettes
- Beaker with distilled water
- Beaker with 1M sucrose solution
- Fine forceps, razor blade
- Graph paper
- Protractor
- Blotting paper

Instructions

- Instruct students to prepare 20 ml solutions of different concentrations as given above.
- Direct the students to follow the instructions given below.
    - Take six pieces of 6 cm long *Colocasia* petioles having uniform diameter and mark the centre of each piece.
    - Split each of them radially in to 4 strips of equal size.

- Place each piece on blank paper and mark the three points as given in the diagram.



- Measure the initial curvature as the angle $A\hat{B}C$.
- Immerse four strips in each of the sucrose solutions and set aside with the lid closed for at least one hour to achieve osmotic equilibrium.
- Remove the strips from the solutions. Blot the excess solution using blotting paper and place on a sheet of paper.
- Draw the outlines of each strip to record the curvature again and measure the angle $A\hat{B}C$.
- Determine the change in curvature of each strip.
    - Plot a graph using concentration of sucrose solutions (in X axis) against the percentage change in curvature (in Y axis).
    - Determine the water potential of *Colocasia* tissues using data obtained.
    - Comment on your observations and give reasons.

(B) Determination of water potential of potato strips

Expected Learning Outcomes

1. Develops methods for measuring the change in length of potato strips.
2. Plots a graph using concentrations of sucrose solutions (in X axis) against the percentage of change in length of potato strips (in Y axis)
3. Interprets experimental results.
4. Determines the water potential of potato tuber cells using the data obtained from the graph.

Materials and Equipment

- Fresh potato tuber
- Six Petri dishes of relevant solutions covered with lids (labeled 0.15M, 0.20M, 0.25M, 0.30 M, 0.35 M, 0.40 M)
- Six test tubes (labeled 0.15M, 0.20M, 0.25M, 0.30 M, 0.35 M, 0.40 M)

- Test tube rack
- Two (10 cm^3 or 25 cm^3) graduated pipettes
- Distilled water
- 1M sucrose solution
- Cork borer
- Two 100 cm^3 beakers
- Graph paper

Instructions

- Direct the students to follow the instructions given below.
    - Cut 12 strips of tissue (5cm in length) using the cork borer.
    - Keep a graph paper below each petri dish.
    - Completely immerse at least 2 strips in each Petri dish. Immediately measure their lengths against the graph paper seen through the bottom of the Petri dishes.
    - Leave in covered Petri dish for 30 minutes to 60 minutes (depending on the diameter of the tubers) to achieve osmotic equilibrium.
    - Measure the lengths again and calculate the mean percentage change in length. Then plot a graph of the mean percentage change in length versus molarity of the sucrose solution.
    - Determine the concentration of the solution which caused no change in length from the graph.
    - Determine the water potential of potato tissue using the given table.

PRACTICAL NO. 21

Determination of rates of transpiration from leaves and shoots

Expected Learning Outcomes

1. Sets up experiments according to the instructions.
2. Uses appropriate techniques to show the relative abundance of stomata on leaves.
3. Uses Ganong's potometer to determine the rate of transpiration.
4. Uses Ganong's potometer to show the environmental factors affecting transpiration.
5. Employs relevant techniques to communicate findings.

Materials and Equipment

- Healthy leaves from a plant like *Hibiscus/*Betel*/Colocasia* to get epidermal peel
- Light microscope
- Ganong's potometer
- Vaseline
- Slides and coverslips

Instructions

- Let the students examine epidermal peel under the microscope and estimate the relative abundance of stomata.
- Guide the students to set up the potometer as follows:
    - Fix a shoot of a plant which is cut underwater to the Ganong's potometer.
    - Apply Vaseline on the rubber stopper to make it air tight.
    - Introduce an air bubble into the capillary tube of potometer.
    - Record the time taken for air bubble to travel a particular distance in the capillary tube.
    - Correlate the rate of movement to the rate of transpiration.
    - Change the environmental factors and note the change in rate of movement of the air bubble.
- Comment on influence of changed environmental factors.

PRACTICAL NO. 22

Study the circulatory system of man using specimens/models/diagrams

Expected Learning Outcomes

1. Observes the location and gross external structure of the human heart, its blood supply and related major arteries and veins.
2. Observes the major features of the internal structure of the heart.
3. Describes the human heart as an example of the mammalian heart with complete double circulation.
4. Describes normal functioning of the heart and circulatory system.
5. Develops the ability to locate and count pulse rate.
6. Recognizes heart sounds by computer animations / simulations.

Materials and Equipment

- A model/chart / computer illustrations showing gross external morphology including pericardium, main vessels entering and leaving the heart and the main coronary vessels.
- A model/chart showing gross internal structure in sectional view including chambers, valves, origin of main vessels, position of pacemaker and Bundle of His.
- Chart showing the cardiac cycle, directions of blood flow, pattern of transmission of neuro- muscular impulse.
- Computer simulations/ animations of cardiac cycle.
- Charts showing the main pattern of arterial and venous circulation and diffusion in capillary beds.

Instructions

- Instruct the students to study the external and internal structure of the heart using the models and charts.
- Direct them to relate the cardiac cycle to the transmission of neuro- muscular impulses.
- Make the students listen to and identify the heart sounds by simulations/computer animations.
- Direct the students to learn to feel the pulse at the wrist or neck.
- Instruct the students to record their observations.

PRACTICAL NO. 23

Study of patterns of nervous systems in animals using models/diagrams

Expected Learning Outcomes

1. Illustrates the gross structure of nervous systems using models, charts and computer animations.
2. Observes and identifies nervous systems of given animals.
3. Compares the nervous systems of given animals.
4. Identifies major parts of the human nervous system.
5. Relates the main parts of the human brain to the main functional areas.
6. Relates the major parts of the human brain to their main functions.

Materials and Equipment

- Chart/diagram of the nerve net of a *Hydra*.
- Prepared slide/chart /diagram of the nervous system of a *Planaria*.
- Model/Chart/diagram showing the nervous system of an earth worm.
- Model/Chart /diagram showing the nervous system of cockroach.
- Model/Chart/diagram showing the human brain and nervous system.

Instructions

- Get students to observe the diversity of nervous systems of *Hydra*, *Planaria*, earth worm, cockroach and human brain and nervous system.
- Direct the students to observe the following in the charts/models/diagrams of the human brain and nervous system.
  - Observe the gross external morphology of the brain and the spinal cord.
  - Observe the sympathetic and parasympathetic nervous systems.
  - In the chart/model of the human brain note:-
    a. the shape and the surface features, convoluted nature and sulci.
    b. identify the main lobes of the brain
    c. study a diagram showing the major regions of the brain in relation to their function.
- Instruct the students to record the observations.

PRACTICAL NO. 24

Study of selected sense organs of animals using diagrams / models /charts

Expected Learning Outcomes

1. Observes the different types of sense organs of animals.

Materials and Equipment

- Hand lens and microscopes
- Chart showing L.S. of ommatidium and compound eye
- Prepared slide of a planarian
- A spider
- A cockroach

Instructions

- Instruct the students to observe the eye spots of the planarian with special reference to appearance and location.
- Direct them to observe the simple eyes of the spider, location and appearance.
- Direct them to observe the eye of the insect with a hand lens.
- Allow them to make appropriate sketches of the sense organs studied and of important parts.

PRACTICAL NO. 25

Study the structure of the human eye and ear using diagrams /models /charts.

Expected Learning Outcomes

1. Makes appropriate sketches of the human eye and the ear.
2. Observes the location and the structure of the human eye and the ear.

Materials and Equipment

- Chart/models of entire human eye and sagittal sections
- Chart showing the retina and retinal cells
- Chart /model of the human ear; external, middle and inner ear

Instructions

- Allow students to observe the location and structure of the human eye.
- Direct the students to relate the main parts of the human eye to their functions.
- Instruct students to study the various parts and functions in balance and in hearing of the human ear.

PRACTICAL NO. 26

Study of major types of excretory organs in animals using diagrams and charts

Expected Learning Outcomes

1. Illustrates gross structure and location of a nephridium .
2. Observes the structure and location of malphigian tubules.
3. Elaborates on the structure of human kidney, ureters , bladder, urethra and their locations.
4. Illustrates the gross internal structure of the kidney.
5. Makes labelled diagrams of observed structures.

Materials and Equipment

- Diagrams/models of nephridium of earthworm.
- Diagrams/models of malphigian tubules of a cockroach.
- Charts/models of human excretory system and slides of L.S of mammalian kidney for study of gross internal structure, diagram of nephron
- Microscope

Instructions

- Allow students to examine the nephridium of earthworm.
- Make them observe the structure and location of the malphigian tubules of cockroach.
- Instruct students to observe the kidney, ureters, urinary bladder of man.
- Make them observe the L.S of the kidney; recognize cortex and medulla, distribution of nephrons and parts of a nephron.
- Instruct them to make labeled line diagrams of observed structures.

PRACTICAL NO. 27

Study of the gross structure of the human skull and vertebral column in relation to their functions of the various parts using models/diagrams/specimens.

Expected Learning Outcomes

1. Describes the morphology of the skull and vertebral column.
2. Relates the structure of the skull to its functions.
3. Analyzes the structure and articulation of the vertebral column in relation to weight bearing and erect posture.
4. Makes appropriate drawings and sketches to highlight prominent and distinctive features of the skull and the various parts of the vertebral column.

Materials and Equipment

Diagrams/models/charts of the human skull and vertebral column with articulations

Instructions

- Make the students observe the following features in the skull:-
  a. Shape, smooth surface and volume
  b. Frontal view with prominent forehead, flattened face, forwardly directed orbits, well formed chin.
  c. Mandible, articulation with skull and dentition.
  d. Inferior, superior, posterior and anterior views of the skull, position of foramen magnum, occipital condyles and articulation with atlas vertebra
  e. Location of auditory apparatus
  f. Nasal region and turbinals
- Ask students to make observations on themselves and on other students and note
  a. three dimensional range of mobility of head and how it moves in relation to the atlas and axis vertebrae
  b. Range of movement of mandible and movements during mastication of solid food material
- Instruct them to observe the following features of the vertebral column
  a. The curvatures of the vertebral column as seen in lateral view
  b. The increase in size of vertebrae from the superior to the inferior part of the vertebral column

c. Vertebrae in the cervical, thoracic, lumbar and sacral regions and the coccyx and the number of vertebrae in each region

d. The relationship of the thoracic vertebrae to the ribs and the nature of the articulation of each rib to the corresponding vertebra

e. The inter – vertebral discs

f. The sacral vertebrae and their relationship to the pelvic girdle

- Instruct to make appropriate drawings and sketches.

PRACTICAL NO.28

Study of the human pectoral and pelvic girdles and appendicular skeleton using specimens/ models/ diagrams

Expected Learning Outcomes

1. Relates the skeletal structure to the range of functions performed.
2. Applies the understanding of skeletal structure and their interrelationships of joints and bones for correct body posture and walking.

Materials and Equipment

- Chart / model /illustration/ computer illustration of the pectoral girdle and the relationship of the girdle to the humerus and to the ribcage.
- Chart /model/ illustration/computer illustration showing the bones of the upper arm, forearm, wrist and hand.
- Chart/model/illustration of pronation and supination and opposability of thumb and fingers.
- Chart / model/ computer illustration of the pelvic girdle, ball and socket joint, thigh, shank, ankle and foot.
- Chart/model /computer illustration of complete articulated human skeleton.

Instructions

- Allow students to observe and study pectoral girdle.
- Allow students to observe and study upper limb.
- Direct the students to study and record the movement of the pelvic girdle, the shoulder joint and the limbs including joints, pronation, supination and opposability.
- Allow students to observe & study pelvic girdle.
- Direct the students to study and record the relationship between structure & function of pelvic girdle, hip joint and lower limb.
- Lead a discussion on weight bearing & bipedalism and structure of the foot.
- Highlight the movements of the leg, joints, heel and toe during walking.

PRACTICAL NO.29

Study of male reproductive system using models or diagrams.

Expected Learning Outcomes

1. Observes and identifies the structure of the male reproductive system.
2. Relates the structure to the functions performed by the parts of reproductive system.

Materials and Equipment

- Chart of vertical sectional view of lower abdominal region of male showing the reproductive organs as well as the urinary system.
- A transverse section of the human testis.
- Electron micrograph of a human sperm
- Microscope

Instructions

- Allow the students to study the chart/diagram/computer illustrations carefully and understand the structure and relative positions of each organ of the male reproductive system.
- Guide them to observe the T.S of testis, to note the various stages of the germinal epithelium, the sperms and their relative arrangements, Leydig cells and Sertoli cells.
- Lead a discussion on the relationship of structure to their functions.

PRACTICAL NO.30

Study of female reproductive system using models or diagrams.

Expected Learning Outcomes

1. Observes and identifies parts of female reproductive system.
2. Uses the microscope to identify follicles of different stages in the human ovary.
3. Elaborates on the electron microscopic structure of human ovum.
4. Observes and identifies the cross section of the uterine wall.
5. Observes developmental stages & position of the foetus within uterus at every trimester.

6. Identifies different components of human placenta.
7. Relates the structure to the functions performed by the various parts.

Materials and Equipment

- Chart of vertical sectional view of the lower abdominal region of a female showing the reproductive organs as well as the urinary system.
- A transverse section of the human ovary.
- Electron micrograph of a human ovum.
- A section/diagram/chart/model showing the uterine wall.
- A section/diagram/chart/model of the human placenta.
- Charts showing the foetus inside the womb at each trimester.
- Microscope

Instructions

- Allow the students to study the chart carefully and understand the structure and relative positions of different organs of the female reproductive system.
- Lead a discussion on the relationship of structure of different organs of the female reproductive system to their functions.

PRACTICAL NO. 31

Study of cross section of primary stem and primary root of a monocot and a dicot

Expected Learning Outcomes

1. Develops the skills of cutting thin sections of parts of plants.
2. Makes accurate observations and study the arrangement of different tissues in primary roots and primary stems under the microscope.
3. Distinguishes anatomical differences between monocot and dicot structures.
4. Makes line drawings of monocot and dicot structures observed under microscope.
5. Labels parts of cross sections and tissues in diagrams.

Materials and Equipments

- Cross section of a dicot root taken from a bean seedling or other similar plant.
- Cross section of an onion root or any other similar plant.

- Cross section of a dicot stem taken from a plant like *Tridax*.
- Cross section of a monocot stem taken from a grass or other similar plant.
- Pith of a *Manihot* stem or potato tuber.
- Razor blades, slides, cover slips , small paint brush, watch glasses.
- Microscope

Instructions

- Guide students to cut thin transverse sections and transfer them to the water in a watch glass.
- Instruct them to mount the thin section to a drop of water on a glass slide and cover it with a cover slip.
- Ask them to observe the prepared slides under the microscope.
- Let them observe the nature and distribution of the different types of tissues and cells.
- Direct them to identify epidermis, cortex, endodermis, pericycle, xylem, phloem and pith of the prepared thin sections.
- Instruct students to make line drawings to demarcate the important structures studied.
- Ask them to label the above mentioned tissues in their diagrams.

PRACTICAL NO.32

Microscopic and macroscopic examination of secondary structure of Dicotyledonous wood.

Expected Learning Outcomes

1. Identifies different tissues in a mature dicot stem.
2. Identifies the growth rings of dicot stem.
3. Develops the ability of preparing a wet mount.

Materials and Equipment

- Part of a dicot stem apex taken from a plant like *Stachytarpheta*
- Part of a secondary thickened dicot plant stem
- Watch glasses with water, slides and cover slips
- Razor blade and small paint brush

- Aniline sulphate solution
- Microscope

Instructions

- Instruct students to cut thin transverse sections of the stem apex and collect in a watch glass filled with water.
- Instruct students to stain with Aniline sulphate solution.
- Ask them to mount sections in a drop of water, on a slide and cover it with a cover slip.
- Let the students observe under low power of microscope and select a thin section where secondary xylem and secondary phloem has just begun to form.
- Direct them to observe under high power and note the distribution of different tissues.
- Let the students observe a cross section of the plant stem and identify important structures such as bark, sap wood, heart wood and growth rings.
- Instruct the students to record their observations.

PRACTICAL NO. 33

Identification of different types of micro-organisms and observation of bacteria and fungi.

Expected Learning Outcomes

1. Identifies major types of micro-organisms.
2. Classifies types of micro-organisms into various taxonomic groups.
3. Uses appropriate techniques for the study of micro-organisms.

Materials and Equipment

- Sample of toddy
- Yoghurt/ curd
- Suspension of Baker's yeast in a sugar solution
- Hay infusion
- Water from a paddy field
- Moldy bread
- Microscopes
- Slides and coverslips

Instructions

- Let the students prepare the following for the microscopic observations;
  a. Sample of toddy
  b. Yoghurt/ curd
  c. Suspension of Baker's yeast in a sugar solution
  d. Hay infusion
  e. Water from a paddy field
  f. Moldy bread

- With samples a – e let them proceed as follows:-
  1. Place a drop of the sample on the center of a slide and cover with a cover slip.
  2. Observe under the high power of microscope.
  3. Note carefully the shape, size and any other features of the micro-organisms in each sample - bacteria, yeast, Protozoa and algae.
- Make them proceed as follows with sample f :-
  1. Place a small fragment of moldy bread in drop of water on a slide. Cover with cover slip.
  2. Observe under the low, medium and high powers of the microscope.
  3. Note the nature and structure of the fungal mycelium.

- Direct the students to record the practical highlighting the following;
  a) Make appropriate drawings and sketches of the various microorganisms.
  b) Make notes on their structure, differences and sizes.
  c) Make comments on procedure and results
  d) Make notes and observations on the budding of yeast.

PRACTICAL NO. 34

Practice techniques for sterilization of water, culture media, glassware, heat labile substances and inoculating needles.

Expected Learning Outcomes

1. Practices techniques used for the sterilization of different materials.

Materials and Equipment

- Autoclave/ Pressure cooker
- Oven
- Culture media
- Inoculating needles
- Cotton wool
- Pipettes

- Conical flasks
- Beakers

Instructions

- Instruct the students to follow the techniques used in sterilization.
  a) Sterilization by dry heat (using direct flame)
     i For inoculating needles, loops and such materials which will not be damaged by heat. Hold in flame of Bunsen burner until red hot.
     ii. In the case of scalpels, metal spatulas and glass rods dip in methylated spirits or ethyl alcohol. Allow excess spirit to drip off and flame the instrument in the Bunsen flame.

  b) Sterilization by dry heat (in the oven)

  For sterilization of dry glassware such as Petri dishes, flasks and pipettes.

  Prepare glassware for sterilization as follows:-

  - Wash glassware, clean and wipe dry thoroughly.
  - Wrap the glassware in Aluminum foil or paper and place in the container.
  - For conical flasks plug the mouth with clean cotton wool and cover the plugs with Aluminum foil.
  - For pipettes plug mouth with cotton wool and heat the tip briefly in the Bunsen flame.
  - Wrap the pipettes individually in Aluminum foil or paper and store in containers.
  - Store all prepared glassware in an oven, at a temperature of 160 ^{0}C. Keep the oven door tightly closed.
  - Keep in oven for 1-2 hrs depending on the amount of glassware in the oven.

c) Sterilization in an autoclave (wet heat).

For sterilization of water/ culture media

i. Prepare the glassware for autoclaving according to the procedure outlined above.
ii. Place the prepared liquid culture media or water in test tubes, flasks or bottles as appropriate.
iii. Plug the containers with cotton wool and cover with Aluminum foil or paper.
iv. If bottles with screw caps are used, loosen the screw cap slightly.
v. Place the containers/ glassware in the autoclave.
vi. Close the lid of the autoclave tightly and open the valve.
vii. Set the pressure at 15 lb / sq inch. and heat to 121 ^{0}C.
viii. Close the valve when water vapor is released.
ix. Autoclave for 15 minutes at 121^{0}C

d) Sterilization by filtration using membrane filter apparatus.

For sterilization of heat labile substances.

i. Sterilize the components of the membrane filter apparatus separately.
ii. Filter the liquid using membrane filters.

- Direct the students to record their observations highlighting the following:
  1. Make appropriate notes of the different types of apparatus used in sterilization.
  2. Make notes and comment on procedures followed.

PRACTICAL NO. 35

Preparation of a simple culture medium (Nutrient Agar) and inoculation with a sample of toddy/ yoghurt.

Expected Learning Outcomes

1. Prepares a simple culture medium.
2. Distinguishes various types of colonies of micro-organisms.
3. Develops skills on inoculation techniques.

Materials and Equipment

- 150 ml flask with screw cap or cotton wool plug
- 100 ml graduated cylinder

- Sterilized rod
- Sterilized Petri dishes
- Inoculating needle
- Bunsen burner
- Autoclave
- Nutrient Agar :-

i.	Peptone	10 g
ii.	Beef extract	10 g
iii.	Sodium chloride	05 g
iv.	Agar	15 g
v.	Distilled water	1000 ml

(Nutrient Agar can be bought from stores)

Instructions

- Direct them to follow the instructions given below.

  i. Preparation of Nutrient agar from prepared material.
- Follow instructions given on the bottle of Nutrient Agar.
- Add the appropriate amount of Nutrient Agar powder to 100 ml of water and boil until agar is dissolved.
- Sterilize the solution by autoclaving at 121 ^{o}C for 15 min (15 lb/sq in.)

  ii. Preparation of agar plates.
  - Pour 15 ml of the sterilized Nutrient Agar into sterilized Petri dishes, using aseptic techniques.
  - Set aside to solidify.

    iii. Inoculation of the plates :
    - Label the bottom of each agar plate using a marker pen.
    - Flame the inoculating loop to redness, allow it to cool and aseptically obtain a loopful of the sample. eg. toddy or yoghurt.
    - Place the loopful of sample on the agar plate at one side or near the edge of the dish and streak on the agar surface in a zig zag pattern
    - Set aside for 24-48 hr. at room temperature
  - Instruct the students to record the practical highlighting the following.
    1. Draw diagrams of the colonies grown on plates.
    2. Make notes on observations and procedure.

PRACTICAL NO. 36

Staining of bacteria found in toddy or yoghurt using a simple stain (Methylene Blue).

Expected Learning Outcomes

1. Prepares smears from solid and liquid samples.
2. Practices simple staining techniques.
3. Uses microscope to examine bacterial smears.

Materials and Equipment

- Toddy, yoghurt and curd samples
- Methylene Blue (dilute solution)
- Slides and coverslips
- Inoculating needles
- Bunsen burner
- Distilled water
- Simple student microscope with low, medium and high power objectives and 5 X, 10 X, 15 X eye pieces.
- Marking pen or wax pencil

Instructions

- Instruct the students to carry out the following procedure.

1. Preparation of smear
    - Clean slides with cleanser, rinse and dry
    - Handle the clean slides by their edges, preferably using a pair of forceps
    - Use marker pen or pencils to label each slide according to the sample used

(A) For the bacterial culture of yoghurt and curd.

- Place 1 or 2 loops full of distilled water on the center of one slide using the sterilized inoculating needle
- Heat the loop until it is red hot and allow to cool.
- Scrape a small amount of the sample using the cooled loop.
- Emulsify the scrapings in the drop of water and spread the suspension in the shape of a circle (the smear should be very thin)

(B) For bacterial culture of toddy.

- Do not use water as the bacteria are already suspended in water. Follow other steps as above
- Let the smear air dry
- Heat fix the smear by passing the slide through a flame two or three times.
- Do not heat fix until the smear is completely air – dried
- Flood the prepared, heat – fixed bacterial smear with 2 or 3 drops of Methylene Blue and allow time for the stain to act (30-60 seconds)
- Wash with tap water to remove the excess stain and gently blot the smear with blotting paper and let it dry.
- Examine the stained smears under the microscope
- Make the students observe and note the colour of the stained bacteria and yeast (in toddy).
- Instruct them to make appropriate diagrams of bacteria/yeast.
- Direct the students to distinguish between bacteria and other microorganisms (yeast).

PRACTICAL NO. 37

Identification of fish, prawn and aquatic plant species used in aquaculture

Expected Learning Outcomes

1. Identifies the main species of fish and prawn used for aquaculture in Sri Lanka.
2. Identifies the major species of ornamental fish and aquatic ornamental plants that are found in Sri Lanka.
3. Compiles reports on field visits to fish breeding stations, shrimp farms and an aquarium.

Materials and Equipment

- Specimens of shrimps such as tiger prawn and Indian white prawn.
- Specimens of fish such as Mossambique tilapia, Nile tilapia, Catla, Rohu and Mrigal

- Specimens of ornamental fish such as guppies, goldfish, carps, gouramies, sword tails, mollies , barbs and angel fish.
- Specimens of aquatic ornamental plants *Cabomba,Ceratophyllum,Vallisneria, Aponogeton, Hydrilla, Pistia*

Instructions

- Allow the students to identify the different species of fish, shrimps , ornamental fish and aquatic plants by using their external features.
- Arrange visits to a shrimp farm, fish breeding station and an aquarium.
- Instruct them to record their observations.

PRACTICAL NO. 38

Study of common insect pests of paddy and coconut in Sri Lanka.

Expected Learning Outcomes

1. Identifies the common insect pests of coconut and paddy in Sri Lanka.
2. Identifies the symptoms of above pest attack by looking at the external appearance of plants.
3. Distinguishes the nature of damage caused to the plants by each pest.

Materials and Equipment

- Specimens and pictures of the following coconut pests.
  a. Black beetle
  b. Red weevil
  c. Coconut Mite
- Specimens and pictures of the following paddy pests
  d. Brown plant hopper
  e. Paddy Bug
  f. Yellow stem borer
- Charts showing damage caused by the attack of each of the above pests /affected plants/affected plant parts by the pests.

Instructions

- Allow the students to examine the external morphology of each pest and note distinctive features by which each can be identified.
- Let students study the charts and observe other important features, the life cycle stages and the life cycle of each pest.
- Direct them to identify affected parts of plant.
- Arrange field visits to observe pests in situ and the nature of damage to the plants.
- Instruct students to record the external features that can be used to identify the above pests.

PRACTICAL NO. 39

Observation of stages of life cycles and study of data on incidence and distribution of the following parasites in Sri Lanka: malarial parasite, filarial parasite and hook worm.

Expected Learning Outcomes

1. Manipulates the microscope to identify different stages of the life cycles of malarial & filarial parasites and hook worms.
2. Identifies the mosquito vectors.
3. Designs relevant means to communicate the distribution pattern of the malaria disease, filariasis and hook worm disease in Sri Lanka.

Materials and Equipment

- Charts of relevant parasites and their life cycles
- Prepared slides of different stages of the life cycles of malaria parasite, filarial parasite and hook worm
- Recent data on the distribution of malaria, filariasis and hook worm infections in Sri Lanka
- Charts, pictures ,specimens and/or slides of vectors
- Live specimens of vectors wherever possible
- Microscope and hand lens

Instructions

- Guide them to identify the different stages of the life cycles of malaria parasite, filarial parasite and hook worm under high power.
- Direct them to draw sketches of these stages and note the features used for identification.
- Direct them to identify malarial and filarial vectors and note their external features.
- Ask them to record their observations.

PRACTICAL NO. 40

Study of different kinds of weeds in a selected area and separation into morpho - species

Expected Learning Outcomes

1. Identifies the general characteristics of weed species.
2. Distinguishes morpho - species using prominent external features of the weed.
3. Identifies the species

Materials and Equipment

- A neglected plot of garden with crop species but overgrown with weeds
- Collecting bags
- Hand lenses

Instructions

- Instruct students to make a rough sketch of the garden plot giving location of crop species.
- Ask students to select random plots of one square foot and study morpho - species distribution of weeds in the plots.
- Guide them to study the characteristics of each separate morpho - species and note down features by which each can be easily identified.
- Identify the species as far as possible.
- Direct them to make sketches recording different types of identified morpho species and make appropriate notes.
- Guide them to make notes on the features of the weed species that enable them to grow faster than the crop species.

Appendix

- Test for Carbohydrates

  1) Test for reducing sugars

  Benedict's Test

  Add 2 cm^3 of a solution of a reducing sugar. Add equal volume of Benedict's solution. Shake and bring gently to boil.

  2) Test for non reducing sugars

  Add 2cm^3 of sucrose solution to 1 cm^3 dil. HCl .Boil for one minute .Neutralize with $NaHCO_3$ and check with pH paper. Carry out Benedict's test.

  3) Test for Starch

  Add 2 cm^3 , 1% starch solution in a test tube and add a few drops of I_2/KI solution.

- Test for Lipids

  Add 2 cm^3 oil to 2 cm^3 of water in a test tube. Add few drops of Sudan III and shake.

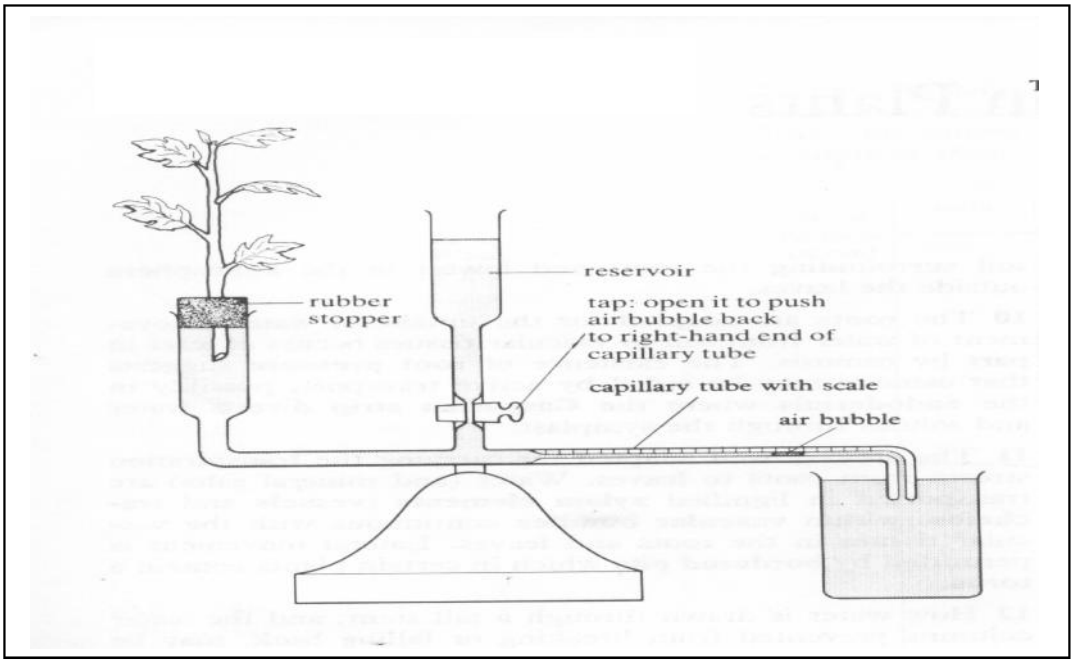
- Test for Proteins

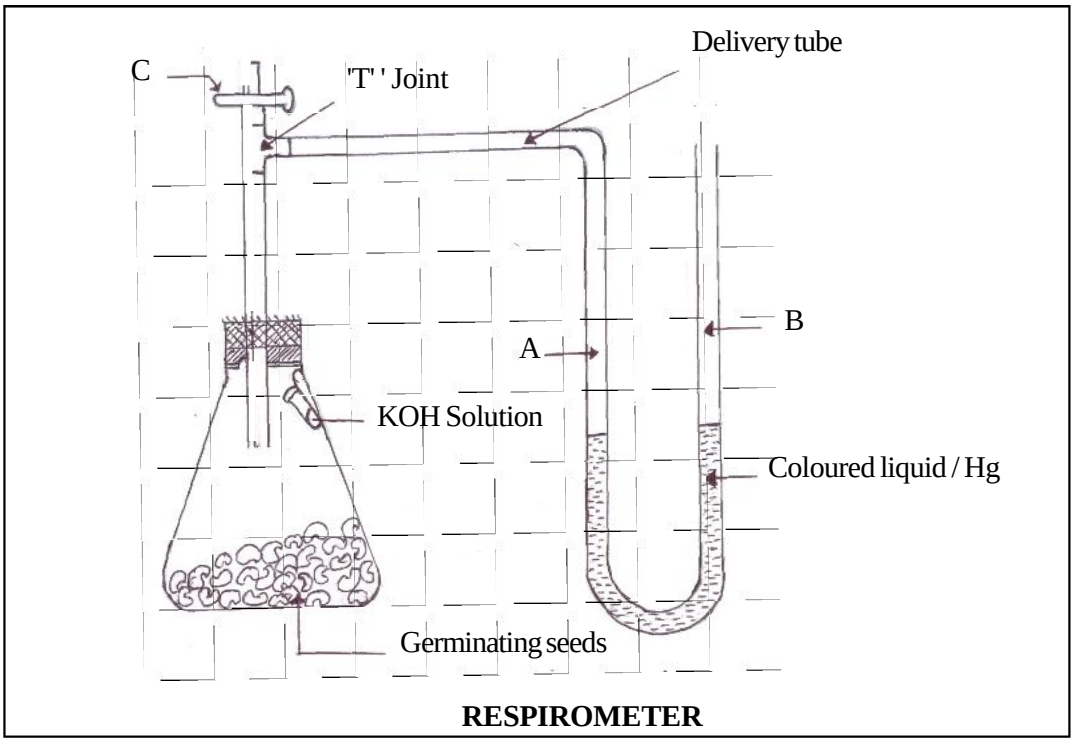
  Biuret test

  Add 2 cm^3 protein solution to equal volume of 5% KOH solution and mix. Add two drops of 1% $CuSO_4$ solution and mix.

  - Preparation of Iodine solution
    Dissolve 1.0 g of Iodine crystals and 2.0 g of Potassium iodide in 300 cm^3 distilled water.
  - Preparation of Formalin to preserve specimens
    Add 10 cm^3 of commercial Formalin to 90 cm^3 of distilled water.
  - Preparation of macerated material
    Add Conc. HNO_3 to plant material. Boil for about five minutes in a water bath. Check the consistency with a glass rod.

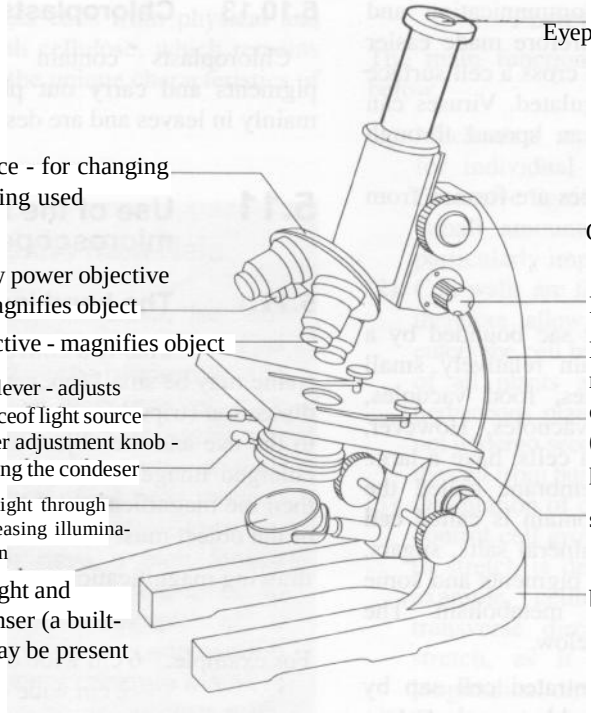
GANONG'S POTOMETER

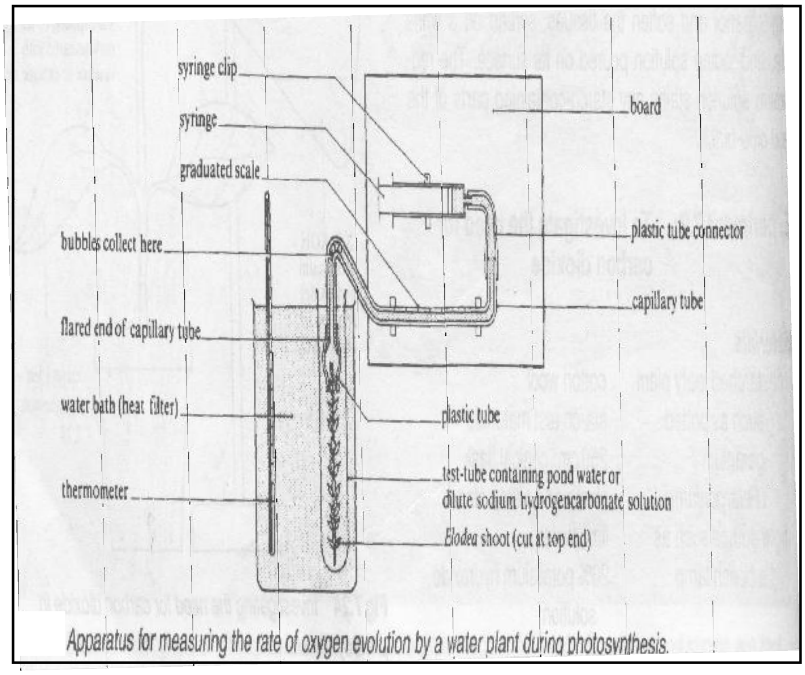




RESPIROMETER

COMPOUND LIGHT MICROSCOPE





Apparatus for measuring the rate of oxygen evolution by a water plant during photosynthesis.