UNIVERSITY OF KERALA

THIRUVANANTHAPURAM

COMPLEMENTARY COURSE

BOTANY

For

FIRST DEGREE PROGRAMME IN

ZOOLOGY/ HOME SCIENCE/BIOCHEMISTRY

UNDER

CHOICE BASED CREDIT- SEMESTER SYSTEM

(w.e.f. 2019 admission onwards)
SEMESTER-I
MICROTECHNIQUE, ANGIOSPERM ANATOMY AND REPRODUCTIVE BOTANY

SEMESTER-II
PHYCOLOGY, MYCOLOGY, LICHENOLOGY, BRYOLOGY, PTERIDOLOGY, GYMNOSPERMS AND PLANT PATHOLOGY

SEMESTER-III
SYSTEMATIC BOTANY, ECONOMIC BOTANY, ETHNO BOTANY AND PLANT BREEDING

SEMESTER-IV
PLANT PHYSIOLOGY, PLANT ECOLOGY, HORTICULTURE AND PLANT BIOTECHNOLOGY
<table>
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<tr>
<th>Course code</th>
<th>Course title</th>
<th>Semester I</th>
<th>Semester II</th>
<th>Semester III</th>
<th>Semester IV</th>
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<tr>
<td></td>
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<td>Contact hours</td>
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<td>BO1131</td>
<td>Microtechnique, Angiosperm Anatomy and Reproductive Botany</td>
<td>2</td>
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<td>BO1231</td>
<td>Phycology, Mycology, Lichenology, Bryology, Pteridology, Gymnosperms and Plant Pathology</td>
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<td>BO1331</td>
<td>Systematic botany, Economic botany, Ethno botany and Plant Breeding</td>
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<td>BO1431</td>
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Total: 14
SEMESTER-I
MICROTECHNIQUE, ANGIOSPERM ANATOMY AND REPRODUCTIVE BOTANY

Course code: BO 1131, Number of credits: 2

Number of contact hours: (Lecture - 36 hrs : Practical - 36 hrs) Total - 72 hrs

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<td>Microtechnique</td>
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<tr>
<td>Angiosperm anatomy</td>
<td>20 hrs</td>
<td>30 hrs</td>
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<tr>
<td>Reproductive Botany</td>
<td>10 hrs</td>
<td>04 hrs</td>
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<td><strong>Total</strong></td>
<td>36 hrs</td>
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Aim of the course: To generate awareness about anatomical features of Angiosperms & reproductive biology as well as to learn techniques for micro preparations.

Objectives:
- To develop skills for preparation and identification of microscopic structures
- To distinguish various tissue systems and internal structure
- To acquire basic knowledge about embryo development and pollen grains

MODULE-I
Microtechnique 6 hrs

1. Killing and Fixing agents – Carnoy’s formula, FAA.
2. Stains and Staining techniques- Double staining. General account; Stains: Saffranin, Haematoxylin, Acetocarmine.

MODULE-II
Angiosperm Anatomy 10 hrs

1. Objective and scope of plant anatomy
2. Tissues – Meristems, Definition, Classification based on origin, position, growth patterns, functions.
5. Tissue systems – Epidermal tissue systems, Ground tissue systems & vascular tissue systems. Different types of vascular arrangements
MODULE-III  

**10 hrs**

1. Primary structure – Root, stem and leaf [Dicot & Monocot]. Secondary growth (Stellar and extra stellar)- Root and stem- cambium (structure and function) annual rings, heart wood and sap wood, tyloses, ring porous wood and diffuse porous wood, Periderm formation-Phellum, Phellogen and Phelloderm ; Lenticels

**Practical**  

**32 hrs**

1. Familiarize Killing and Fixing agents, Stains
2. Simple permanent tissue – Parenchyma, Chlorenchyma, Aerenchyma, Collenchyma and Sclerenchyma
3. Primary structure – Dicot stem: *Centella*.
4. Monocot stem: Grass.
5. Dicot root: Pea or *Limnanthemum*
6. Monocot root: *Colocasia*.
7. Secondary structure - Stem [Normal type]- *Vernonia*.
8. Secondary structure - Root [Normal type]- *Carica papaya*; Aerial root - *Tinospora*/*Ficus*.
9. Anomalous secondary thickening – *Boerhaavia*

MODULE- IV  

**Reproductive Botany**  

**10 hrs**

1. Micro sporogenesis - structure and functions of wall layers.
2. Development of male gametophyte - Dehiscence of anther.
4. Pollination - Fertilization - Double fertilization. Structure of Embryo-Dicot [*Capsella*]

**Practical**  

**4 hrs**

Students should be familiar with the structure of anther and embryo, (Permanent slides can be used)

**REFERENCES**


8
SEMMESTER-II

PHYCOLOGY, MYCOLOGY, LICHENOLOGY, BRYOLOGY, PTERIDOLOGY, GYMNOSPERMS AND PLANT PATHOLOGY

Course code: BO 1231, Number of credits: 2

Number of contact hours: 36 hrs (Lecture); 36 hrs (Practical) Total- 72 hours

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<tr>
<td>Phycology</td>
<td>09 hrs</td>
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<tr>
<td>Mycology</td>
<td>09 hrs</td>
<td>08 hrs</td>
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<tr>
<td>Plant Pathology</td>
<td>03 hrs</td>
<td>04 hrs</td>
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<tr>
<td>Bryology</td>
<td>06 hrs</td>
<td>06 hrs</td>
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<tr>
<td>Pteridology</td>
<td>06 hrs</td>
<td>06 hrs</td>
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<tr>
<td>Gymnosperms</td>
<td>03 hrs</td>
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<td><strong>Total</strong></td>
<td>36 hrs</td>
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Aim of the course: To create awareness about the world of microbes and non flowering plants.

Objectives:

⇒ To familiarize characteristic features of microbes and their significance in environment
⇒ To generate idea about types of algae, fungi, lichen and their economic as well as evolutionary significance
⇒ To familiarize the students the characteristic features, life cycle and evolutionary significance of Bryophytes, Pteridophytes and Gymnosperms.
⇒ To impart knowledge about diseases in plants

MODULE-I

Phycology 9 hrs

1. Salient features of the following major groups with reference to the structure, reproduction and life cycle of the types given below (Excluding the developmental details):
   a. Cyanophyceae - *Nostoc*
   b. Chlorophyceae - *Chlorella, Oedogonium* and *Chara*
   c. Phaeophyceae - *Sargassum*
   d. Rhodophyceae - *Polysiphonia*

Practical 8 hrs

1. Make micro preparations of vegetative and reproductive structures of the types mentioned in the syllabus.
2. Identify the algal specimens up to the generic level and make labeled sketches of the specimens observed
SEMESTER-II

MODULE-II

Mycology 9 hrs

1. Characteristic features of the following major groups with reference to the structure, reproduction and life cycle of the types given below (Excluding the developmental details)–
   a. Zygomycotina - Rhizopus
   b. Ascomycotina
      i. Discomycetes - Peziza
   c. Basidiomycotina
      i. Teliomycetes - Puccinia
   d. Economic importance of Fungi

Lichenology

General account and economic importance; structure, reproduction and life cycle of Usnea

Practicals 8 hrs

A detailed study of structure and reproductive structures of types given in the syllabus and submission of record.

Rhizopus, Peziza, Puccinia. And Usnea.

PlantPathology 3 hrs

1. A brief account on the following plant diseases with reference to the symptoms, causative organism, spread of the disease and effective control measures.
   a. Brown spot disease of Paddy
   b. Powdery mildew of Rubber
   c. Tapioca Mosaic Virus
   d. Quick wilt of Pepper

2. Method of preparation and mode of action of the following fungicides- Bordeaux mixture, Tobacco decoction.

Practical 4 hrs

Students are expected to observe the symptoms and causal organisms of all plant diseases mentioned above.

MODULE-IV 6 hrs

Bryology

1. Introduction and Classification
2. Study of the habit, thallus organization, vegetative and sexual reproduction and alternation of generation of the following types (Developmental details are not required).
   Riccia, Funaria
3. Economic Importance of Bryophytes.
SEMESTER-II

Practical 6 hrs

1. Riccia— Habit - Internal structure of thallus – V. S. of thallus through archegonia, antheridia and sporophyte
2. Funaria— Habit, V. S. of archegonial cluster, V .S. of antheridal cluster, Sporophyte V.S.

Pteridology 6 hrs

1. Introduction: General characters morphological and phylogenetic classification.
2. Study of the habitat, habit, internal structure, reproduction and life cycle of the following types (Developmental details not required). Selaginella and Pteris

Practical 6 hrs

2. Pteris- Habit, Rhizome and petiole T. S., sporophyll T.S

MODULE-V

Gymnosperms 3 hrs

1. Introduction and classification of gymnosperms.
2. Study of the Habit, Anatomy, Reproduction and life cycle of -Pinus
   (Developmental details are not required)

Practical 4 hrs


REFERENCES

5. Gupta V .K. and Varshneya U. D (1967) – An Introduction to Gymnosperms
SEMESTER-II

SEMESTER-III

SYSTEMATIC BOTANY, ECONOMIC BOTANY, ETHNO BOTANY, PLANT BREEDING

Course code: BO 1331, Number of credits: 3

Number of contact hours: (Lecture 54 & Practical 36) Total-90 hrs

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<td>Systematic Botany</td>
<td>33 hrs</td>
<td>32 hrs</td>
</tr>
<tr>
<td>Economic Botany</td>
<td>08 hrs</td>
<td>04 hrs</td>
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<tr>
<td>Ethnobotany</td>
<td>02 hrs</td>
<td>00 hrs</td>
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<tr>
<td>Plant Breeding</td>
<td>11 hrs</td>
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<td><strong>Total</strong></td>
<td>54 hrs</td>
<td>36 hrs</td>
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**Aim of the course:** To understand classification, identification and ethnobotanical importance of angiosperms along with plant breeding techniques.

**Objectives:**

- To introduce importance of morphological characters in classification and plant identification.
- To develop skill in identification of plants.
- To acquire knowledge about economic, ethnobotanical significance and pharmacognosy of plants
- To get knowledge about plant breeding techniques

**MODULE- I**

**Systematic Botany** 11 hrs

1. Floral morphology: Parts of a flower, types of inflorescence – Cymose (Simple, monochasial & Dichasial), Racemose- (Simple raceme, Corymb, Spike, Head), Special type- Cyathium (Brief account only) aestivation and placentation, Types of Fruits - Simple fruits - dry (Pea), Fleshy (Mango), Aggregate fruits (*Polyalthia*), Multiple fruits (Jack fruit) - Floral diagram and Floral formula.
2. Definition, scope and significance of Taxonomy.
3. Systems of classification:
   a. Artificial
   b. Natural - Bentham and Hooker (detailed account)
   c. Phylogenetic

**MODULE-II** 22 hrs

A study of the following families with emphasis on the morphological peculiarities and economic importance of its members. (Based on Bentham and Hooker’s System)
SEMESTER-III

1. Annonaceae
2. Malvaceae
3. Rutaceae
4. Leguminosae
5. Rubiaceae
6. Asteraceae
7. Apocynaceae
8. Solanaceae
9. Verbenaceae
10. Euphorbiaceae
11. Liliaceae
12. Poaceae

Practical / fieldwork  32 hrs

1. Students must be able to identify the angiosperm members included in the syllabus. Draw labeled diagram of the habit, floral parts, L.S of flower, T.S of ovary, floral diagram, floral formula and describe the salient features of the member in technical terms.
2. Students must submit the practical records at the time of practical examination.

MODULE-III

Economic Botany  8 hrs

Study of the Botanical name, Family, Morphology of useful parts, and utility of the following;
- Cereals and Millets – Paddy and Ragi
- Legumes - Ground nut, Blackgram.
- Sugar yielding plants - Sugarcane.
- Spices & condiments - Cumin, Clove, Cardamom and Pepper
- Fibre - Cotton
- Dyes - Henna
- Resins - Asafoetida.
- Tuber crops - Tapioca, Colocasia.
- Tropical Fruits - Banana, Jackfruit.
- Oil yielding - Sesame oil, Coconut.
- Medicinal plants - Ocimum, Adhatoda, Sida, Turmeric.

Practical  4 hrs

Identify the economic products obtained from the plants mentioned under Economic Botany.

MODULE-IV

Ethnobotany  2 hrs

1. Study of common plants used by tribes-Neem, Trichopus zeylanicus
MODULE-V

Plant Breeding

1. Introduction, objectives in plant breeding.
2. Plant introduction - Agencies of plant introduction in India, Procedure of introduction -
3. Acclimatization - Achievements.
5. Procedure of hybridization, inter generic, inter specific, inter varietal hybridization with examples. Composite and synthetic varieties.
7. Polyploidy breeding (brief account).
8. Breeding for disease resistance (brief account).
9. Mutation breeding (brief account).

REFERENCES

1. Acquaah G (2007). Principles of Plant Genetics and Breeding, Blackwell Publishing Ltd. USA
SEMESTER-IV

PLANT PHYSIOLOGY, PLANT ECOLOGY, HORTICULTURE AND PLANT BIOTECHNOLOGY

Course Code: 1431, Number of credits: 3

Number of contact hours: 54 hrs (Lecture); 36 hrs (Practical) Total-90 hrs

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<td>Plant Physiology</td>
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<td>Plant Ecology</td>
<td>08hrs</td>
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<tr>
<td>Horticulture</td>
<td>06hrs</td>
<td>02hrs</td>
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<tr>
<td>Plant Biotechnology</td>
<td>10hrs</td>
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<td><strong>Total</strong></td>
<td><strong>54 hrs</strong></td>
<td><strong>36 hrs</strong></td>
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Aim of the course: To create awareness about physiological aspects of growth & metabolism along with knowledge about Ecology, horticulture and Biotechnology

Objectives:

- To understand physiology of absorption, photosynthesis and respiration.
- To study ecosystem and ecological modifications
- To generate awareness about horticultural techniques.
- To familiarize plant tissue culture techniques

MODULE-I

Plant Physiology 10 hrs

1. General introduction: physiological processes, their significance and applications.
2. Water relations of plants: Importance of water to plant life.
   b. Ascent of sap: vital and physical theories.
3. Mineral nutrition: macro and micro elements, role of essential elements and their deficiency symptoms. Mechanism of mineral absorption (a) passive absorption-exchange and Donnan equilibrium (b) active absorption-carrier concept.
 MODULE-II 10 hrs

 MODULE-III 10 hrs
3. Translocation of solutes: Path way of movement, phloem transport, mechanism of transport - Munch hypothesis, protoplasmic streaming theory - activated diffusion hypothesis, electro osmotic theory.

Practical 15 hrs
1. Water potential of onion peel / Rhoeo peel by plasmolytic method
2. Papaya petiole osmoscope.
3. Determination of water absorption and transpiration ratio.
4. Measurement of rate of transpiration using Ganong’s potometer or Farmer’s potometer.
5. Evolution of oxygen during photosynthesis.
7. Ganong’s respirometer and measurement of R.Q.
8. Alcoholic fermentation using Kühne’s fermentation vessel.

 MODULE-IV

Plant Ecology 8 hrs
1. Definition-Scope and relevance to society and human environment. Need for public awareness
2. Ecosystems-Concept of an ecosystem- structure and function of an ecosystem-
4. Ecological succession-Definition- primary, secondary- hydrosere.
5. Food chains -Food web & ecological Pyramids.
6. Introduction- types, characteristic features, structure and functions of the following ecosystems.
SEMESTER-IV


Practical 13 hrs

1. Study of ecological and anatomical modifications of Xerophytes, Hydrophytes, Halophytes, Epiphytes and Parasites.
2. Observation and study of different ecosystems mentioned in the syllabus.

MODULE-V

Horticulture 6 hrs

1. Introduction to Horticulture
2. Garden tools and implements - Lawn mower, hand trowel, nursery spade, spade fork, garden hoe, weeder, tillers
3. Methods of vegetative propagation: Cutting, grafting, budding, layering, special methods of propagation,
4. propagation by seeds.
5. Media for propagation of plants — soil, sand, peat, sphagnum moss, vermiculture, soil mixture,
6. Nursery beds
7. Manures – organic and inorganic

Practical 2 hrs


MODULE - VI

Biotechnology 10 hrs

1. Introduction – History – major achievements – Biotechnology in India

Practical 6 hrs

1. Preparation of media, sterilization, inoculation and callus induction (Demonstration only).

REFERENCES

MODEL QUESTION PAPER

FIRST SEMESTER B. SC. DEGREE (CBCSS) EXAMINATION

Complementary Botany for Zoology, Home Science and Biochemistry

BO1131- Microtechnique, Angiosperm Anatomy and Reproductive Botany
(2019 Admission Onwards)

Time : 3 Hours Max. Marks : 80

(Draw Diagrams wherever necessary)

SECTION- A

I. Answer all Questions, each carries one mark.

1. Name a killing and Fixing fluid
2. What are Tyloses?
3. What is middle lamella?
4. Define exarch condition
5. What is Dendrochronology?
6. Comment on closed vascular bundle
7. Write a note on Orthotropous ovule
8. What is Coleoptile?
9. What is palynology?
10. Name a complex tissue

(10x1 = 10 marks)

SECTION –B

II. Answer any eight of the following. Each carry two marks.

11. Comment on FAA
12. What is Histogen Theory
13. What are Annual rings
14. Explain Lenticels and their function
15. Give an account of laticiferous tissue
16. Write a note on Tapetum
17. Distinguish between endothecium and endothelium
18. Write down the structure of monocot embryo
19. Draw a labelled diagram of a bicollateral vascular bundle
20. Describe mesophyll tissue
21. What is double fertilization?
22. Describe glandular tissue

(8x2=16 marks)
MODEL QUESTION PAPER

SECTION –C

III. Answer any six of the following not more than 120 words. Each carry four marks.

23. Describe with labelled diagram the structure of Dicot leaf
24. Explain the salient features of periderm.
25. Distinguish between monocot and dicot root
26. Describe phloem and its function
27. Describe microsporogenesis
28. Describe different types of endosperm
29. Write an account heartwood and sapwood
30. Describe anomalous secondary thickening in Boerhaavia stem
31. Explain Hydathodes and the phenomenon of guttation

(6x4=24 marks)

SECTION –D

IV. Write an essay on any two of the following, each carry 15 marks.

32. Explain meristematic tissues and various theories of apical organization of stem
33. Give an account of normal secondary thickening in a dicot stem with labelled diagrams
34. Describe megasporogenesis and development and structure of Polygonum type of embryosac
35. Write an essay on permanent tissues with suitable diagrams

(2x15=30)
MODEL QUESTION PAPER
SECOND SEMESTER B. SC. DEGREE (CBCSS) EXAMINATION

Complementary Botany for Zoology, Home Science and Biochemistry
BO1231-Phycology, Mycology, Lichenology, Bryology, Pteridology,
Gymnosperms and Plant Pathology
(2019 Admission Onwards)

Time : 3 Hours  Max.Marks : 80

(Draw Diagrams wherever necessary)

SECTION- A

I. Answer all Questions, each carries one mark.
1. Pigment which give red colour to Rhodophyceae.
2. Name a unicellular algae.
3. Reserve food material of Phaeophyceae.
4. Name the Causative organism of Quick Wilt of Rubber.
5. Name a coprophilous Fungus.
6. What is Peristome?
7. Write a note on Cup Fungi.
8. Give an example for fungicide.
9. What is Yellow Shower?
10. Give an example for heterosporous pteridophyte.

(10x1=10 marks)

SECTION –B

II. Answer any eight of the following.Each carry two marks.
11. Why the endosperm of Pinus is haploid?
12. What are Pyrenoids?
13. Structure of the thallus of Rhizopus.
14. Write any two economic importance of Lichens.
15. Write short note on heteroecious fungus.
16. Explain Polyembryony
17. Write about any two root characters shown by Rhizophore of Selaginella.
18. Describe the receptacle in Sagassum.
19. Describe the mode of reproduction in Chlorella.
20. Write the difference between teleutospores and uredospores.
21. What are dwarf shoots?
22. What is alternation of generation?

(8x2=16 marks)
MODEL QUESTION PAPER

SECTION –C

III. Answer any six of the following not more than 120 words. Each carry four marks.

23. Describe with labelled diagram the structure of sporophyte of Funaria.
24. Explain the salient features of Phaeophyceae.
25. Explain the parts of globule and nucule of Chara.
26. Describe the different types of pigments in Algae.
27. Write the ecological and economic importance of Usnea.
28. Describe the reproduction in Pteris.
29. Write an account on the reproduction in Oedogonium.
30. Write the causative organism, symptoms and control measures of Powdery Mildew of Rubber.
31. Explain the xerophytic adaptations found in the anatomy of Pinus needle.

(6x4=24)

SECTION –D

IV. Write an essay on any two of the following, each carry 15 marks.

32. Explain with diagrams the structure, reproduction and life cycle of Polysiphonia.
33. Give an account of different stages of life cycle of Puccinia with suitable Diagrams.
34. Describe the vegetative, sexual reproduction and alternation of generation in Riccia.
35. Write an essay on the reproduction and life cycle of Selaginella.

(2x15=30)
MODEL QUESTION PAPER

FOURTH SEMESTER B. SC. DEGREE (CBCSS) EXAMINATION

Complementary Botany for Zoology, Home Science and Biochemistry
BO 1431: Plant Physiology, Plant Ecology, Horticulture and Plant Biotechnology
(2019 Admission Onwards)

Time : 3 hours Max. Marks. 80

(Draw Diagrams wherever necessary.)

SECTION – A

I. Answer all questions in one word or one sentence. Each question carries one Mark.

1. Define Totipotency
2. What is Imbibition?
3. What is R.Q.?
4. Which are ‘turgor operated valves’ in plants?
5. Name any two antitranspirants
6. Which are primary macro nutrients?
7. What is Redifferentiation?
8. Expand RuBP
9. What are Lithophilous halophytes?
10. What are drought escaping plants?

(10x1=10 Marks)

SECTION – B

II. Answer any eight questions, not to exceed a paragraph. Each question carries two marks.

11. What is substrate level phosphorylation? Give an example.
12. Write a note on plasmolysis.
13. Distinguish between apoplastic and symplastic pathways.
14. Comment on cohesion and adhesion properties of water.
15. What is Guttation?
16. Mention symptoms of deficiency due to phosphorus.
17. In a non-turgid cell DPD = OP – WP, explain.
18. How wind influence stomatal transpiration?
19. Write four major differences between respiration and photo respiration.
20. Write about organic fertilizers.
21. Write a note on physiological effects of cytokinin.
22. Define food chain.

(8x2=16 Marks)
SECTION – C

III. Answer any six questions, not to exceed 120 words. Each question carries four marks.

23. Explain the different phases of growth.
24. How plant cell act as an osmotic system?
25. Explain the structure of chloroplast with diagram.
26. Explain Red drop and Emerson’s enhancement effect.
27. Write is note on water potential and its components.
29. What are different types of ecological pyramids?
30. Explain the role of Phytchrome in flowering.
31. Explain cyclic photophosphorylation with illustration

(6x4=24 Marks)

SECTION – D

IV. Write essay on any two of the following, not more than three pages. Each question carries 15 marks.

32. Explain C3 pathway and briefly explain how it differs from C4 pathway?
33. Define callus and how it is produced? Explain somatic embyogenesis
34. What is ecological succession? Describe kinds of succession and mechanisms of succession.
35. Explain Krebs cycle and write a brief note on its significance.

(2x15=30 Marks)
MODEL QUESTION PAPER
B. SC. DEGREE PROGRAMME (CBCSS) PRACTICAL EXAMINATION

Botany Complementary Practical -Course Code: BO1432

1. Make suitable micropreparation of A, identify giving reasons and describe its structure with the help of labelled diagram. Leave the preparation for valuation. (Preparation-2, Labelled Diagram-2, Reasons-3, Identification-1) (8 Marks)

2. Refer the specimen B to its family giving reasons. (8 Marks)
   (Identification-1, Reasons upto series-2, Description of plant in technical terms -2, Family characters-2)


4. Make a suitable micropreparation of E. Identify the ecological group and write the anatomical adaptations. (5 Marks)
   (Ecological group-1, Morphological Adaptations-2, Anatomical Adaptations-2)

5. Identify and draw labelled diagram of F (3 Marks)
   (Identification-1, Labelled diagram- 2)

6. Identify the disease G and name the causative organism. (2 Marks)
   (Disease-1, Causative organism-1)

7. With the help of a labelled diagram explain the aim and working of the experiment H. (Aim-1, Labelled Diagram-1, Working-2) (4 Marks)

8. Identify and write notes on I (3 Marks)
   (Identification-1, Notes-2)

9. Spot at sight specimens, J, K and L (3 x 3 = 9 Marks)
   (Major group 1, Genus-1, Part of the plant-1)

10. Write the binomial, family and morphology of the useful part of M and N (3x2=6 Marks)
    (Binomial 1, Family-1, Morphology-1)

Record -20 marks (Content-15, Neatness-5)
KEY TO SPECIMENS

A. Anatomy - Primary Root/Stem
   Normal Secondary Dicot stem/Root (*Vernonia*/Papaya)/Aerial Root (*Ficus*/
   *Tinospora*) Anomalous Secondary Dicot Stem (*Boerhaavia*)

B. Taxonomy

C. Thallophyta/Bryophyta

D. Pteridophyta/Gymnosperm

E. Ecology-Hydrophyte/Xerophyte/Epiphyte

F. Embryology

G. Plant Pathology

H. Plant Physiology

I. Stains/Fixatives

J. Thallophyta

K. Bryophyta/Pteridophyta

L. Gymnosperms

M. Economic Botany

N. Economic Botany