

**COMPLEMENTARY COURSES FOR MODEL-II  
(VOCATIONAL) B Sc ZOOLOGY - AQUACULTURE**

**COMBINATION OF COURSES AND SEMESTER-WISE DISTRIBUTION**

Sem.	Course category	Course code	Course title	Instr. hrs.*		Credits
				Th.	Pr.	
I	Compl.1	BO1CMVOT01	Plant Diversity and Plant Pathology	54	36	2 + 1
II	Compl.2	BO2CMVOT02	Plant Physiology	54	36	2 + 1
III	Compl.3	BO3CMVOT03	Angiosperm Taxonomy and Economic Botany	54	36	3 + 1
IV	Compl.4	BO4CMVOT04	Anatomy and Applied Botany	54	36	3 + 1

**SEMESTER I**

**Complementary course 1                      Code: BO1CMVOT01**  
**PLANT DIVERSITY AND PLANT PATHOLOGY**  
**For B. Sc. Zoology Model II - Vocational**  
**(Theory 54 hrs; Practical 36 hrs; Credits 2 + 1)**

**Objectives:**

- Acquire fundamental knowledge in plant science and to make the student to understand that Botany is an integral part of the human life and developments.
- Foster and encourage an attitude of curiosity, appreciation and enquiry of various life forms of plants.
- Understand the diversity of plants with respect to Algae, Fungi, Lichens, Bryophytes, Pteridophytes and Gymnosperms.

**PLANT DIVERSITY (45 hrs)**

**Module 1: Diversity of plants (5 hrs)**

Introduction to the origin of plant diversity in the existing forms of plants, evolutionary trends among plants; general classification of plants – Eichler’s system.

**Module 2: Algae (16 hrs)**

General characters and classification of Algae up to classes (F E Fritsch); range of thallus variation. Reproduction and life history of the following groups with reference to the types quoted: Cyanophyceae – *Nostoc*; Chlorophyceae - *Oedogonium* (*Volvox*, *Spirogyra*, *Cladophora* –Vegetative features only); Phaeophyceae - *Ectocarpus* (*Vegetative only*), *Sargassum* (vegetative and reproductive features); Rhodophyceae – *Polysiphonia*. Economic importance of Algae: food, industry, medicine, biofertilizers; algal bloom. Role of algae in Aquaculture.

**Module 3: Fungi (16 hrs)**

General characters and outline on the classification of fungi by Ainsworth. General characters, thallus structure, reproduction and life history of the following groups with reference to the types quoted: Zygomycotina – *Rhizopus*; Ascomycetes – *Xylaria*; Basidiomycetes – *Puccinia*; Deuteromycetes - General characters only. Economic importance of Fungi: as food, in industry, decomposition of

organic matter; fungal toxins and human health. Fungal diseases of fishes: Causative organism, symptoms and control measures of following diseases:

(a) Saprolegniasis (b) Branchiomycosis.

Lichens: Classification based on thallus morphology. *Usnea* - morphology and anatomy of vegetative and reproductive structure. Economic importance of lichen: food, industry, medicine.

**Module 4: Bryophytes (2 hrs)**

General account; *Riccia* - morphology, anatomy, reproduction and life cycle.

**Module 5: Pteridophytes (3 hrs)**

General account; *Selaginella* - morphology, anatomy (stem), reproduction and life cycle.

**Module 6: Gymnosperms (3 hrs)**

General account; *Cycas* - morphology, anatomy (leaf let), reproduction and life cycle.

**PLANT PATHOLOGY (9 hrs)**

**Module 7: Plant diseases and their control (9 hrs)**

Classification of plant diseases based on causative organism and symptoms; different types of defence mechanisms in plants - morphological, anatomical and physiological; use of fungicides, pesticides and antibiotics for disease control. Study the following diseases with special emphasis on causative organism, symptoms and control measures:

Nut fall of Arecanut, Bacterial blight of Paddy, Leaf mosaic disease of Tapioca, Abnormal leaf fall of Rubber.

**PRACTICAL (36 hrs)**

1. Identification and micro preparation of the following:

**Algae:** Vegetative structure of *Nostoc*, *Volvox*, *Spirogyra*, *Oedogonium*, *Cladophora*, *Polysiphonia*. Vegetative and reproductive structure of *Sargassum*.

**Fungi:** Vegetative and reproductive structure of *Rhizopus*, *Xylaria*, *Puccinia*.

**Lichen:** Morphology of *Usnea* thallus and Apothecium.

**Bryophytes:** *Riccia* thallus anatomy.

**Pteridophyte:** *Selaginella* – Anatomy of Stem and Morphology of Strobilus.

**Gymnosperms:** *Cycas* – Anatomy of leaflet, morphological features of megasporophyll, microsporophyll and ovule.

2. Identify plant diseases mentioned in the syllabus.

**REFERENCES**

1. Ahamdijan, Vernon, Mason H E, 1973. The Lichens. Academic press, New York.
2. Alexopoulos C J, Mims C W, 1983. Introductory Micology. Wiley Eastern, New York.
3. Bhatia K N, 1975. A treatise on Algae. S. Chand and co.
4. Bilgramie K S, Dube H C, 1976. Text Book of Modern Plant pathology. Vikas Publishing House Pvt. Ltd. New Delhi.
5. Chaube H S, Ramji S, 2001. Introductory Plant Pathology. International Book Distributing Co. Lucknow.
6. Chopra R N, Kumra P K, 1988. Biology of Bryophytes. Wiley Eastern Ltd. New Delhi.
7. Fritsch F E, 1945. Structure and Reproduction of Algae Vol. I & II. Cambridge University Press.
8. Gangulee H C, Kar A K, 1993. College Botany Vol. II. New Central Book Agency, Calcutta.
9. Kanika Sharma, 2009. Manual of Microbiology. Ane Books Pvt. Ltd.
10. Mamatha Rao, 2009. Microbes and Non-flowering plants: Impact and applications. Ane Books Pvt. Ltd.
11. Pandey S N, Trivedi P S, 1994. A Text book of College Botany Vol. I.

12. Pandey S N, Trivedi P S, 1998. A Text book of College Botany Vol. II.
13. Pandey B P, 2007. College Botany Vol. I. S.Chand and Company.
14. Pandey B P, 2007. College Botany Vol. II. S Chand and Company.
15. Sharma P D, 2003. Microbiology, Plant Pathology and Biotechnology. Rasthogy Publications.
16. Vasishta B R. Bryophyta. S Chand and Co. New Delhi.

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**SEMESTER II**

**Complementary course 2                      Code: BO2CMVOT02**  
**PLANT PHYSIOLOGY**  
**For B. Sc. Zoology Model II - Vocational**  
**(Theory 54 hrs; Practical 36 hrs; Credits 2 + 1)**

**Objectives:**

- Make the students realize the importance of all physiological processes which take place in plants.
- Understand the mechanism of various physiological processes related to plant life.

**Module 1: Water relations (15 hrs)**

Introduction and unifying principles of plant physiology \*(Reference 14). Plant water relations: physical aspects of water absorption - Diffusion, DP, DPD. Imbibition. Osmosis - OP, Exosmosis, Endosmosis, Plasmolysis. Water potential and its components.

Movement of water in soil towards root by bulk flow; mechanism of water absorption by root - active and passive absorption. Movement of water towards xylem by apoplast and symplast pathway. Ascent of sap – theories - transpiration pull theory, root pressure theory, guttation.

Transpiration: types, mechanism of transpiration and stomatal movement ( $K^+$  - ABA theory), significance and factors affecting transpiration; antitranspirants.

Stress physiology: Water stress

**Module 2: Mineral nutrition (8 hrs)**

Major and minor elements - criteria for essentiality of mineral elements, hydroponics; Absorbable form, function and deficiency symptom of the following mineral nutrients – N, P, K, Mg, B, Fe, Zn.

Nitrogen metabolism: sources of nitrogen, biological nitrogen fixation, mechanism of nitrogen fixation in root nodule of legume; synthesis of aminoacids - reductive and transamination reactions.

**Module 3: Photosynthesis (13 hrs)**

Basic requirements of Photosynthesis: Light - PAR; organs and site of photosynthesis, chloroplast, Photosynthetic pigments, action spectrum, absorption spectrum; Photosynthetic unit; Red drop and Emerson's enhancement effect, two pigment systems,

Mechanism of photosynthesis: light dependent reaction - cyclic and non cyclic photo phosphorylation. Chemi osmotic theory of ATP formation. Light independent reaction (dark reactions) - C3 cycle; brief account on C4 and CAM Cycles. Factors affecting photosynthesis. Photorespiration (brief study only). Blackman's law of limiting factors.

**Module 4: Translocation of organic solutes (6 hrs)**

Substances translocated, path of translocation, direction of translocation; source-sink concept, mechanism of translocation (pressure flow hypothesis).

**Module 5: Growth and Development (12 hrs)**

Seed structure, seed dormancy, causes of seed dormancy, and methods of breaking dormancy. Germination of seeds: physiological changes; growth, growth regions, growth rate, phases of growth, sigmoid growth curve. Plant growth regulators: auxins, gibberellins, cytokinins, abscissic acid and ethylene and their physiological role (brief study only). Abscission, senescence. Photoperiodism: definition - short day plants, long day plants, day neutral plants. Vernalization. Role of phytochrome in photoperiodism.

**PRACTICAL (36 hrs)****Core experiments**

1. Demonstration of osmosis using potato tuber osmoscope/ papaya petiole osmoscope.
2. Separation of leaf pigments by paper chromatography.
3. Compare the stomatal indices of hydrophytes and xerophytes

**Demonstration experiments**

1. Measure the rate of transpiration by Ganong's potometer.
2. Relationship between transpiration and absorption.
3. Measurement of growth using Arc Auxanometer.
4. Demonstration of geographic curvature using Clinostat.
5. Evolution of oxygen during photosynthesis.
6. Mohl's half leaf experiment.
7. Light screen experiment.

**REFERENCES**

1. Hopkins W G, Norman P A, Huner, 2008. Introduction to Plant Physiology. John Wiley & Sons, New York.
2. Jain V K, 2008. Fundamentals of Plant Physiology. S Chand and Co.
3. Kochhar P L, Krishnamoorthy H N. Plant Physiology. Atmaram and sons, Delhi.
4. Kumar and Purohit. Plant Physiology: Fundamentals and Applications. Agrobotanical Publishers.
5. Malik C P, 2002. Plant Physiology. Kalyani publishers.
6. Mukherjee S, Ghosh A K, 2005. Plant Physiology. New Central Book Agency, Calcutta.
7. Noggle G R, Fritz G J, Introductory Plant Physiology. Prentice Hall of India.
8. Pandey S N, Sinha B K, 2006. Plant physiology. Vikas Publishing House, New Delhi.
9. Salisbury F B, Ross C W, 1992. Plant Physiology. CBS publishers and Distributers, New Delhi.
10. Sinha A K, 2004. Modern Plant Physiology. Narosa publishing House, New Delhi.
11. Srivastava H S, 2004. Plant physiology and Biochemistry. Rasthogi publications.
12. Verma V, 2007. Text Book of Plant Physiology. Ane Books Pvt. Ltd.
13. Verma S K, Mohit Verma, 2006. A text book of Plant physiology, Biochemistry and Biotechnology. S Chand and Co.
- \*14. Lincoln Taiz, Eduardo Zeiger, 2015. Plant physiology and Development VI Edn). Sinauer Associates Inc.

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**SEMESTER III**

**Complementary course 3                      Code: BO3CMVOT03**  
**ANGIOSPERM TAXONOMY AND ECONOMIC BOTANY**  
**For B. Sc. Zoology Model II - Vocational**  
**(Theory 54 hrs; Practical 36 hrs; Credits 3 + 1)**

**Objectives:**

- Acquaint the student with the objectives and components of Taxonomy.
- Help the student to understand the systems of classification of angiosperms.
- Help the student to identify the common angiosperm species of Kerala.
- Familiarize the student with plants of immense economic importance.

**ANGIOSPERM TAXONOMY (38 hrs)**

**Module 1: Morphology (10 hrs)**

Leaf - simple, compound; venation and phyllotaxy. Flower as a modified shoot, structure of flower - floral parts, their arrangement, relative position; cohesion and adhesion of floral parts, symmetry of flowers; types of aestivation and placentation; floral diagram and floral formula. Inflorescence: racemose - simple, spike, spadix, catkin, corymb, umbel and head; cymose - simple, monochasial-helicoid and scorpioid; special types - cyathium, verticillaster. Fruits: outline on the classification; Simple: Fleshy - drupe, berry, hesperidium; Dry - Dehiscent - legume, capsule; Indehiscent - Caryopsis, Cypsella, Schizocarpic - lomentum, carcerulus, regma, cremocarp with examples. Aggregate. Multiple: sorosis, syconus. (Examples should be from families prescribed in the syllabus).

**Module 2: Plant classification and Herbarium techniques (8 hrs)**

Importance of plant classification, types of classification - artificial, natural and phylogenetic (brief account only); binomial nomenclature; ICBN (Brief account only). Bentham and Hooker's system of classification (up to series), its merits and demerits. Cytotaxonomy and chemotaxonomy (brief account only). Herbarium techniques; importance of herbarium.

**Module 3: Angiosperm families (20 hrs)**

Study of the following families of Bentham and Hooker's system of classification with special reference to major identifying characters and economic importance: Annonaceae, Malvaceae, Rutaceae, Leguminosae (Mimosaceae, Caesalpiniaceae and Fabaceae), Apiaceae (Umbelliferae), Rubiaceae, Asteraceae (Compositae), Apocynaceae, Lamiaceae (Labiatae), Euphorbiaceae, Areaceae (Palmae), Poaceae (Gramineae).

**ECONOMIC BOTANY                      (16 hrs)**

**Module 4: Classification (10 hrs)**

Classification of economically important plants based on their uses. Study of the following groups of plants with special reference to their botanical name, family, morphology of useful part, economically important products and uses: Cereals - Paddy, Wheat; Pulses - Green gram, Bengal gram; Tuber crops - Tapioca; Spices - Pepper, Cardamom; Beverages - Tea, Coffee; Oil yielding plants - Coconut, Groundnut; Fibre yielding plants - Cotton, Coir; Timber yielding plants - Teak, Rose wood; Latex yielding plants - Para rubber; Bio pesticides - Neem, Tobacco; Ornamental plants - Rose, Orchids, Anthurium.

**Module 5: Medicinal plants (6 hrs)**

Study of the following medicinal plants with special reference to their binomial, family, morphology of useful parts and uses: *Adhatoda*, *Aloe*, *Bacopa*, *Catharanthus*, *Eclipta*, *Neem*, *Ocimum*, *Phyllanthus amarus*, *Rauvolfia*, *Sida*.

**PRACTICAL (36 hrs)**

1. Identify the different types of inflorescences and fruits of typical plants belonging to the families prescribed in the syllabus.
2. Identify typical local plants belonging to the families prescribed in the syllabus.
3. Describe the floral parts in technical terms and draw the L.S. of flower, construct the floral diagrams and write the floral formula of at least one flower from each family.
4. Study the botanical name, family, morphology of the useful part and the uses of the medicinal plants listed in the syllabus. .
5. Study of the groups of plants mentioned in the economic botany syllabus with special reference to their botanical name, family, morphology of useful part, economic products and uses

**REFERENCES**

1. Eames A J, 1969. *Morphology of Angiosperms*. McGraw – Hill, New York.
2. Hill A F, 1952. *Economic Botany: A Text book of Useful Plants and Plant Products*. Tata McGraw-Hill Publishing Company Limited, New Delhi.
3. Jain S K, 1987. *A Manual of Ethnobotany*. Scientific Publishers, Jodhpur.
4. Kochhar S L, 1981. *Economic Botany in the Tropics*. Macmillon India Limited, Delhi.
5. Lawrence G H M, 1951. *Taxonomy of Vascular Plants*. Oxford & IBH, New Delhi.
6. Naik V N, 1984. *Taxonomy of Angiosperms*. Tata McGraw Hill Publishing Co, New Delhi.
7. Pandey S N, S P Misra, 2008. *Taxonomy of Angiosperms*. Ane Books India, New Delhi.
8. Sharma O P, 1993. *Plant Taxonomy*. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
9. Simpson B S, M Conner – Ogorzaly, 1986. *Economic Botany: Plants in Our World*. McGraw Hill Book Company, New York.
10. Singh G, 1999. *Plant Systematics – Theory and Practice*. Oxford & IBH, New Delhi.

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<b>SEMESTER IV</b>
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**Complementary course 4**

**Code: BO4CMVOT04**

**For B. Sc. Zoology Model II - Vocational  
ANATOMY AND APPLIED BOTANY**

**(Theory 54 hrs; Practical 36 hrs; Credits 3 + 1)**

**Objectives:**

- Understand different types of plant tissues.
- Understand the internal structure of different plant organs with reference to their functions.
- Understand the process of normal and anomalous secondary thickening in plants.
- Know the morphological and anatomical adaptations of plants growing in different habitats.
- Understand the applications of botanical knowledge in the field of crop improvement for human prosperity.

**PLANT ANATOMY (34 hrs)****Module 1: Cells and tissues (9 hrs)**

Gross structure of primary and secondary cell walls; structure and function of plasmodesmata; non-living inclusions - cystolith, raphides; Tissues - meristematic and permanent, types of meristems;

simple and complex tissues, secretory tissues (nectaries, hydathodes, mucilage ducts and lactiferous tissue).

**Module 2: Anatomy of plant organs (16 hrs)**

Primary structure of stem and root in dicots and monocots; anatomy of monocot and dicot leaf. Secondary thickening in dicot stem and dicot root; growth rings, dendrochronology, heart wood and sap wood; tyloses; hard wood and soft wood. Anomalous secondary thickening in *Bignonia*.

**Module 3: Ecological anatomy (9 hrs)**

Study of the morphological and anatomical adaptations of the following groups: Hydrophytes – *Nymphaea*, *Hydrilla*; Xerophytes – *Nerium*; Epiphytes - *Vanda*.

**APPLIED BOTANY (20 hrs)**

**Module 4: Plant breeding (10 hrs)**

Objectives of plant breeding, methods of plant improvement - plant introduction, acclimatization, plant quarantine; selection - mass selection, pureline selection and clonal selection; hybridization - intervarietal, interspecific and intergeneric; procedure of hybridization.

**Module 5: Artificial vegetative propagation methods (4 hrs)**

Propagation of plants through cutting, layering - air layering; budding T and patch budding; grafting - tongue and splice grafting. Role of cambium in budding and grafting.

**Module 6: Plant tissue culture (6 hrs)**

Principles of tissue culture, micropropagation - different steps - selection of explants, culture media, sterilization (explants and culture media), callus. Regeneration of plants: organogenesis, somatic embryogenesis; artificial seeds; applications of plant tissue culture.

**PRACTICAL (36 hrs)**

1. Primary structure of stem and root of dicots and monocots; Dicot stem - *Centella*; Monocot stem – Bamboo, grass, asparagus; Dicot root - *Tinospora*; Monocot root - *Colocasia*, *Musa*.
2. Structure of dicot stem and dicot root after secondary thickening; Stem - *Vernonia*, *Eupatorium*; Root - *Tinospora*, *Papaya*.
3. Anomalous secondary thickening in *Bignonia*.
4. Anatomical adaptations of Hydrophytes - *Nymphaea* petiole, *Hydrilla* stem; Xerophytes - *Nerium* Leaf; Epiphytes - Velamen root of *Vanda*.
5. Emasculation of pea or *Caesalpinia* flower.
6. Demonstrate T and patch budding.
7. Demonstration of tissue culture techniques: culture media, surface sterilization and inoculation of explants.
8. Identification of non living inclusions - cystolith, raphides.

**REFERENCES**

1. Christopher E P, 1958. *Introductory Horticulture*. McGraw Hill, New York.
  2. Esau K, 1965. *Plant Anatomy*. Wiley, New York.
  3. Fahn A, 1985. *Plant Anatomy*. Pergamon Press, Oxford.
  4. Hartman H T, D E Kester, 1991. *Plant Propagation: Principles and Practices*. Prentice Hall of India, New Delhi.
  5. Kumar N, 1994. *Introduction to Horticulture*. Rajalakshmi Publications, Nagercoil.
  6. Pandey B P, 1984. *Plant Anatomy*. S Chand and Company, New Delhi.
  7. Vasishta V C, 1978. *Plant Anatomy*. S Nagin and Company, Jalandhar.
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