



Parvatibai Chowgule College of Arts and Science  
(Autonomous)

Accredited by NAAC with Grade 'A+'  
Best Affiliated College-Goa University Silver Jubilee Year Award

DEPARTMENT OF BOTANY

SYLLABUS FOR THREE/FOUR YEAR  
UNDERGRADUATE DEGREE HONOURS  
PROGRAMME IN B.Sc. Botany

(Implemented from the Academic Year 2023-2024  
onwards)

**Annexure A**  
**BSc. BOTANY 4 YEARS HONOURS LIST OF COURSES 2024-25**  
**UNDER NEP 2020**

**COURSE STRUCTURE**

Semester	Course Code	Course Title	Nomenclature	Credits
I	UG-BOT-101	Diversity of Lower Plants I (Microbes, Algae, Fungi)	DSC	4
	UG-BOT-MDC 1	Plant Animal Interaction / Economic Botany	MDC	3
	UG-BOT-SEC 1	Basics in Horticulture	SEC	3
II	UG-BOT-102	Diversity of Lower Plants II (Bryophytes, Pteridophytes, Gymnosperms)	DSC	4
	UG-BOT-MDC 2	Kitchen Gardening	MDC	3
	UG-BOT-SEC 2	Algal Biotechnology	SEC	3
III	UG-BOT-201	Ecology and Conservation	DSC	4
	UG-BOT-202	Cell Biology and Biomolecules	DSC	4
	UG-BOT-203	Ecology and Conservation	DSC	4
	UG-BOT-MDC 3	Basics in Horticulture	MDC	3
	UG-BOT-SEC 3	Basics in Microbiology / Plant pathology	SEC	3
IV	UG-BOT-204	Plant Anatomy and Embryology	DSC	4
	UG-BOT-205	Cytogenetics	DSC	4
	UG-BOT-206	Plant Breeding and Biostatistics	DSC	4
	UG-BOT-207	Enzymes and Its Metabolic pathways	DSC	4
	UG-BOT-VOC 1	Horticulture, Floriculture & Landscaping	VOC	4
V	UG-BOT-301	Plant Physiology	DSC	4
	UG-BOT-302	Systematics of Flowering Plants and Phylogeny	DSC	4
	UG-BOT-303	Techniques and Instrumentation	DSC	4
	UG-BOT-VOC 2	Herbal Cosmetology	VOC	4
VI	UG-BOT-305	Plant Genetic Engineering	DSC	4
	UG-BOT-306	Plant Molecular Biology	DSC	4
	UG-BOT-307	Plant Tissue Culture	DSC	4
	UG-BOT-308	Project	DSC	4
	UG-BOT-VOC 3	Applied Mycology	VOC	4
VI I	UG-BOT-401	Plant Drug Technology and Pharmacognosy	DSC	4
	UG-BOT-402	Bioinformatics	DSC	4
	UG-BOT-403	Evolutionary biology/ Plant-Animal Interaction	DSC	4
	UG-BOT-404	Organic Farming	DSC	4
	UG-BOT-405	Ethno-botanical Concept	DSC	4
VIII	UG-BOT-406	Plant Biotechnology	DSC	4
	UG-BOT-407	Plant Embryology	DSC	4
	UG-BOT-408	Plant Biochemistry	DSC	4
	UG-BOT-409	Industrial Botany	DSC	4
	UG-BOT-410	Bioresource Management	DSC	4



	<b>UG-BOT-307</b> Plant tissue culture <hr/> <b>UG-BOT-PRJ:</b> Project			
<b>VII</b>	<b>UG-BOT-401</b> Plant Drug Technology and Pharmacognosy <hr/> <b>UG-BOT-402</b> Bioinformatics <hr/> <b>UG-BOT-403</b> Evolutionary biology/ Plant-Animal Interaction <hr/> <b>UG-BOT-404</b> Organic Farming	<b>UG-BOT-405</b> Ethno-botanical Concept		
<b>VIII</b>	<b>UG-BOT-406</b> Plant Biotechnology <hr/> <b>UG-BOT-407</b> Plant Embryology <hr/> <b>UG-BOT-408</b> Plant Biochemistry <hr/> <b>UG-BOT-409</b> Industrial Botany	<b>UG-BOT-410</b> Bioresource Management		

# SEMESTER I

## DISCIPLINE SPECIFIC CORE COURSE

### COURSE TITLE: DIVERSITY OF LOWER PLANTS (MICROBES, ALGAE, FUNGI) (THEORY)

**COURSE CODE: UG-BOT-101**

**MARKS: 100 (75 theory + 25 Practical)**

**CREDITS: 4 (3 theory + 1 Practical)**

**COURSE DURATION: 45 HOURS**

**PREREQUISITE COURSES: Biology at XII preferred.**

#### COURSE OBJECTIVES:

This paper provides knowledge on basic knowledge of the lower group of organisms. (microbes, algae and fungi)

#### COURSE OUTCOMES:

Upon successful completion of the course, students will be able:

**CLO1:** State, describe and explain the characters and evolutionary aspects of different groups of lower plants upto fungi.

**CLO2:** Define, Describe, correlate and compare the algae and fossils.

**CLO3:** Position a given alga as per the classification studied.

**CLO4:** Sketch the morphology and anatomy of selected algae and fungi.

#### MODULE I: MICROBES

15 lecs

- 1.1 Cell types, prokaryotic and eukaryotic cells. Evolution of cells. Endosymbiotic theory: Origin of plastids, oxygen revolution
- 1.2 Microbes from the environment (Air, soil and water). Structure of Virus, bacteriophage and TMV.
- 1.3 Five kingdom classification
- 1.4 Distribution, systematic position and life cycle of Cyanophyceae: *Nostoc*.

#### MODULE II: ALGAE AND FUNGI

15 lecs

- 2.1 ALGAE: Classification of algae (Cyanobacteria, Chlorophyta, Phaeophyta and Rhodophyta) following Lee (1999) upto groups with general characters and examples
- 2.2 Type study: Charophyta: *Chara*, Chlorophyta: *Chlamydomonas* or *Chlorella*, Rhodophyta: *Polysiphonia*, Phaeophyta: *Sargassum*.

- 2.3 FUNGI: General characteristics, Classification, economic importance. Systematic position, life history of *Puccinia* and *Penicillium*

**MODULE III: PALEOBOTANY, LICHENS, MYCORRHIZAE AND ECONOMIC IMPORTANCE.** 15 lecs

- 3.1 Fossils and fossilization, importance of fossils, Birbal Sahni institute
- 3.2 Lichens: Structure, Ecological and economic importance of Lichens
- 3.3 Mycorrhizae: Types and significance
- 3.4 Economic and/or ecological importance of Viruses, Bacteriophage, TMV, Cyanobacteria, algae and fungi

**TOTAL 45**

**COURSE TITLE: DIVERSITY OF LOWER PLANTS (MICROBES, ALGAE,  
FUNGI) (PRACTICAL)**

**COURSE CODE: UG-BOT-101**

**MARKS: 25**

**CREDITS: 1**

**PRACTICAL SESSION: 15 (Inclusive of 3 PA)**

1.	Observation and study of Bacterial colonies	1
2.	Isolation and observation of microorganisms from different habitats: Air, soil and water.	3
3.	Morphological study of algal and Blue green algal forms: <i>Oscillatoria / Nostoc, Chara / Spirogyra, Sargassum, Polysiphonia</i>	3
4.	Morphological study of fungal forms: <i>Puccinia, Penicillium, Albugo</i> and <i>Rhizopus</i>	3
5.	Observation of Mycorrhizal root colonization	1
6.	Study of lichens (Permanent slide/ specimen)	1
7.	Study of fossils: (Permanent slide/ specimen)	1
8.	Mini project: i. Collection and field study of locally available Algae, fungi and Lichens	2
	<b>TOTAL</b>	<b>15</b>

**MANDATORY REFERENCES:**

1. Alexopoulos, Constantine J.; Mims, Charles W. (1983). *Introductory Mycology*; 3<sup>rd</sup> edition; New Delhi: Wiley Eastern Limited.
2. Fritsch, F.E., (1956). *The structure and reproduction of the Algae*; Volume I and II. Cambridge University Press.



3. Gupta, P.K. (1999). A Text-book of Cell and Molecular Biology. Rastogi Publications, Meerut, India.
4. Kar, Ashok Kumar; Gangulee, Hirendra Chandra (2006). *College Botany: Volume II*; 2<sup>nd</sup> Edition; Kolkata: New Central Book Agency (P)Ltd.
5. Prescott, H. (2008). *Microbiology*. Boston: McGraw-Hill Higher Education.
6. Verma P.S. and Agarwal V. K. (1998). Cell Biology, Genetics, Molecular Biology, Evolution and ecology. Edn.14

**ONLINE RESOURCES:**

1. <https://www.pdfdrive.com/the-structure-and-reproduction-of-the-algae-d34383978.html>
2. <https://www.pdfdrive.com/virus-an-illustrated-guide-to-101-incredible-microbes-d158088974.html>

**MULTIDISCIPLINARY COURSES (MDC)**

**Plant Animal Interaction**

**COURSE TITLE: PLANT ANIMAL INTERACTIONS**

**COURSE CODE: UG-BOT-MDC 1**

**MARKS: 75**

**CREDITS: 3**

**DURATION: 45 HOURS**

**COURSE OBJECTIVES:**

To bridges the gap between Plants and animal interactions (various disciplines, viz. botany, zoology, microbiology. etc) and apply this knowledge in the area of Biodiversity, Conservation, pollination, crop productivity, biological control and bioprospecting.

**COURSE OUTCOME**

**CLO1:** Would have understood intricate evolutionary relationship between plants and animals including their interdependence.

**CLO2:** Should have learnt the role herbivory in phytochemical evolution and it's importance in plant based drugs.

**CO3:** Would have understood the importance of multicultural practices in the control of pests, organic farming and reduction of synthetic pesticides.

**CLO4:** Able to appreciate the ecosystem services through this plant animal interaction.

**CLO5:** Able to work in field of Research, Forestry and Biodiversity Management.

**MODULE I: DIVERSITY OF PLANT-ANIMAL INTERACTIONS**      **15 lecs**

- 1.1                      Plant animal interactions- Mutualism, Antagonism, Commensalism, Competition, Multi-trophic level interactions; Coevolution and co-speciation of plants and animals;

- 1.2 Evolutionary history of interactions and evidences in the geological past; principle of allocation. Adaptive radiation.
- 1.3 Plant communities as animal habitats- Adaptations, ecological segregation within and between habitats.
- 1.4 Mechanisms of habitat selection, habitat selection theory, Plant-animal interactions in agricultural ecosystems; future directions.

**MODULE II: POLLINATION BIOLOGY & FRUITS, SEEDS AND DISPERSAL AGENTS** 15 lecs

- 1.1 Pollination: Importance of cross pollination. Special differentiation associated with pollinator attraction – advertisement and reward (pollen. Nectar, elaiophores, resin glands, osmophores, optical displays and visual clues).
- 1.2 Floral adaptation to different pollinators; insect visitors, birds, bats, non-flying animals. Sapromyiophily, Broodsite pollination; fig-wasp interaction and pollination.
- 1.3 Pollination biology and gene flow: foraging theory, foraging strategies and time-niche strategies.
- 1.4 Plant adaptations - Fruit chemistry (chemical compartmentalization - pulp and seed, nutritional aspect of pulp, palatability inhibitors and toxins). Seed coat, seed toxins. Phenology; signals, fruit size and fruit production. Dispersers: range of seed dispersers, frugivores as foragers.
- 1.5 Animal adaptations – External and internal morphology, digestive physiology, behaviours.

**TOTAL 30**

**COURSE TITLE: PLANT ANIMAL INTERACTIONS**

**COURSE CODE: UG-BOT-MDC1**

**MARKS: 25**

**CREDITS: 1**

**PRACTICAL SESSION: 15 (Inclusive of 3 PA)**

1.	Study of trap mechanisms in carnivorous plants	2
	1. Pitfall traps of Pitcher plants ( <i>Nepenthes</i> )	
	2. Flypaper of Sundews ( <i>Drosera</i> )	
	3. Snap traps (or steel traps) of the Venus flytrap ( <i>Dionaea muscipula</i> )	
	4. Suction traps, of bladderworts ( <i>Utricularia</i> )	
2.	Techniques for the identification of osmophores in flower.	1
3.	Estimation of sugars in nectar using Benedict's reagent.	2
4.	Study of plant defence against herbivores.	2
	1. Trichomes ( <i>Urtica dioica</i> )	
	2. Raphids in plant tissue. ( <i>Colocasia</i> / <u><i>Commelina</i></u> )	
5.	Sampling of nectar by centrifugation and estimation of sugar content in nectar.	2
6.	Visit to wildlife sanctuary and observing plant animal interactions in nature	2
7.	Mini project:	4
	1. Study of Principal groups of dispersers and their salient characteristics.	
	2. Ant-plant symbioses [granivores ants, ant gardens (Fungus growers) and leaf-cutting ants]	
	3. Mimicry in plants	
	4. Foliar signals in plants	
	<b>TOTAL</b>	<b>15</b>

#### MANDATORY REFERENCES

1. Abrahamson, W.G. (ed.). 1989. Plant-animal interactions. McGraw-Hill Book Company, NY.
2. Burslem, D., M. Pinard and S. Hartley. 2005. Biotic Interactions in the Tropics: Their Role in the Maintenance of
3. Species Diversity. Cambridge University Press. Crawley, M.J. 1986. Plant Ecology. Blackwell Scientific Publications.

4. Endress, P.K. 1994. Diversity and Evolutionary biology of tropical flowers. Cambridge University Press.
5. Harborne, J.B. 1988. Introduction to ecological biochemistry. Academic Press.
6. Herrera, Carlos M. and Olle Pellmyr (eds.). 2002. Plant-Animal Interactions: An Evolutionary Approach. Blackwell Science.
7. Holldobler, B. and Wilson, E.O. 1990. The Ants. Springer Verlag.
8. Lloyd, D.G. and Barret, S.C.H. 1996. Floral Biology: studies on Floral evolution in Animal pollinated plants. Chapman & Hall.
9. Price, P.W., T.M. Lewinsohn, G.W. Fernandes and W.W. Benson. 1991. Plant-Animal Interactions: Evolutionary
10. Ecology in Tropical and Temperate Regions. A Wiley Interscience publication
11. Proctor, M., Yeo, P. and Lack, A. 1996. The Natural History of Pollination. Harper Collins Publishers.
12. Richards, A.J. 1986. Plant Breeding systems. George Allen & Unwin, London.
13. Schaefer, M.H. and G.D. Ruxton. 2011. Plant-Animal Communication. Oxford University Press.
14. Seckbach, J. and Z. Dubinsky. 2010. All Flesh Is Grass: Plant-Animal Interrelationships. Springer Science & Business Media.
15. Smith, R.L. 1990. Ecology and field biology. Harper Collins
16. Knaebe, Silvio & Mack, Pierre & Chen<sup>2</sup>, Ang & Bocksch, Sigrun. (2015). 2.11 Available methods for the sampling of nectar, pollen, and flowers of different plant species. Julius-Kühn-Archiv. 131-138.

#### **ONLINE RESOURCES:**

1. <https://botany.org/home/resources/carnivorous-plants-insectivorous-plants.html>
2. [https://www.researchgate.net/publication/302580569\\_211\\_Available\\_methods\\_for\\_the\\_sampling\\_of\\_nectar\\_pollen\\_and\\_flowers\\_of\\_different\\_plant\\_species](https://www.researchgate.net/publication/302580569_211_Available_methods_for_the_sampling_of_nectar_pollen_and_flowers_of_different_plant_species)

**SKILL ENHANCEMENT COURSE (SEC)**

**COURSE TITLE : BASICS IN HORTICULTURE (THEORY)**

**COURSE CODE : UG-BOT-SEC 1**

**CREDITS : 3 (2 Theory + 1 Practical)**

**MARKS : 75 (50 T+25P)**

**DURATION : 30**

**PREREQUISITE COURSES : Nil**

**COURSE OBJECTIVES**

Is to provide entrepreneur opportunities.

**COURSE LEARNING OUTCOMES**

Upon completion of the course, the student will be able to :

**CLO1:** Explain the basics of Horticulture, floriculture and landscaping. Inculcate the technique of vegetative propagation of plants.

**CLO2:** Outline the requirements for building up nurseries, garden, etc.

**CLO3:** Identify and relate the scope of these fields in building up career

**CL O 4:** Identify and relate the scope of these fields in building up career

**MODULE I: TOOLS AND TECHNIQUES IN HORTICULTURE, FLORICULTURE AND PROPAGATION METHODS 15**

- 1.1 Definition and importance; Pomoculture, Olericulture, Floriculture.
- 1.2 Fertilizers: inorganic, Organic – biofertilizers: vermicomposting, green manure, algal culture, FYM.
- 1.3 Irrigation: Surface, Sprinkle, Drip and Gravity irrigation
- 1.4 Introduction to Green house, Poly house, Moist chamber, Net frame, Introduction to Hydroponics.

- 1.5 Introduction to sexual methods (seed propagation) – Definition, Merits and Demerits, Criteria for selection of seeds.
- 1.6 Asexual (Vegetative) propagation – Definition, and types- Cutting (root, stem, leaf), Layering (simple, air), Grafting (Whip, Approach) and Budding (T, patch), Stock –scion relationship in important horticultural crops.  
Use of plant growth regulators in horticulture

**MODULE II: LANDSCAPING**

**15**

- 1.1 Locations in the garden- edges, hedges, fence, lawn, flower beds.
- 1.2 Avenue, water garden (with two examples of each).  
Focal point. Auto CAD in garden designing.
- 1.3 National parks, Botanical gardens, water garden, rockery plants, Bonsai techniques, Hydroponics.
- 1.4 Lawn making: type of lawn grasses and maintenance.  
Plants suitable for hedges. Aftercare: Weeding, top dressing methods of pruning and topiary

**TOTAL**

**30**

**COURSE TITLE: BASICS IN HORTICULTURE (PRACTICAL)**

**PAPER CODE : UG-BOT-SEC 1**

**MARKS: 25 Marks**

**CREDITS: 1 credit**

1.	Familiarizing gardening tools and implements	01
2.	Preparation of nursery bed and polybag filling	01
3.	Preparation of potting mixture – Potting, repotting	02
4.	Methods in vegetative propagation (cutting, grafting, budding, layering)	02
5.	Garden designing using Auto CAD software/any app	01
6.	Preparation of organic compost & vermicompost	02
7.	Establishment of vegetable garden using organic compost & vermi-compost	03
8.	Flower arrangement	01
9.	Improving the shelf life of cut flowers using chemicals.	01
10.	Visit to nurseries, gardens and Report.	01
	<b>Total</b>	<b>15</b>

**MANDATORY REFERENCES**

- 1.Swarup V. (1997). Ornamental horticulture. MacMillan India Limited, NewDelhi.
- 2.Randhava, G.S, (1973) – Ornamental horticultural in India Today andTomorrow Printers and Publishers, NewDelhi.
- 3.Trivedi TP (2007). Ornamental horticultural in India. Indian Council of Agricultural Research NewDelhi.



4. Nayak, K.C. South Indian fruits and their culture P.L. Varadaraj & Co., & Lingichetti Street, Madras.

5. Edment Senn Andrews (1994) Fundamentals of Horticulture – Tata McGraw Hill Publishing Co., Ltd., Delhi.

**ONLINE RESOURCES:**

1. [http://agritech.tnau.ac.in/horticulture/horti\\_index.html](http://agritech.tnau.ac.in/horticulture/horti_index.html)

# **SEMESTER**

# **II**

## DISCIPLINE SPECIFIC CORE COURSE

**COURSE TITLE: CELL BIOLOGY AND BIOMOLECULES (THEORY)**

**COURSE CODE: UG-BOT-103**

**MARKS: 100 (75 Theory+ 25 Practicals)**

**CREDITS: 4 (3 Theory+ 1 Practical)**

**COURSE DURATION: 45 HOURS**

**PREREQUISITE COURSES:** Biology at XII<sup>th</sup> preferred.

This course will provide a detailed discussion on a wide range of topics in Cell biology & Bio- molecules emphasizing experimental approaches and key experiments that have provided important insights. The course is aimed at conveying an understanding of how cellular structure and function arise as a result of the properties of cellular macromolecules. Emphasis will be on the dynamic nature of cellular organization, structure and function.

### **COURSE OUTCOME:**

Upon successful completion of the course, students will be able:

**CLO 1:** Recognise, classify cell, explain cell theory, evolution and biogenesis

**CLO 2:** Define, describe, classify and explain cytoskeleton, cell organelle, biomolecules.

**CLO 3:** Define, describe, compare, explain, illustrate cell wall and plasma membrane

**CLO 4:** Predict and interpret the importance of cell

### **MODULE I: INTRODUCTION TO CELL, ULTRA-STRUCTURE AND FUNCTION OF CELL WALL AND PLASMA MEMBRANE 15 lecs**

- 1.1 Discovery and basic properties of cells
- 1.2 Structure and functions of cytoskeleton
- 1.3 Structure and function of Microtubule, Intermediate filaments, Microfilaments
- 1.4 Structure and function of cell wall, Chemical composition of cell wall
- 1.5 Extracellular matrix and cell interactions, Gap -Junctions & plasmodesmata
- 1.6 Structure and function of plasma membrane, Active and Passive transport of solute (channels & pumps).

### **MODULE II: STUDY OF CELL ORGANELLES 15 lecs**

- 2.1 Structure & functions of Chloroplast, Mitochondria, Peroxisome, Glyoxysome & Lysosomes; Semi autonomy and gene control
- 2.2 Nucleus and its Organization; Nuclear envelope, nuclear pore complex, Nuclear matrix, Chromosomes and chromatin structure
- 2.3 Structure and function of ribosome
- 2.4 Endomembrane systems- Endoplasmic reticulum and Golgi complex

**MODULE III: BIOCHEMISTRY OF MINO ACIDS AND PROTEINS  
CARBOHYDRATES, LIPIDS**

**15 lecs**

- 3.1 Definition & importance of biomolecules; types of bonds in bio- molecules; pH and buffers; Water as a biological solvent  
3.2 Classification and biological functions of carbohydrates and lipids  
3.3 Classification and biological functions of amino acids, proteins.

**TOTAL**

**45**

**COURSE TITLE: CELL BIOLOGY & BIOMOLECULES (PRACTICAL)  
COURSE CODE:UG-BOT-102**

**MARKS: 25**

**CREDITS: 1**

**PRACTICAL SESSION: 15 (Inclusive of 3 PA)**

- |    |   |           |
|----|---|-----------|
| 1. | Study of cell structure in <i>Hydrilla</i> and <i>Tradescantia</i> staminal Hairs | <b>1</b>  |
| 2. | Examination of prokaryotic cell, eukaryotic cell and cell organelles by EM graphs | <b>1</b>  |
| 3. | Preparation of temporary slides to observe different types of cells               | <b>2</b>  |
| 4. | Staining and Preparation of slides:   | <b>6</b>  |
|    | i. Cytochemical staining of Nucleus- Acetocarmine                                 |           |
|    | ii. Cytochemical staining of polysaccharides- Periodic Acid Schiff's (PAS)        |           |
|    | iii. Cytochemical staining of Mitochondria – Jannis Green                         |           |
|    | iv. Cytochemical staining of Total proteins Bromophenol blue                      |           |
|    | v. Cytochemical staining of Histones – Fast Green                                 |           |
| 5. | Qualitative detection of Macromolecules ( Carbohydrates, Proteins, Lipids)        | <b>3</b>  |
| 6. | Prepararions of solutions (Normal, Molar, PPM) and Buffers                        | <b>2</b>  |
|    | <b>TOTAL</b>  | <b>15</b> |

**REFERENCES:**

List of books recommended for reference

**MANDATORY READING:**

1. Gupta, P.K. (1999). *A Text-book of Cell and Molecular Biology*. Meerut, India: Rastogi Publications.
2. Karp, G. (1999). *Cell and molecular Biology, Concepts and experiments*. 2nd edition. USA: John Wiley and Sons Inc.

3. U. Satyanarayana and U. Chakrapani. (2000). *Biochemistry*, 4th edition., Kolkata: Elsevier Pub.
4. Verma P.S. and Agarwal V. K. (1998). *Cell Biology, Genetics, Molecular Biology, Evolution and ecology*. 14th Ed. New Delhi: S Chand Publishers.

#### Supplementary Reading

1. David L. Nelson & Michael M. Cox. (2013). *Lehninger Principles of Biochemistry*, 4th ed. New York: W.H. Freeman & Co.
2. Donald Voet., Judith G. Voet and Charlotte W. Pratt. (2002). *Fundamentals of Biochemistry*, 2nd edition, John Wiley and Sons Pvt Ltd.
3. Robert A. Horton. (2006). *Principles of Biochemistry*. 4th ed. Pearson Prentice Hall.
4. Jeremy M. Berg, John L. Tymoczko and Lubert Stryer (2002). *Biochemistry* 5th edition, New York; W.H.Freeman & Company
5. Paul Flinch (1999). *Carbohydrate structure, Synthesis & Dynamics*. The Netherlands: Kluwer Academic Pub.
6. Randall J. Weselake Email author Stacy D. Singer Guanqun Chen. (2018, July 19). *Introduction to Plant Biomolecules and Cellular Metabolism*. Retrieved February 13, 2020, from Springer: [https://link.springer.com/chapter/10.1007/978-1-4939-8616-3\\_2](https://link.springer.com/chapter/10.1007/978-1-4939-8616-3_2)
7. 2013, November 11). Retrieved February 13, 2020, from NPTEL: <https://nptel.ac.in/courses/102103012/>
8. BIOLOGY JUNCTION. (2017, April 21). Retrieved February 13, 2020, from Structure & Function of the Cells: <https://www.biologyjunction.com/cell++notes+bi.html>.

#### ONLINE RESOURCES

1. [www.britannica.com](http://www.britannica.com)
2. <https://www.springer.com>
3. <https://www.biologydiscussion.com>
4. [www.cellbiologyjournal.org](http://www.cellbiologyjournal.org)
5. [www.academia.edu](http://www.academia.edu)

**MULTIDISCIPLINARY COURSES (MDC)**

**COURSE TITLE: ETHNO-BOTANICAL CONCEPTS (THEORY)**

**COURSE CODE: BOT-I.GEC-3.**

**MARKS: 100 (75 theory + 25 Practical)**

**CREDITS: 4 (3 theory + 1 Practical)**

**COURSE DURATION: 45 HOURS**

**PREREQUISITE COURSES:** Biology at XIIth preferred.

**COURSE OBJECTIVES:** This course will deal with the origin, utilization, cultivation and uses of plants known in traditional herbal medicine; endangered and rare useful plants, it also deals with the various methods of ethnobotanical studies and roles of ethnobotany in biodiversity conservation and socio-economic development.

**COURSE OUTCOMES**

**CLO1.** Enumerate the concept, scope and objectives of ethnobotany with reference to tribal lifestyle

**CLO2.** Analyse the role of various plants in traditional and modern medicine

**CLO3.** Infer the legal aspects of ethnobotany

**CLO4.** Evaluate different ethnobotanical methodologies

**MODULE I: INTRODUCTION TO ETHNOBOTANY**

**15**

- 1.1 Introduction, concept, scope and objectives.
- 1.2 Ethnobotany as an interdisciplinary science.
- 1.3 Major and minor ethnic groups or Tribals of India, and their life styles.
- 1.4 Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses.

**15**

## MODULE II: ROLE OF ETHNOBOTANY IN MODERN MEDICINE

- 2.1 Medico-ethnobotanical sources in Goa, India.  
Significance of the following plants in ethnobotanical practices (along with their habitat and morphology) a) *Azadirachta indica* b) *Ocimum sanctum* c) *Vitex negundo*. d) *Gloriosa superba* e) *Pongamia pinnata* f) *Cymbopogon citratus*.
- 2.2 Role of ethnobotany in modern medicine with special example *Rauvolfia serpentina*, *Curcuma longa*, *Garcinia indica*, *Syzygium cumini*
- 2.3 Role of ethnic groups in conservation of plant genetic resources.

## MODULE III: ETHNOBOTANY AND LEGAL ASPECTS

15

- 3.1 Ethnobotany as a tool to protect interests of ethnic groups.
- 3.2 Sharing of wealth concept with few examples from Goa, India.  
Biopiracy, Intellectual Property Rights and Traditional Knowledge.

**TOTAL 45**

### COURSE TITLE: ETHNO-BOTANICAL CONCEPTS (PRACTICAL)

COURSE CODE: BOT-I.GEC-3

MARKS: 25

CREDITS: 1

COURSE DURATION: 15 SESSIONS (*inclusive of 3 PA*)

- |    |  |   |
|----|--|---|
| 1. | Collection, processing and preservation of ethnobotanical specimens;<br><i>Aahatoda varcca</i> , <i>Aegle marmelo</i> , <i>Boerhaavia diffusa</i> ,<br><i>Cassia tora</i> , <i>Selaginella sp</i> , <i>Ficus religiosa</i> , <i>Ficus benghalensis</i> , <i>Azadirachta indica</i> . | 4 |
| 2. | Identify and document plant parts used in preparation of crude drugs/herbal formulations.  | 2 |
| 3. | Preparation of natural Holi colours using Turmeric, Hibiscus, Marigold, <i>Chrysanthemums</i> .  | 2 |

4.	Virtual demo of Halotherapy.	1
5.	Visit temples and sacred groves of Goa and understand the culture and ecology and report submission.	2
6.	Mini projects	4
	1. Survey for collection of Archaeological Resources from local tribes, Folk songs, folk tales and proverbs.	
	2. Traditional germplasm management: in situ and ex-situ conservation	
	3. Observation of archaeobotanical remains and collection of data.	
	<b>TOTAL</b>	<b>15</b>

#### **MANDATORY REFERENCES**

1. S.K. Jain, (1995) Manual of Ethnobotany, Scientific Publishers, Jodhpur.
2. S.K. Jain (1981) Glimpses of Indian. Ethnobotny, Oxford and I B H, New Delhi
3. Lone et al, Palaeoethnobotany
4. S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.
5. S.K. Jain, 1990. Contributions of Indian ethnobotny. Scientific publishers, Jodhpur.
6. Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons- Chichester
7. Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India. Botanical Survey of India. Howrah.
8. Rajiv K. Sinha (1996)– Ethnobotany The Renaissance of Traditional Herbal Medicine – INA –SHREE Publishers, Jaipur

#### **ONLINE REFERENCES:**

<https://www.forestessentialsindia.com/blog/how-to-prepare-natural-colours-for-the-festivities-of-holi.html>



## **SKILL ENHANCEMENT COURSE (SEC)**

**COURSE TITLE: ALGAL BIOTECHNOLOGY (THEORY)**

**COURSECODE: UG-BOT-SEC 2**

**MARKS: 75(50Theory+25Practicals)**

**CREDITS: 3(2Theory +1Practical)**

**COURSE DURATION: 30 HOURS**

### **COURSEOBJECTIVES:**

This course provides knowledge on diversity of algal types in Goa and understands the potential significance of algal resources as food, fodder, fuel and environment sustenance.

### **COURSEOUTCOMES: Students will be able to**

**CLO1:** Apprise the students to the methods of algal culture techniques.

**CLO2:** Assess, compare and manage algal in water bodies

**CLO3:** Explore algal bio-resources and understand their commercial applications.

**CLO4:** Understand opportunities for start-ups through eco-friendly bio- fertilizer production using algae.

## **MODULE I: METHODS OF ALGAL ISOLATION, CULTURE AND ALGAL POLLUTION 15**

### **UNIT1: METHODS OF ALGAL ISOLATION, CULTURE**

- 1.1 Introduction to Algal Biotechnology, freshwater and marine algae
- 1.2 Methods of algal isolation
- 1.3 Types of algal cultures (synchronous, continuous, mass culture)
- 1.4 Maintenance and multiplication of algae(Cyanophyta)

### **UNIT 2: ALGAL POLLUTION**

- 2.1 Algae as indicator of pollution
- 2.2 Eutrophication and its impact on water quality, Algal Blooms and their control
- 2.3 Phycoremediation

## **MODULE II: COMMERCIAL APPLICATIONS OF ALGAL TECHNOLOGY 15**

- 3.1 Single cell algal proteins
- 3.2 Algae as food and fodder

- 3.3 Algae in pharmaceutical industries
- 3.4 Algae in biofuels and bioplastics
- 3.5 Algae as Biofertilizers

**COURSE TITLE: ALGAL BIOTECHNOLOGY  
(PRACTICALS)**

**PAPER CODE: UG-BOT-SEC 2**

**MARKS: 25**

**CREDITS:1**

**COURSE DURATION: 15 SESSIONS**

1.	Sterilization of glassware, preparation of media (freshwater algae)	2
2.	Culturing of freshwater algae	1
3.	Chromatographic separation of algal pigments	2
4.	Isolation and estimation of algal proteins	2
5.	Preparation of algal biofertilizer (powdered and liquid)	2
6.	Visit to NIO and submission of report	1
	Mini Projects	5
	1. Collection, culturing and maintenance of commonly found algae in Goa (Fresh & marine water, one each)	
	2. Survey of market products of algal material	
	<b>Total</b>	<b>15</b>

**MANDATORY REFERENCES**

- 1. Becker, S. W. (1994). *Micro Algae Biotechnology and Microbiology*. Cambridge University Press.
- 2. Ignacimuthu, S. (1996). *Basic Biotechnology*. New Delhi: Tata McGraw Hill Publishing Limited.
- 3. Tridevi, P.C. (2001). *Algal Biotechnology*. Jaipur: Point Publisher.
- 4. Venkatraman, G.S. (1972). *Algal Biofertilizers and Rice Cultivation*. New Delhi: Today and Tomorrows Printers and Publishers.

5. Zajic, J.E. (1970). *Properties and Products of Algae*. New York: Plenum Press.
6. Bold, H.C. and Wynne, M.J. (1976). *Introduction to Algae structure and reproduction*. Prenticehall.
7. Prescott, G.W. (1970). *How to know freshwater Algae*. W.C. Braun & Co.
8. Desikachary, T.V. (1972). *Taxonomy and Biology of Blue Green Algae*. University of Madras

#### **ONLINE RESOURCES:**

- Aziz M.A. and Ng W.G. (1993). Industrial wastewater treatment using an activated algae-reactor. *Water Sci. Technol.* **28:71–76**.
- Thomas D.G., Minj N., Mohan N. and Rao P.H. (2016.) Cultivation of microalgae in domestic wastewater for biofuel applications – An upstream approach. *J. Algal Biomass Utiln.* **7(1):62-70**
- Power, M., Vander Meer, J., Tchelat, R. (1998). Molecular based methods can contribute to assessment of toxicological risks and bioremediation strategies. *J. Microbiol. Methods*, **32:107–119**.

# **SEMESTER II**

Course Title : **KITCHEN GARDENING (THEORY)**  
Course Code : **UG-BOT-MDC 2**  
Credits : **02**  
Marks : **50**  
Duration : **30 hours**

**COURSE OBJECTIVES:**

The course provides knowledge of principles and practices of Kitchen Gardening.

**COURSE OUTCOMES:**

Upon successful completion of the course, students will be able:

**CLO1:** Explain the principles of kitchen gardening, soil fertility and management.

**CLO2:** Identify the importance of pest control and sustainable gardening practices.

**CLO3:** Identify and describe various herbs, vegetables and fruits suitable for kitchen gardening, considering local climate and growing conditions.

**CLO4:** Develop skills in planting, nurturing, and maintaining a variety of vegetables and herbs.

**MODULE 1: INTRODUCTION TO KITCHEN GARDENING, SOIL, SOIL FERTILITY MANAGEMENT AND FERTILIZERS. 15 hrs**

Introduction To Kitchen Gardening. Soil types and characteristics, Soil health and soil tillage.

Factors affecting soil fertility and Productivity. Potting mixtures. Plant nutrients. Types of Fertilizers and manures, Vermicomposting.

**MODULE II: CULTIVATION AND PLANT DISEASE MANAGEMENT 15 hrs**

Cultivation, harvesting and Nutritional value of following crops of India: Onion, Potato, Tomato, Cauliflower, Coriander, Cucurbits and Cabbage. Cultivation, harvesting and Nutritional value of following crops of Goa: Agasaim Brinjal, seven ridge Okra, Red Amaranthus, Khola Mirch, Kokum.

Fruits in kitchen garden: Papaya, Guava, Banana, Coconut. Plant protection: Cultural and mechanical.

Plant protection: Bio-pesticide and Bio-control agents. Allelopathic methods of weed control.

**TOTAL 30 hrs**

Course Title : **KITCHEN GARDENING (PRACTICAL)**

Course Code : **UG-BOT-MDC 2**

Credits : **01**

Marks : **25**

Duration : **30 hours (15 sessions)**

<b>Sr. No.</b>	<b>Practical Title</b>	<b>Practical sessions</b>
1.	Ideal potting mix	01
2.	Effect of VAM and compost on growth of plants.	02
3.	Study of soil (pH, texture and WHC)	01
4.	Soil analysis of NPK (Based on secondary data obtained from ICAR)	01
5.	Study of germination percentage of various seeds	01
6.	Understanding growth rate of (any 2) leafy vegetables.	01
7.	Market survey (to be done by students) to understand the market value of various vegetables.	01
8.	Mini Project:	
	1. Preparation of compost	02
	2. Setting up of a Kitchen Garden on campus.	04
	3. Growing microgreens	01
<b>Total</b>		<b>15</b>

## REFERENCES

1. Chakraverty, A. (1991). *Post-harvest technology of cereal, pulses and oil seeds*. Oxford: IBHPublishing Co. Pvt Ltd.
2. Deshmukh, S.N. (2012). *Organic Farming: Principles, Prospects and Problems*, India: AgrobiosPublishers.
3. Kanwar, J.S. (1978). *Soil Fertility, Theory and Practice*. Indian Council of Agricultural Research Publication.
4. Kochhar, S.L. (2012). *Economic Botany in Tropics*. New Delhi: MacMillan & Co.
5. Matt Montanez (2017). *Vegetable Gardening for Beginners*. My Ebook Publishing House.
6. Richard Bird. (2016). *The Kitchen Garden Book: The Complete Practical Guide to Kitchen Gardening, from Planning and Planting to Harvesting and Storing*: Anness Publishing.
7. Wickens, G.E. (2001). *Economic Botany: Principles & Practices*. Netherlands: Kluwer Academic Publishers.

# **SEMESTER III**

Course Title : **DIVERSITY OF LOWER PLANTS II (BRYOPHYTES, PTERIDOPHYTES, GYMNOSPERMS) (THEORY)**

Course Code : **UG-BOT-201**

Credits : **03**

Marks : **75**

Duration : **45 hours**

Prerequisite : **Biology at XII preferred.**

**COURSE OBJECTIVES:**

This paper provides basic knowledge of Diversity Of Lower Plants II (Bryophytes, Pteridophytes, Gymnosperms).

**COURSE OUTCOMES:**

Upon successful completion of the course, students will be able:

**CLO1:** State, describe and explain the characters and evolutionary aspects of bryophytes.

**CLO2:** State, describe and explain the characters and evolutionary aspects of pteridophytes.

**CLO3:** State, describe and explain the characters and evolutionary aspects of gymnosperms

**CLO4:** Identify, Sketch the morphology and anatomy of selected bryophytes, pteridophytes and gymnosperms.

**MODULE I: BRYOPHYTES**

**15 hrs**

General characters, classification and alternation of generation

Type study: Study of morphological and anatomical studies and reproductive character of *Riccia*, *Marchantia*, *Anthoceros* and *Funaria*.

Evolution of sporophyte in Bryophytes, Ecological and Economic Importance of Bryophytes.

**MODULE II: PTERIDOPHYTES**

**15 hrs**

General characters, classification, alternation of generation.

Type study: Structure, reproduction, life history and systematic position of *Psilotum*, *Lycopodium* and *Marsilea*.

Stelar evolution, Ecological and Economic Importance of Pteridophytes.

**MODULE III: GYMNOSPERMS**

**15 hrs**

General characters, classification, alternation of generation of Gymnosperms.

Type study: Systematic position, life history of *Cycas*, *Pinus* and *Gnetum*

Ecological and Economic Importance of gymnosperms.

**TOTAL 45 hrs**



Course Title : **DIVERSITY OF LOWER PLANTS II (BRYOPHYTES, PTERIDOPHYTES, GYMNOSPERMS) (PRACTICAL)**  
 Course Code : **UG-BOT-201**  
 Credits : **01**  
 Marks : **25**  
 Duration : **30 hours (15 sessions)**

Sr. No.	Practical Title	Practical sessions
1.	Morphological and anatomical study of: Bryophyte ( <i>Riccia</i> and <i>Anthoceros/ Funaria</i> )	03
2.	Morphological and anatomical study of: Pteridophyte ( <i>Selaginella</i> and <i>Lycopodium/Psilotum</i> )	03
3.	Morphological and anatomical study of: Gymnosperm ( <i>Cycas</i> and <i>Pinus</i> )	03
4.	Understanding stellar evolution	01
5.	Mini Project: 1. Mini project: Collection and field study of locally available Bryophytes, Pteridophyte, Gymnosperms. 2. Preservation of Bryophytes, Pteridophytes and Gymnosperms by Herbarium technique.	05
<b>Total</b>		<b>15</b>

**List of books recommended for reference:**

**Mandatory Reading**

1. Bhatnagar, S.P. and Moitra, A. (1996). *Gymnosperms*. New Age International Limited.
2. Parihar N.S. (2012); An introduction to Embryophyta: Pteridophytes. Vol II, fifth edition, Surjeet Publications.
3. Parihar N.S. (2013). An introduction to Embryophyta: Bryophyta. Vol I, fifth edition, Surjeet Publications.
4. Sharma, O. P. (2017). *Diversity of Microbes and Cryptogams- Bryophyta*. McGraw Hill Education.
5. Sharma, O. P. (2017). *Diversity of Microbes and Cryptogams- Pteridophyta*. McGraw Hill Education.
6. Smith, Gilbert M. (1955). *Cryptogamic Botany Bryophyta & Pteridophyta Volume 2*; 2<sup>nd</sup> Edition; McGraw-Hill book Comp. Tokyo.

**Supplementary Reading**

1. Kar, Ashok Kumar; Gangulee, Hirendra Chandra (2006). *College Botany: Volume II*; 2<sup>nd</sup> Edition; Kolkata: New Central Book Agency (P)Ltd.

**Web References:**

1. <https://www.conifers.org/>
2. [http://www.bsienvi.nic.in/Database/Pteridophytes-in-India\\_23432.aspx](http://www.bsienvi.nic.in/Database/Pteridophytes-in-India_23432.aspx)

Course Title : **ECONOMIC BOTANY (THEORY)**  
Course Code : **UG-BOT-202**  
Credits : **03**  
Marks : **75**  
Duration : **45 hours**  
Prerequisite : **Biology at XII preferred.**

**COURSE OBJECTIVES:**

This course facilitate knowledge on the value of plants with scientific information and critical thinking to strengthen knowledge on economic botany.

**COURSE OUTCOMES:**

Upon successful completion of the course, students will be able:

**CLO1:** Identify and categorize economically important plants/plant parts.

**CLO2:** State, describe and explain the use of plants as an alternative to synthetic and chemical products.

**CLO3:** State, describe and explain the uses of natural plant products.

**CLO4:** Develop skills in extracting valuable plant products of potential market and economic value.

**MODULE I: ORIGIN OF CULTIVATED PLANTS (CENTRES OF ORIGIN, CEREALS & LEGUMES) 15 hrs**

Centres of origin: Concept, Vavilov's work, examples of major plant introduction; evolution of new crops/ varieties; crop domestication.

Organizations and their mandates – NRRI, CFTRI, SBRI.

Importance of germplasm, threats to genetic diversity.

Classification, description and economic importance of Cereals and Legumes: Wheat, Rice (local varieties) and Millets (any one), Chick pea, Cow pea and one fodder legumes.

**MODULE II: SOURCES OF SUGARS & STARCH, OILS & FATS, DRUGS & NATURAL RUBBER 15 hrs**

Sugar & Starch sources: Sugarcane; Potato & Dioscorea.

Fat and Oil sources: Groundnut, Coconut, Soybean.

Extraction and applications of essential oils: Eucalyptus and mustard oils.

Therapeutic and habit-forming drugs: Cinchona, Cannabis, Tobacco (Morphology, processing, uses and health hazards).

Tapping, processing and uses of *Hevea brasiliensis*.

**MODULE III: CLASSIFICATION, GENERAL DESCRIPTION AND USES OF SPICES, BEVERAGES, FRUIT AND NUTS, FIBERS AND TIMBER PLANTS**

**15 hrs**

Spices & condiments: Clove, Black pepper, cinnamon, turmeric

Beverages: Tea & Coffee

Fruits: Mango, Cashew & Jackfruit

Fibers: Coconut, cotton & Jute.

General account of Timber Plants: Teak and Matti.

**TOTAL 45 hrs**

Course Title : **ECONOMIC BOTANY (PRACTICAL)**

Course Code : **UG-BOT-202**

Credits : **01**

Marks : **25**

Duration : **30 hours (15 sessions)**

<b>Sr. No</b>	<b>TOPICS</b>	<b>Practical Sessions</b>
1	Morphological and Anatomical study of cereal and legumes seeds (rice and groundnut).	04
2	Study of essential oil yielding plant parts (Coconut (dry copra), <i>Eucalyptus</i> (leaf), Citrus (rind))	02
3	Mini Projects: <ul style="list-style-type: none"> <li>i. Extraction of essential oil from plant sources (Distillation method)</li> <li>ii. Analysis of starch content from plant sources (fruits, rhizome, tubers)</li> <li>iii. Phytochemical analysis of plants for drugs, alkaloids and dyes</li> <li>iv. Study of Fibers from plants</li> <li>v. Study of local fruits and spices</li> </ul>	07
4	Field Visit to Farm/ Rubber Plantation	02
<b>Total</b>		<b>15</b>

**REFERENCES:**

1. Kochhar, S.L. (2012). *Economic Botany in Tropics*. New Delhi: MacMillan & Co.
2. Pandey, B. P. (2015). *Economic Botany*. New Delhi: S. Chand & Company.
3. Subrahmanyam, N. S. and Sammbamurty, A.V.S.S. (2008). *A textbook of Moderneconomic Botany*. New Delhi: CBS Publishers & Distributors.
4. Wickens, G.E. (2001). *Economic Botany: Principles & Practices*. Netherlands: Kluwer Academic Publishers.

**Web links:**

1. <https://www.econbot.org> › home › education
2. <https://www.loc.gov> › scitech › tracer-bullets › economic.
3. <https://www.kew.org> › science › collections › economic.

Course Title : **PLANT PATHOLOGY (THEORY)**  
Course Code : **UG-BOT-203**  
Credits : **03**  
Marks : **75**  
Duration : **45 hours**  
Prerequisite : **Biology at XII preferred.**

**COURSE OBJECTIVES:**

To make the students aware of various plant pathogens and their control.

**COURSE OUTCOME:**

Upon successful completion of the course, students will be able to:

**CLO1:** Identify various diseases and its causal agents of economically important plants.

**CLO2:** Explain plant pathogen interaction.

**CLO3:** Analyze control measures to deal with pathogens.

**CLO4:** Isolate, observe and culture plant disease causing pathogens.

**MODULE I: AN INTRODUCTION AND EPIDEMIOLOGY OF PLANTS DISEASES**

**15 hrs**

History, Definitions and Importance of plant pathology.

Concepts and types of diseases in plants.

Infectious agents (nematodes, protozoans, bacteria, fungi & viruses).

Growth, reproduction, survival, multiplication and dispersal of important plant pathogens (*Puccinia*).

Disease triangle.

**MODULE II: PLANT DISEASE DEVELOPMENT (PATHOGENESIS) AND MANAGEMENT**

**15 hrs**

Parasitism and pathogenicity. Symptomatology. Host parasite interaction (recognition and infection).

Role of enzymes, toxins & growth regulators in pathogenesis.

Quantitative resistance (Physical, Biological & cultural methods).

Biochemical defense mechanism (oxidative burst; Phenolics, Phytoalexins, PR proteins, antimicrobial substances and plantibodies). Quarantine measures.

**MODULE III: GENETICS OF PLANT DISEASE AND STUDY OF PLANT DISEASES IN INDIA**

**15 hrs**

Altered plant metabolism due to pathogens attack. Genetics of resistance ('R' & avr genes, elicitors responses)

Signaling and programmed cell death.

Study of Diseases (Name of disease, pathogen, symptoms and control measures need to be studied).

Important diseases (Any 2 of each) of Paddy, Arecanut, Wheat, Banana, Coconut, Sugarcane, Mango, Amaranth and Radish.

**TOTAL 45 hrs**

Course Title : **PLANT PATHOLOGY (PRACTICAL)**

Course Code : **UG-BOT-203**

Credits : **01**

Marks : **25**

Duration : **30 hours (15 sessions)**

<b>Sr. No</b>	<b>Topics</b>	<b>Practical Sessions</b>
1	Isolation and culture of fungal and bacterial pathogens.	02
2.	Demonstration of Koch's postulates	01
3.	Assay for cellulase /pectinase enzyme from diseased plant	02
4.	Study of plant diseases with reference to pathogen & symptomology (Viral, Bacterial & Fungal) (any 10 as per theory)	05
5	Anatomical observations of fungal infected plants (rust, blight, rots)	03
6	Study of antagonistic behavior of bacterial pathogens	01
7.	Mini project: Collection and identification of plant diseases (Any five)	01
<b>Total</b>		<b>15</b>

## REFERENCES

1. Agrios, G.N. (2005). *Plant Pathology* (5th ed.). London: Academic Press.
2. Aneja, K.R. (2009). *Experiments in Microbiology Plant Pathology & Biotechnology*. 4<sup>th</sup> ed. New Delhi: New Age International (P) Limited.
3. Bilgrami, K.H. & Dube, H.C. (1976). *A textbook of Modern Plant Pathology*. Lucknow: International Book Distributing Co.
4. Gunasekaran, P. (2005). *Laboratory manual in Microbiology*. New Delhi: New Age International (P) Limited.
5. Mehrotra, R.S. & Agarwal, A. (2017). *Plant Pathology*: Bangalore: MaGraw Hill Education.
6. Mehrotra, R.S. (1980). *Plant Pathology*. New Delhi: TMH
7. Ownley, B. H. & Trigiano, R. N. (2017). *Plant Pathology, Concepts and Laboratory Exercises*.

Florida: CRC Press.

8. Pandey, B.P. (1999). *Plant Pathology, Pathogen and Plant diseases*. New Delhi: S. Chand & Co.
9. Rangaswami, G. (1999). *Disease of Crop plants of India*. New Delhi: Prentice Hall of India Pvt. Ltd.
10. Sharma, P.D. (2018). *Plant Pathology*. New Delhi: Rastogi Publishers.
11. Singh, R. S. (2019). *Introduction to Principles of Plant Pathology*. USA: Medtech.

**WEBLINKS:**

1. <https://www.springer.com/journal/42161>
2. <https://bsppjournals.onlinelibrary.wiley.com/journal/13653059>



Course Title : **BASICS IN HORTICULTURE (THEORY)**  
Course Code : **UG-BOT- MDC 3**  
Credits : **02**  
Marks : **50**  
Duration : **30 hours**  
Prerequisite : **Biology at XII preferred.**

**COURSE OBJECTIVES:**

Is to provide entrepreneur opportunities.

**COURSE OUTCOMES:**

Upon successful completion of the course, students will be able to:

**CO1:** Explain the basics of Horticulture, floriculture and landscaping

**CO2:** Examine the requirements for building up nurseries, garden, etc.

**CO3:** Identify and apply the scope of these fields in building up career.

**CO4:** Demonstrate the technique of vegetative propagation of plants.

**MODULE I: TOOLS AND TECHNIQUES AND PROPAGATION METHODS 15 hrs**

Definition and importance; scope of Pomoculture, Olericulture, Floriculture. Fertilizers: inorganic, Organic – biofertilizers: vermin composting, green manure, algal culture, FYM. Irrigation: Surface, Sprinkle, Drip and Gravity irrigation. Introduction to Green house, Poly house, Moist chamber, Net frame. Introduction to sexual methods (seed propagation)– Definition, Merits and Demerits, Criteria for selection of seeds. Asexual (Vegetative) propagation – Definition, and types- Cutting (root, stem, leaf), Layering (simple, air), Grafting (Whip, Approach) and Budding (T, patch), Stock –scion relationship in important horticultural crops. Use of plant growth regulators in horticulture.

**MODULE II: LANDSCAPING**

**15 hrs**

Types of gardens: Formal, informal and kitchen garden.

Locations in the garden with suitable plant examples - edges, hedges, fence, lawn, flower beds.

Avenue, water garden (with two examples of each). Focal point. Auto CAD in garden designing.

National parks, Botanical gardens, water garden, rockery plants, Bonsai techniques, Hydroponics.

Lawn making: Type of lawn grasses and maintenance.

Aftercare: Weeding, top dressing methods of pruning and topiary.

**TOTAL 30 hrs**

Course Title : **BASICS IN HORTICULTURE (PRACTICAL)**  
Course Code : **UG-BOT- MDC 3**  
Credits : **01**  
Marks : **25**  
Duration : **30 hours (15 sessions)**

<b>SR.NO</b>	<b>TOPICS</b>	<b>PRACTICAL SESSIONS</b>
1.	Preparation of nursery bed and polybag filling	01
2.	Preparation of potting mixture – Potting, repotting	02
3.	Field work in cutting, grafting, budding, layering	02
4.	Garden designing using Auto CAD software/any app	01
5.	Familiarizing gardening tools and implements	01
6.	Flower arrangement	01
7.	Visit to nurseries, gardens and Report	01
8.	Improving the shelf life of cut flowers using chemicals	01
9.	Mini Project:	
	a) Establishment of vegetable garden using organic compost & vermicompost.	03
	b) Preparation of organic compost & vermicompost	02
	<b>Total</b>	<b>15</b>

#### **REFERENCES:**

1. Edment Senn Andrews (1994) Fundamentals of Horticulture – Tata McGraw Hill Publishing Co., Ltd., Delhi.
2. Nayak, K.C. South Indian fruits and their culture P.L. Varadaraj & Co., & Lingichetti Street, Madras.
3. Randhava, G.S, (1973) – Ornamental horticultural in India Today and Tomorrow Printers and Publishers, New Delhi.
4. Swarup V. (1997). Ornamental horticulture. MacMillan India Limited, New Delhi.
5. Trivedi TP (2007). Ornamental horticultural in India. Indian Council of Agricultural Research New Delhi.

#### **WEBLINK**

1. [http://agritech.tnau.ac.in/horticulture/horti\\_index.html](http://agritech.tnau.ac.in/horticulture/horti_index.html)

Course Title : **BASICS IN MICROBIOLOGY (THEORY)**  
Course Code : **UG-BOT-SEC-3**  
Credits : **02**  
Marks : **50**  
Duration : **30 hours**  
Prerequisite : **Biology at XII preferred.**

**COURSE OBJECTIVES:**

The objective of this course is to introduce students to microbial world. The course is aimed to understand microbial survival and distribution, their structure and composition and its characterization.

**COURSE OUTCOMES:**

Upon successful completion of the course, students will be able:

**CLO1:** Identify the significance of microbial diversity and its classification and distribution.

**CLO2:** Correlate and compare the structural composition and reproductive behavior of various microorganisms.

**CLO3:** Demonstrate microbial culturing and their growth characteristics.

**CLO4:** Develop skills of aseptic techniques to avoid microbial contamination.

**MODULE I: HISTORY, CLASSIFICATION AND ULTRASTRUCTURE 15 hrs**

History and Scope of Microbiology

Microbial Taxonomy: Bergey's Manual of Classification – archaea, bacteria, protozoa, fungi, algae

Bacterial cell organization and ultrastructure: Cell wall structure and chemical composition, Gram characteristics; pili, fimbriae and capsule; flagella structure and function; nucleoid and plasmids; endospore: structure, sporulation and germination; reserve materials.

Structure and general characteristics of viruses, viral replication (Lytic and Lysogenic).

Reproduction in bacteria: Binary fission, Conjugation, Transformation and Transduction.

**MODULE II: ISOLATION, CHARACTERIZATION OF MICROBIAL GROWTH 15 hrs**

Sterilization Techniques and their types.

Types of culture media: synthetic/defined, solid, liquid, selective, differential.

Cultivation of microorganisms: Broth culture, agar plate, pour plate.

Microbial growth: Growth curve; diauxic growth curve; growth factors.

Determination of viable count: Serial dilution, spread plating, pour plating, determination of colony forming units (cfu) and calculation of viable count.

Preparation of pure cultures, streak plate, colony morphology.

**TOTAL 30 hrs**

Course Title : **BASICS IN MICROBIOLOGY (PRACTICAL)**  
 Course Code : **UG-BOT-SEC-3**  
 Credits : **01**  
 Marks : **25**  
 Duration : **30 hours (15 sessions)**

SR.NO	TOPICS	PRACTICAL SESSIONS	List of books
1.	Introduction to laboratory equipments: autoclave, laminar air flow, hot air oven, microscopes, pH meter.	01	
2.	Sterilization of glassware	01	
3.	Preparation of media and sterilization	01	
4.	Preparation of media agar plates	01	
5..	Isolation of pure cultures (T-streak, quadrant)	02	
6.	Serial dilution and cell count by Hemocytometer	02	
7.	Gram staining techniques of bacteria (Any 3)	03	
8.	Mini Project: a) Microbial examination of water b) Bacteriological testing of milk	04	
		<b>Total</b>	<b>15</b>

**recommended for reference:**

**Mandatory Reading**

1. Anantnaryan, Paniker, C. K. J. (2005). *Textbook of Microbiology*. 7<sup>th</sup> edition. Orient Blackswan.
2. Aneja, K. R. (2007). *Experiments in Microbiology, Plant Pathology and Biotechnology*. 5<sup>th</sup> edition. New Age International Publishers.
3. Atlas, R. M. (1997). *Principles of Microbiology*. 2<sup>nd</sup> edition. McGraw Hill.
4. Dubey, R. C. and Maheshwari, D. K. (2002). *Practical Microbiology*. New Delhi: S Chand & Company Ltd.
5. Madigan, M. T., Martinko, J. M. and Parker, J. (2007). *Brock's Biology of Microorganisms*. Pearson Prentice Hall.
6. Pelczar, M. J., Chan E., C. S. and Krieg, N. R. (1993). *Microbiology*. Fong and Sons Printers Pvt. Ltd.
7. Prescott, L. M. (2005). *Microbiology*. 6<sup>th</sup> edition. McGraw Hill.
8. Willey, J. M., Sherwood, L., Woolverton, C. J. and Prescott, L. M. (2008). *Prescott, Harley and Klein's Microbiology*. New York. McGraw Hill Higher Education.

### **Supplementary Reading**

1. Salle, A. J. (1999). *Fundamental Principles of Bacteriology*. 7th edition. McGraw Hill.
2. Powar, C. B. and Daginawala, H. F. (1982). *General Microbiology*. Volume II. Mumbai : Himalaya Publishing House.

### **Web References:**

1. <https://microbenotes.com/streak-plate-method-principle-methods-significance-limitations/>
2. <https://microbiologyinfo.com/gram-staining-principle-procedure-interpretation-examples-and-animation/>
3. <https://www.biologydiscussion.com/bacteria/reproduction-in-bacteria-5-methods-with-diagram/47062>
4. <https://microbenotes.com/history-of-microbiology/>

# SEMESTER IV

Course Title : **PLANT ANATOMY AND EMBRYOLOGY (THEORY)**  
Course Code : **UG-BOT-204**  
Credits : **03**  
Marks : **75**  
Duration : **45 hours**  
Prerequisites : **Biology at XII<sup>th</sup> preferred.**

**COURSE OBJECTIVES:**

This course deals to understand the plant anatomy and embryology of angiosperm plants. Importance of studying this paper is highlighted reflecting on the current changing needs of the students by providing latest information. Practical component will provide an ample understanding of anatomical and embryological features.

**COURSE OUTCOME:**

Upon successful completion of the course, students will be able:

**CLO1:** Define, describe and explain theories, the basic plant organization and anatomical features of shoot, root and leaf.

**CLO2:** Define, describe, explain wood structure and its components.

**CLO3:** Define, describe, explain components and processes in reproductive biology, pollination and fertilization.

**CLO4:** Examine the organization of tissues and embryological features through histological techniques.

**MODULE I: SHOOT, ROOT AND LEAF ANATOMY**

**15 hrs**

Organization of Shoot apical meristem. Apical cell theory, Histogen theory, Tunica-Corpus theory, Cyto-histological zonation. Organization of root apical meristem. Korper-Kappe theory, Quiescent centre. Anatomy of leaf: epidermis, mesophyll and vascular tissue. Stomata and its diversity, leaf abscission.

**MODULE II: WOOD STRUCTURE**

**15 hrs**

Vascular cambium, Secondary xylem, Xylary elements.

Secondary phloem, Phloem elements and Periderm. Conifer wood, Dicotyledon wood, wood anatomy-TS, TLS, RLS.

**MODULE III: REPRODUCTIVE BIOLOGY, POLLINATION AND FERTILIZATION**

**15 hrs**

Floral development: ABC model of flowering.

Structure and development of male gametophyte- Microsporangium Microsporogenesis & Pollen grains. Structure and development female gametophyte – Megasporangium. Mechanism of pollination and fertilization- types of pollination, germination of pollen grain, pollen pistil interaction, self-incompatibility. Double fertilization, embryo (dicot and monocot) and endosperm formation. General account of Apomixis and Polyembryony.

**TOTAL 45 hrs**

Course Title : **PLANT ANATOMY AND EMBRYOLOGY (PRACTICAL)**

Course Code : **UG-BOT-204**

Credits : **01**

Marks : **25**

Duration : **30 hours (15 sessions)**

<b>Sr. No.</b>	<b>Practical Title</b>	<b>Practical sessions</b>
1.	Study of simple and complex tissues by using permanent slides/ EM graphs.	02
2.	Microscopic study of wood tissues in T.S, T.L.S. and R.L.S. (Permanent slides) and maceration (Any one species).	03
3.	Study of Meristems, Microsporogenesis and Megasporogenesis through permanent slides.	02
4.	Embryo and Endosperm with haustoria mounting ( <i>Tridax / Cucurbit</i> ).	02
5.	In vitro growth of pollen tube in <i>Portulaca/ Vinca</i> .	01
6.	Pollen studies: Chitaley's method for analysis in <i>Ipomoea, Ocimum, Hibiscus, Acacia auriculiformis</i> and Grass.	02
7.	Mini Project: Study of diversity in leaf anatomy, stomata and female gametophyte exhibiting self-incompatibility.	03
<b>Total</b>		<b>15</b>



**REFERENCES:**

1. Bhojwani, S. S and Bhatnagar, S.P. (2009). *The Embryology of Angiosperms*, New Delhi: Vikas Publishing House Pvt. Ltd.
2. Dwivedi. J.N. (1988). *Embryology of Angiosperms*. Meerut: Rastogi and Co.
3. Esau, K. (1977). *Plant Anatomy*, 2<sup>nd</sup> Edition. New Delhi: Wiley Eastern Private Limited.
4. Fahn, A. (1982). *Plant Anatomy* (3rd edition). Oxford: Pergoman Press.
5. Maheswari, P. (1971). *An Introduction to the Embryology of Angiosperms*. New Delhi: Tata McGrawhill.
6. Mauselth, J.D. (1988). *Plant Anatomy*. California, USA: The Benjamin Cummings Publishing Co. Inc.
7. Pandey, B.P. (1978). *Plant Anatomy*. New Delhi: S Chand and Co.
8. Pandey, B.P. (1981). *A textbook of Botany Angiosperms*. New Delhi: S. Chand and Co.

**Weblinks:**

1. <http://virtualplant.ru.ac.za/Main/ANATOMY/prac9.htm>
2. <http://www.biologydiscussion.com/plants/wood-anatomy-of-some-important-plants-biology/57016>

**MANDATORY READING:**

Bhojwani, S. S and Bhatnagar, S.P. (2009). *The Embryology of Angiosperms*, New Delhi: Vikas Publishing House Pvt. Ltd.,

Course Title : **CYTOGENETICS (THEORY)**

Course Code : **UG-BOT-205**

Credits : **03**

Marks : **75**

Duration : **45 hours**

### **COURSE OBJECTIVES:**

This course will enable the students to understand fundamentals of genetics and evolution.

### **COURSE OUTCOMES:**

Upon successful completion of the course, students will be able to:

**CLO1:** Restate, apply, analyse and access the fundamentals of Mendelian genetics and linkage.

**CLO2:** Discuss, explain and interpret extra nuclear inheritance and Sex-linked inheritance

**CLO3:** Identify, explain, compare and contrast various chromosomal aberrations.

**CLO4:** Analyze and evaluate Mendelian genetics at a practical level.

### **MODULE I: Mendelian Genetics, Linkage and Mutation**

**15 hrs**

Mendel's Laws, backcross and test cross. Allelic and non-allelic interactions, Epistatic interactions. Multiple alleles in *Drosophila* (eye colour), man (blood groups) and plants (self-incompatibility). Linkage- Coupling and Repulsion Hypothesis Chromosome maps. Mutations and its types. Types of mutagens. Transitions and transversions; frame shift mutations. DNA repair mechanisms, Applications of mutations.

### **MODULE II: Extranuclear inheritance and Sex-linked inheritance**

**15 hrs**

Extranuclear inheritance and maternal influence: Kappa particles in *Paramecium*; CO<sub>2</sub> sensitivity in *Drosophila*; cytoplasmic inheritance in mitochondria and plastids; Shell coiling in snails; eye colour in flour moth.

Sex Chromosomes, Mechanisms of sex determination; Genic balance mechanism.

Sex-linked inheritance- X linked and Y linked inheritance.

### **MODULE III: Genetic variation due to chromosome structure and number**

**15 hrs**

Chromosomal aberrations – duplications, deletions, inversions and translocation

Variations in chromosome number; auto-and allo-polyploidy - types and effects; artificial induction of polyploidy. Auto and allo-polyploid crop species Aneuploid segregations in plants- tetrasomics and

nullisomics; triploid and tetraploid plants. Applications of polyploidy.

**TOTAL 45 hrs**

Course Title : **CYTOGENETICS (PRACTICAL)**

Course Code : **UG-BOT-205**

Credits : **01**

Marks : **25**

Duration : **30 hours (15 sessions)**

<b>Sr. No.</b>	<b>Practical Title</b>	<b>Practical sessions</b>
1.	Study of Mitosis and meiosis using suitable plant material	03
2.	Karyotype analysis and preparation of ideogram	02
3.	Detection of anomalies in cell division using suitable plant material.	02
4.	Study of multiple allelism in blood groups of human beings.	01
5.	Effect of physical and chemical mutagen on seed germination	03
6.	Preparation of chromosome maps from 3-point test cross data and calculation of Interference and coincidence	01
7.	Induction of polyploidy using Colchicine treatment.	02
8.	Study of sex-linked inheritance	01
	<b>Total</b>	<b>15</b>

**List of books recommended for reference:**

**Mandatory References:**

1. Gardner, E.J., Simmons, M.J. and Snustad, D.P. (1991) Principles of Genetics (8th edition). John Wiley & sons, India.
2. Gardner, Eldon J.; Snustad, Peter D.; (1984) Principles of Genetics; 7th edition; New York: John Wiley & Sons.
3. Griffiths, A.J.F., Wessler, S.R., Carroll, S. B. and Doebley, J. (2010) Introduction to Genetic Analysis (10th edition). W. H. Freeman and Co., U.S.A.
4. Gupta, P.K. (1990) Genetics. Rastogi Publications .
5. Gupta, P.K.; (2004) Cytogenetics; 1st edition, reprint; Meerut: Rastogi Publications.
6. Gupta, P.K.; Genetics: A textbook for University students; 3rd edition; Meerut: Rastogi Publications (2007).
7. Klug, W.S., Cummings, M.R. and Spencer, C.A. (2009) Concepts of Genetics, (9 th edition). Benjamin Cummings, U.S.A.
8. Pierce, B. (2008) Genetics : A Conceptual Approach 3rd Edition, Freeman & Co.
9. Shukla, R.S. and Chandel, P.S.; (2007) Cytogenetics, Evolution, Biostatistics and Plant Breeding.
10. Snustad, P. and Simmons, M. (2006) Principles of Genetics, 4th Edition, John Wiley and Sons Co.
11. Verma, P.S., Agarwal, V. K. (2009) Genetics, (9th Revised Edition). S. Chand and Co., New Delhi.
12. W. S. Klug, M. R. Cummings, C. A. Spencer. (2006) Concepts of Genetics 8 Edition, Pearson Education International.

**Supplementary References:**

1. Russell, P. (2006) Genetics 2nd Edition, Pearson International (2006).
2. Watson, J. D., Baker, T. A. Bell, S. P. Gann, A. Levine, M. Losick, R. (2004) Molecular Biology of the Gene 5th Edition, Pearson Education.

**Web References:**

1. <https://ndli.iitkgp.ac.in>

Course Title : **PLANT BREEDING AND BIOSTATISTICS (THEORY)**

Course Code : **UG-BOT-206**

Credits : **03**

Marks : **75**

Duration : **45 hours**

### **COURSE OBJECTIVES:**

To enable the students to learn various techniques in plant breeding with regards to crop productivity.

### **COURSE OUTCOMES:**

Upon successful completion of the course, students will be able:

**CLO1:** Identify and assess the role of various institutions, certification programs and breeders, rights in plant breeding.

**CLO2:** Describe and compare various techniques in hybridization and mutation breeding

**CLO3:** Analyze and practice various bio statistical methods.

**CLO4:** Interpret, analyse and evaluate various experiments in plant breeding and biostatistics.

### **MODULE I: INTRODUCTION TO PLANT BREEDING, ORGANISATIONS AND CERTIFICATIONS** **15 hrs**

Introduction, history, objectives, achievements and prospects. Centres of origin of crop plants. Organizations & their mandate – CCARI- ICAR, ICRISAT, IRRI (Indian & International) Plant breeders' & Farmers' Rights, Phytosanitary and Seed Certifications.

### **MODULE II: HYBRIDISATION, HETEROSIS, INBREEDING DEPRESSION AND MUTATION BREEDING** **15 hrs**

Pure line and mass selection, Types and Techniques in hybridization. Introduction, domestication and acclimatization. Heterosis and inbreeding depression.

Varieties developed in India through mutation breeding; Limitations of mutation breeding.

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**MODULE III: BIostatistical METHODS AND GENETICS OF PATHOGENICITY**

**15 hrs**

Introduction to biostatistics: Terms used in biostatistics, types of data, Sampling theories- random sample, sample size determination, precision, data collection, processing and presentation of data: qualitative and quantitative data.

Measures of central tendency: Mean, Median, Mode. Measures of variation: standard deviation, standard error. Concept of correlation between two variables and regression line, Chi square.

Physiological races and types. Genetics of pathogenicity; vertical and horizontal resistance & breeding for various abiotic and biotic stresses in rice/wheat.

**TOTAL            45 hrs**

Course Title : **PLANT BREEDING AND BIostatISTICS (PRACTICAL)**

Course Code : **UG-BOT-206**

Credits : **01**

Marks : **25**

Duration : **30 hours (15 sessions)**

<b>Sr. No.</b>	<b>Practical Title</b>	<b>Practical sessions</b>
1.	Emasculation and bagging of flowers using suitable plant material and Estimation of fruit and seed set in emasculated flowers	03
2.	Correlation of floral structure with pollination system	01
3.	Estimation of pollen fertility (pollen viability) in locally grown crop species (any two).	02
4.	Study of centres of origin of some important crop plants.	01
5.	Study of soil pH using different soil types & relate it to crops	01
6.	Analysis of data for mean, median & mode, Standard deviation	03

and standard error using suitable plant samples

7.	Determination of correlation and regression, Chi square analysis	03
8	Visit to CCARI- ICAR	01
	<b>Total</b>	<b>15</b>

### List of books recommended for reference:

#### Mandatory References:

1. Acquaah, G. (2007) Principles of Plant Genetics & Breeding. Blackwell Publishing.
2. Mahajan, B.K.; (1997) Methods in biostatistics; 6th edition; New Delhi:Jaypee Brothers.
3. Shukla, R.S. and Chandel, P.S.; (2007) Cytogenetics, Evolution, Biostatistics and Plant Breeding.
4. Singh, B.D. (2005) Plant Breeding: Principles and Methods (7th edition). Kalyani Publishers, Ludhiana.
5. Singh, B.D.; (2009) A textbook of Plant Breeding; Kalyani Publishers.
6. Zar J H, (1998) Biostatistical analysis 4th ed. Prentice Hall.

#### Supplementary References:

1. Sokal R R and Rahlf H A. (1995) Biometry: the principles and practice of Statistics for Biology. research. 3rd edi W H Freeman and Co.

#### Web References:

1. <https://icar.org.in>
2. <https://ndli.iitkgp.ac.in>

Course Title : **ECOLOGY AND CONSERVATION (THEORY)**

Course Code : **UG-BOT-207**

Credits : **03**

Marks : **75**

Duration : **45 hours**

### **COURSE OBJECTIVES:**

Objective of this paper is to provide introductory knowledge on biotic and abiotic environmental factors, pollution and phytogeography with regards to Government regulations towards environmental management with respect to agriculture and food security.

### **COURSE OUTCOMES:**

Upon successful completion of the course, students will be to:

**CLO1:** Discuss, explain and review the concept of ecosystem, phytogeography and population ecology.

**CLO2:** Analyze and evaluate the pollution scenario of the area and relate the theory in the natural environment and work towards conservation of the environment and its legalities.

**CLO3:** Quantitatively estimate the oxygen and Carbon dioxide from different water samples.

**CLO4:** Evaluate and determine minimum area of sampling unit (using quadrant) for the study of local vegetation.

### **MODULE 1: CONCEPT OF ECOSYSTEM, PHYTOGEOGRAPHY AND POPULATION ECOLOGY** **15 hrs**

Concept of Ecosystem, Ecological adaptations of plants belonging to following ecological groups: Hydrophytes, Xerophytes and Halophytes. Shelford's law of tolerance. Introduction to Species diversity indices (Simpson's & Shannon-Weiner) of herbaceous vegetation.

Phytogeography – plant distribution, theories on plant distribution; Endemism, Biomes of the world and phytogeographical regions of India.

Population Ecology: Survivorship curves- Type I, Type II, Type III.

Population growth: Population growth curves – Carrying capacity K, Exponential growth (J shaped curve) and Logistic growth (S shaped curve).



**MODULE II: ECOLOGICAL FACTORS AND COMMUNITY RELATIONSHIPS**

**15 hrs**

Light - quality, duration, absorption, intensity & effects on plants.

Temperature-variation due to altitude effects on plants, thermal constant and stratification. Water-precipitation, moisture & measurement of rainfall, Wind - speed, advantages and damages caused to plants. Soil- Soil profile, texture, classification and organic matter. Community relationships: Biotic interactions, Gaia Hypothesis, Introduction to Optimal foraging theory.

**MODULE III: POLLUTION, LAWS AND ORGANISATIONS**

**15 hrs**

Air pollution- polluting gases; ozone depletion, greenhouse effect, global warming, acid rain and smog. Water pollution-eutrophication, sewage, industrial waste, heavy metal Pollution. Soil pollution – chemical pollutants and Bioremediation. Forest conservation act, Indian forest act, Biodiversity act, Western Ghat. Protection act, Kasthurirangan Act, Gadgil committee report, Mining committee reports, wild life act (recent acts to be studied). Organizations (National & International) working for conservation (NEERI, TERI, MSSRF, IUCN, TRAFFIC).

**TOTAL 45 hrs**

Course Title : **ECOLOGY AND CONSERVATION (PRACTICAL)**

Course Code : **UG-BOT-207**

Credits : **01**

Marks : **25**

Duration : **30 hours (15 sessions)**

<b>Sr. No</b>	<b>Topics</b>	<b>Practical Sessions</b>
1.	Study of ecological instruments i.e. lux meter, rain gauge, hygrometer, wet and dry bulb thermometer, maximum and minimum thermometer.	02
2.	To study the physical and chemical characters (moisture, texture and pH) of Sand, Loam and Clay.	02

3. Analysis of different water samples for oxygen and carbon-dioxide content. 03
4. Estimation of total carbonates from soil sample 01
5. Visual interpretation of remotely sensed image for vegetation types (Land use land cover, NDVI) 01
6. Anatomical study of Hydrophytes (leaf), Xerophytes (succulents) and Halophytes (leaf) 01
7. Mini project: To determine minimum area of sampling unit (quadrat) for the study of local community and to determine species diversity index (Simpson's & Shannon-Weiner) of herbaceous vegetation. 05

**Total 15**

#### **REFERENCES:**

1. Ambasht, R.S. (1988). *A Text Book of Plant Ecology*. Varanasi: Students Friends Co.
2. Day A. K., (2002). *Environmental Chemistry*. Fourth Edition. New Delhi: New Age International Publishers.
3. Jogdand, SN, (1995), *Environmental Biotechnology*. Mumbai: Himalaya Publishing House.
4. Moore, P.W. and Chapman, S.B. (1986). *Methods in Plant Ecology*. Blackwell Scientific Publications.
5. Odum E.P. and Barret G.W., (2004) *Fundamental of Ecology*. Fifth edition, Brooks/Cole Publishers.
6. P. D. Sharma (2004), *Ecology and environment*. 7th edition, Meerut: Rastogi publications.
7. Piper, C.S. (1950). *Soil and Plant Analysis*. Australia: University of Adelaide,
8. Sangodkar U.M.X and Masur Patil Uma (2018). *Fundamentals in Environmental Biotechnology*, 1<sup>st</sup> Edition, CinnamonTeal Publishers.
9. Santra S.C., (2017). *Environmental Science*. New Delhi: New Central Agency.
10. Sharma B. K., (2001). *Environmental chemistry*. Sixth revised edition. Meerut: Goel publication house.
11. Sharma, P.D. (2017). *Ecology and Environment*. 13th edition. Meerut. Rastogi Publishers.
12. Subrahmanyam, N.S.; Sambamurty, A.V.S.S. (2006); *Ecology*; 2<sup>nd</sup> edition; New Delhi: Narosa Publishing House.

**Web links:**

1. Science Direct: <https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/carrying-capacity>.
2. World Wide Fund – India: <https://www.wwfindia.org/>
3. NEERI: <https://www.neeri.res.in/>
4. TRAFFIC: <https://www.worldwildlife.org/initiatives/traffic-the-wildlife-trade-monitoring-network>
5. International Union for conservation of nature: <https://www.iucn.org/>
6. MSSRF- <https://www.mssrf.org/>
7. TERI-<https://www.teriin.org/>

Course Title : **HORTICULTURE, FLORICULTURE & LANDSCAPING (THEORY)**

Course Code : **UG-BOT- VOC 1**

Credits : **03**

Marks : **75**

Duration : **45 hours**

**COURSE OBJECTIVES:**

To provide entrepreneur opportunities.

**COURSE OUTCOMES:**

Upon successful completion of the course, students will be able to:

**CO1:** Explain the basics of Horticulture, floriculture and landscaping.

**CO2:** Outline the requirements for building up nurseries, garden, etc.

**CO3:** Demonstrate the technique of vegetative propagation of plants.

**CO4:** Identify and apply the scope of these fields in building up career.

**MODULE I: INTRODUCTION TO HORTICULTURE**

**15 hrs**

Definition and importance; scope of Pomoculture, Olericulture, Floriculture. Fertilizers: inorganic, Organic – biofertilizers: vermicomposting, green manure, algal culture, FYM. Pots (Earthen, Fibre, Polythene bags), potting and repotting; potting mixture; Top dressing. Irrigation: Surface, Sprinkle, Drip and Gravity irrigation.

**MODULE II: INTRODUCTION TO FLORICULTURE AND PROPAGATION METHODS**

**15 hrs**

Knowledge of annual, biennials and perennials with reference to ornamental flowers. Cultivation of commercial flowers – Rose, Jasmine, *Chrysanthemum.*, *Crossandra* & Orchid. Nursery maintenance; Cut flowers; flower arrangements (including ikebana); improving shelf life of cut flowers.

Sexual methods (seed propagation) – Definition, Merits and Demerits, Criteria for selection of seeds.

Asexual (Vegetative) propagation – Definition, and types- Cutting (root, stem, leaf), Layering (simple, air), Grafting (Whip, Approach) and Budding (T, patch), Stock –scion relationship in important horticultural crops.

**MODULE III: INTRODUCTION TO LANDSCAPING**

**15 hrs**

Types of gardens: Formal, informal and kitchen garden.

Locations in the garden with suitable plant examples- edges, hedges, fence, lawn, flower beds.

Avenue, water garden (with two examples of each). Focal point. Auto CAD in garden designing.

National parks, Botanical gardens, water garden, rockery plants, Bonsai techniques, Hydroponics.

Lawn making: steps in lawn making, grasses and maintenance.

Aftercare: Weeding, top dressing methods of pruning and topiary.

**TOTAL 45 hrs**

Course Title : **HORTICULTURE, FLORICULTURE & LANDSCAPING (PRACTICAL)**

Course Code : **UG-BOT-VOC 1**

Credits : **01**

Marks : **25**

Duration : **30 hours (15 sessions)**

<b>Sr. No.</b>	<b>Practical Title</b>	<b>Practical sessions</b>
1.	Preparation of nursery bed and polybag filling	01
2.	Preparation of potting mixture – Potting, repotting.	02
3.	Field work in cutting, grafting, budding, layering	02
4.	Garden designing using Auto CAD software/any app	01
5.	Familiarizing gardening tools and implements	01
6.	Flower arrangement	01
7.	Visit to nurseries, gardens and Report.	01
8.	Improving the shelf life of cut flowers using chemicals	01
9.	Mini Project:	05
	a) Establishment of vegetable garden using organic compost & vermicompost.	
	b) Preparation of organic compost & vermicompost.	
	<b>Total</b>	<b>15</b>

**REFERENCES:**

1. Edment Senn Andrews (1994) Fundamentals of Horticulture – Tata McGraw Hill Publishing Co., Ltd., Delhi.
2. Nayak, K.C. South Indian fruits and their culture P.L. Varadaraj & Co., & Lingichetti Street, Madras.
3. Randhava, G.S, (1973) – Ornamental horticultural in India Today and Tomorrow Printers and Publishers, New Delhi.
4. Swarup V. (1997). Ornamental horticulture. MacMillan India Limited, New Delhi.
5. Trivedi TP (2007). Ornamental horticultural in India. Indian Council of Agricultural Research New Delhi.

**WEBLINK**

1. [http://agritech.tnau.ac.in/horticulture/horti\\_index.html](http://agritech.tnau.ac.in/horticulture/horti_index.html)

**Annexure I:**

**(Summary of changes incorporated in the existing approved syllabus if any)**

Semester	Course Title	Existing (Indicate only the unit where the change is proposed)	Changes Proposed	Specify the reason for the change
II	<i>Ethno-botanical Concepts</i> Course replaced by <b><i>Kitchen Gardening</i></b> Course	<i>Ethno-botanical Concept</i> Course	<b><i>Kitchen Gardening</i></b> Course	Considering the difficulty level of a technical paper i.e. <i>Ethno-botanical Concepts</i> , for B.A. students, it was replaced with a more generic paper i.e. <b><i>Kitchen Gardening</i></b>