Four Years Graduate Programme in
BOTANY
(NEP – 2020)

DISCIPLINE CORE PAPERS (DSC)

Sl. No.	Semester Details	Subject	Paper No
1	Semester I	Microbial Diversity and Technology	**A-1**
2	Semester II	Diversity and Conservation of Non Flowering Plants	**A-2**
3	Semester III	Plant Anatomy and Development Biology	**A-3**
4	Semester IV	Ecology and Conservation Biology	**A-4**
5	Semester V	Plant taxonomy and Resource Botany	**A-5**
		Genetics and Cell Biology	**A-6**
6	Semester VI	Plant Physiology and Biochemistry	**A-7**
		Plant Biotechnology	**A-8**
7	Semester VII	Molecular Biology	**A-9**
		Seed Biology and Seed Technology	**A-10**
		Plant Health Technology	**A-11**
8	Semester VIII	Medicinal Plants and Phytochemistry	**A-12**
		Bioinformatics and Computational Biology	**A-13**
		Research Methodology	**A-14**

CORE SPECIFIC ELECTIVE PAPERS (DSE)

Sl No.	Semester Details	Subject: Botany	Credits	Paper No
1	Semester V	**DSE 1:** Algal and Fungal Biotechnology	03	E-1
2	Semester VI	**DSE 2:** Herbal Technology	03	E-2
3	Semester VII	**DSE 3:** Plant Propagation and Tissue Culture	03	E-3
4	Semester VIII	**DSE 4:** Landscaping, Gardening and Green House Technology	03	E-4

B.Sc. BOTANY: Semester - 1

Title of the Course: Microbial Diversity and Technology

Number of Theory Credits	Number of lecture hours/semester	Number of practical Credits	Number of practical hours / semester
4	**56**	**2**	**56**

Content of Theory Course 1	56 Hrs
Unit –1	15
Chapter No. 1: Microbial diversity-Introduction to microbial diversity; Hierarchical organization and positions of microbes in the living world: Whittaker's five-kingdom system and Carl Richard Woese's three-domain system. Distribution of microbes in soil, air, food and water. Significance of microbial diversity in nature.	5
Chapter No. 2 History and development of microbiology-Microbiologists and contributions of - Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Dmitri Iwanowski, Sergius Winogradsky and M W Beijerinck and Paul Ehrlich**.** Contributions of any two Indian microbiologists.	5
Chapter No. 3 Microscopy-Working principle and applications of light, dark field, phase contrast and electron microscopes (SEM and TEM). Microbiological stains (acidic, basic and special) and Principles of staining. Simple, Gram's and differential staining.	5

Unit – 2	15
Chapter No. 4. Culture media for Microbes-Natural and synthetic media, Routine media -basal media, enriched media, selective media, indicator media, transport media, and storage media.	5
Chapter No. 5. Sterilization methods -Methods of disinfection: antiseptic, tyndallisation and Pasteurization. **Sterilization-**Physical methods: dry heat, moist heat, UV light, ionization radiation, filtration. Chemical methods - phenolic compounds, anionic and cationic detergents.	5
Chapter No. 6. Microbial Growth-Microbial growth and measurement. Nutritional types of Microbes- autotrophs and heterotrophs, phototrophs and chemotrophs; lithotrophs and organotrophs.	5
Unit – 3	11
Chapter No. 7 Microbial cultures and preservation-Microbial cultures. Pure culture and axenic cultures, subculturing. Preservation methods-overlaying cultures with mineral oils, lyophilisation. Microbial culture collections and their importance. A brief account on ITCC, MTCC and ATCC.	5
Chapter No. 8. Viruses- General structure and classification of Viruses; ICTV system of classification. Structure and multiplication of TMV, SARS-COV-2, and Bacteriophage (T2). Cultivation of viruses. Vaccines and types.	4
Chapter No. 9. Viroids- general characteristics and structure of Potato Spindle	2

Tuber Viroid (PSTVd); Prions - general characters and Prion diseases**.** Economic importance of viruses.	
Unit – 4	15
Chapter No. 10. Bacteria- General characteristics and classification.(Bergey's classification) Archaebacteria and Eubacteria. Ultrastructure of Bacteria; Bacterial growth and nutrition. Reproduction in bacteria- asexual and sexual methods. Study of *Rhizobium* and its applications. A brief account of Actinomycetes. Mycoplasmas and Phytoplasmas- General characteristics and diseases.	5
Chapter No. 11. Fungi-General characteristics and classification (Alexopoulos classification). Thallus organization and nutrition in fungi. Reproduction in fungi (asexual and sexual). Heterothallism and parasexuality. Type study: Morphology of *Phytophthora,Rhizopus, Neurospora, Puccinia, Penicillium and Trichoderma***.** Morphology and reproduction of Phytophthora and Puccinia. VAM **Fungi** and their significance. **Microbial plant diseases**-Late Blight of Potato, Black stem rust of wheat; Downy Mildew of Bajra, Grain smut of Sorghum, Sandal Spike, Citrus Canker, Root Knot Disease of Mulberry. Economic importance of Fungi.	7
Chapter No. 12. Lichens – Structure and reproduction.	3

References

1. Ananthnarayan R and Panikar JCK. 1986. Text book of Microbiology. Orient Longman ltd. New Delhi.
2. Arora DR. 2004. Textbook of Microbiology, CBS, NewDelhi.
3. William CG. 1989. Understanding microbes. A laboratory text book for Microbiology. W.H. Freeman and Company. New York.
4. Dubey RC and Maheshwari DK. 2007. A textbook of Microbiology, S. Chand and Company, NewDelhi.
5. Dubey RC and Maheshwari DK. 2002. A Text book of Microbiology, S.C.Chand and

Company, Ltd. Ramnagar, New Delhi.

6. Sharma R. 2006. Text book of Microbiology. Mittal Publications. New Delhi. 305pp.
7. Sharma PD. 1999. Microbiology and Plant Pathology. Rastogi publications. Meerut, India.
8. Vasanthkumari R. 2007. A textbook of Microbiology, BI Publications Pvt. Ltd., New Delhi.
9. Alexepoulos CJ and Mims CW. 1989. Introductory Mycology, Wiley Eastern Ltd., NewDelhi.
10. Allas RM. 1988. Microbiology: Fundamentals and Applications, Macmillan publishing co. New York.
11. Brook TD, Smith DW and Madigan MT. 1984. Biology of Microorganisms, 4thed. Eaglewood Cliffts. N.J.Prentice- Hall. New Delhi.
12. Burnell JH and Trinci APJ. 1979. Fungal walls and hyphal growth, Cambridge UniversityPress. Cambridge.
13. Jayaraman J. 1985. Laboratory Manual of Biochemistry, Wiley Eastern Limited. New Delhi.
14. Ketchum PA. 1988. Microbiology, concepts and applications. John Wiley and Sons. New York.
15. Michel J, Pelczar Jr.EC and Krieg CR. 2005. Microbiology, Mc.Graw-Hill, New Delhi.
16. Powar CB and Daginawala. 1991. General Microbiology, Vol – I and Vol – II Himalaya publishing house,Bombay.
17. Reddy S and Ram. 2007. Microbial Physiology. Scientific Publishers, Jodhpur, 385pp.
18. Sullia SB and Shantharam S. 1998. General Microbiology. Oxford and IBH publishing Co.Pvt.Ltd. New Delhi.
19. Schlegel HG. 1986. General Microbiology. Cambridge. University Press. London, 587pp.
20. Roger S, Ingrahan Y, Wheelis JL, Mark L and Page PR. 1990. Microbial World5th edition. Prentice-Hall India, Pvt. Ltd. New Delhi.
21. Sullia SB. and Shantharam S. 2005. General Microbiology, Oxford and IBH, NewDelhi.

Content of Practical Course 1: List of Experiments to be conducted

Practical 1: Safety measures in microbiology laboratory and study of equipment/appliances used for microbiological studies (Microscopes, Hot air oven, Autoclave/Pressure Cooker, Inoculation needles/loop, Petri plates, Incubator, Laminar flow hood, Colony counter, Haemocytomer, Micrometer.

Practical 2: Preparation of culture media (NA/PDA) sterilization, inoculation, incubation of *E coli / B. subtilis/* Fungi and study of cultural characteristics.

Practical 3: Enumeration of soil/food /seed microorganisms by serial dilution technique.

Practical 4: Preparation of agar slants, inoculation, incubation, pure culturing and preservation of microbes by oil overlaying.

Practical 5: Determination of cell count by using Haemocytometer and determination of microbial cell dimension by using Micrometer.

Practical 6: Simple staining of bacteria (Crystal violet /Nigrosine blue) / Gram's staining of bacteria.

Practical 7: Isolation and study of morphology of *Rhizobium* from root nodules of legumes

Practical 8: Preparation of spawn and cultivation of paddy straw (Oyster) mushroom.

Practical 9: Study of vegetative structures and reproductive structures of any six of the following: *Albugo,Phytophthora, Rhizopus/Mucor, Saccharomyces, Neurospora/ Sordaria, Puccinia, Agaricus, Lycoperdon, Aspergillus/Penicillium, Trichoderma.(Depending on local availability)*

Practical 10: Study of late blight of Potato, Downy mildew of Bajra, Citrus canker, Tobacco mosaic disease, Sandal spike disease.

Practical 11: Study of well-known microbiologists and their contributions through charts and photographs.

Practical-12: Visit to water purification units/Composting/ microbiology labs/dairy and farms to understand role of microbes in day today life. Field study report is to be documented in the practical record only.

Scheme of Formative Assessment : Semester - 1

Pedagogy:
Lectures, Practicals, Field and laboratory visits, Participatory Learning, Seminars, Assignments, specimen submission etc

Formative Assessment	
Assessment Occasion/ type	**Weightage in Marks**
I TEST	10
II TEST	10
ASSIGNMENT	10
SEMINAR	10
Total	40

B.Sc. BOTANY: Open Elective Course (OE-1)

I Semester

Title of the Course: Plants and Human Welfare

Course Outcome:

On completion of this course, the students will be able to

1. To make the students familiar with economic importance of diverse plants that offer resources to human life.
2. To make the students known about the plants used as-food, medicinal value and also plant source of different economic value .
3. To generate interest amongst the students on plants importance in day today life, conservation, ecosystem and sustainability.
4.

Number of Theory Credits	Number of lecture hours/semester	Number of practical Credits	Number of practical hours / semester
3	30	0	00

Content of Theory Course 1	30 Hrs
Unit I	
Origin of Cultivated Plants. Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions. Crop domestication and loss of genetic diversity (Only conventional plant breeding methods). Importance of plant bio- diversity and conservation.	2
Unit II	
Cereals: Wheat and Rice (origin, evolution, morphology, post-harvest processing & uses).Green revolution. Brief account of millets and their nutritional importance.	3

Unit III	
Legumes: General account (including chief pulses grown in Karnataka- red gram, green gram, chick pea, soybean). Importance to man and ecosystem.	2
Unit IV	
Fruits: Mango,grapes and Citrus (Origin, morphology,cultivation ,processing and uses)	02
Unit V	
Cash crops: Morphology, new varieties and processing of sugarcane, products and by-products of sugarcane industry. Natural Rubber –cultivation, tapping and processing.	03.
Unit VI	
Spices: Listing of important spices, their family and parts used, economic importance with special reference to Karnataka. Study of fennel, clove, black pepper and cardamom.	03
Unit VII	
Beverages: Tea,Coffee(morphology,processing&uses)	02
Unit VIII	
Oils and fats: General description, classification, extraction, their uses and health implications; groundnut, coconut, sunflower and mustered (Botanical name, family & uses). Non edible oil yielding trees and importance as biofuel. Neem oil and applications.	02
Unit IX	
Essential Oils: General account. Extraction methods of sandal wood oil, rosa oil and eucalyptus oil. Economic importance as medicine, perfumes and insect repellents.	02

Unit X	
Drug-yielding plants: Therapeutic and habit-forming drugs with special reference to Cinchona, Digitalis, Aloe vera and Cannabis.	03
Unit XI	
Fibers: Classification based on the origin of fibers; Cotton and jute (origin morphology, processing and uses).	03
Unit XII	
Forests: Forest and forest products. Community forestry. Concepts of reserve forests, sanctuaries and national parks with reference to India. Endangered species and red data book.	03

Text Books and References

1. Kochhar, S.L. (2012). Economic Botany in Tropics. New Delhi, India: MacMillan & Co.
2. Wickens, G.E. (2001). Economic Botany: Principles &Practices.The Netherlands: Kluwer Academic Publishers.
3. Chrispeels, M.J. and Sadava, D.E. (1994) Plants, Genes and Agriculture.Jones& Bartlett - Publishers.

Scheme of Formative Assessment : (OE-1)

Semester - 1

Pedagogy:

Lectures, Practicals, Field and laboratory visits, Participatory Learning, Seminars, Assignments, specimen submission etc

Formative Assessment	
Assessment Occasion/ type	**Weightage in Marks**
I TEST	10
II TEST	10
ASSIGNMENT	10
SEMINAR	10
Total	40

B.Sc. BOTANY: Semester – 2

Title of the Course: Diversity of Non- Flowering Plants

Number of Theory Credits	Number of lecture hours/semester	Number of practical Credits	Number of practical hours/semester
4	56	2	56

Content of Theory Course 2	56Hrs
Unit –1	15
Chapter No. 1 Algae –Introduction and historical development in algology. Distribution of Algae. General characteristics, classification of algae by Fritsch. Diversity- habitat, thallus organization, pigments, reserve food, flagella types, life-cycle and alternation of generation in Algae.	5
Chapter No. 2 Morphology and reproduction and life-cycles of Nostoc, Scytonema, *Oedogonium, Chara, Sargassum and Polysiphonia*. Diatoms and their importance.	5
Chapter No. 3 Algal cultivation- a general account. Cultivation of microalgae- *Spirulina* and *Dunaliella;* Algal products- Food and Nutraceuticals, Feed stocks, food colorants; fertilizers, aquaculture feed; therapeutics and cosmetics; medicines; dietary fibres from algae. Algal blooms and toxins.	5
Unit – 2	15

Chapter No. 4. Bryophytes – General characteristics and classification (Rothmaler) of Bryophytes.	3
Chapter No. 5 Distribution, morphology, anatomy, reproduction and life-cycles of *Riccia, Anthoceros*, and *Funaria*. Ecological and economic importance of Bryophytes.	7
Chapter No. 6. . Pteridophytes- General characteristics and classification (Smith); Distribution, morphology, anatomy, reproduction and life-cycle in *Selaginella*, *Equisetum*, *Pteris* and *Marselia.*	5
Unit – 3	15
Chapter No. 7 A brief account of heterospory and seed habit. Stelar evolution in Pterodophytes. Affinities and evolutionary significance of Pteridophytes. Ecological and economic importance.	5
Chapter No. 8. Gymnosperms- General characteristics. Distribution and classification of Gymnosperms (Sporne). Study of the habitat, habit, anatomy, reproduction and life-cycle in Cycas, Pinus and Gnetum.	5
Chapter No. 9. Affinities and evolutionary significance of Gymnosperms. Economic importance of Gymnosperms - food, timber, industrial uses and medicines.	5
Unit – 4	11

Chapter No. 10. Origin and evolution of Plants: Origin and evolution of plants through Geological Time scale.	2
Chapter No. 11. Paleobotany- Paleobotanical records, plant fossils, Types of plant fossils - impressions, compressions, incrustation, actual remains petrifaction. Radiocarbon dating. A general account of fossil Bryophytes.	5
Chapter No. 12. Fossil taxa- *Rhynia, Lepidodendron, Cycadeoidea*. Contributions of Birbal Sahni. Birbal Sahni Institute of Paleosciences.	4

References:

1) Chopra, G.L. A text book of Algae. Rastogi & Co., Meerut, Co., New Delhi, Depot. Allahabad.

2) Johri, Lata anf Tyagi, 2012, A Text Book of, Vedam e Books, New Delhi.

3) Sharma, O.P. 1990. Text Book of Pteridophyta. McMillan India Ltd. New Delhi.

4) Sharma, O.P. 1992. Text Book of Thallophytes. McGraw Hill Publishing Co. New Delhi.

5) Sharma, O.P., 2017, Algae Singh-Pande-Jain 2004-05. A Text Book of Botany. Rastogi Publication, Meerut.

6) Sambamurty, A.V.S.S.. A Text Book of Algae. I.K. International Private Ltd., NewDelhi.

7) Agashe, S.N. 1995. Paleobotany. Plants of the past, their evolution,paleoenvironment and Allied plants. Hutchinson & Co., Ltd., London.

8) Anderson R.A. 2005, Algal cultural Techniques, Elsievier, London.

9) Publication, Application in exploration of fossil fuels. Oxford & IBH., New Delhi.

10) Eams, A.J., (1974) Morphology of vascular plants - Lower groups. Tata Mc Grew-Hill Publishing Co. New Delhi, Freeman & Co., New York.

11) Fritze, R.E. 1977. Structure and reproduction of Algae. Cambridge UniversityPress.

12) Goffinet B and Shaw A.J. 2009, Bryophyte Biology, 2nd ed. Cambridge UnversityPress, Cambridge.Gymnosperms.

13) Srivastava, H N, 2003. Algae Pradeep Publication, Jalandhar, India.

14) Kakkar, R.K. and B.R.Kakkar (1995) The Gymnosperms (Fossils and Living)Central Publishing House, Allahabad.

15) Kumar H. D., 1999, Introductory Phycology, Affiliated East-West Press, Delhi.

16) Lee, R.E., 2008, Phycology, Cambridge Unversity Press, Cambridge. 4th edition.McGraw Hill Publishing Co., New Delhi.

17) Parihar, N.S. 1970. An Introduction to Embryophyta. Vol. I. Bryophyta. CentralBook, Allhabad.

18) Parihar, N.S. (1976) An Introduction to Pteridophytes, Central Book Depot,Allhabad.

19) Parihar, N.S. 1977. The Morphology of Pteridophytes. Central Book Depot., Allahabad.Press, Cambridge.

20) Rashid, A. 1998. An Introduction to Pteridophyta. II ed., Vikas Publishing House, New Delhi.

21) Smith, G.M. 1971. Cryptogamic Botany. Vol. II. Bryophytes & Pteridophytes. Tata Tata McGraw Hill Publishing, New Delhi.

22) Smith, G.M. 1971. Cryptogamic Botny. Vol.I Algae & Fungi. Tata McGraw Hill Publishing. New Delhi.

23) Sporne, K.R. 1965. The Morphology of Gymnosperms. Hutchinson & Co., Ltd.,London.

24) Stewart, W.M. 1983. Paleobotany and the Evolution of Plants, CambridgeUniversity Cambridge.

25) Sundarajan, S. 1997. College Botany Vol. I. S Chand & Co. Ltd., New Delhi.

26) Vanderpoorten, A. and Goffinet, B. 2009, Introduction to Bryophytes, Cambridge Unversity Press, Cambridge.

27) Vashista, B.R. 1978. Bryophytes. S Chand & Co. Ltd., New Delhi.

Content of Practical Course 2: List of Experiments to be conducted

Practical-1: Study of morphology, classification, reproduction and lifecycle of *Nostoc*, *Scytonema*, *Oedogonium.*

Practical-2: Study of morphology, classification, reproduction and life-cycle of *Chara, Sargassum*, *Polysiphonia/ Batrachospermum*.

Practical -3: Study of important blue green algae causing water blooms in the lakes.

Practical-4: Study of morphology, classification, reproduction and life-cycle of *Riccia/Anthoceros.* Any one locally available moss.

Practical-5: Study of morphology, classification, anatomy, reproduction and life-cycle of *Selaginella and Equisetum.*

Practical -6: Study of morphology, classification, anatomy, reproduction and life-cycle of *Pteris* and *Marselia*.

Practical -7: Study of morphology, classification, anatomy and reproduction in *Cycas*.

Practical -8: Study of morphology, classification, anatomy and reproduction in *Pinus*.

Practical -9: Study of morphology, classification, anatomy and reproduction in *Gnetum*.

Practical -10: Study of important ornamental ferns.

Practical -11: Preparation of natural media and cultivation of *Azolla* in artificial ponds.

Practical -12: Media preparation and cultivation of *Spirulina*.

Practical -13: Study of different algal products and fossils impressions and slides.

Practical-14: Visit to algal cultivation units/lakes with algal blooms/Fern house/Nurseries/Geology museum/lab to study plant fossils and the report is to be documented in the practical record.

Scheme of Formative Assessment : Semester - 2

Pedagogy:

Lectures, Practicals, Field and laboratory visits, Participatory Learning, Seminars,Assignments, specimen submission etc

Formative Assessment	
Assessment Occasion/ type	**Weightage in Marks**
I TEST	10
II TEST	10
ASSIGNMENT	10
SEMINAR	10
Total	40

B.Sc. BOTANY: Open Elective Course (OE-2)

II Semester

Title of the Course: Plant Propagation, Nursery management and Gardening

Paper Outcome:

On completion of this course, the students will be able to

1. To gain knowledge of gardening, cultivation, multiplication, raising of seedlings of garden plants.

2. To get knowledge of new and modern techniques of plant propagation.

3. To develop interest in nature and plant life.

5.

Number of Theory Credits	Number of lecture hours/semester	Number of practical Credits	Number of practical hours / semester
3	30	0	00

Content of Theory Course 1	36 Hrs
Unit I	
Nursery: Definition, objectives and scope and general practices and building up of infrastructure for nursery, planning and seasonal activities. Planting - direct seeding and transplants, Soil free/soilless/ synthetic growth mediums for pots and nursery.	04
Unit II	
Seed: Structure and types - Seed dormancy; causes and methods of breaking dormancy. Seed storage: Seed banks, factors affecting seed viability, genetic erosion Seed production technology. Seed testing and certification.	06
Unit III	

Vegetative propagation: Air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings. Hardening of plants .Green house ,mist chamber, shed root, shade house and glass house.	06
Unit IV	
Gardening: Definition, objectives and scope. Different types of gardening - landscape and home/terrace gardening, parks and its components. Plant materials and design. Computer applications in landscaping, Gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting.	08
Unit V	
Sowing/raising of seeds and seedlings - Transplanting of seedlings - Study of cultivation of different vegetables and flowering plants: cabbage, brinjal, lady's finger, tomatoes, carrots, bougainvillea, roses, geranium, ferns, petunia, orchids etc. Storage and marketing procedures. Developing and maintence of different types of lawns. Bonsai technique.	06

Text Books and References

1. Agrawal, P.K. (1993). Hand Book of Seed Technology. New Delhi, Delhi: Dept. of Agriculture and Cooperation, National Seed Corporation Ltd.
2. Bose T.K., Mukherjee, D. (1972). Gardening in India. New Delhi, Delhi: Oxford & IBH Publishing Co.
3. Jules, J. (1979). Horticultural Science, 3rd edition. San Francisco, California: W.H. Freeman and Co.
4. Kumar, N. (1997). Introduction to Horticulture. Nagercoil, Tamil Nadu: Rajalakshmi Publications.

Additional Resources:

1. Musser E., Andres. (2005). Fundamentals of Horticulture. New Delhi, Delhi: McGraw Hill Book Co.
2. Sandhu, M.K. (1989). Plant Propagation. Madras, Bangalore: Wile Eastern Ltd.

Scheme of Formative Assessment : (OE-2)

Semester - 2

Pedagogy:

Lectures, Practicals, Field and laboratory visits,Participatory Learning, Seminars, Assignments, specimen submission etc

Formative Assessment	
Assessment Occasion/ type	**Weightage in Marks**
I TEST	10
II TEST	10
ASSIGNMENT	10
SEMINAR	10
Total	40

Mangalore University

Question paper pattern of UG Botany Core subject

Total marks **60**

PART A

I. Answer any **Five** of the following (5X2=10)

(Two questions from each unit)

1.

2.

3.

4.

5.

6.

7.

8.

PART B

UNIT 1

9. a) 4 marks

b) 4 marks

OR

10. a) 5 marks

b) 3 marks

UNIT 2

11. a) 4 marks

b) 4 marks

OR

12. a) 5 marks

b) 3 marks

UNIT 3

13. a) 4 marks

b) 4 marks

OR

14. a) 5 marks

b) 3 marks

UNIT 4

15. a) 4 marks

b) 4 marks

OR

16. a) 5 marks

b) 3 marks

PART C

III. Answer any **Three** of the following (6X3=18)

17.

18.

19.

20.

B.Sc. BOTANY: Semester III

Theory: Discipline Specific Core Course (DSCC)

Title of the Course and Code:

BOT-A-3.1: PLANT ANATOMY AND DEVELOPMENT BIOLOGY

Course No.	Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/ Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
BOT-A-3.1	DSCC	Theory	04	04	56 hrs	2hrs	40	60	100

Course Outcome:

On completion of this course, the students will develop the following skills:

1. Observation of variations that exist in internal structure of various parts of a plant and among different plant groups in support of the evolutionary concept.
2. Skill development for the proper description of internal structure using botanical terms, their identification and further classification.
3. Induction of the enthusiasm on internal structure of locally available plants.
4. Understanding various levels of organization in a plant body with an outlook in the relationship between the structure and function through comparative studies.
5. Observation and classification of the floral variations from the premises of college and house.
6. Understanding the various reproductive methods sub-stages in the life cycle of plants
7. Observation and classification of the embryological variations in angiosperms.
8. Enthusiasm to understand evolution based on the variations in reproduction among plants

PLANT ANATOMY

Unit 1: Plant Cells, Tissues and Tissue systems 14 Hrs

Introduction, objectives and scope of Plant Anatomy; General structure of plant cells - structure of plant cell wall.

Tissue and tissue systems - Definitions, structure and functions of Meristematic tissues and permanent tissues (Simple and Complex). A brief account of plant secretary tissues/cells. Concept of tissue systems - Ground tissues, Dermal tissues and Vascular tissues.

Classification of meristems: Based on location (apical, intercalary and lateral), Origin (promeristem, primary and secondary meristem) and function (protoderm, procambium and ground meristem).

Apical meristems*:* Generalised structure of shoot apex, theories on organization of Shoot Apical Meristem (SAM) - Apical cell theory, Tunica-Corpus theory and Histogen theory. Generalised structure of root apex, theories on organisation of Root Apical Meristem (RAM) – Apical Cell Theory, Histogen theory, Quiescent centre theory and Korper – Kappe theory.

Unit II: Primary and Secondary anatomy of Angiosperms 14 Hrs

Primary anatomy of root: Dicot (Tridax/Sunflower), monocot (Maize).

Primary anatomy of stem: Dicot (Tridax/Sunflower), Monocot (Maize), Nodal anatomy.

Anatomy of leaf: Dicot (Tridax/Sunflower), Monocot (Maize). Types of trichomes and stomata.

Secondary Growth: Normal Secondary growth in stem and root (Tridax/Sunflower). Anomalous secondary growth in *Aristolochia* and *Boerhaavia* (dicot stem), *Dracaena* (monocot stem).

Applications of anatomy in Plant systematics, forensics and Pharmacognosy.

DEVELOPMENT BIOLOGY

Unit III: Differentiation and Morphogenesis in Plants 14 Hrs.

Introduction to the concepts of differentiation and morphogenesis (definitions and significance in plant growth and development process). Concept of totipotency and de-differentiation.

Differentiation and cell polarity in acellular (*Dictyostelium*), Unicellular (*Acetabularia*) and multicellular plant system (*Arabidiopsis*).

Shoot Apical meristem (SAM): Origin, structure and function, Cytohistological zonation and Ultrastructure of meristems.

Organogenesis: Differentiation of root, stem, leaf and axillary buds; bud dormancy

Leaf development: Mechanism of leaf primordium initiation, development and Phyllotaxis, Diversity in size, shape and arrangement of leaves

Structure and function of root apical meristem (RAM): Root cap, quiescent centre and origin of lateral roots.

Flower development: Overview of flower initiation and development, Genetic control of flower development - ABC model of flower development. Senescence in plants – a general account.

Unit IV: Reproductive Biology 14 Hrs.

Introduction, Scope and contributions of Indian embryologists: P. Maheshwari, B G L Swamy

Microsporangium: Development and structure of mature anther; Anther wall layers; Tapetum -types, structure and functions; sporogenous tissue.

Microsporogenesis - Microspore mother cells, microspore tetrads and its types; Pollinia.

Microgametogenesis – Formation of vegetative and generative cells, structure of male gametophyte. Pollen embryosac (Nemec phenomenon).

Megasporangium – Structure of typical Angiosperm ovule.Types of ovules- Anatropous, Orthotropous, Amphitropous, Campylotropous, Circinotropous. **Megagametogenesis –**Female gametophyte embryosac- monosporic - *Polygonum* type, bisporic – *Allium* type, tetrasporic - *Fritillaria* type. Structure of mature embryosac.

Pollination and fertilization: Structural and functional aspects of pollen, stigma and style. Post pollination events; Current aspects of fertilization; Significance of double fertilization, Post fertilization changes.

Endosperm – Types and its biological importance. Free nuclear (*Cocos nucifera*), cellular (*Cucumis)*, helobial types. Ruminate endosperm.

Embryogenesis : Structure Dicot and Monocot seed, Dicot (*Capsella bursa-pastoris)*and Monocot (*Najas)* embryo development.

B.Sc. BOTANY: Semester III

Practical: Discipline Specific Core Course (DSCC)

Title of the Course and Code:

BOT-A-3.2: PLANT ANATOMY AND DEVELOPMENT BIOLOGY

Course No.	Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/ Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
BOT-A-3.2	DSCC	Practical	02	04	56 hrs	3hrs	25	25	50

LIST OF EXPERIMENTS

LIST OF EXPERIMENT TO BE CONDUCTED

Practical No.1

i) Study of meristem (Permanent slides/ Photographs).

ii) Study of Simple Tissues: Parenchyma, Collenchyma and Sclerenchyma

Practical No.2

Complex Tissues - xylem and phloem; Maceration technique to study elements of xylem and phloem

Practical No.3

Study of primary structure of dicot and monocot stem

Practical No.4

Study of primary structure of dicot and monocot root and leaf

Practical No. 5

Study of Normal secondary growth structure in dicot stem and root (Sunflower) and Anomalous secondary growth: *Aristolochia, Boerhaavia* (dicot stem) *Dracaena* (monocot stem)

Practical No. 6

Study of trichomes (any three types) and stomata (any three types) with the help of locally available plant materials

Practical No. 7

Permanent slides of Microsporogenesis and male gametophyte Mounting of Pollen grains of Grass and *Hibiscus* and Pollinia of *Calotropis*

Practical No. 8

Pollen germination (hanging drop method) and Effect of Boron and Calcium on pollen germination

Practical No. 9

Permanent slides of types of ovules, Megasporogenesis and embryosac development.

Practical No. 10

Types of placentation: Axile, Marginal and Parietal types. Sectioning of ovary, for the studied types of placentation

Practical No. 11

Mounting of embryo: Any locally available seeds. Tridax and Cyamopsis, Mounting of endosperm: *Cucumis*

Practical No. 12

Histochemical localization of proteins/ carbohydrates

Practical No. 13 and 14

Mini project work in groups of 3-5 students, from the following list. This is to be recorded in the practical record book.

a) Study of pollen morphology of different flowers with respect to shape, colour, aperture etc.

b) Pollen germination of different pollen grains and calculating percentage of germination.

c) Calculating percentage of germination of one particular type of pollen grain collected from different localities/ under different conditions.

d) Study of placentation of different flowers.

e) Any other relevant study related to Anatomy / Embryology.

Text Books for Reference:

1. Bhojwani and Bhatnagar, Introduction to Embryology of Angiosperms –Oxford & IBH, Delhi
2. Bhojwani Sant Saran, 2014.Current Trends in the Embryology of Angiosperms**,** Woong-Young Soh, Springer Netherlands,
3. Coutler E. G. , 1969. Plant Anatomy – Part I Cells and Tissues – Edward Arnold, London.
4. Dickison, W.C. (2000). Integrative Plant Anatomy, Harcourt Academic Press, USA
5. Eames A. J. - Morphology of Angiosperms - Mc Graw Hill, New York.
6. Esau, K. 1990. Plant Anatomy, Wiley Eastern Pvt Ltd New Delhi
7. Evert, R.F. (2006) Esau's Plant Anatomy: Meristem, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. John Wiley and Sons, Inc
8. Fahn, A.1992. Plant Anatomy, Pergamon Press, USA
9. Johri, B.M. l., 1984.Embryology of Angiosperms, Springer-Verlag, Netherlands.
10. Karp G., 1985. Cell Biology; Mc.Graw Hill Company
11. Maheshwari,P 1950. An introduction to the embryology of angiosperms. New York: McGraw-Hill
12. Mauseth, J.D. (1988). Plant Anatomy, the Benjammin/Cummings Publisher, USA.
13. Nair P .K .K - Pollen Morphology of Angiosperms - Scholar Publishing House, Lucknow
14. Pandey S.N. 1997, Plant Anatomy and Embryology .A. Chadha, Vikas Publication House Pvt Ltd;
15. Pandey, B. P., 1997. Plant Anatomy, S.Chand and Co. New Delhi
16. Raghavan, V., 2000. Developmental Biology of Flowering plants, Springer, Netherlands.
17. Saxena M. R. – Palynology – A treatise - Oxford & I. B .H., New Delhi.

18. Shivanna, K.R., 2003. Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt.Ltd. Delhi.
19. Vashishta .P.C .,1984. Plant Anatomy – Pradeep Publications – Jalandhar
20. Vashishta, P.C. 1997. Plant Anatomy, Pradeep Publications
21. T Pullaiah, K C Naidu and K Lakhminarayana, 2017. Plant Development. Daya Publishing House, New Delhi.

Online Resources : https://onlinecourses.nptel.ac.in/noc19_bt17/preview

B.Sc. BOTANY –Semester III

Open Elective Course (OEC - 3)
(OEC for other students)
Paper: Community Forestry
Code: OEC-3.1

Course No.	Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
OEC-3.1	OEC	Theory	03	03	42 hrs	2 hrs	40	60	100

Learning outcomes:

After completion of the course, the students will be able to;

- Understand community forestry and its conservation
- Examine the use of trees and community forestry
- Interpret the role of indigenous / tribal people in conservation of forest
- Examine the role of various community forestry conservation programs
- Measure the different properties of trees such as wood volume, age, height etc.

Unit I — 14 lectures

Community forestry - Definition, Indigenous community based forestry systems, Case studies of indigenous forest management systems in India, History of commercial forestry in India, Diseases of commercial forestry, maintenance of forests, Protection from fire, illicit felling, Measurement of Trees- Height, girth, wood density, wood quality, clear and selective felling.

Unit II — 14 lectures

Role of community forestry in Environmental conservation, Water shed management, soil management and poverty reduction, Trees as a forest management tool, managing vegetation to modify climate, soil conditions & ecological processes. Social considerations on land-uses.

Unit III — 14 lectures

State-sponsored community forestry and conservation programs, Changing paradigms in forestry and environmental conservation, Community-managed commercial timber harvesting. Community based forestry and collaborative conservation in India. Factors contributing to the rise of community forestry, Role of tribes in forest management.

Suggested Reading

1. Agrawal, A and C.C. Gibson. (2001). Introduction: The Role of Community in Natural Resource Conservation. In: Agrawal, A and C. C. Gibson (eds).Communities and the Environment. NJ: Rutgers University Press

2. Mosse, D.(2001).‘People's knowledge’, participation and patronage: operations and representations in rural development. In: Cook, B & Kothari, U (eds), Participation the newtyranny? Zed Press

3. Ong, C.K. & Huxley, P.K. (1996). Tree Crop Interactions–A Physiological Approach. ICRAF.

4. Robinson, D. (2018). The Economic Theory of Community Forestry (Routledge Explorations in Environmental Economics) Routledge.

5. Sagreiya, K.P. (1979). Forests and Forestry. National Book Trust, India, New Delhi, P1-307.

B.Sc. BOTANY –Semester III
Open Elective Course (OEC - 3)
(OEC for other students)
Paper: Algal Cultivation and Applications
Code: OEC-3.2

Course No.	Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
OEC -3.2	OEC	Theory	03	03	42 hrs	2 hrs	40	60	100

Learning outcomes:

On completion of this course, the students will be able to;

- Understand core concepts and fundamentals of various levels of algal growth
- Translate various algal technologies for benefit of ecosystem
- Demonstrate algal growth in different types of natural water.
- Analyze emerging areas of Algal Biotechnology for identifying commercial potentials of algal products & their uses.

Unit I — 14 lectures

A brief account of culture techniques and media for algal research. Measurement of algal growth: lag phase, log phase, stationary phase and death phase using biomass, chlorophyll content. Limits to algal growth in natural waters. Dynamics and consequences of marine & freshwater algal blooms; Causative factors for eutrophication and its impact on algal blooms.

Unit II — 14 lectures

Algal immobilization: methods and applications, Algal technologies for the restoration/maintenance of soil fertility; reclamation of usar soils. Restoration of degraded aquatic systems through algae; High rate algal ponds for the treatment of wastewaters for the production of useful biomass & fuels.

Unit III — 14 lectures

Emerging areas of Algal Biotechnology: Single cell proteins, bio-fertilizers, Algae as food, medicine, feed, Biofuel, industrial products such as phyco-colloid Agar-agar, Algin, Carrageenan, Diatomite); A brief account of commercial potentials of algal products & their uses. Algae as indicators of pollution. Biofouling, Sewage disposal.Waste-land reclamation. Use of Algae in experimental studies. Algae in space. Algal toxins.

Suggested Readings

1. Hoek, C. and Van D. (2009) Algae: An Introduction to Phycology. Cambridge University Pres

2. Bast, F. (2014). An Illustrated Reviewon Cultivation and Life History of Agronomically Important Seapl ants. In Seaweed: Mineral Composition, Nutritional and Antioxidant Benefits and Agricultural Uses, Eds. Vitor Hugo Pomin, 39-70. Nova Publishers, New York ISBN:978-1-63117-571-8

3. Kumar, H.D.(1999). Introductory Phycology. Affiliated East-West Press, Delhi

4. Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization. Aravali International, NewDelhi.

5. Bast, F. (2014). Seaweeds: Ancestors of land plants with rich diversity. Resonance,19 (2)1032-1043*ISSN*:0971-8044

B.Sc. BOTANY – Semester III

Open Elective Course (OEC - 3)
(OEC for other students)
Paper: Landscaping and Gardening
Code: OEC-3.3

Course No.	Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
OEC -3.3	OEC	Theory	03	03	42 hrs	2 hrs	40	60	100

Learning outcomes:

After the completion of this course the learner will be able to:

- Apply the basic principles and components of gardening
- Conceptualize flower arrangement and bio-aesthetic planning
- Design various types of gardens according to the culture and art of bonsai
- Distinguish between formal, informal and free style gardens
- Establish and maintain special types of gardens for outdoor and indoor land scaping

Unit I — 14 lectures

Principles of gardening, garden components, adornments, lawn making, methods of designing rockery, water garden. Special types of gardens, their walk-paths, bridges, constructed features; their design, values in land scaping. planting trees, shrubs and herbaceous perennials. climbers and creepers, palms, ferns, grasses and succulents. Green house.

Unit II — 14 lectures

Flower gardens: importance, production details and cultural operations, constraints, post-harvest practices. Bio-aesthetic planning, definition, need, round country planning, urban planning and planting avenues in schools, villages, railway stations, dam sites, hydroelectric stations, colonies, river banks, play grounds.

Unit III — 14 lectures

Land scape designs, Urban land scaping, Land scaping for specific situations - institutions, industries, residents, hospitals, road sides, traffic islands, dam sites, IT parks, corporate; establishment and maintenance. Styles of garden - formal, informal and freestyle gardens. Types of gardens - vertical gardens, roof gardens, parks and public gardens, indoor gardening, therapeutic gardening. Culture of bonsai, art of making bonsai, non-plant components, water-scaping, xeri-scaping, hardscaping; Computer Aided Designing (CAD) for outdoor and indoor scaping, exposure to CAD (Computer Aided Designing). Eco-tourism.

Suggested Readings

1. Berry, F. and Kress, J. (1991). Heliconia: An Identification Guide. Smithsonian Books

2. Butts, E. and Stensson, K. (2012). Sheridan Nurseries: One hundred years of People, Plans, and Plants. Dundurn Group Ltd.

3. Russell, T.(2012). Nature Guide: Trees: The world in your hands (Nature Guides).

B.Sc. BOTANY: Semester IV

Theory: Discipline Specific Core Course (DSCC)

Title of the Course and Code:

BOT-A-4.1: Ecology and Conservation Biology

Course No.	Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/ Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
BOT-A-4.1	DSCC	Theory	04	04	56 hrs	2hrs	40	60	100

Course outcome:

1. A basic course to understand ecosystem functioning
2. Chapters on autecology, community ecology and population ecology can be of use in higher studies
3. Chapters on global warming and pollution of various kinds are very relevant and helps to appreciate these problems
4. It gives an exhaustive idea about biodiversity at different levels and groups of plants
5. A detailed account on endemism and the various uses of biodiversity further emphasises the importance of biodiversity
6. Also, there is a detailed study on the use of remote sensing in monitoring various aspects of diversity
7. With the tremendous human impact on biodiversity the course becomes very relevant

Contents of Theory Course

Unit 1	Topics	Teaching Hours
I	**Introduction to Ecology and Conservation Biology:** Definitions, Principles of Ecology, Brief History, Major Indian Contributions, Scope and importance. Ecological levels of organisation. **Ecological factors:** Climatic factors: light, temperature, precipitation and humidity. **Edaphic factors**: Soil and its types, soil texture, soil profile, soil formation; physico-chemical properties of soil - mineral particle, soil pH, soil aeration, organic matter, soil humus and soil microorganisms. Topographic Factors: Altitude **Ecological groups of plants and their adaptations:** Morphological and anatomical adaptations of hydrophytes, xerophytes, epiphytes and halophytes mesophytes	14 hrs
II	**Ecosystem Ecology:** Introduction, types of ecosystems with examples -terrestrial and aquatic, natural and artificial. Structure of ecosystem: Biotic and Abiotic components, detailed structure of a pond ecosystem. Ecosystem functions and processes: Food chain-grazing and detritus; Food web. Ecological pyramids -Pyramids of energy, biomass and number. Principles of Energy flow in ecosystem.	14 hrs

	Bio-geo chemical cycles: Gaseous cycles -carbon and nitrogen, Sedimentary cycle- Phosphorus. Ecological succession: Definition, types- primary and secondary. General stages of succession. Hydrosere and xerosere. **Community Ecology:** Community and its characteristics – frequency, density, Abundance, cover and basal area, phenology, stratifications, life-forms. Concept of Ecotone and Ecotypes. Intra-specific and Inter-specific interactions with examples. **Ecological methods and techniques:** Methods of sampling plant communities – transects and quadrates. Remote sensing as a tool for vegetation analysis, land use – land cover mapping. **Population Ecology:** Population and its characteristics – Population density, natality, mortality, age distribution, population growth curves and dispersal.	
III	**Phytogeography and Environmental issues:** Theory of land bridge, theory of continental drift, polar oscillations and glaciations. Centre of origin of plant-Vavilov's concept, types. Phytogeographical regions - concept, phytogeographical regions of India. Vegetation types of Karnataka – Composition and distribution of evergreen, semi-evergreen, deciduous, scrub, mangroves, shola forests and grasslands. An account of the vegetation of the Western Ghats. Pollution: Water pollution: Causes, effect, types; water quality indicators, water quality standards in India, control of water pollution; Waste water treatment. Water pollution disasters – National mission on clean Ganga, Minamata, Pacific gyre garbage patch, Exxon valdez oil spill. Air pollution: Causes, effect, air quality standards, control; acid rain, global warming, ozone depletion Soil pollution: Causes, effect, solid waste management, control measures of soil pollution.	14hrs
IV	**Biodiversity and its conservation:** Biodiversity: Definition, types of biodiversity - habitat diversity, species diversity and genetic diversity, Global and Indian species diversity. Sustainable development goals in biodiversity conservation. Values of Biodiversity – Economic and aesthetic value, Medicinal and timber yielding plants. NTFP. Concept of Biodiversity Hotspots, Biodiversity hot spots of India. Concept of endemism and endemic species. IUCN plant categories with special reference to Karnataka/ Western Ghats, Red data Book Biodiversity Conservation- Indian forest conservation act, Biodiversity bill (2002). Threats to biodiversity. Conservation methods *In-situ* methods –Biosphere reserves, National parks, Sanctuaries, Sacred grooves. *Ex-situ* methods-Botanical gardens, Seed bank, Gene banks, Pollen banks, Culture collections, Cryopreservation.	14 hrs
Total		**56 Hours**

SUGGESTED REFERENCE BOOKS:

1. Sharma, P.D. 2018. Fundamentals of Ecology. Rastogi Publications.
2. Odum E.P. (1975): Ecology By Holt, Rinert& Winston.
3. Oosting, H.G. (1978): Plants and Ecosystem Wadworth Belmont.
4. Kochhar, P.L. (1975): Plant Ecology. (9th Edn.,) New Delhi, Bombay, Calcutta-226pp.,
5. Kumar, H.D. (1992): Modern Concepts of Ecology (7th Edn.,) Vikas Publishing Co., New Delhi.
6. Kumar H.D. (2000): Biodiversity & Sustainable Conservation. Oxford & IBH Publishing Co Ltd. New Delhi.
7. Newman, E.I. (2000): Applied Ecology, Blackwell Scientific Publisher, U.K.
8. Chapman, J.L&M.J. Reiss (1992): Ecology (Principles & Applications). Cambridge University Press, U.K.
9. Malcolm L. Hunter Jr., James P. Gibbs, Viorel D. Popescu, 2020. Fundamentals of Conservation Biology, 4th Edition. Wiley-Blackwel.
10. Saha T. K., 2017. Ecology and Environmental Biology. Books and Allied Publishers.

B.Sc. BOTANY: Semester IV

Practical: Discipline Specific Core Course (DSCC)

Title of the Course and Code:

BOT-A-4.2: Ecology and Conservation Biology

Course No.	Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/ Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
BOT-A-4.2	DSCC	Practical	02	04	56 hrs	3hrs	25	25	50

List of Practicals

Practical No.	Experiments
1	Determination of pH of different types of Soils, Estimation of salinity of soil/water samples.
2	Study of Ecological instruments – Wet and Dry thermometer, Altimeter, Hygrometer, Soil thermometer, Rain Gauge, Barometer, etc
3	Determination of water holding capacity of soil samples
4	Determination of Biological oxygen demand (BOD)
5	Determination of Chemical oxygen demand (COD)
6	Determination of soil texture of different soil samples.
7	Hydrophytes: Morphological adaptations in *Pistia, Eichhornia, Hydrilla, Nymphaea.* Anatomical adaptations in *Hydrilla* (stem) and *Nymphaea* (petiole).
8	Xerophytes: Morphological adaptations in *Asparagus, Casuarina, Acacia, Aloe vera, Euphorbia tirucalli.* Anatomical adaptations in phylloclade of *Casuarina* .
9	Epiphytes: Morphological adaptations in *Acampe, Bulbophyllum, Drynaria*.Anatomical adaptations in epiphytic root of *Acampe/ Vanda.* Halophytes: study of Vivipary in mangroves; Morphology and anatomy of Pneumatophores.
10	Study of a pond/forest ecosystem and recording the different biotic and abiotic components
11	Demonstration of different types of vegetation sampling methods – transects and quadrats. Determination of Density and frequency.
12	Application of remote sensing to vegetation analysis using satellite imageries
13 and 14	Field visits to study different types of local vegetations/ecosystems and the report to be written in practical record book.

B.Sc. BOTANY –Semester IV
Open Elective Course (OEC - 4)
(OEC for other students)
Paper: Plant Diversity and Human Welfare
Code: OEC-4.1

Course No.	Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
OEC - 4.1	OEC	Theory	03	03	42 hrs	2 hrs	40	60	100

Learning outcomes:

After the completion of this course, the learner will be able to:

- Develop understanding of the concept and scope of plant biodiversity
- Identify the causes and implications of loss of biodiversity
- Apply skills to manage plant biodiversity
- Utilize various strategies for the conservation of biodiversity
- Concept ualize the role of plants in human welfare with special reference to India

Unit I: Plant Diversity and its Scope 14 lectures

Levels of biodiversity: Genetic, Species and Ecosystem; Agro-biodiversity and cultivated plant taxa and related wild taxa. Values and uses of Biodiversity, Methodologies for valuation, Ethical and aesthetic values, Uses of plants; Ecosystem services.

Unit II: Loss of Biodiversity and Management of Plant Biodiversity 14 lectures

Loss of biodiversity-causes and implications, Hotspots of biodiversity, extinction of species, projected scenario for biodiversity loss. Organizations associated with biodiversity management, IUCN, UNEP, WWF, UNESCO, NBPGR; Biodiversity legislation; Information management and communication.

Unit III: Conservation of Biodiversity, Role of Plants in Relation to Human Welfare 14 lectures

Conservation of genetic, species and ecosystem diversity, *In situ* and *ex situ* conservation strategies, India's biodiversity and its conservation Social approaches to conservation, Biodiversity awareness programmes, Sustainable development. Importance of forestry their utilization and commercial aspects; Avenue trees; Ornamental plants of India; Alcoholic beverages; Fruits and nuts; Wood and its uses; their commercial importance, NTFP,

Suggested Readings

1. Krishnamurthy, K.V. (2004).An Advanced Text Book of Biodiversity-Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi.
2. Singh, J. S., Singh, S.P. and Gupta, S.(2006). Ecology Environment and Resource

Conservation. Anamaya Publications, New Delhi, India.
3. Reddy, K.V. and Veeraiah, S. (2010). Biodiversity and Plant Resources. Aavishkar publication, New Delhi.
4. Heywood, V.H. and Watson, R.T.(1995). Global biodiversity and Assessment. Cambridge University Press.

B.Sc. BOTANY –Semester IV
Open Elective Course (OEC - 4)
(OEC for other students)
Paper: Medicinal Plants in Health Care
Code: OEC-4.2

Course No.	Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
OEC - 4.2	OEC	Theory	03	03	42 hrs	2 hrs	40	60	100

Learning outcomes:

On completion of this course, the students will be able to:

- Recognize the basic medicinal plants
- Apply techniques of conservation and propagation of medicinal plants.
- Setup process of harvesting, drying and storage of medicinal herbs
- Propose new strategies to enhance growth of medicinal herbs considering the practical issues pertinent to India

Unit I: History and Traditional System of Medicine **14 lectures**

History, Scope and Importance of Medicinal Plants; Traditional systems of medicine; Definition and Scope.

Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in ayurvedic treatments,

Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine.

Unani: History, concept: Umoor-e-tabiya, tumors treatments / therapy, polyherbal formulations.

Unit II: Conservation, Augmentation and Ethnobotany and Folk Medicine

14 lectures

Conservation of Endemic and endangered medicinal plants, Red list criteria; ***In situ*** conservation: Biosphere reserves, sacred groves, National Parks; ***Ex situ*** conservation: Botanic Gardens, Seed bank pollenbank cryopreservation.

Propagation of Medicinal Plants: Objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of greenhouse for nursery production, propagation through cuttings, layering, grafting and budding.

Ethnobotany and Folk medicines. Definition; Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: Folk medicines of ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India.

Unit III Medicinal Plants 14 lectures

Brief description of selected plants and derived drugs, namely Guggul (*Commiphora*) for hypercholesterolemia, *Boswellia* for inflammatory disorders, Arjuna (*Terminalia arjuna*) for cardioprotection, turmeric (*Curcuma longa*) for wound healing, antioxidant and anticancer properties, Kutaki (*Picrorhiza kurroa*) for hepatoprotection, Opium Poppy for analgesic and antitussive, Cinchona and Artemisia for Malaria, Rauwolfia as tranquilizer, Podophyllum as antitumor. Vinearosea as anticancerous, Morinda citrifolia, Acorus calamus, ocinunsanchem. Tinospora cordifolia, *Coleus amboinicu*, *Piper nigrum*

Suggested Readings:

1. Akerele, O., Heywood, V. and Synge, H. (1991). The Conservation of Medicinal Plants. Cambridge University Press.
2. AYUSH (www.indianmedicine.nic.in). About the systems—An overview of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy. New Delhi: Department of Ayurveda, Yogaand Naturopathy, Unani, Siddha and Homoeopathy (AYUSH), Ministry and Family Welfare, Government of India.
3. CSIR- Central Institute of Medicinal and Aromatic Plants, Lucknow (2016). *Aush Gyanya*: Handbook of Medicinal and Aromatic Plant Cultivation.
4. Dev, S. (1997). Ethno-therapeutics and modern drug development: The potential of Ayurveda. *Current Science* 73:909–928.
5. Evans, W.C. (2009). Trease and Evans Pharmacognosy, 16thedn. Philadelphia, PA: Elsevier Saunders Ltd.
6. Jain, S.K. and Jain, Vartika. (eds.) (2017). Methods and Approaches in Ethnobotany: Concepts, Practices and Prospects. Deep Publications, Delhi
7. Kapoor, L.D. (2001). Handbook of Ayurvedic medicinal plants. Boca Raton, FL: CRC Press.
8. Saroya, A.S. (2017). Ethnobotany. ICAR publication.
9. Sharma, R.(2003). Medicinal Plants of India-An Encyclopaedia. Delhi: Daya Publishing House.
10. Sharma, R. (2013) Agro Techniques of Medicinal Plants. Daya Publishing House, Delhi.
11. Thakur, R.S., H.S. Puri, and Husain, A.(1989). Major medicinal plants of India. Central Institute of Medicinal and Aromatic Plants, Lucknow, India.

B.Sc. BOTANY –Semester IV
Open Elective Course (OEC - 4)
(OEC for other students)
Paper: Floriculture
Code: OEC-4.3

Course No.	Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
OEC - 4.3	OEC	Theory	03	03	42 hrs	2 hrs	40	60	100

Learning outcomes:

After completing this course the learner will be able to;

- Develop conceptual understanding of gardening from historical perspective
- Analyze various nursery management practices with routine garden operations.
- Distinguish among the various Ornamental Plants and their cultivation
- Evaluate garden designs of different countries
- Appraise the landscaping of public and commercial places for floriculture.
- Diagnose the various diseases and pests of ornamental plants.

Unit I **14 lectures**

Introduction: Importance and scope of floriculture and landscape gardening. Nursery Management and Routine Garden Operations: Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Wintering; Mulching; Topiary; Role of plant growth regulators.

Unit II **14 lectures**

Ornamental Plants: Flowering annuals; perennials; Divine vines; Shade and ornamental trees; Ornamental bulbous and foliage plants; Cacti and succulents; Palms and Cycads; Ferns and fern allies; Cultivation of plants in pots; Indoor gardening; Bonsai. Principles of Garden Designs: English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flowerbeds, Shrubbery, Borders, Water-garden. Some Famous gardens of India.

Floriculture and green house technology. Commercial aspects and exporting of flowers and ornamental plants. Quranatine and testing requirements.

Unit III **14 lectures**

Landscaping Places of Public Importance: Landscaping highways And Educational institutions. Commercial Floriculture: Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life; Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolus, Marigold, Rose, Lilium, Orchids). Diseases and Pests of Ornamental Plants.

Suggested Readings

1. Randhawa, G.S. and Mukhopadhyay, A. (1986).Floriculture in India. Allied Publishers.
2. Adams, C., M. Early and J. Brrok (2011). Principles of Horticulture. Routledge, U.K

B.Sc. BOTANY: Semester III

Practical: Discipline Specific Core Course (DSCC)

PLANT ANATOMY AND DEVELOPMENT BIOLOGY

Question Paper Pattern and Scheme of evaluation

Time: 2 hrs. Max. Marks: 25

1. Prepare a temporary stained section of the material **A**. Sketch, label and identify. Leave the preparation for inspection. 05
2. Calculate the percentage of pollen germination/mounting of embryo or pollinia **B.** 04
3. Sketch, label and identify with reasons **C, D** and **E.** 09
4. Practical Record 07

Sl. No.	Question	Experiment	Marks allotment	
1	A		Prepn 02 Labelled Sk 02 Id 01 05	Reg. No. of Candidates Assigned Reg. No. of absentees: Total examined: Examiners: 1.External 2.Internal
2	B		Prepn 01 Procedure 01 Calculation/diagram 02 04	
3	**C** **D** **E**		Labelled Sk 01 Identification 01 Reasons 01 03each	
4		Practical Record	07	

Note:

A: Dicot/Monocot stem or root

B: Pollen of Vinca/ Impatiens/ Calotropis/ embryo of mustard or any locally available seed

C, D and **E:** Permanent slide on tissue types/ placentation/ovule types/anther/ leaf anatomy

B.Sc. B0TANY SEMESTER IV
Ecology and Conservation Biology

Question Paper Pattern and Scheme of evaluation

Time: 2 hrs. Max. Marks: 25

1. Prepare a stained temporary mount of the T.S. of material **A**. Draw a neat labelled diagram. Leave the slide for inspection. 05
2. Determine the water holding capacity/ BOD/ COD/ pH/ texture/ salinity of soil/ water sample 05
3. Identify the ecological instrument **C,** Describe its working mechanism. Mention any one uses 04
4. Identify the ecological group of **D** and **E**. Comment on their ecological features/ adaptation 06
5. Practical Record with field visit report 05

Sl. No.	Question	Experiment	Marks allotment	
1	A		Prepn 02 Labelled diagram 02 Id 01 05	Reg. No. of Candidates Assigned
2	B		Requirements 01 Procedure 02 Setting 01 Result 01 05	Reg. No. of absentees:
3	**C**		Identification 01 Working principle 02 Use 01 04	Total examined:
	D **E**		Ecological group 01 Features 02 03each	Examiners: 1.External
4		Practical Record Filed visit report }	05	2.Internal

Note:
A: Plant material from ecological group must be selected

MANGALORE UNIVERSITY

(B3-I) Model Programme Structure for Bachelor of Science (Basic/Hons.) Programme with (Subjects with practical)

[Biochemistry, Biotechnology, Botany, Chemistry, Electronics, Geography, Mathematics, Philosophy, Physics, Statistics, Zoology, Psychology, Microbiology, Physical Education, Yogic Science]

Sem.	Discipline Core(DSC) (Credits)	Discipline Elective(DSE) /Open Elective (OE) (Credits)	Ability Enhancement Compulsory Courses (AECC), Languages (Credits) (L+T+P)		Skill Enhancement Courses (SEC)		Total Credits
					Skill based (Credits)(L+T+P)	Value based (Credits) (L+T+P)	
I	DSC A1(4) A2(2) DSC B1(4) B2(2)	OE-1 (3)	L1-1(3), L2-1(3) (4 hrs. each)	Env. Studies (3) (3+0+0)	SEC-1: Digital Fluency(2) (2+0+0)	Yoga/ Health & Wellness/ Sports NCC/NSS/R&R(S&G)/ Cultural &Others (2) (0+0+4)	25/26
II	DSC A3(4) A4(2) DSC B3(4) B4(2)	OE-2 (3)	L1-2(3), L2-2(3) (4 hrs. each)	SEC-1: Digital Fluency (2) (2+0+0)	Env. Studies (3) (3+0+0)		26/25
Students exiting the programme after securing 46 credits will be awarded UG Certificate in the relevant Discipline provided they secure 4 credits in work based vocational courses during summer term or internship/Apprenticeship in addition to 6 credits from skill-based courses earned during first year.							
III	DSC A5(4) A6(2) DSC B5(4) B6(2)	OE-3 (3)	L1-3(3), L2-3(3) (4 hrs. each)	Indian Constitution (3) (3+0+0)	SEC-2:AI/Financial Edu.& Inv. Aw.(2)(2+0+0)	Yoga/ Health & Wellness/ Sports NCC/NSS/R&R(S&G)/ Cultural &Others (2) (0+0+4)	25
IV	DSC A7(4), A8(2) DSC B7(4), B8(2)	Indian Constitution (3)(3+0+0)	L1-4(3), L2-4(3) (4 hrs. each)	OE-3 (3)	SEC-3: Financial Edu. &Inv.Aw /AI(2)(2+0+0)		25
Students exiting the programme after securing 92 credits will be awarded UG Diploma in Discipline A and B provided they secure 4 credits in skill basedVocational courses offer during first –or –second –year summer term.							
V	DSC A9(4) A10(2) A11(4) A12(2);		DSC B9(4), B10(2),B11(4), B12(2)		SEC-4: SEC-4: Cyber Security(2) (2+0+0)/General Aptitude (3) (2+0+2)		26/27
VI	DSC A13(4) A14(2), A15(4), A16(2);		DSC B13(4), B14(2), B15(4),B16(2)		Project work (2)		26
Students exiting the programme after 3 years will be awarded UG Degree in Disciplines A and B as double majors upon securing 136 credits and satisfying the minimum credit requirements under each category of courses prescribed							
B.Sc. (Honours with Research) in Discipline A			**B.Sc. (Honours) in Discipline A**				
VII	DSC A17(4), A18(2), A19(4), A20(2); Res. Methodology-1 (4)	DSE-E1 (3), Vocational-1(3) Res. Proposal formulation (2)*	DSC A17(4), A18(2), A19(4), A20(2); Res. Methodology-1 (4)		DSE-E1(3), Vocational-1(3)		22
VIII	DSC A21(4)	DSE-E2(3), Vocational -2 (3)Research Project (10+2*)	DSC A21(4),A22(2) Internship/Apprenticeship (4)		DSE –E2(3), E3(3) Vocational -2(3), 3(3);		22
Bachelor of Science Degree Honours with or without research, B.Sc.(Honours with Research) or B.Sc. (Honours) in Discipline A upon securing 176 credits and satisfying the minimum credit requirements under each category of courses prescribed.							

Note: Only those students who secure 75% marks or CGPA if 7.5 and above in the first six semesters may choose to undertake research in the fourth year. Honours students not undertaking research have to do 3to 4 Additional courses/Entrepreneurship courses and Internship/Apprenticeship for 12 credits.

MANGALORE UNIVERSITY

Listing of Courses from V and VI Semesters for the Undergraduate Program in

BOTANY AND ANOTHER SUBJECT AS DOUBLE MAJORS IN THIRD YEAR

Sem. No.	Course Category	Course Code	Course Title	Credits Assigned	Instructional hours per week		Duration of Exam (Hrs.)	Exam/ Evaluation Pattern (Marks)		
					Theory	Practical		IA	Exam	Total
V	DSC	BOT C9-T	Plant Morphology and Taxonomy	4	4		2	40	60	100
		BOT C10-P	Plant Morphology and Taxonomy	2		4	3	25	25	50
		BOT C11-T	Genetics and Plant Breeding	4	4		2	40	60	100
		BOT C12-P	Genetics and Plant Breeding	2		4	3	25	25	50
VI	DSC	BOT C13-T	Cell Biology	4	4		2	40	60	100
		BOT C14-P	Cell Biology	2		4	3	25	25	50
		BOT C15-T	Plant Physiology and Biochemistry	4	4		2	40	60	100
		BOT C16-P	Plant Physiology and Biochemistry	2		4	3	25	25	50

Open Electives for non-BOTANY Students are also to designed and contents drafted for the first three semesters with multiple options.

Note:

1. If any Elective or Vocational course involves theory-cum-practical (2+1 credit), then IA to Exam Marks will be in the ratio of 50:50. The practical part isto be evaluated as part of IA. Semester end examination is only in theory component and questions from practical part, if any.
2. C11, C12, C13 and C14- paper model syllabus given below is designed for single major therefore C11& C13 consists of 3 credits and C12, C14 containsthe related practical syllabus respectively. University BoS who choose double major will have to include 4 credit syllabus (one extra unit) for C11 and C13 papers along with the practical experiments in their respective practical papers (C12, C14)

1. Plant Morphology and Taxonomy (Theory)

Program Name	**B.Sc. in BOTANY**	Semester	**V**
Course Title	**Plant Morphology and Taxonomy(Theory)**		
Course Code:	**DSC – BOT-C9 - T**	No. of Credits	**04**
Contact hours	**60 Hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s):

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

CO1. Understand the main features in Angiosperm evolution

CO2. Identify, classify and describe a plant in scientific terms, thereby, Identification of plants using dichotomous keys. Skill development in identification and classification offlowering plants.

CO3. Interpret the rules of ICN in botanical nomenclature.

CO4. Classify Plant Systematic and recognize the importance of herbarium and Virtual Herbarium, Evaluate the important herbaria and botanical gardens.

CO5. Recognise locally available angiosperm families, economically important plants. Appreciation of human activities in conservation of useful plants from the past to the present.

Contents	**60 Hrs**
Unit 1:	**15 hrs**
Morphology of Root, Stem and Leaf. Their modifications for various functions. Inflorescence – types. Structure and variations of flower. Fruits–types. Floral diagram and floral formula. **Introduction to Taxonomy**: History, objectives, scope and relevance of Taxonomy **Systems of classification**: Artificial, Natural and Phylogenetic; brief account of Linnaeus', Bentham & Hooker's, Engler and Prantl's system and APG IV System (2016) - Merits and demerits of classification. **Taxonomic literatures:** Floras, Monograph, Revisions, Journals. **Herbaria and Botanical gardens:** Important herbaria and botanical gardens of the world and India. Technique of Herbarium Preparation and role of botanical gardens. **Virtual herbarium;** E-flora; Documentation.	
Unit 2:	**15 hrs**
Taxonomic Hierarchy: Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concepts (biological, morphological, evolutionary). Modes of speciation. Problems with species concepts. Rankless system of phylogenetic systematics. **Botanical Nomenclature:** Principles and rules (ICN); Latest code –brief account, Brief account of Ranks of taxa, Type concept (Typification), Rule of priority, Author citation., valid publication, rejection of names, principle of priority and its limitations; Names of hybrids/cultivated species. **Plant identification**: Taxonomic dichotomous keys; indented (yoked) and bracketed keys. (brief account only).	

Unit 3:	15 hrs
Plant descriptions and diagnostic features of Angiosperm families: Common Terminologies used for description of vegetative and reproductive parts of the following plant families: **Brassicaceae, Malvaceae, Anacardiaceae, Fabaceae (with sub-Families), Cucurbitaceae, Apiaceae, Rubiaceae, Asteraceae, Apocynaceae, Solanaceae, Lamiaceae, Amaranthaceae, Euphorbiaceae**	
Unit 4:	**15 hrs**
Plant descriptions and diagnostic features of Angiosperm families: **Orchidaceae, Liliaceae, Arecaceae and Poaceae**. **Biometrics, Numerical Taxonomy; Phenetics and Cladistics:** Characters; Variations; OTUs, character weighting and coding; Cluster analysis; Phenograms, cladograms (definitions and differences). **Origin and evolution of angiosperms;** Co-evolution of angiosperms and animals; Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram). **Molecular taxonomy:** DNA sequences of chloroplast genes (*atp*B, rbcL, ITS, trnL) and one nuclear gene (nuclear ribosomal 18s DNA).	

Course Title	**Plant Morphology and Taxonomy (Practical)**	Practical Credits	**02**
Course Code	**DSC – BOT - C10- P**	Contact Hours	**56 Hours**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**

Practical Content (4hrs each session)

1. Study of root, stem and leaf structure and modifications.
2. Study of inflorescence types. Studyof flower and its parts.
3. Study of fruits. Floral diagram and floral formula.

4-10. Study of 14 families* with suitable diagrams, technical terms (description, V.S. flower, section of ovary, floral diagram, floral formula and systematic position according to Bentham & Hooker's system of classification).

11-13. Identify plants/plant products of economic importance belonging to the families mentioned in the syllabus; with binomial, family and morphology of useful parts. Cotton, Mango, Red gram, Green gram, Horse gram, Black gram, Bengal gram, Indigo, Brinjal, Tomato, Chilly, Tamarind, Bitter gourd, Asafoetida, Cumin, Coriander, Coffee, Rubber, Castor, Ginger, Turmeric, Coconut coir, Arecanut, Rice, Wheat, Ragi, Sugarcane, Periwinkle, Sarpagandha, Adusoge.

14. **Field visit**: Local or outside/Botanical Garden/ tribal settlements.

Submission: Record book, Tour report and Herbarium (any 2).

*Dicotyledons –any 12; Monochlamydae- any 1; Monocotyledons- any 2

Pedagogy: Teaching and learning, conducting experiments, field visits

Formative Assessment for Theory	
Assessment Occasion/type	**Marks**
Test	20
Assignments	10
Seminar	10
Total	**40 Marks**
Formative Assessment as per NEP guidelines are compulsory	

Pedagogy: Teaching and learning, conducting experiments, field /Lab. Visits

Formative Assessment for Practical	
Assessment Occasion/type	**Marks**
Attendance	05
Test	10
Submission (Record book, Tour report)	10
Total	**25 Marks**
Formative Assessment as per NEP guidelines are compulsory	

GENERAL PATTERN OF THEORY QUESTION PAPER

(60 marks for semester end Examination with 2 hrs duration)

Part-A

1. Question number 01-12 carries 2 marks each. Answer any 10 questions: 20 marks.

Part-B

2. Question number 13-20 carries 10 Marks each. Answer any 04 questions: 40 marks.

(Minimum 1 question from each unit and 10 marks question may have sub-questions for 7+3 or 6+4)

Total: 60 Marks Note:

Proportionate weight-age shall be given to each unit based on number of hours prescribed.

SCHEME OF PRACTICAL EXAMINATION

(Distribution of marks): 25 marks for the Semester end examination

1. Identify, classify and describe the specimen A & B taxonomically 6 Marks
2. Explain the specimen C using technical terms 4 Marks
3. Write the floral diagram and floral formal of the given specimen D 2 Marks
4. Identification of Specimen/slides E, F,G and H 8 Marks
5. Submission (Journal / Record + two herbarium) 5 Marks

Total 25 marks

General instructions:

Q1. A- Specimen from Dicotyledons, B-Monochlamydae/MonocotyledonsQ2.
Give specimen from the family they studied (C)
Q3. Give specimen from the family they studied (D)
Q4. Specimen /Slides/ materials from Root/Stem/Inflorescence (E), Flower/Fruit (F) and Economic importance (G & H)
Q5. Submission (Journal/ Record + two herbarium)

Note: Same Scheme may be used for IA (Formative Assessment) examination

References	
1	Baker. H.G. 1970. Plant and Civilization, Wadsworth Publishing Company.
2	Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons –Chichester
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4	Datta S C, *Systematic Botany*, 4th Ed, Wiley Estern Ltd., New Delhi, 1988.

5	Eames A. J. - *Morphology of Angiosperms* - Mc Graw Hill, New York.
6	Hall, B.G. (2011). *Phylogenetic Trees Made Easy: A How-To Manual*. Sinauer Associates, Inc. USA
7	Heywood - *Plant taxonomy* - Edward Arnold London.
8	Jeffrey C .J. and A. Churchil - *An introduction to taxonomy* – London.
9	Jeffrey, C. (1982). An Introduction to *Plant Taxonomy.* Cambridge University Press, Cambridge
10	Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F., Donogue, M.J., 2002. *Plant Systematics: A Phylogenetic approach,* 2nd edition. Sinauer Associates, Inc., USA.
11	Lawrence - *Taxonomy of Vascular Plants* - Oxford & I B H, New Delhi.
12	Manilal, K.S. and M.S. Muktesh Kumar 1998. *A Handbook on Taxonomy Training*. DST, New Delhi.
13	Manilal, K.S. and A.K. Pandey, 1996. *Taxonomy and Plant Conservation*. C.B.S. Publishers & Distributors, New Delhi.
14	Manilal, K.S. 2003. *Van Rheede'sHortusMalabaricus. English Edition*, with Annotations andModern Botanical Nomenclature. (12 Vols.) University of Kerala, Trivandrum.
15	Naik V.N., *Taxonomy of Angiosperms*, 1991. Tata Mcgraw-Hill Pub. Co. Ltd., New Delhi.
16	Pandey, S. N, and S.P. Misra (2008)-*Taxonomy of Angiosperms*- Ane Books India, New Delhi.
17	Radford A B, W C Dickison, J M Massey & C R Bell, *Vascular Plant Systematics*, 1974,Harper & Row Publishers, New York.
18	Singh G.2012. *Plant systematics: Theory and Practice*. Oxford and IBH, Pvt. Ltd., New Delhi.
19	Singh V. & Jain - *Taxonomy of Angiosperms* - Rastogi Publications, Meerut.
20	Sivarajan V. V - *Introduction to Principles of taxonomy* - Oxford &I B H New Delhi.
21	Any local/state/regional flora published by BSI or any other agency.
22	Morphology of Angiosperms – John Merie Coulter and Charles, MJP Publishers, 03-03-2023
23	Taxonomy of Angiospers – S.N. Pandey, Ane Books Pvt. Ltd. 2019-10-05

Genetics and Plant Breeding (Theory)

Program Name	**B.Sc.in BOTANY**	Semester	**V**
Course Title	**Genetics and Plant Breeding(Theory)**		
Course Code:	**DSC – BOT-C11- T**	No. of Credits	**04**
Contact hours	**60 Hours**	Duration of SEA/Exam	**2hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s):

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

CO1.Understand the basics of genetics and plant breeding

CO2.Identify, calculate and describe crossing over, allelic generations and frequencies of recombination.

CO3.Interpret the results of mating and pollinations.

CO4.Classify Plant pollination methods

CO5.Recognise modes of inheritance of traits/phenotypes and Phenotype-genotype correlation.

Contents	**60Hrs**
Unit 1:	**15hrs**
Mendelian genetics and its extension: History; Principles of inheritance: law of segregation, law of independent assortment. Test cross and back cross, Autosomes and sex chromosomes; Probability and pedigree analysis. Incomplete dominance (*Mirabilis*) and Codominance (Rhododendron); Multiple alleles (self-sterility in tobacco), Lethal alleles (Snapdragon), Epistasis- 9:7, 9:3:4, 12:3:1, 15:1. Brief account on Pleiotropy, Penetrance and Expressivity. Polygenic inheritance (kernel color in wheat)	
Unit 2:	**15hrs**
Extra chromosomal inheritance, Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast. **Linkage and crossing over** – types, Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence. **Mechanisms of sex determination in Plants** – *Melandrium, Coccinia indica* and *Maize.* **Variation in chromosome number**: Aneuploidy and its types, Euploidy and its types. Polyploidy in plants: Auto and allopolyploids- natural and artificial with examples, significance of polyploidy.	

Unit 3:	15hrs
Chromosomal Aberrations: Types and cytological consequences of Deletion, Duplication, Inversion and translocation. **Structure of Gene**: Cistron, recon and muton concept. Prokaryotic and eukaryotic genes. Genetic code and its properties **Gene mutations**, Types of mutations- Spontaneous, Induced; Molecular basis of Mutations (base substitutions and frameshift mutations); Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Role of Transposons in mutation. **Population and Evolutionary Genetics:** Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, genetic drift.	
Unit 4:	**15hrs**
Plant Breeding: Introduction and objectives, Scope Important achievements and undesirable consequences of plant breeding. **Methods of crop improvement:** Introduction, Acclimatization; Selection methods: Mass line, Pure line, Clonal. **Vegetative Propagation in plants**: Layering and Grafting **Male sterility**-Types, production and significance in plant breeding. **Hybridization**: Methods, Types, Advantages and Limitations. Role of mutations in Plant breeding, Role of biotechnology in crop improvement- Transgenic plants.	

Course Title	**Genetics and Plant Breeding (Practical)**	Practical Credits	**02**
Course Code	**DSC – BOT – C12 - P**	Contact Hours	**56 Hours**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**

Practical Content (4hrs each session)

1. Vegetative reproduction methods- Cutting, Layering
2. Grafting and its methods.
3. Hybridization: Emasculation, bagging, pollination and production of hybrids
4. Estimation of percentage of Pollen viability/Pollen fertility.
5. Mendel's laws through seed ratios (monohybrid, dihybrid, test cross and back cross)
6. Laboratory exercises in probability and chi-square.
7. Chromosome mapping using point test cross data.
8. Genetic problems: Incomplete dominance and Polygenic inheritance.
9. Genetic problems: Gene interactions (9:7, 9:3:4)
10. Genetic problems: Gene interactions (12:3:1, 15:1)
11. Determination of linkage and cross-over analysis (through two/three point test cross data)
12. Study of aneuploidy: Trisomy in Datura using photographs.
13. Chromosomal aberrations: Translocation Ring, Laggards and Inversion Bridge using photographs.
14. Visit to nursery/Plant breeding stations/KVKs.

Pedagogy: Teaching and learning, Seminar, Assignments, etc

Formative Assessment for Theory	
Assessment Occasion/type	**Marks**
Test	20
Assignments	10
Seminar	10
Total	**40 Marks**
Formative Assessment as per NEP guidelines are compulsory	

Pedagogy: Teaching and learning, conducting experiments, field /Lab. Visits

Formative Assessment for Practical	
Assessment Occasion/type	**Marks**
Attendance	05
Test	05
Field visit	05
Submission	10
Total	**25Marks**
Formative Assessment as per NEP guidelines are compulsory	

GENERAL PATTERN OF THEORY QUESTION PAPER

(60 marks for semester end Examination with 2 hrs duration)

Part-A

1. Question number 1-12 carries 2 marks each. Answer any 12 questions: 20 marks

Part-B

2. Question number 13-20 carries 10 Marks each. Answer any 04 questions: 40 marks

(Minimum 1 question from each unit and 10 marks question may have sub-questions for 7+3 or 6+4)

Total: 60 Marks Note:

Proportionate weightage shall be given to each unit based on number of hours prescribed.

SCHEME OF PRACTICAL EXAMINATION

(Distribution of marks): 25 marks for the Semester end examination

1. Perform the pollen viability/fertility of the given sample **A** 6 Marks
2. Solve the given genetic problems **B and C** 8 Marks
3. Identification of Specimen/slides/Photographs **C, D** and **E** 6 Marks
4. Submission (Journal / Record) 5 Marks

Total 25 marks

General instructions:

Q1 Material Cassia/Vinca/Ipomia/Hibiscus (A)Q2
Genetic problems (B & C)
Q3. Layering/Grafting/Emasculation/bagging –C; Trisomy in Datura, linkage and cross-over, Translocation Ring, Laggards and InversionBridge (D and E)
Q4. Submission (Journal/ Record)

Note: Same Scheme may be used for IA (Formative Assessment) examination

References

1	Acquaah, G. (2007). Principles of Plant Genetics &Breeding.NewJearsey, U.S.: Blackwell Publishing.
2	Singh, B.D. (2005). Plant Breeding: Principles and Methods, 7th edition. New Delhi, Delhi: Kalyani Publishers.
3	Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding, 2nd edition. New Delhi, Delhi: Oxford – IBH.
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5	Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis, 10th
	edition. New York, NY: W.H. Freeman and Co.
6	Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics, 10th edition. San Francisco, California: Benjamin Cummings
7	Raven, F.H., Evert, R. F., Eichhorn, S.E. (1992).Biology of Plants. New York, NY: W.H. Freeman and Co.
8	Welsh, J. R. (1981). Fundamentals of Plant Genetics and Breeding. John Wiley and Sons, New York.
9	Poehlman, J.M. (1987). Breeding Field Crops, 3rd Ed. AVI Publishing Co. Inc., Westport, Connecticut
10	Chopra, V.L. (2000). Plant Breeding: Theory and Practice 2nd Ed. Oxford & IBH, New Delhi.
11	Fundamentals of Genetics – 6th edition 2022- B.D. Singh
12	Fundamentals of Genetics & Molecular Biology – Dr. Vishnu Shankar Sinha.

Cell Biology (Theory)

Program Name	**B.Sc. in BOTANY**	Semester	**VI**
Course Title	**Cell Biology (Theory)**		
Course Code:	**DSC-BOT - C13-T**	No. of Credits	**04**
Contact hours	**60 Hours**	Duration of SEA/Exam	**2hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s):

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

CO1. Understand of Cell metabolism, chemical composition, physiochemical and functional organization of organelle

CO2. Learn the contemporary approaches in modern cell and molecular biology.

CO3. Study the organization of cell, cell organelles and biomolecules (i.e protein, carbohydrate, lipid, and nucleic acid)

CO4. Gain knowledge on the activities in which the diverse macro molecules and microscopicstructures inhabiting the cellular world of life are engaged.

CO5. Understand the various metabolic processes such as respiration, photosynthesis etc. which are important for life.

Contents	**60Hrs**
Unit 1:	**15hrs**
Cell as a unit of structure and function, Characteristics of prokaryotic and eukaryotic cells, Cell wall - distribution, chemical composition, functions, and variations in prokaryotic and eukaryotic cells (primary and secondary wall), Glycocalyx, Cell-cell interactions/Junctions. Cell membrane-Structure and functions, active and passive transport, proton pumps associated (Na-K, Ca-calmodulin etc. and their distribution), phagocytosis, pinocytosis, exocytosis. Structure, function and biogenesis of mitochondria and chloroplast, An account of transport in mitochondria and chloroplasts (Tim/Tom; Tic/Toc) and semiautonomous nature of mitochondria and chloroplast. Brief account on different types of plastids.	

Unit 2:	**15hrs**
Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing; Smooth ER and lipid synthesis, export of proteins and lipids; Golgi Apparatus – organization, protein glycosylation, protein sorting and export from Golgi Apparatus; Ribosomes, peroxisomes, Lysosomes and Vacuoles. Nuclear envelope, structure of nuclear pore complex, nuclear lamina, transport across nuclear membrane, Nucleolus, Ergastic substances.	
Unit 3:	**15hrs**
Chromosomes: Size and number of chromosomes, Gross and ultra structure, types of chromosomes based on the position of centromere, Heterohromatin, euchromatin, paranemic and plectonemic coils, autosomes and allosomes, karyotype and idiogram, properties and functions of chromosomes. Brief account of supernumerary chromosomes in plants. Phases of eukaryotic cell cycle, Process of mitosis and meiosis; significance, Regulation of cell cycle- checkpoints, role of protein kinases. Concept of Programmed Cell Death. Signal Transduction: Receptors and primary and secondary signal transduction, pathway.	
Unit 4:	**15hrs**
DNA as the carrier of genetic information – Griffith experiment, Avery, McCarty and MacLeod experiment, Hershey - Chase experiment DNA: Chemical composition, types - A, B and Z DNA, structure-Watson & Crick model, Semiconservative replication. RNA: Structure and functions of mRNA, tRNA and rRNA. Gene Expression: Transcription and Translation in prokaryotes, process of Gene splicing. Regulation of gene expression in prokaryotes- Lac operon model. Gene regulation in eukaryotes- transcriptional and post-transcriptional.	

Course Title	**Cell Biology (Practical)**	Practical Credits	**02**
Course Code	**DSC-BOT - C14-P**	Contact Hours	**56 Hours**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**

Practical Content (4hrs each session)

1. Study of plant cell structure with the help of epidermal peel mount of Onion/Rhoeo
2. Study of cell and its organelles with the help of electron micrographs/Photographs
3. Measurement of length and breadth of plant cell using micrometry (Using Onion or Rheo leaf cells).
4. To demonstrate the effect of heat on permeability of cell membrane of beet root cells.
5. Study of different concentrations of alcohol on cell membrane permeability
6. Study of ergastic substances - starch (potato), aleurone (wheat grain), calcium oxalate (Pistia), calcium carbonate (Ficus leaf) and oil globules (castor seed).
7. Study of mitosis by squash technique using Onion root tip cells
8. Study of meiosis using Rheo / Onion flower buds
9. Observation of permanent slides of mitosis and meiosis
10. Study of mitotic index from suitable plant material
11. Estimation of total chlorophyll in leaves
12. Demonstration of DNA isolation from plant cells
13. Study of Karyotype using chart.
14. Techniques of preparation of permanent and semi-permanent cytological slides

Pedagogy: Teaching and learning, Seminar, Assignments, etc

Formative Assessment for Theory	
Assessment Occasion/type	**Marks**
Test	20
Assignments	10
Seminar	10
Total	**40 Marks**
Formative Assessment as per NEP guidelines are compulsory	

Pedagogy: Teaching and learning, conducting experiments, field /Lab. Visits

Formative Assessment for Practical	
Assessment Occasion/type	**Marks**
Attendance	05
Test	05
Field visit	05
Submission	10
Total	**25Marks**
Formative Assessment as per NEP guidelines are compulsory	

GENERAL PATTERN OF THEORY QUESTION PAPER

(60 marks for semester end Examination with 2 hrs duration)

Part-A

1. Question number 01-12 carries 2 marks each. Answer any 10 questions: 20 marks.

Part-B

2. Question number 13-20 carries 10 Marks each. Answer any 04 questions: 40 marks. (Minimum 1 question from each unit and 10 marks question may have sub-questions for 7+3 or 6+4)

Total: 60 Marks

Note: Proportionate weightage shall be given to each unit based on number of hours prescribed.

SCHEME OF PRACTICAL EXAMINATION

(Distribution of marks): 25 marks for the Semester end examination

CELL BIOLOGY

Time: 03 hrs Marks: 25

1. Prepare a squash of onion root tip, Identify and explain any one stage with a labelled diagram. 06 marks
2. Find out the cell length and breadth of a given material using Micrometry/Estimation the total amount of chlorophyll (B) 06 marks
3. Identify the slides/ cell organelles C, D, E & F 08 marks
4. Submission (Journal/ Record) 05 marks

Total 25 marks

General instructions:

Q1. Give specimen from Onion root tip (A)
Q2. Give pecimen sample (B)
Q3. Give one slide each from mitosis, meiosis, ergastic substances(C), (D) and (E), one photograph of a cell organelle (F)
Q4. Submission (Journal/ Record)

Note: Same Scheme may be used for IA (Formative Assessment) examination

References	
1	Cooper, G.M., Hausman, R.E. (2009). The Cell: A Molecular Approach, 5th edition. Washington, D.C.: ASM Press & Sunderland, Sinauer Associates, MA
2	Karp, G. (2010). Cell Biology, 6th edition. New Jersey, U.S.A.: John Wiley & Sons.
3	De Robertis, E. D. P. and De Robertis R. E. 2009. Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia.
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5	Reven, F.H., Evert, R.F., Eichhorn, S.E. (1992). Biology of Plants. New York, NY: W.H.Freeman and Company
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8	Verma, P. S. (2004). Cell Biology, Genetics, Molecular Biology: Evoloution and Ecology. India: S. Chand Limited.
9	Molecular biology of the cell by Albert Bruce 6th edition. 2014

PLANT PHYSIOLOGY AND PLANT BIOCHEMISTRY (THEORY)

Program Name	**BSc/ BOTANY**	Semester	**VI**
Course Title	**Plant Physiology and Plant Biochemistry (Theory)**		
Course Code:	**BOT C15-T**	No. of Credits	**04**
Contact hours	**60 Hours**	Duration of Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite (s):

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

CO1. Ascertain the Importance of water and the mechanism of transport.

CO2. Explain the biosynthesis and breakdown of biomolecules.

CO3. Interpret the role of plant hormones in plant development and about secondary metabolites.

CO4. Perceive the basic functions and metabolism in a plant body.

CO5. Understand the importance of nutrients in plant metabolism and crop yield.

Contents	**60 Hrs**
UNIT 1	**15 Hrs**
Plant water relations: Mechanism of water absorption, Factors affecting water absorption. **Mechanism of ascent of sap:** Vital and physical force theories. **Transpiration.** Types and process. Mechanism of guard cell movement. K+ ion exchange mechanism. Antitranspirants. Guttation. **Translocation of organic solutes:** Transport of organic solutes. path of transport, vein loading and unloading. Transcellular hypothesis, mass flow hypothesis. **Mineral nutrition:** Essential elements: Classification - Macro and Micronutrients. Functions and deficiency symptoms of macro elements- N, P, K and Mg. Functions and deficiency symptoms of Micronutrients-Zn, Mn and B. Hydroponics and its applications. Mechanism of mineral salt absorption: Passive absorption – diffusion, ion exchange. Active absorption- Cytochrome pump theory, Protein Lecithin theory .	
UNIT 2	**15 Hrs**
Enzymes - classification, kinetics and mechanism of action. **Bioenergetics:** Definition, examples for major bioenergetic processes. **Photosynthesis**: Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of carbon fixation; Photorespiration. **Respiration**: Glycolysis, TCA cycle; Oxidative phosphorylation, Glyoxylate cycle, Oxidative Pentose Phosphate Pathway. Anaerobic respiration – alcoholic and lactic acid fermentation. ATP yield during aerobic and anaerobic respirations. Respiratory quotient.	
UNIT 3	**15 Hrs**

Plant growth regulators: Definition and classification, Role of Auxins, Gibberlins, cytokinins, ABA and ethylene on plant growth and development. Practical utility in agriculture and horticulture, Synthetic growth regulators. **Sensory Photobiology**: Biological clocks, photoperiodism, function & structure of phytochromes, phototropins & cryptochromes. **Plant movements**: Nastic movements – nyctinasty, chemo nasty and seismonasty. Tropic movements –phototropic, hydrotropic, geotropic and thigmotropic. **Dormancy in plants:** Definition and types. Bud dormancy - induction and breaking. Seed dormancy – causes and methods of breaking.	
UNIT 4	**15 Hrs**
Carbohydrate metabolism – Classification of Carbohydrates. Structure of ribose and deoxyribose sugars, glucose, fructose, sucrose, starch and cellulose, Metabolism of sucrose and starch, **Nitrogen metabolism** - Sources of nitrogen, physical and biological nitrogen fixation and mechanism of biological nitrogen fixation- asymboitic and symbiotic, formation of root nodules in Leguminous plants, Nitrate reduction and amino acid synthesis. **Fat metabolism** - General account of fats, synthesis of glycerol, synthesis of fatty acids, and condensation of fatty acid and glycerol, fat degradation, β (Beta) -oxidation, glyoxylate cycle and its significance, plant waxes **Secondary plant products**: structure, biosynthesis and distribution of terpenes, phenolics and nitrogen containing compounds.	

Course Title	**Plant Physiology and Biochemistry (Practical)**	Practical Credits	**2**
Course Code	**BOT C16-P**	Contact Hours	**4 Hours**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**

Practical Content

Major Experiments:

1. To determine the osmotic pressure of the cell sap by plasmolytic method.
2. To demonstrate root pressure / transpiration pull in plants.
3. To demonstrate that oxygen is liberated in the process of photosynthesis.
4. Separation of photosynthetic pigments by paper chromatography and measure their Rf values.
5. To isolate and identify the amino acids from a mixture using paper chromatography.
6. Determination of RQ of germinating seeds using Ganong's Respirometer.
7. Qualitative test for Starch, Protein, Reducing Sugars, and Lipids.
8. Estimation of carbohydrates
9. Estimation of proteins
10. Estimation of TAN(Titratable acid Number) from Bryophllum leaves/Aloe Vera ..

Minor experiments:

11. Experiment to demonstrate the phenomenon of exosmosis and endosmosis by potato osmoscope and thistle funnel experiment.
12. Study of Phototropism, hydrotropism and geotropism
13. a) Demonstration of fermentation using Kuhn's fermentation vessel
    b) Measurement of linear growth of a plant using arc auxanometer
14. To compare the rate of transpiration from the two surfaces of leaf by cobalt chloride paper method

Pedagogy: Teaching and learning, Seminar, Assignments, etc

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Pedagogy: Teaching and learning, conducting experiments, field /Lab. Visits

Formative Assessment for Practical	
Assessment Occasion/type	**Marks**
Attendance	05
Test	05
Field visit	05
Submission	10
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Total: 60 Marks

Note: Proportionate weight-age shall be given to each unit based on number of hours prescribed.

SCHEME OF PRACTICAL EXAMINATION

PLANT PHYSIOLOGY AND PLANT BIOCHEMISTRY

Time =03 hrs **Marks =25**

1. Conduct Major Experiment A 06 marks
2. Comment on minor Experiments B & C 06 marks
3. Micro Chemical test D 03 marks
4. Estimation of proteins/ carbohydrates/TAN 05 marks
5. Practical Record 05 marks

REFERENCES

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12. Plant physiology and development by Taiz March 2018, 6th edition
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