UNIVERSITY OF LUCKNOW
Department of Botany

Ordinance for Undergraduate Programmes (2023) (Under NEP 2020 Framework)

Proposed Syllabus for Four Year (Eight Semester) UG (B.Sc.) Programme in BOTANY based on the New Education Policy – 2020 with effect from the Session 2024-25

Year	Semester	Paper Code	Paper Title	Credits	
				Major	Minor
I	I	BOT-101T	Diversity of Plant Viruses, Bacteria, Fungi and Algae	4	0
		BOT-102P	Diversity of Micro-organisms	4	0
		BOT-Q-1	Diversity of Plant Viruses, Bacteria, Fungi and Algae	0	2
		BOT-Co-C-1*	Bonsai Cultivation	2	2
	II	BOT-201T	Diversity of Bryophytes, Pteridophytes, Gymnosperms and Palaeobotany	4	0
		BOT-202P	Diversity of Archegoniates	4	0
		BOT-Q-2	Diversity of Bryophytes, Pteridophytes, Gymnosperms and Palaeobotany	0	2
		BOT-Vo-C-1*	Mushroom Cultivation Technology	2	2
II	III	BOT-301T	Plant Taxonomy, Development and Reproduction	4	0
		BOT-302P	Plant Architecture	4	0
		BOT-Q-3	Plant Taxonomy, Development and Reproduction	0	2
		BOT-Co-C-2*	Gardening and Landscaping	2	2
	IV	BOT-401T	Ecology, Soil Science and Environmental Pollution	4	0
		BOT-402P	Plants and Environment	4	0
		BOT-Q-4	Ecology, Soil Science and Environmental Pollution	0	2
		BOT-Vo-C-2*	Hydroponic Cultivation of Plants	2	2
III	V	BOT-501T	Cytology, Genetics and Plant Breeding	4	0
		BOT-502T	Plant Physiology	4	0
		BOT-503IN	Internship/Term Paper/Minor Project	4	0
	VI	BOT-601T	Plant Biochemistry	4	0
		BOT-602P	Cytogenetics, Plant Physiology and Biochemistry	4	0
		BOT-603Ta	Plant Resource Utilization	4	0
		BOT-603Tb	Ethnobotany		
		BOT-603Tc	Plant Biotechnology		
IV	VII	BOT-701T	Applied Microbiology and Plant Pathology	4	0
		BOT-702T	Trends in Plant Sciences	4	0
		BOT-703T	Techniques and Instrumentation	4	0
		BOT-704P	Applications & Techniques in Microbial and Plant Sciences	4	0
		BOT-705Ta	Environmental Awareness and Ethics	4	0
		BOT-705Tb	Plant Systematics		
		BOT-705Tc	Conservation Biology		
	VIII	BOT-801T	Research Methodology	4	0
		BOT-802TP	Term Paper	4	0
		BOT-803D	Major Research Project/Dissertation	12	0

Note 1. The theory papers BOT-Q-(1-4) offered in the first two years (Semesters I-IV) shall constitute the **Minor** papers for Science/Other Faculty students who have **not** opted for Botany as either of the two Major subjects.

Note 2. The papers offered in the first three years (Semesters I-VI) shall constitute the papers for students with Botany as **first Major subject** and for those with Botany as a **second Major Subject**. In addition those with Botany as first major subject will opt for Internship in the V Semester and any one paper from 603 (Ta-Tc) in VI semester.

Note 3. *Vocational and Co—curricular courses offered by Department of Botany.

B.Sc. (SEMESTER–I)
BOTANY: MAJOR
BOT-101T: DIVERSITY OF PLANT VIRUSES, BACTERIA, FUNGI AND ALGAE
Theory-4 Credits

Course Outcome:

After the completion of the course the students will be able to:

1. Develop an understanding about the classification and diversity of plant viruses, bacteriafungi, algae and lichens
2. Gain an insight into the role played by each group in the biosphere, along with theireconomic importance
3. Learn how to identify each group on the basis of their morphological characteristics
4. Understand the various stages in their cycles
5. Learn about their various associations
6. Understand the host–pathogen relationship, recognize the symptoms and diseases causedby them

Unit I

Nature, classification and structure (helical and icosahedral symmetry) of plant viruses; Symptoms (external & internal) of virus infected plants; Transmission of plant viruses; Genome organization and replication of tobacco mosaic virus; Techniques in plant virology - purification, serology and electron microscopy; Structure and replication of bacteriophage; Structure and replication of viroids.

Unit II

Overview of cell structure and function in the prokaryotes (Bacteria and Archaea); Classification of prokaryotes based on cell structure (Archaea, Gram-positive and Gram-negative bacteria, Mollicutes); Metabolic diversity of bacteria (phototrophy, chemolithotrophy, autotrophy, heterotrophy, fermentation); Bacterial cell division and microbial growth; Bacterial genome and plasmids; Variability in bacteria: Mutation and genetic recombination; Microbial growth control; Bacterial culture and staining; Economic importance of bacteria.

Unit III

Overview of the cell structure and function in eukaryotes (Yeast); Classification, thallus organisation and reproduction in fungi; Economic importance of fungi; characteristics and life cycles of the following fungi: Oomycota - *Albugo, Pythium*; Zygomycota - *Rhizopus*; Chytridiomycota - *Synchytrium*; Ascomycota - *Saccharomyces, Aspergillus, Ascobolus*; Basidiomycota - *Ustilago, Puccinia, Agaricus*; Deuteromycota (mitosporic fungi)- *Fusarium*.

Lichens: classification, thallus organization, reproduction, physiology and role in environmental pollution.

Unit IV

General features, range of thallus organization, classification; ultrastructure of eukaryotic algal cell and cyanobacterial cell; economic importance of algae.
Characters and life cycle of: Cyanophyta - *Microcystis, Oscillatoria*; Chlorophyta - *Volvox, Hydrodictyon, Oedogonium, Coleochaete, Chara*; Bacillariophyta - *Navicula;* Xanthophyta - *Vaucheria*; Phaeophyta - *Ectocarpus*; Rhodophyta – *Polysiphonia.*

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3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
4. Annie Ragland, 2012. Algae and Bryophytes, Saras Publication, Kanyakumari, India.
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Suggested Reading:

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2. Prescott's Microbiology, J. Willey, L. Sherwood, 10th edition, 2017, McGraw-Hill Education.
3. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology,

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4. Plant Pathology, G.N. Agrios, 5th edition, 2005, Elsevier.
5. Alcamo's Fundamentals of Microbiology, J.C. Pommerville, 2nd edition, 2013, Jones and Bartlett Learning.
6. Microbiology: An Introduction, G.J. Tortora, B.R. Funke, C.L. Case, 11th edition, 2016,
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B.Sc. (SEMESTER–I)
BOTANY
BOT-102P: DIVERSITY OF MICROORGANISMS
Practical-4 Credits

Course Outcome:

After the completion of the course the students will be able to:

1. Understand the working of instruments, learn techniques related to the study of microbes, and appreciate the importance of lab etiquettes and good lab practices necessary while handling microbes
2. Develop the techniques and skills necessary for identification of viruses, bacteria, fungi and algae
3. Learn how to identify the various groups based on their morphological characteristics
4. Learn about the pathogenic aspects of virus, bacteria and fungi

Unit I

Instruments & Techniques

- Laboratory safety and good laboratory practices
- Principles and application of Laboratory instruments-microscope, incubator, autoclave, centrifuge, Laminar air flow cabinet, filtration unit, shaker, pH meter.
- Buffer preparation & titration
- Cleaning and Sterilization of glasswares
- Preparation of media- Nutrient Agar and Broth
- Inoculation and culturing of bacteria in Nutrient agar and nutrient broth
- Preparation of agar slant, stab, agar plate
- Phenol Coefficient method to test the efficacy of disinfectants

Unit II

Symptoms of plant virus infection, and Bacterial Identification

- Study the external symptoms of plant virus infection
- Study of morphological forms of bacteria
- Gram-staining of bacteria
- Cultural characteristics of bacteria on nutrient agar
- Pure culture techniques
- Biochemical characterization of bacteria: Carbohydrate fermentation test, Mannitol motility test, Gelatin liquefaction test, Urease test, Nitrate reduction test, Catalase test, Oxidase test, Starch hydrolysis, Casein hydrolysis.

Unit III

Mycology

- Isolation of saprophytic fungi
- Identification of fungi by lactophenol cotton blue method: *Synchytrium, Rhizopus, Saccharomyces, Aspergillus, Ascobolus, Ustilago, Puccinia, Fusarium, Alternaria.*
- *Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills
- Lichens: crustose, foliose and fruticose specimens.

Unit IV

Phycology

Type study of Algae and Cyanobacteria

- Cyanophyceae- *Nostoc.*
- Chlorophyceae- *Volvox, Hydrodictyon, Oedogonium, Coleochaete, Chara*
- Xanthophyceae- *Vaucheria*
- Bacillariophyceae- *Navicula*
- Phaeophyceae- *Sargassum, Ectocarpus*
- Rhodophyceae- *Polysiphonia*

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1. Agrios, G.N. (1997). Plant Pathology, 4th edition. Cambridge, U.K.: Academic Press.
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B.Sc. (SEMESTER–II)
BOTANY: MAJOR
BOT-201T: DIVERSITY OF BRYOPHYTES, PTERIDOPHYTES, GYMNOSPERMS AND PALAEOBOTANY
Theory-4 Credits

Course Outcome:

After the completion of the course the students will be able to:

1. Develop awareness about the group of plants that have given rise to land habit and the flowering plants.
2. Develop an understanding of plant evolution
3. Develop critical understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms
4. Understand the life cycles of non-flowering plants
5. Know the importance of studying fossils

Unit I General characters, classification, reproduction and affinities of Bryophytes; Gametophytic and sporophytic organization of Bryophyta - *Pogonatum*; Anthocerotophyta – *Anthoceros.* General characters of Marchantiophyta; Gametophytic and sporophytic organization of *Riccia, Marchantia, Frullania*.
Unit II General characters, affinities, classification, and stelar system in Pteridophytes; Heterospory and seed habit; Morphology, anatomy, development, vegetative and reproductive parts in Psilopsida- *Rhynia*; Lycopsida- *Lycopodium, Selaginella*; Sphenopsida- *Equisetum*; Filicopsida- *Adiantum, Nephrolepis, Marsilea*.
Unit III General characters, affinities, classification of Gymnosperms; Morphology, anatomy, development and reproduction in Cycadales- *Cycas,* Coniferales- *Pinus*
Unit IV Morphology, anatomy, development and reproduction in Ephedrales- *Ephedra*. Elementary Palaeobotany: General account, types of fossils, methods of fossilization, and geological time scale.

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2. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
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Suggested Reading:

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B.Sc. (SEMESTER–II)
BOTANY
BOT-202P: DIVERSITY OF ARCHEGONIATES
Practical-4 Credits

Course Outcome:

1. Through a field study they will be able to see these plants growing in nature and becomefamiliar with the biodiversity.
2. Develop an understanding of the morphology, anatomy, reproduction and developmentalchanges through typological study.
3. Create a knowledge base in understanding plant diversity, economic values and taxonomyof lower group of plants.

UNIT I

Bryophytes

- *Marchantia*- Morphology of thallus, W.M. rhizoids and scales, V.S. thallus through Gemma cup, W.M. gemmae (all temporary slides), V.S. antheridiophore, archegoniophore, L.S. sporophyte (all permanent slides)
- *Frullania*- Morphology of thallus, WM leaf, under leaf, leaf cells and oil bodies, male andfemale bracts, perianth, spores and elaters
- *Anthoceros*- Morphology of thallus, WM rhizoids, thallus cells (for chloroplast and pyrenoids), Capsule wall for stomata, spores and elaters, LS sporophyte
- *Pogonatum*- morphology, W.M. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides), permanent slides showing antheridial and archegonial heads, L.S. capsule and protonema.

Unit II

Pteridophytes

- *Lycopodium*- Habit, stem T.S., strobilus V.S.
- *Selaginella*- Habit, rhizophore T.S, stem T.S, axis with strobilus, V.S. of strobilus, Megasporophyll and microsporophyll.
- *Equisetum*- Habit, rhizome and stem T.S., V.S. of strobilus
- *Marsilea*- Habit, TS rhizome and petiole, structure of sporocarp (slides only); *Nephrolepis*- Habit, structure of sori, TS petiole and rhizome

Unit III

Gymnosperms

- *Cycas*- Habit, coralloid root and coralloid and normal root T. S., T. S. of leaflet and Rachis,
- *Cycas*- Micro and mega sporophyll, male cone V. S., micro sporophyll T. S. , entire and V. S. of ovule (slides only)
- *Pinus*- Branch of indefinite growth, spur shoot, T. S of old stem and needle R . L .S and T.

L. S. of stem

- *Pinus*- Male and female cone, V .S. of male and female cone
- *Ephedra*- Habit, stem T. S (young and mature), leaf T. S, male and female strobilus, V. S. of male and female cone, ovule V. S. and seed (slides only)

Unit IV

Palaeobotany and Palynology

- Morphology of *Rhynia* and fossils gymnosperms & other groups.
- Visit to Birbal Sahni Institute of Palaeosciences (BSIP)
- Virtual conference with Scientists of BSIP to learn about fossilization.
- Mark and know about Indian geographical sites rich in plant fossils.

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Suggested Reading:

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B.Sc. (SEMESTER–III)
BOTANY: MAJOR
BOT-301T: PLANT TAXONOMY, DEVELOPMENT AND REPRODUCTION
Theory-4 Credits

Course Outcome:

After the completion of the course the students will be able to:

1. Develop an understanding of phylogenetically important groups of flowering plants, and gain a broad understanding of the process of evolution
2. Understand morphology, anatomy, reproduction and developmental changes therein through typological study and create a knowledge base in understanding plant diversity, economic values and taxonomy of Angiosperms
3. Understand the composition, modifications, internal structure and architecture of flowering plants for becoming a Botanist

Unit – I

- Systematics: Principles of classification, nomenclature; Comparative study of different classificationsviz. Linnaeus, Bentham and Hooker, Cronquist; Herbarium and Botanical gardens.
- Taxonomic study of following families and their economic importance:
  Dicots: Acanthaceae, Amaranthaceae, Apiaceae, Apocynaceae, Asteraceae, Bombacaceae, Brassicaceae, Caesalpiniaceae, Convolvulaceae, Cuscutaceae, Cucurbitaceac, Euphorbiaceae, Lamiaceae, Malvaceae,Mimosaceae, Myrtaceae, Nelumbonaceae, Nymphaeaceae, Papilionaceae, Ranunculaceae, Rosaceae, Rubiaceae, Rutaceae, Scrophulariaceae, Solanaceae.

Unit - II

- Taxonomic study of following families and their economic importance:
  Monocots: Arecaceae, Cyperaceae, Liliaceae and Poaceae
- General morphology and development of the floral organs; Root-shoot transition, Plant modifications;Phylloclade, Phyllode and Cladode

Unit III

- Development: Meristems: Classification, Root Apical Meristem, Shoot Apical Meristem
- Growth and differentiation of Root, Shoot and Leaf; Cambium – Tissue differentiation, secondary growthand its anomalies

Unit IV

- Reproduction: Structure and development of male and female gametophytes- microsporogenesis microgametogenesis; Megasporogenesis and megagametogenesis.
- Introduction to palynology; Morphology, viability and germination of pollen; Embryo sac types and development.
- Double fertilization; Endosperm development and its morphological nature; Embryogeny; Apomixis and Polyembryony.

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B.Sc. (SEMESTER–III)
BOTANY
BOT-302P: PLANT ARCHITECTURE
Practical-4 Credits

Course Outcome

After the completion of the course the students will be able to:

1. Gain an understanding of the history and concepts underlying various approaches to plant taxonomy and classification
2. Learn the major patterns of diversity among plants, and the characters and types of data used to classify plants
3. Become familiar with major taxa and their identifying characteristics, and to develop in depth knowledge of the current taxonomy of a major plant family
4. Discover and use diverse taxonomic resources, reference materials, herbarium collections, publications

Unit I

Taxonomic Identification using plant structure

Classify 25 plants on the basis of Taxonomic description (Plant Morphology, Anatomy, Reproductiv parts, Habit, adaptation anomalies) according to Bentham and Hooker system of classification in th following families:

- Malvaceae
- Fabaceae (Papilionaceae)
- Solanaceae
- Scrophulariaceae
- Acanthaceae
- Labiatae (Lamiaceae)
- Rubiaceae.

Unit II

Angiosperm Morphology

- To study of diversity in leaf shape, size and other foliar features.
- To study monopodial and sympodial branching.
- Morphology of Fruits (different types)
- Inflorescence types- study from fresh/ preserved specimens
- Flowers- study of different types from fresh/ preserved specimens
- Study of ovules (permanent slides/ specimens/photographs)- types (anatropous, orthotropous, amphitropous and campylotropous)
- Modifications in roots,stems, leaves and inflorescences

Unit III

Plant Anatomy

- Normal & Anomalous secondary thickening - *Bignonia, Dracaena, Boerhaavia diffusa, Nyctanthes*
- Study of primary and secondary growth in root and stem of monocots and dicots by section cutting and permanent slides.
- Study of internal structure of dicot and monocot leaves.
- Study of structure of stomata.

Unit IV

Reproductive Botany

- Structure of anther, microsporogenesis and pollen grains
- Structure of ovule and embryo sac development (through slides).
- Study of embryo development in monocots and dicots.
- Vegetative propagation by means of cutting, budding and grafting exercises.
- Study of seed germination.
- Study of pollen morphology of the following plants –*Hibiscus, Vinca, Ixora,* by microscopic observation.
- Calculation of pollen viability percentage using in vitro pollen germination techniques

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B.Sc. (SEMESTER–IV)
BOTANY: MAJOR
BOT-401T: ECOLOGY, SOIL SCIENCE AND ENVIRONMENTAL POLLUTION
Theory-4 Credits

Course Outcome:

After the completion of the course the students will be able to:

1. Appreciate complex interrelationship between organisms and environment
2. Understand methods for studying vegetation, community patterns and processes, ecosystem functions, and principles of phytogeography
3. Gain knowledge that is critical in evolving strategies for sustainable natural resource management and biodiversity conservation

Unit– I

- Ecosystem: Concepts, types and components.
- Food chains, food webs, mineral cycles (N, C, S, P) and ecological pyramids.
- Plant community and Plant succession - hydrosere, xerosere etc.
- Ecology: definition, factors and scope, Ecological groups and their adaptation (hydrophytes, xerophytes, halophytes etc.
- Population and its characters.

Unit-II

- Phytogeography: Types (static and dynamic), basic principles governing geographical distribution of plants, Phytogeographic regions of world and India
- Agroecological and Floristic zones of India, Natural vegetation of India, Vegetational types in Uttar Pradesh, Endemism.

Unit III

- Mineral resources of planet earth, conservation of mineral resources.
- Soil science: soil formation, profile development; soil composition.
- Types and properties of soils (Texture, density, temperature, organic matter, soil pH, ion exchange)
- Soil erosion and soil conservation.
- Problem soils and their reclamation.

Unit-IV

- Environmental pollution: air, water, soil, radioactive, thermal and noise pollutions;their sources, effects and control.

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B.Sc. (SEMESTER–IV)
BOTANY
BOT-402P: PLANTS AND ENVIRONMENT
Practical-4 Credits

Course Outcome:
After the completion of the course the students will be able to:

1. Understand the complex inter-relationship between organisms and environment
2. Get to know about the properties of soil and the importance of soil organic matter
3. Learn about the methods for studying vegetation, community patterns and processes, ecosystem functions

Unit I

Ecology & environment

- Ecological adaptations – Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites
- Study of morphological adaptations of hydrophytes and xerophytes (four each).
- Study of biotic interactions of: Stem parasite (*Cuscuta*), Root parasite (*Orobanche*) Epiphytes, Predation (Insectivorous plants).
- Observation and study of different ecosystems.
- Field visit to familiarize students with local ecological sites.

Unit II

Biodiversity and Phytogeography

- Study of community structure by quadrat method and determination of (i) Minimal size of the quadrat, (ii) Frequency, density and abundance of components (to be done during field visit).
- Marking of vegetation types of India and the World on maps
- Phytogeographical areas of India (on maps)

Unit III

Soil Formation, Properties & Conservation

- Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper)
- Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.
- Determination of organic matter of different soil samples by Walkley & Black rapid titration method.
- Soil forming minerals
- Soil Profile study
- Soil types of India-Map

Unit IV

Pollution &Waste management

- Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter
- Estimation of hardness and dissolved oxygen content in water samples
- Comparative anatomical studies of leaves from polluted and less polluted areas.
- Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
- Making compost from kitchen waste /vermicomposting

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Suggested Readings:

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2. Practical Botany (Part II) Author: N. C. Aery, Sunil D Purohit & Gotam K Kukda 2013 Apex Publishing House,Raj.
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B.Sc. (SEMESTER–V)
BOTANY
BOT-501T: CYTOLOGY, GENETICS AND PLANT BREEDING
Theory-4 Credits

Course Outcome:
After the completion of the course the students will be able to:

1. Acquire knowledge on ultrastructure of cell
2. Understand the organization of DNA in Prokaryotes and Eukaryotes, DNA replication mechanism, genetic code and transcription process
3. Understand techniques of plant breeding
4. Interpret the Mendel's principles, acquire knowledge on cytoplasmic inheritance and sex linked inheritance

Unit – I Cell structure Cell organelles-Basic organization and function of nucleus, chloroplast, mitochondria, endomembrane system, peroxisomes and lysosomes Chromosome composition and organization- nucleosome and solenoid model
Unit- II Salivary gland, lampbrush and B chromosomes. Cell division – mitosis, meiosis and their significance Principles of inheritance, incomplete dominance, co-dominance Gene interaction- Complementary gene interaction, Epistasis, Duplicate gene interaction
Unit-III Linkage, Linkage map (basic concept) Extrachromosomal Inheritance- variegation in four o'clock plant; shell coiling in snail; kappa particles in *Paramecium*. Sex determination. Structural variation in chromosomes - Deletion, Duplication, Inversion, Translocation, Variations in chromosome number- different types of euploids and aneuploids and their evolutionary importance Mutation- spontaneous, induced mutations, mutagens, molecular mechanism and evolutionary significance
Unit – IV Hybridization, heterosis, cytoplasmic male sterility, and its applications, selection, breeding for disease resistance, drought tolerance and quality traits Classification of data, mean, median and mode, standard deviation, standard error, variance, co-relation, X^2 test.

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B.Sc. (SEMESTER–V)
BOTANY
BOT-502T: PLANT PHYSIOLOGY
Theory-4 Credits

Course Outcome:

After the completion of the course the students will be able to:

1. Assimilate knowledge about biochemical constitution of plants
2. Understand the physiological and metabolic processes of plant growth and development
3. Learn the symptoms of mineral deficiency in crops and their management
4. Know the role of plants in development of natural products, nutraceuticals, antioxidants, role of phytohormones and the effect of light on plant growth and reproduction

Unit – I

Plant - water relations: diffusion and osmosis, osmotic potential, absorption of water, ascent of sap. Transpiration: significance and factors affecting it; mechanism of stomatal opening and closing.

Mineral nutrition: essentiality of elements; sand and water culture; macro- and micronutrients, their roles and deficiency symptoms; mechanism of ion uptake (passive and active)

Unit – II

Photosynthesis: photosynthetic pigments; photochemical reactions- reaction centres, O_2 evolution, photophosphorylation; CO_2 fixation - C_3 and C_4 carbon cycle, CAM plants, photorespiration and glycolate metabolism, factors affecting photosynthesis.

Unit - III

Respiration: aerobic and anaerobic respiration; respiratory pathways- glycolysis, Krebs cycle, pentose phosphate pathway; electron transport, oxidative phosphorylation, cyanide resistance .

Lipid metabolism: fatty acid synthesis and its oxidation (α and β).

Nitrogen metabolism: nitrogen cycle, biological nitrogen fixation, nitrite and nitrate reduction, nitrogen assimilation.

Unit – IV

Growth: general aspects and phases of growth; flowering- photoperiodism and vernalization, circadian rhythm; seed germination; bud and seed dormancy; abscission and senescence.

Phytohormones: discovery, physiological roles, Applications of auxins, kinetin, gibberellins, abscisic acid, ethylene, plant hormone mutants.
Plant movement- nastic and tropic.

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B.Sc. (SEMESTER–V)

BOTANY

BOT-503IN: INTERNSHIP/TERM PAPER/MINOR PROJECT

(4 Credits)

B.Sc. (SEMESTER–VI)

BOTANY

BOT-601T: PLANT BIOCHEMISTRY

Theory-4 Credits

Course Outcome:

After the completion of the course the students will be able to:

1. Assimilate knowledge about biochemical constitution of plants
2. Learn about the structure and classification of carbohydrates, lipids and amino acids
3. Learn about the catalytic activity of enzymes and their classification

Unit I Carbohydrates: classification, structure and properties of- monosaccharides (aldose and ketose sugars); oligosaccharides (reducing and non-reducing sugars); polysaccharides (storage- starch, inulin; structural- cellulose, pectin, chitin, aminoglycans, peptidoglycans, glycoprotein, glycolipids).
Unit II Lipids: classification, structure and properties of fatty acids (saturated and unsaturated); simple lipids, compound lipids and derived lipids. Vitamins: structure and properties of vitamins.
UNIT III Amino acids: classification, structure and properties of amino acids, essential and non-essential amino acids. Proteins: classification, structural organization of proteins, biological roles of proteins.
Unit IV Enzymes: Discovery, classification and characteristics of enzymes; general structure; active sites; action specificity; mode of action; aspects of enzyme kinetics (Michaelis-Menten constant); enzyme inhibition, factors affecting catalytic efficiency of enzyme. Bioenergetics: Laws of thermodynamics; concept of Gibb's free energy in plants; redox reactions; high energy rich compounds.

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2. Fundamentals of Plant Biochemistry and Biotechnology N.K. Gupta and S. Gupta 2018, Kalyani Publishers
3. Fundamentals Of Biochemistry J.L. Jain, S. Jain, and N. Jain 2018. S. Chand Publications
4. Essentials Of Biochemistry. Nisha Khalsa, 20016 Pointer Press, Jaipur

5. Elements of Biochemistry HS Srivastava 20014, Rastogi Publication
6. Plant Physiology and Biochemistry, HS Srivastava 2016, Rastogi Publications
7. Biochemistry, K Trehan, 2019, 3rd Edition. New Age International Pvt. Ltd.

Suggested Readings:

1. Lehninger Principles of Biochemistry (2017), David L Nelson & Michael Cox; WH Freeman & Co., New York, San Francisco.
2. Biochemistry (2015), Jeremy M. Berg. Lubert Stryer, John Tymoczko, Gregory Gatto; W. H. Freeman & Co., New York, San Francisco.
3. Biochemistry and Molecular Biology of Plants (2015), Buchanan, Gruissem& Jones; Wiley Blackwell/IK International Pvt Ltd, New Delhi.
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B.Sc. (SEMESTER–VI)
BOTANY
BOT-602P: CYTOGENETICS, PLANT PHYSIOLOGY AND BIOCHEMISTRY
Practical-4 Credits

Course Outcome:

After the completion of the course the students will be able to:

1. Interpret the Mendel's principles, acquire knowledge on cytoplasmic inheritance and sex linked inheritance
2. Learn about the various physiological processes and cellular metabolism in plants
3. Become familiar with various methods of biochemical analysis
4. Study the various factors affecting enzyme activity

Unit I

Genetics

- Cell division
- Monohybrid cross (Dominance and incomplete dominance)
- Dihybrid cross (Dominance and incomplete dominance)
- Gene interactions (All types of gene interactions mentioned in the syllabus)
    - Recessive epistasis 9: 3: 1.
    - Dominant epistasis 12: 3: I
    - Complementary genes 9: 7
    - Duplicate genes with cumulative effect 9: 6: 1
    - Inhibitory genes 13: 3
- Observe the genetic variations among inter and intra specific plants.
- Demonstration of Breeding techniques-Hybridization, case studies of mutation, polyploidy, emasculation experiment

Unit II

Plant Water Relations

- Study of phenomenon of imbibition using gram seeds and demonstration of imbibitional pressure (demonstration experiments).
- Study of the phenomenon of osmosis using (a) traube's cell and (b) cellophane membranes (demonstration experiments).
- Determination of osmotic pressure of the vacular sap of the epidermal cells of *Rhoeo discolor* leaves using a non-electrolyte (sucrose) solution.
- Study of the structure of stomata and stomatal frequency in the epidermal peeling.
- Measurement of the rate of transpiration by (i) weight method (ii) collecting and weighing the transpired water and (iii) Ganong's potometer method (demonstration experiments).
- Study of the relative stomatal opening using Darwin's porometer
- Demonstration of the relative rates of transpiration and absorption (T/A).

- Demonstration of the ratio between transpiration and evaporation (T/E).
- Demonstration of the suction force created during transpiration and evaporation.
- Study of the hydathode structure and the phenomenon of guttation.
- Demonstrate that tissues outside xylem are not essential in the movement of water in the stem (ringing experiment).
- Study of the tissues involved in the conduction of water.
- Influence of the concentration of soil solution on the rate of water absorption (demonstration experiment).

Unit III

Plant Metabolism

- Extraction of the chloroplastic pigments and their separation by (a) chemical extraction and (b) paper chromatography and study of their properties in (a) transmitted light and (b) reflected light (fluorescence) and absorption spectra.
- Effect of certain internal and external factors on photosynthesis: (a) light (b) chlorophyll (c) carbon dioxide (d) free gaseous exchangethrough stomata in land plants. Measurement of the effect of (i) light intensity and (ii)carbon dioxide concentration on the rate of photosynthesis by bubble count method (Wilmott's bubbler method).
- Demonstrate that light is not necessary for starch synthesis.
- Demonstrate that during gaseous exchange in respiration: (a) O_2 is taken up and (b) CO_2 is giving out.
- Demonstrate alcoholic fermentation (Kuhne's tube).

Plant Development and Movements

- Demonstration of the measurement of respiratory quotient by Ganong's respirometer (in seeds rich in carbohydrates, protein, lipids or organic acids).
- Demonstration of the phenomenon of apical dominance.
- Demonstrate phototropism of shoot and the site of photoreception therein.
- Demonstration of hydrotropism in roots.
- Demonstration of the relation between presentation time and gravitropism by means of klinostat.
- Demonstration of seismonastic movement in *Mimosa pudica.*

Unit IV

Techniques for biochemical analysis

- Preparation of solutions -percentage, molar & normal solutions, dilution from stock solution etc.
- Qualitative analysis of carbohydrates
- Qualitative analysis of Lipids and their solubility in different solvents
- Qualitative analysis of amino acids and proteins

Enzymes

- Effect of enzyme concentration on the activity of catalase
- Effect of substrate concentration on the activity of catalase
- Effect of H^+ concentration on the activity of catalase
- Effect of inhibitor on the activity of catalase.

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2. Lewin's GENES XII , 12th edition- by Jocelyn E. Krebs, Elliott S. Goldstein , Stephen T.Kilpatrick, Cenveo Publishers, 2018.
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5. Genetics: A Mendelian Approach- by Peter J Russell, Pearson, 2010.
6. Keith Wilson and John Walkers Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, 1975.
7. Molecular Cell Biology- by Harvey Lodish, Arnold Berk , Chris A. Kaiser, Monty Krieger, Mathew P. Scott, Anthony, Brest Cher, Hidde Ploegh, Paul Matsudaira, W.H. Freeman & company, 1986.
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B.Sc. (SEMESTER–VI)
BOTANY
BOT-603Ta: PLANT RESOURCE UTILIZATION
Theory-4 Credits

Course Outcome:

After the completion of the course the students will be able to:

1. Gain knowledge about the introduction, cultivation and domestication ofcrops.
2. Get an insight into the cultivation practices of some major crops
3. Learn about the commercial products obtained from plants
4. Gather information on methods of conserving plant diversity

Unit I Centres of diversity of plants, origin of crop plants, domestication and introduction of crop plants. Cultivation, production and uses of - wheat, rice, maize and legumes
Unit II Plants yielding fatty/essential oils, spices, beverages (tea, coffee, cocoa), fiber (cotton, coconut, jute, flax); medicinal and petro plants
Unit III Timber yielding plants (teak, sheesham, mango, deodar, sal), gums and resins (*Acacia*, *Commiphora*, *Pinus*), dye yielding plants (*Carthamus, Indigofera, Rubia, Haematoxylum*)
Unit IV Conservation of plant resources for agriculture and forestry *In situ* conservation: sanctuaries, national parks, biosphere reserves, wetlands, mangroves. *Ex situ* conservation: field gene banks, seed banks, cryobanks.

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4. Kochhar, SL., 2012, Economic Botany in the Tropics, 4th edition, Macmillan India

5. Mahajan, BK., 2010, Methods in Biostatistics for Medical Students and Research Workers, 7th edition, Jaypee Publishers
6. Trivedi, PC., Sharma, N., 2010, Plant Resource Utilization and Conservation, Pointer Publishers,

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B.Sc. (SEMESTER–VI)
BOTANY
BOT-603Tb: ETHNOBOTANY
Theory-4 Credits

Course Outcome:
After the completion of the course the students will be able to:

1. Understand the ethnobotanical details of plants
2. Learn about the uses of plants by various tribes of India
3. Gain knowledge about the chemistry of plants and herbal preparations
4. Understand phytochemical analysis related to medicinally important plants and economic products produced by the plants
5. Learn about the economically important plants in our daily life and also about the traditional medicines and herbs, and its relevance in modern times

Unit I

Ethnobotany
Methodologies of ethnobotanical research: Field work, Literature, Herbaria and Musea and other aspects of ethnobotany. Importance of ethnobotany in Indian systems of medicine (Siddha, Ayurveda and Unani, Homoeopathy), Role of AYUSH, NMPB, CIMAP
Tribal knowledge towards disease diagnosis, treatment, medicinal plants, plant conservation and cultivation.

Unit II

Medicinal aspects
Study of common plants used by tribes(*Aegle marmelos, Ficus religiosa, Cynadon dactylon, Eclipta alba, Oxalis, Ocimum sanctum* and *Trichopus zeylanicus)* Ethnobotanical aspect of conservation and Management of plant resources, Preservation of primeval forests in the form of sacred groves of individual species and Botanical uses depicted in our epics. Plants in primary health care*:* Common medicinal plants*: Tinospora, Acorus, Ocimum,* Turmeric and Aloe and Indian Pharmacopeia, Quality Evaluation of crude drugs & adulteration

Unit III

Pharmacognosy
Preparation of drugs for commercial market - Organoleptic evaluation of drugs - Microscopic evaluation of drugs - Physical evaluation of drugs - Active and inert constituents of drugs - Classification of drug plants - individual drugs - drug adulteration. Sources of crude drugs – roots, rhizome, bulb, corm, leaves, stems, flowers, fruits and seeds; organoleptic study of *Adhatoda vasica, Andrographis paniculata, Azadirachta indica, Coriandrum sativum, Datura metal, Eclipta alba, Emblica officinalis, Ocimum sanctum, Phyllanthus amarus, Ricinus communis, Vinca rosea and Zingiber officinale.*

Unit IV

Herbal Preparations

Collection of wild herbs - Capsules - compresses - Elixirs - Glycerites - Hydrotherapy or Herbal bath - Herbal oils - Liquid extracts or Tincture - Poultices - Salves - Slippery elm slurry and gruel - Suppositories - Teas. Plant natural products, general detection, extraction and characterization procedures. Glycosides and Flavonoids and therapeutic applications. Anthocyanins and Coumarins and therapeutic applications, Lignans, Terpenes, Volatile oils and Saponins, Carotenoids and Alkaloids Carotenoids and pharmacological activities.

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B.Sc. (SEMESTER–VI)
BOTANY
BOT-603Tc: PLANT BIOTECHNOLOGY
Theory-4 Credits

Course Outcome:
After the completion of the course the students will be able to:

1. Gain insight into use of biotechnology in improving food quality, pest and disease resistance, plant development, production of proteins, enzymes and vaccines
2. Acquire knowledge about plant tissue culture
3. Understand the importance of the subject in sustainable development

Unit I

Introduction to recombinant DNA
Isolation of genomic and plasmid DNA, Plasmid vectors, Restriction digestion and ligation, Transformation, Selection of recombinants, Transgenic plants

Unit II

Applications of Genetic engineering in Agriculture
Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug)

Unit III

Industrial and Medical Applications of Genetic Engineering
Production of Industrial enzymes (Aspergillase, Pectinase, Protease, Lipase), Recombinant vaccines, Recombinantinterferon, Production of antibiotics; Biosafety concerns

Unit IV

Plant Tissue Culture
Principles, components and techniques of in vitro plant cultures, Callus cultures, Cell culture, cell suspension cultures, Embryogenesis and organogenesis, Protoplast- isolation and culturing of protoplast-principle and application, regeneration of protoplasts, protoplast fusion and somatic hybridization-selection of hybrid cells, Somaclonal variations, Plant secondary metabolite production.

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B.Sc. (SEMESTER–VII)
BOTANY
BOT-701T: APPLIED MICROBIOLOGY AND PLANT PATHOLOGY
Theory-4 Credits

Course Outcome:

After the completion of the course the students will be able to:

1. Understand the impact and significance of microbes in maintaining a healthy ecosystem
2. Gain knowledge about microbial formulations used as biopesticides or biofertilizers
3. Learn about the host –pathogen interaction and disease management
4. Gain knowledge about uses of microbes for plant growth promotion and as biocontrol agents
5. Learn about the methods for detection of plant pathogens

Unit I Microbial symbioses and their significance Plant microbiome and plant health (PGPR and defence priming) Biofertilizers and biopesticides Microbial fermentations, antibiotics, vaccines Microbes in bioremediation Biological control and IPM
Unit II Impact of crop diseases on global food security Stages in the development of disease in plants Bacterial secretion systems, effectors and pathogenesis Plant immunity Biochemistry of host-virus interaction (Hypersensitive response), systematic acquired resistance (SAR) Engineering pathogen resistance in plants
Unit III Purification of plant viruses Serological and molecular methods for detection and identification of plant viruses and bacteria Modern methods of plant virus control (cross protection, PDR, RNAi, CRISPR-Cas system) Viral and Bacterial diseases: Symptoms, Causal organism, Disease cycle and Control measures of - Mosaic diseases on Tobacco and Cucumber, Yellow vein mosaic of bhindi, Tomato leaf curl, Citrus canker, Soft rot of fruits and vegetables, Scab of potato, Little leaf of brinjal
Unit IV Molecular identification of fungal species Mycorrhizal fungi and their significance Fungal diseases and their control: Symptoms , Causal organism, Disease cycle and Control measures of – Damping off of seedlings, Whiterust of Crucifers, Late blight of Potato, Loose smut of wheat, Black stem rust of wheat, Early blight of potato, *Alternaria* leaf spot, Red rot of sugarcane, Wilt of arhar

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B.Sc. (SEMESTER–VII)
BOTANY
BOT-702T: TRENDS IN PLANT SCIENCES
Theory-4 Credits

Course Outcome:

After the completion of the course the students will be able to:

1. Gain insight into new methods, techniques and protocols that advance our ability to study and understand the biology of plants
2. Utilize their knowledge for human welfare
3. Learn about the responses of plants to various abiotic stresses
4. Understand the applications of nanotechnology in various spheres

Unit I

IPR & Traditional Knowledge

IPR and WTO (TRIPS, WIPO), Patent Act 1970 and its amendments, TIFAC, NRDC, Rights, Procedure of obtaining patents, Working of patents, Infringement, Copyrights, Trademarks, Geographical Indications, Traditional Knowledge Digital Library, Protection of Traditional Knowledge & Protection of Plant Varieties and Biotech inventions.

Unit II

Nanotechnology

Fundamentals of nanoscale self-assembly process involved in important functional biomolecules such as Nucleic acid (DNA and RNA), Proteins, Enzymes. Cell structure and organelles,nanoscale assembly of cellular components (cell membrane and liposomes). Nanoscale assembly of microorganisms (virus). Nano-particles synthesis, Biological synthesis of Nanoparticles, Advantages and applications of biologically synthesized nanomaterials. Introduction to biological nanomaterials, Biomineralization, Magnetosomes, nano-pesticides, nano-fertilizers, nano-sensors.

Unit III

Stress Physiology

Plant responses to various types of abiotic stresses: drought, salinity, flooding, extreme temperature (low and high), metal toxicity, ozone and UV-B radiations. Oxidative stress and redox metabolism: Reactive oxygen species (ROS)- singlet, superoxide, hydrogen peroxide and hydroxyl radicals in plants. Site of generation and biological effect of ROS- oxidative damage, oxidation of lipids, proteins and nucleic acids. Antioxidant defense mechanisms.

Unit IV

Bioinformatics

Basics of Bioinformatics & Phylogenetic Analysis

Scope of bioinformatics - Genomics, Transcriptomics, Proteomics, Metabolomics, Molecular Phylogeny, Applications of bioinformatics; biological databases - NCBI, nucleic acid databases (GenBank, EMBL), protein databases (Swiss-Prot, PDB), metabolic pathway database (KEGG); Phylogenetic analysis: Similarity, identity and homology, Alignment – local and global, pairwise and multiple sequence, Methods of Alignment (BLAST and FASTA); Phylogenetic tree and analysis.

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1. Hopkins and Hunner. 2011. Introduction to plant physiology. Willey Publication. UK. 3. Schulze, 4. Taiz and Zeigar 2010. Plant Physiology
2. YubingXie. 2012. Nanotechnology. CRC Press.The Nanobiotechnology Handbook. CRC Press.
3. Sulabha K. Kulkarni. 2014 Nanotechnology : Principles and Practices. CP publishing, New Delhi.
4. B S Murty, P Shankar, Baldev Raj, B B Rath, James Murday. 2012. Textbook of Nanoscience and Nanotechnology. Springer.
5. Ghosh Z, Mallick B (2012) Bioinformatics: Principles and Applications. Oxford University Press. ISBN-13: 978-0-19-569230-3.
6. Rastogi SC, Mendiratta N, Rastogi P (2011) Bioinformatics: Concepts, Skills & Applications. CBS Publishers & Distributors Pvt. Ltd. ISBN: 81-239-1482-2.

Suggested Reading:

1. K. K. Chattopadhyay and A. N. Banarjee. 2009. Introduction to Nanoscience and Nanotechnology. PHI Publication
2. David S. Goodshell. 2004. Bionanotechnology-Lessons from nature. John Wiley Publications
3. Abiotic Stress Adaptation in Plants: Physiological, Molecular and Genomic Foundation (2010), Ashwani Pareek, S.K. Sopory, Hans J. Bohnert and Govindjee; Springer Publication.
4. Buchanan, Greessam and Jones .2002. Biochemistry and Molecular Biology of plants. American society of plant biology. USA.

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B.Sc. (SEMESTER–VII)
BOTANY
BOT-703T: TECHNIQUES AND INSTRUMENTATION
Theory-4 Credits

Course Outcome:

After the completion of the course the students will be able to:

1. Investigate natural metabolic products of plants using various techniques
2. Understand growth and development in plant cells through various techniques
3. Use knowledge in diverse applications such as detection of adulterants in food items, purification of proteins and enzymes
4. Use these techniques in metabolomic studies

UNIT – I Sand culture/water culture and controlled soil culture techniques Tracer techniques: Detection and measurement of isotopes and applications Microscopy: Bright field, phase contrast, fluorescence, confocal, transmission electron microscopy, scanning electron microscopy Microtomy
UNIT – II Centrifugation and ultracentrifugation techniques and their applications. Chromatography- Paper, TLC, Column, Gel Filtration, Affinity, Ion Exchange, HPLC, GC Flow cytometry: Principles and Applications
UNIT – III Photometry: Colorimetry and Spectrophotometry (UV-visible). Fluorescence spectrometry, Chemiluminescence Spectrometry, Atomic Absorption/emission spectrometery Basic features and principles of IR, Raman, Mass, NMR, ESR
UNIT – IV Electrophoretic techniques and their applications. Amino acid analysis and protein sequencing. Applications and detection of proteins and nucleic acids (Western Transfers and Immuno blots and Southern blot), MAB technology. DNA chip technology and Microarray

REFERENCES

Books:

1. Simon Roe, ed. (2001), Protein purification techniques: A practical approach, 2nd edition, Oxford University Press
2. K. Wilson, J. Walker (2010). Principles and Techniques of Biochemistry and Molecular Biology, Seventh Edition, Cambridge University Press, NewYork, USA.

Suggested Readings:

1. E.J. Hewitt (1966).Sand and water culture methods used in the study of plant nutrition. Commonwealth Agricultural Bureaux, FarnhamRoyl. Bucks, England.
2. G. Hegyi, J. Kardos, M. Kovács, A. Malnasi-Csizmadia, L. Nyitray, G. Pal, L.Radnai, A.Reményi, I. Venekei (2013). Introduction to Practical Biochemistry, ELTE Faculty of Natural Sciences, Institute of Biology
3. K. Wilson, J. Walker (2010). Principles and Techniques of Biochemistry and Molecular Biology, Seventh Edition, Cambridge University Press, NewYork, USA.
4. Phillip Sheeler and Donald E Bianchi (2006). Cell and Molecular Biology, John Wiley and Sons, Inc. U.K.
5. R. Boyer (2000). Modern Experimental Biochemistry, Pearson Education, Asia
6. S.E. Ruzin (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York
7. S.K. Sawhney, Randhir Singh (2000). Introductory Practical Biochemistry, Narosa Publishing House, New Delhi.

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B.Sc. (SEMESTER–VII)
BOTANY
BOT-704P: APPLICATIONS IN MICROBIAL AND PLANT SCIENCES
Practical-4 Credits

Course Outcome:
After the completion of the course the students will be able to:

1. Isolate and study plant pathogens in order to correctly identify them
2. Learn to devise methods of controlling plant pathogens based on the nature of propagules and mode of transmission
3. Practice biological control of pests instead of depending on harmful chemical pesticides
4. Learn to mitigate the use of chemical fertilizers, and increase the use of biofertilizer
5. Understand techniques that are useful in the study of plant pathogens and biomolecules
6. Learn about the host responses to stress, and its quantification

Unit I
Experimental Plant Pathology:

- Study of fermentative diversity of bacteria.
- Isolation and characterization of soil bacteria.
- Morphology and staining of nitrogen fixing bacteria.
- Enumeration of rhizosphere to non rhizosphere population of bacteria.
- Isolation of antagonistic bacterial sp. from the rhizosphere.
- Isolation of Phosphate solubilizing microorganisms.
- Microscopic observations of root colonization by VAM fungi.
- Isolation of phyllosphere microflora.

Unit II
Practicals in Applied Microbiology:

- Study of diseased plant specimens and materials
- Preparation of media for isolation of the pathogen: bacteria (NA) and fungi(PDA).
- Isolation of pathogens from infected material
- Study of the hypersensitive response during virus infection
- Insect transmission of plant virus
- Purification of plant virus
- Serological detection of plant viruses

Unit III
Stress physiology:

- Quantitative estimation of proline in water stressed leaf tissues.
- Quantitative estimation of hydrogen peroxide content in leaf tissues.
- Qualitative visualization of superoxide anions in stressed leaf tissues.
- Quantitative estimation of ascorbic acid in plant tissue.

Unit IV
Techniques and Instrumentation:

- Chromatographic procedures (gel filtration) for separation of low molecular and high molecular weight leaf extract components.
- Thin layer chromatography for detection of amino acids
- Isolation of proteins from leaf sap through precipitation and centrifugation.
- Separation of proteins by electrophoresis.

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1. Matthew's Plant Virology, R. Hull, 4th edition, 2003, Elsevier.
2. Prescott's Microbiology, J. Willey, L. Sherwood, 10th edition, 2017, McGraw-Hill Education.
3. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology,
4. Edited by A. Hofmann, S. Clokie, 8th edition, 2018, Cambridge University Press.
5. Plant Pathology, G.N. Agrios, 5th edition, 2005, Elsevier.
6. Alcamo's Fundamentals of Microbiology, J.C. Pommerville, 2nd edition, 2013, Jones and
7. Bartlett Learning.
8. Microbiology: An Introduction, G.J. Tortora, B.R. Funke, C.L. Case, 11th edition, 2016,
9. Pearson India Education Webster, J., Weber, R. (2007). Introduction to Fungi, 3rd edition. Cambridge, U.K.: Cambridge University Press.
10. Text Book of Mycology by A.K. Sarbhoy; ICAR Publications, New Delhi, 2006.

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1. Aneja, K. R. 1993. Experiments in Microbiology, Pathology and Tissue Culture, Vishwa Prakashan, New Delhi.
2. Dubey, R. C. and Maheshwari. D.K. 2012. Practical Microbiology, S. Chand & Company, Pvt. Ltd., New Delhi.
3. Kodo, C.I. and Agarwal, H.O.1972. Principles and techniques in Plant Virology, Van Nostrand, Reinhold Company, New York.
4. MadhaveeLatha, P. 2012, A Textbook of Immunology, S. Chand & Company Pvt. Ltd., New Delhi
5. Agrios, G.N. (1997). Plant Pathology, 4th edition. Cambridge, U.K.: Academic Press.
6. Gokare A. Ravishankar , Ranga Rao Ambati 2019 Handbook of Algal Technologies and Phytochemicals Volume II: Phycoremediation, Biofuels and Global Biomass Production Print ISBN: 9780367178192
7. Amos Richmond Ph.D., Prof. Emeritus, Qiang Hu Ph.D 2013. Handbook of Microalgal Culture: Applied Phycology and Biotechnology, Second Edition Print ISBN:9780470673898.
8. Trigiano Robert N. 2007. Plant Pathology Concepts and Laboratory Exercises. 2 nd Edition, CRC Press. U.K.

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https://www.apsnet.org/edcenter/disimpactmngmnt/topc/EpidemiologyTemporal/Pages/ManagementStrategies.aspx

B.Sc. (SEMESTER–VII)
BOTANY
BOT-705Ta: ENVIRONMENTAL AWARENESS AND ETHICS
Theory-4 Credits

Course Outcome:

After the completion of the course the students will be able to:

1. Understand the relationship of humans and environment and their moral obligation to protect the environment
2. Promote sustainable development of the planet
3. Generate environment consciousness in themselves and the community

Unit I **Pollution and Waste management:** Environmental pollution, Environmental protection laws, Regulatory framework for pollution monitoring and control; Bioremediation, Activated Sludge Process (ASP) – Trickling Filters – oxidation ponds, fluidized bed reactors, membrane bioreactor, neutralization, ETP sludge management; digesters, up flow anaerobic sludge blanket reactor, fixed film reactors, sequencing batch reactors, hybrid reactors, bioscrubbers, biotrickling filters
Unit II **Types of waste & Circular Economy:** Case study: Ganga Action Plan; Yamuna Action Plan; implementation of CNG ;Waste- Types, collection and disposal, Recycling of solid wastes (hazardous & non-hazardous) - classification, collection and segregation, Incineration, Pyrolysis and gasification, Sanitary landfilling; composting, Biogas production, Circular Economy & sustainability.
Unit III **Environmental audit & Sustainability:** Concept of environmental audit; Guidelines of environmental audit; Methodologies adopted along with some industrial case studies; Environmental standards: ISO 14000 series; Scheme of labelling of environment friendly products (Ecomark); Life cycle analysis; Concept of energy and green audit, Sustainability indices; Strategies and debates on sustainable development; Concept of Sustainable Agriculture; India's environment action programme: issues, approaches and initiatives towards Sustainability; Sustainable development in practice; Urbanization; Concept and characteristics of smart city; Urban resources and environmental problems; Carrying capacity analysis; Concept of ecological footprints.
Unit IV **Environmental ethics, Carbon Credits and Role of GIS:** Carbon credit: concept, exchange of carbon credits. Carbon sequestration, importance, meaning and ways. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Wasteland reclamation. Consumerism and waste products. Clean development mechanism. Geographical Information Systems: definitions and components; spatial and non-spatial data; GIS software packages; GPS survey, data import, processing, and mapping. Applications and case studies of remote sensing and GIS in land use planning, forest resources& agriculture studies

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Books:
Green Technology: An Approach For Sustainable Environment ISBN : 9788177543438Edition : 01Year : 2021Author : Dr. Purohit SSPublisher : Agrobios (India)

Suggested Reading:
Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries Policy and Science Considerations. MartinusNijhoff Publishers

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B.Sc. (SEMESTER –VII)
BOTANY
BOT-705Tb: PLANT SYSTEMATICS
Theory-4 Credits

Course Outcome:

After the completion of the course the students will be able to:

1. Learn how plant specimens are collected, documented, and curated for a permanent record
2. Observe, record, and employ plant morphological variation and the accompanying descriptive terminology
3. Gain experience with the various tools and means available to identify plants and trace their phylogeny
4. Develop observational skills and field experience
5. Identify a taxonomically diverse array of native plants
6. Recognize common and major plant families
7. Comprehend the concepts of plant taxonomy and classification of Angiosperms according to modern approaches

Unit I Principles of systematics, Relevance and role of Systematics; Approaches to classification, Phenetic, Phylogenetic and cladistics; Relative merits and demerits of major systems of classification viz. Bentham and Hooker, Engler and Prantl, Hutchinson, Cronquist, Dahlgen and Thorne; APG system, Origin and Evolution of Angiosperms
Unit II Herbarium & Botanical Gardens. ICN (History, Principles and Applications), Protologue and Botanic literature (Monographs, Icones, Floras and Taxonomic literature); Species Concept: Various models; Speciation and Variation Phytogeography with special reference to discontinuous areas, endemism, hotspots and hottest hotspots GIS and Phylocode
Unit III Modern tools and evidence of taxonomy viz: Morphology and Anatomy: Epidermis and otherstructures associated with it, Node, Leaf, Flower Embryology, Palynology, Reproductive Biology, Ovular morphology and Seed Coat; Cytotaxonomy, Phytochemistry, Sieve Elements Plastids and Ecology.
Unit IV Sexual dioecism; Interesting taxonomic features and interrelationships of following Dicot families: Acanthaceae, Aizoaceae, Amaranathaceae, Asclepiadaceae, Asteraceae, Betulaceae,Bombaceae, Cactaceae, Caesalpiniaceae, Capparaceae, Caryophyllaceae, Casurinaceae,Cucurbitaceae, Ericaceae, Euphorbiaceae, Fagaceae, Fumariaceae, Malvaceae, Mimosaceae,Nelumbonaceae, Nymphaeaceae, Papaveraceae, Paplionaceae, Passifloraceae, Polygonaceae,Primulaceae, Ranunculaceae, Rosaceae, Rubiaceae, Scrophulariaceae, TiliaceaeandTrochodendraceae. Special features of Insectivorous/Parasitic and Saprophytic families Interesting taxonomic features and inter-relationships of following Monocot families and treatment of monocots in evolutionary systems of classification: Alismataceae, Arecaceae, Commelinaceae, Cyperaceae, Liliaceae, Orchidaceae, Poaceae, and Zingiberaceae.

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Books:

1. Davis, P. H. and V. H. Heywood. 1991. Principles of Angiosperm Taxonomy. Today and Tomorrow Publications, New Delhi
2. Eames, A.J. 1961. Morphology of Angiosperms. McGraw Hill, NY.
3. Naik, V. N. 1984. Taxonomy of Angiosperms Tata McGrow-Hill Publication Com
4. Pandey, B.P. 2007. Taxonomy of Angiosperms. S. Chand and Company Limited. New Delhi
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6. John Firminger Duthie- Flora of Upper Gangetic Plants, Shiva offset Press, vol.I, 1903, vol.II, 1911.
7. John Hutchinson- The families of flowering plants, Clorendon Press, 1959.
8. Arthur John Cronquist- The evolution and classification of flowering plants, Shiva offset Press, 1981.
9. Alfred Barton Randle- The classification of flowering plants, Harvard University, 1904.
10. Gurcharan Singh- Plant systematic, Oxford & IBH Publishing Company Pvt. Ltd., 1999.
11. Tod F. Stuessy-Plant taxonomy, Shiva offset Press, 2002.
12. Peter H.A. Sneath and Robert R. Sokal- Numerical taxonomy, Wayne State University Press, 1973.
13. T. Pullaiah- Taxonomy of angiosperms, Regency Publications, New Delhi, 1998.

Suggested Readings:.

1. Sharma, O.P. 2009. Plant Taxonomy. Tata McGraw-Hill. Mumbai.
2. Singh Gurcharan. 2004. Plant Systematics : Theory and practice Oxford and YBH, Publishing Co. Pvt. Ltd., New Delhi
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https://www.delta-intkey.com/

B.Sc. (SEMESTER–VII)
BOTANY
BOT-705Tc: CONSERVATION OF BIODIVERSITY
Theory-4 Credits

Course Outcome:

After the completion of the course the students will be able to:

1. Get an overview of the significance of plant diversity, and an insight into global strategies for developing workable models for its exploration and conservation
2. Develop an understanding of the importance of national parks, biosphere reserves and sanctuaries
3. Understand the role played by government and non-government organizations in conserving biodiversity

UNIT – I • Plant diversity concepts, importance of Species diversity in Ecosystems, Ecosystem functions and services. • Levels of Biodiversity - Ecosystem diversity, Species diversity and its measure, Species - richness, evenness, abundance and genetic diversity. • Abiotic and biotic factors affecting biodiversity, causes of biodiversity loss (viz. ecosystem, degradation, land-use change, fragmentation, invasive species, climate change, pollution, overexploitation and co-extinctions).
UNIT – II • Need for biodiversity conservation, Types of conservation (preventive, remedial and restoration). • Current status of biodiversity conservation and Red list index. • Conservation status by IUCN red list categorized criteria (DD, LC, NT, VU, EN, CR, EW and EX). • Community based conservation strategies, Indigenous and traditional knowledge in biodiversity.
UNIT – III • In situ conservation - Protected areas and its types, Biosphere reserves, National parks, Wildlife sanctuaries and Sacred groves. • Ex situ conservation- Botanical gardens, Seed banks. • In-vitro storage of germplasm and cryopreservation. • Concept of diversity hot spots, Biodiversity hotspots in India.
UNIT – IV • International and National conservation policies. • Role of government agencies and NGOs in plant conservation. • General account of important authorities and institutions - UNEP, DST, MoEF, BSI, NBPGR, CPCB, NMPB, AYUSH.

Suggested Readings:

1. Plant Conservation and Biodiversity Editors: Hawksworth, David L., Bull, Alan T. (Springer)
2. Biological Diversity and Its Conservation, Sharma Dushyant Kumar, Daya Publishing House
3. A Handbook of Plant Resource Utilization and Conservation, Bijan Bihari Dutta
4. Biodiversity: Concepts and Conservation, B.B. Hosetti, S. Ramkrishna, Aavishkar Publishers, Distributors, Jaipur

B.Sc. (SEMESTER–VIII)
BOTANY
BOT-801T: RESEARCH METHODOLOGY
Theory-4 Credits

Course Outcome:

The undergraduate students will develop a research orientation and become acquainted with the fundamentals of research methods.

1. Understand the basic concepts and techniques used in research viz. sampling techniques, research designs and techniques of analysis.
2. Develop understanding of the basic framework of research process.
3. Learn how to review literature and collect data
4. Develop an understanding of the ethical dimensions of conducting applied research.
5. Appreciate the components of scholarly writing and evaluate its quality.

Unit I **Basic Concepts of Research:** Meaning of research in biological sciences; Research methods vs Research methodology; Motivation and objectives of research problem Selecting and formulating a research problem. Types of research: Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical
Unit II **Research Design and Survey of Literature:** Concept and need, Identification of Research problem, defining and delimiting Research problem. Basic principles of research design-objectives, introduction, rationale of work, material and methods, designing experiments. Necessity and importance of review of literature in defining a research problem; Primary and secondary sources of literature- reviews, treatise, monographs, web as a source for searching literature. Identifying the gap areas from literature review.
Unit III **Data Collection, Analysis and Scientific writing**: Observation and collection of data. Data processing, analysis, interpretation and their applications. Format of writing research paper, popular scientific articles for general awareness, review and reports-layout, structure, language, illustrations and tables; Procedure of reference citation. Principles of biostatistics. Computer application: Operating systems, software, molecular modelling using computer.
Unit IV **Application of Results and Ethics**: Environmental impacts; Ethical issues; Ethical committees; Commercialization; Copy right; Royalty: Intellectual property rights and patent law; Trade related aspects of intellectual property rights; Reproduction of published material; Impact factor and citation index; Plagiarisms; Reference citation and acknowledgement; Reproducibility and accountability.

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Pawar, B.S. (2009). Theory building for hypothesis specification in organizational studies, Response Books, New Delhi.
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Suggested Reading:

1. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual.
2. Neuman, W.L. (2008). Social research methods: Qualitative and quantitative approaches,Pearson Education
3. Best and Kahn, Research Methodology, PHI Limited.
4. Rand R.Wilcox Fundamentals of modern statistical methods
5. Design of Experience: Statistical Principles of Research Design and Analysis, by Robert O. Kuehl Brooks/cole.

B.Sc. (SEMESTER–VIII)
BOTANY
BOT-802TP: TERM PAPER
Theory-4Credits

B.Sc. (SEMESTER–VIII)
BOTANY
BOT-803D: MAJOR RESEARCH PROJECT/DISSERTATION
(12 Credits)

Course Outcome

The full semester External Project/Dissertation is designed to ensure that the student is able to apply the knowledge gained in the previous semesters in specific areas of interest in a problem solving environment, gaining bench-experience, to serve as a springboard for a professional future.

External Project/Dissertation

External Project/Dissertation for Semester VIII will be carried out by the students in various recognized/established labs of Parent/Other Universities, of Institutes under CSIR, ICMR, IIT, ICAR, DST, DBT, Industry, Government Departments etc. (to be arranged by the students themselves, including whatever expenses become due in this regard).

B.Sc. (SEMESTER–I)
BOTANY: MINOR
BOT-Q-1: DIVERSITY OF PLANT VIRUSES, BACTERIA, FUNGI AND ALGAE
Theory-2 Credits

Course Outcome:
After the completion of the course the students will be able to:

1. Develop an understanding about the classification and diversity of plant viruses, bacteria fungi, algae and lichens.
2. Gain an insight into the role played by each group in the biosphere, along with their economic importance.
3. Learn how to identify each group on the basis of their morphological characteristics.
4. Understand the various stages in their cycles.
5. Learn about their various associations.
6. Understand the host–pathogen relationship, recognize the symptoms and diseases caused by them.

Unit I

- Overview of plant viruses (nature & classification).
- Symptoms of virus infected plants.
- Methods of plant virus transmission.
- Structure and replication of tobacco mosaic virus (TMV).
- Detection of plant viruses (electron microscopy and serology).
- Overview of prokaryotic cell structure and function (Bacteria and Archaea).
- Diversity of bacteria (Proteobacteria, Firmicutes, Mollicutes, Phototrophs and Chemolithotrophs).
- Bacterial cell division and microbial growth control.
- Genetic variability in bacteria.
- Economic importance of bacteria.

Unit II

- Eukaryotic cell structure and function.
- General characteristics of fungi.
- Comparative life cycles of *Pythium, Synchytrium, Rhizopus, Aspergillus* and *Ustilago.*
- Economic importance of fungi
- General features and thallus organization in Algae
- Classification of Algae (Major Groups).
- Comparative life cycles of *Oscillatoria, Volvox, Navicula, Vaucheria, Ectocarpus* and *Polysiphonia.*
- Economic importance of Algae.

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2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
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B.Sc. (SEMESTER–II)

BOTANY: MINOR

BOT-Q-2: DIVERSITY OF BRYOPHYTES, PTERIDOPHYTES, GYMNOSPERMS AND PALAEOBOTANY

Theory-2 Credits

Course Outcome:

After the completion of the course the students will be able to:

1. Develop awareness about the group of plants that have given rise to land habit and the flowering plants.
2. Develop an understanding of plant evolution.
3. Develop critical understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms.
4. Understand the life cycles of non-flowering plants.
5. Know the importance of studying fossils.

Unit I

- General characters, classification and affinities of Bryophytes.
- Comparative morphological, anatomical and reproductive account of *Pogonatum*; *Anthoceros. Marchantia* and *Frullania*.
- General characters, affinities, classification and stelar systems in Pteridophytes, Heterospory and seed habit.
- Comparative morphological, anatomical and reproductive account of *Rhynia, Lycopodium, Equisetum, Adiantum* and *Marsilea*.

Unit II

- General characters, affinities and classification of Gymnosperms
- Comparative morphological, anatomical and reproductive account of *Cycas, Pinus* and *Ephedra*.
- Elementary Palaeobotany: General account, types of fossils, methods of fossilization, geological time scale and continental drift.

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3. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.
4. Rashid A (1999) An Introduction to Pteridophyta, Vikas Publishing House Pvt. Ltd. New Delhi.
5. Sharma OP (1990) Textbook of Pteridophyta. MacMillan India Ltd. Delhi.
6. Vashishtha BR, Sinha AK and Kumar A (2010) Botany for Degree Students – Pteridophyta, S. Chand and Company,
7. Vashishtha BR, Sinha AK and Kumar A (2010) Botany for Degree Students – Gymnosperms, S. Chand and
8. Parihar NS (1976) Biology and Morphology of Pteridophytes. Central Book Depot.
9. Bhatnagar SP (1996) Gymnosperms, New Age International Publisher.
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1. Biology of Bryophytes. - R.N. Chopra and P.K. Kumra. New Age International (P) Limited,
2. New Delhi 1988.
3. An Introduction to Bryophyta. (Diversity, Development and Differentiation). – A.Rashid.
4. Publication House Pvt. Ltd., 1998.
5. Bryophytes – A Broad Perspective. - Prem Puri. Atma Ram & Sons, Delhi & Lucknow, 1985
6. The Morphology of Pteridophytes, K.R. Sporne, Hutchinson & Co Publishers Ltd., 1962.
7. Gymnosperms- Extinct and Extant, C.M. Govil, Krishna Prakashan Media (P) Ltd, 2007.
8. Embryology of Gymnosperm, Hardev Singh, Gebruder Borntraeger, Berlin, 1978.

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B.Sc. (SEMESTER–III)
BOTANY: MINOR
BOT-Q-3: PLANT TAXONOMY, DEVELOPMENT AND REPRODUCTION
Theory-2 Credits

Course Outcome:

After the completion of the course the students will be able to:

1. Develop an understanding of phylogenetically important groups of flowering plants, and gain abroad understanding of the process of evolution.
2. Understand morphology, anatomy, reproduction and developmental changes therein throughtypological study and create a knowledge base in understanding plant diversity, economic values and taxonomy of Angiosperms.
3. Understand the composition, modifications, internal structure and architecture of floweringplants for becoming a Botanist.

Unit – I

- Principles of classification, nomenclature; study of different classification systems viz. Linnaeus, Bentham and Hooker, Cronquist; Herbarium and Botanical gardens.
- Taxonomic study of following families and their economic importance:
  Dicots: Amaranthaceae, Apiaceae, Apocynaceae, Asteraceae, Brassicaceae, Caesalpiniaceae, Cucurbitaceac, Euphorbiaceae, Lamiaceae, Malvaceae,Mimosaceae, Nelumbonaceae, Nymphaeaceae, Papilionaceae, Ranunculaceae, Rosaceae, Rubiaceae, Rutaceae, Solanaceae.
  *Monocots:*Arecaceae, Cyperaceae, Liliaceae and Poaceae.

Unit - II

- General morphology and development of the floral organs, plant modifications- Phylloclade, Phyllode and Cladode.
- Meristems – Classification, Root Apical Meristem, Shoot Apical Meristem.
- Cambium – Tissue differentiation, secondary growthand its anomalies.
- Structure and development of male and female gametophytes.
- Morphology, viability and germination of pollen and Embryo sac types.
- Double fertilization, Endosperm development, Embryogeny, Apomixis and Polyembryony.

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1. Naik, V. N. (1984) Taxonomy of Angiosperms Tata McGrow-Hill Publication Com. Ltd., New Delhi
2. Pullaiah, T. - Taxonomy of Angiosperms, Regency Publications, New Delhi, 1998.
3. Dutta A.C. 2016. Botany for Degree Students. Oxford University Press.
4. E.J.Eames . Morphology of Vascular Plants, Standard University Press.
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9. Bhattacharya et. al. 2007. A textbook of Palynology, Central, New Delhi.
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11. P.K.K. Nair- A textbook of Palynology.
12. Johri, B. M. 1984. Embryology of Angiosperms. Springer-Verleg, Berlin.

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1. Arthur John Cronquist- The Evolution and Classification of Flowering Plants, Shiva offset Press, 1981.
2. P.H. Davis and B.H. Heywood- Principles of Angiosperm Taxonomy, Princeton Press, 1963.
3. Gurcharan Singh- Plant Systematic, Oxford & IBH Publishing Company Pvt. Ltd., 1999.
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6. Singh, V., Pande, P.C. and D.K. Jain (1987) Anatomy of Seed Plants, Rastogi Publications, Meerut .
7. Nair, P.K.K. Ed. (1980) Glimpses in Plant Research. Aspects of Reproductive Biology Vol VI
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B.Sc. (SEMESTER–IV)
BOTANY: MINOR
BOT-Q-4: ECOLOGY, SOIL SCIENCE AND ENVIRONMENTAL POLLUTION
Theory-2 Credits

Course Outcome:

After the completion of the course the students will be able to:

1. Appreciate complex interrelationship between organisms and environment.
2. Understand methods for studying vegetation, community patterns and processes, ecosystem functions, and principles of phytogeography.
3. Gain knowledge that is critical in evolving strategies for sustainable natural resource management and biodiversity conservation.

Unit– I

- Ecosystem: Concepts and components, kinds of ecosystems, food chains, food webs and ecological pyramids.
- Plant community and plant succession - hydrosere, xerosere etc.
- Ecology: definition and scope, ecological groups & their adaptations, hydrophytes, xerophytes and halophytes.
- Phytogeographical regions of India and world, static and dynamic plant geography.
- Vegetational types in Uttar Pradesh.

Unit-II

- Mineral resources of planet earth and their conservation
- Soil formation, profile development and composition.
- Properties of soil and soil types.
- Soil erosion and soil conservation.
- Environmental pollution: air, water, soil, radioactive, thermal and noise pollution.

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1. Chapman and Riss. Ecology: Principles and Applications, Latest Ed., Cambridge University Press
2. Shukla, R.S. & Chandel, P.S. Plant Ecology, Latest Ed., S. Chandel and Co.
3. Kumar, H.D. Modern Concept of Ecology, Latest Ed. Vikas Publishing House
4. Begon, M., Herper, J.L. and Townsend, C.R. Ecology- Individuals, Populations and Communities (3rd ed.), Oxford Blackwell Science
5. Verma, P.S. & Agarwal, U.K. Concept of Ecology, Latest Ed., S. Chand & Company
6. Sharma, P.D. 2015. Elements of Ecology, Latest Ed., Rastogi Publications
7. Ambasht, R.S. &Ambasht, N.K. A Text Book of Plant Ecology, Latest Ed., CBS Publication & Distributors
8. Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.
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10. Singh, J.S. Singh, S.P. and Gupta, S.R. 2008. Ecology Environment and Resource Conservation. Anamaya Publishers. New Delhi

Suggested Readings:

1. Swarup, R, S.N. .Mishra, V.P Jauhari. Encyclopedia of Ecology, Environment and Pollution Control, , Mittal
2. Publication, New Delhi, 1999
3. Nyle C. Brady and Ray R. Weil, The nature and properties of soils, Pearson Education Pvt. Ltd., 2002
4. Richard T. Wright and Bernard J. Nebel Environmental Science, , Prentice Hall India Pvt. Ltd., 2002
5. Daniel D. Ohiras Natural Resource Conservation, 10th edition, , Pearson Publication, 2019
6. Santra, S.C., Environmental Science, New Central Book Agency Pvt. Ltd., 2001
7. Abbasi, S. A. and Ramasamy, E. V. (1999). Biotechnological Methods of Pollution Control. Universities Press (India) Limited, Hyderabad
8. Odum, E.P., Fundamentals of Ecology, 3rd edition, , Natraj Publication, 1971
9. Maslin, M. 2014. Climate Change: A Very Short Introduction. Oxford Publications.
10. Mathez, E.A. 2009. Climate Change: The Science of Global Warming and our Energy Future.Columbia University Press.
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B.Sc. (SEMESTER – I)
BOTANY (Co-curricular Course)
BOT-Co-C-1: Bonsai Cultivation
Theory-2 Credits

Course outcome-

After completion of the course the student will:

1. Get an overview of the art of Bonsai and its applied aspects
2. Acquire basic skills and aesthetics needed to create a Bonsai.
3. Understand the concept and importance of Bonsai.

Unit-I

- Introduction to Bonsai, Special characteristics of Bonsai.
- Basic concept, Art and aesthetics of Bonsai, Aesthetic principles history, purpose, and importance.
- Tools and equipments used for bonsai.
- Concept of style, Catalogue of styles, Common styles: Formal upright, Informal upright, Slant, Cascade, Semi-cascade and other styles.
- Rules for Bonsai making (Trunk and Branches).
- Preparation of Bonsai: Selection of plant, and conditions required for the growth of bonsai.

Unit-II

- Visual balance, Proportion elements, Flexibility of the rules.
- Aesthetic guidelines- Gravitas, Miniaturization, Lignifications, Asymmetry, Leaf reduction, Nebari, Ramification, Deadwood, Curvature.
- Cultivation of Bonsai.
- Agro-techniques for Bonsai: Propagation (Seeds, Cutting, Dividing, and Layering), season, potting and re-potting, Different containers of Bonsai.
- Fertilizer application (Forms of fertilizer, Methods and time of fertilizer application).
- Training for desired shape of Bonsai (Pruning, Pinching of buds, Wiring, Arranging branches, Fertigation)
- Pest and Disease management in Bonsai.

Suggested Readings

1. The Ancient Art of Bonsai, Elizabeth Chute, 2002
2. Intermediate Bonsai, Thomas L. Zane, 1991
3. Bonsai Basics, Step-by-Step Guide to Growing, Training & General Care Christian Pessey and Rémy Samson, Sterling Pub, 1993
4. Bonsai; 101 Essential tips, Harry Tomlinson and Carol Watson, DK Pub., 2003
5. The Bonsai Handbook, David Prescott and Colin Lewis New Holland, 2003.
6. Indoor Bonsai, Paul Lesniewicz, Blandford Press, 1986
7. Bonsai, a beginners guide, Bonsai Empire, 2014
8. Little Book of Bonsai, (Master the Art of Growing Miniature Trees), Malcom & Hughes, 2016

B.Sc. (SEMESTER – III)
BOTANY (Co-curricular Course)
BOT-Co-C-2: Gardening and Landscaping
Theory-2 Credits

Course outcome:
After completion of the course the student will:

1. Develop a keen interest in Gardening and Landscaping, an applied aspect of Botany, and acquire the basic skills and aesthetics needed to create a beautiful and green environment
2. Assess the role of plants in the well being of the society and appreciate the joy of interacting with the mother earth

Unit-I

- Introduction to Gardens: Components and aesthetics, water, stream, fountain, waterfall, pavement, rocks, roads, wall fences, gates, hedges, arches, shrubberies, pergolas, statues, towers, screens, bridges, night lights, flower beds, raised beds, carpet bedding, borders, plant containers, plant stands and Lawn.
- Components of landscape: Plant materials and tools, Hardscaping, Softscaping, Aquascaping and Xeriscaping.
- Landscaping for Residence, commercial places, institutions and hotels.
- Computer Applications, Softwares and AI tools.

Unit-II

- Vegetative Propagation Techniques: Cuttings, Grafting, Budding and Layering.
- Plant hormones and Plant Nutrition.
- Plant disease management: Herbicides, Insecticides, fertilizers and manure, Bifertilizers, Biopesticides and Vermicomposting.
- Types of gardens: English, Mughal, Japanese.
- Specialized gardens: Herbal garden, Kitchen garden, Rose garden, Topiary garden, Rock garden, Terrace garden, Water garden, Bottle garden, Tray garden, Sunken garden.
- Modern Trends: Vertical garden/Green wall and Green façade.

Suggested Readings:

1. Peter McHoy-Garden planning & garden design. (Southwater Publication).
2. Deborah L. Martin- Rodale's basic gardening. (Rodale Books Publication).
3. Brian Capon- Botany for Gardeners, 3rd edition (Timber Press)
4. Hartmann & Kester-Plant Propagation: Principles & Practices (Pearson)
5. Elizabeth Barlow Rogers- Landscape Design: A Cultural and Architectural History.(Harry N. Abrams)
6. Chris Young- Encyclopedia of Landscape design. (D K Publication).

B.Sc. (SEMESTER–II)

BOTANY (Vocational Course)

BOT-Vo-C-1: MUSHROOM CULTIVATION TECHNOLOGY

Theory- 2 Credits

Course Outcome:

After the completion of the course the students will:

1. Have a general idea of classification and features of macro fungi/ edible mushrooms.
2. Have a comparative knowledge of structure and life cycle of selected mushrooms.
3. Know about the pest and diseases of mushrooms and their management.
4. Know about mushroom cultivation technique such as filling up of compost, spawning, preparation of casing material and its application
5. Can generate self employment as well as entrepreneurship in mushrooms.

Unit I

- Introduction to mushrooms and its classification.
- Cultivation methods of mushrooms.
- Spawn Preparation: Preparation of spawn substrate, Preparation of Pure culture, media used in raising Pure culture.
- Instrumentation and culture preparation of spawn and its storage.
- Cultivation of edible white button mushroom: Preparation of compost, casing, crop care.
- Cultivation of edible mushroom (*Pleurotus* sp): Mushroom Substrate selection, Substrate soaking, pasteurization, bagging, spawning, incubation and harvesting.

Unit II

- Storage of fresh mushrooms: Storage of mushrooms at low temperature, Storage of dried mushrooms,Control Storage.
- Value added products of mushrooms.
- Different methods of mushroom processing: Caning of mushrooms, Dehydration of mushrooms, Packing of mushrooms.
- Marketing strategies and Entrepreneurship in mushrooms.
- Pest and diseases of mushrooms and their management.

Since this is a Vocational Course, Theory and Practical will go accordingly.

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Books:

1. Mushroom Production and Processing Technology by Pathak, Yadav and Gour (2010). Published by Agrobios (India).
2. Mushroom Production and Management by Awasthi LP and Shukla AC (2023). Kalyani Publishers, N. Delhi, ISBN: 9789355405319.
3. Hand Book of Mushroom Cultivation, Processing and Packaging by Eiri Staff (2007). Publisher- Engineers India Research Institute.

Suggested Readings:

1. Applied Mycology (Entrepreneurship with Fungi). by Shukla AC (2022). Springer Publications [ISBN:978-3-030-90648-1].
2. Mushroom Cultivation by Tripathi, D.P.(2005) Oxford & IBH Publishing Co. PVT.LTD, New Delhi.
3. Handbook on Mushrooms by Nita Bahl (2000). Oxford & Ibh Publishing Co. Pvt Ltd.

B.Sc. (SEMESTER–IV)
BOTANY (Vocational Course)
BOT-Vo-C-2: HYDROPONIC CULTIVATION OF PLANTS
Theory-2 Credits

Course Outcome:

1. After the completion of the course the students will be able to:
2. Understand fundamental metabolic functions of various essential nutrient elements in plant growth and development.
3. Understand nutritional requirements of plant growth under controlled condition.
4. Preparation of nutrient stocks and supply solutions, understand differences between plant cultivation in soil and without soil.
5. Understand about various media for support of plants in hydroponics, types of hydroponic system.
6. Learn management of green house and hydroponic system, pest control and management of mineral deficiency and toxicity.

Unit I • Scope of Hydroponics and terminology (Water Culture, Sand culture, Gravel Culture, and Rockwool culture, etc). • History of Hydroponics • Functions of macronutrients and micronutrients. • Nutrient solutions compositions. • Preparing nutrient solution stock and inter-stock.
Unit II • Types of support media: Rockwool, Vermiculite, Sand, LECA (Expanded Clay). • Rate and frequency of irrigation; Feeding and aeration (in water culture). • Solution dispensation options in closed and open hydroponic systems. • Greenhouse Management: Pest and Disease • Controlling light, pH and salinity, Management of mineral deficiency and toxicity.

Since this is a Vocational Course, Theory and Practical will go hand in hand.

Suggested Readings:

1. Resh HM (2013) Hydroponic food production, CRC Press, Boca Raton, FL
2. Kozai T, Niu G, Takagaki M Ed. (2016) Plant Factory: An indoor vertical farming system for efficient quality food production. Academic Press, Elsevier Inc.
3. Sinha P, Gopal R (2015) Sand culture technique and biochemical method, LAP Lambert Academic Publishing, Saarbruecken, Germany.
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6. Sharma CP (2006) Plant Micronutrients, Science Publisher, Enfield, New Hampshire, USA

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2. https://www.bartonbreeze.com/hydroponic-farm-setup
3. https://www.verticalroots.com/the-what-and-why-of-hydroponic-farming/
   https://www.thespruce.com/beginners-guide-to-hydroponics-1939215
4. https://ag.umass.edu/greenhouse-floriculture/fact-sheets/hydroponic-systems