PROPOSED STRUCTURE OF SYLLABUS

Deen Dayal Upadhyaya Gorakhpur University

दीनदयाल उपाध्याय गोरखपुर विश्वविद्यालय

UG PROGRAMME -BOTANY

(FACULTY OF SCIENCE)

National Education Policy-2020

THREE PLUS ONE FRAMEWORK 2024

UG Syllabus Specimen Structure Table

FRAMEWORK OF THREE PLUS ONE UG PROGRAMME IN BOTANY MAJOR 2024

Year/ Semester	Subject 1 Major 1	Subject 2 Major 2	Subject 3 Minor	SEC Skill enhancement course/ vocational	AEC Ability Enhancement Courses/ CoCurricular	Research project /Dissertation/ /internship/Field work/ Survey	Total credits	Degree and credits
1st year/ I SEM	Botany 6 credits(4+2)	6	6	SEC – 1 (3 CREDITS)	AEC -1 (2 CREDITS)		23	Certificate in Faculty (46 Credits)
1st year/ II SEM	Botany 6 credits(4+2)	6	6	SEC – 2 (3 CREDITS)	AEC -2 (2 CREDITS)		23	
2nd year/ III SEM	Botany 6 credits(4+2)	6	6	SEC – 3 (3 CREDITS)	AEC -3 (2 CREDITS)		23	Diploma in Faculty (96 Credits)
2nd year/ IV SEM	Botany 6 credits(4+2)	6	6		AEC -4 (2 CREDITS)	Any one (3 credits)	23	
3rd year/ V SEM	Botany 10 c,2X4+2	10					20	UG Degree (132 Credits)
3rd year/ VI SEM	Botany 10 c,2X4+2	10					20	
4th year/ VII SEM	Botany 20 c,4X4+4						20	UG Honors (172 credits)
4th year/ VIII SEM	Botany 20 c,4X4+4						20	
OR	For Students who secured 75% Marks in First Six Semesters							
4th year/ VII SEM	Botany 20 c,4X4+4						20	UG Honors with Research (172 credits)
4th year/ VIII SEM	Botany 20c,2X4					Research Project (12 Credits)	20	

PROPOSED COURSE STRUCTURE FOR BOTANY (MAJOR)

SEMESTER-WISE TITLES OF THE PAPERS IN B.SC. (BOTANY)			
YEAR	**COURSE CODE**	**PAPER TITLE**	**CREDITS**
		CERTIFICATE COURSE	
FIRST YEAR		**Semester-I**	
	BOT 101F	Paper: Plant Biodiversity-I	4+0
	BOT 102F	Practical Sem I	0+2
		Semester-II	
	BOT 103F	Plant Biodiversity-II	4+0
	BOT 104F	Practical Sem II	0+2
		DIPLOMA COURSE	
SECOND YEAR		**Semester-III**	
	BOT 201F	Microbiology and Plant Pathology	4+0
	BOT 202F	Practical Sem III	0+2
		Semester-IV	
	BOT 203F	Plant Biochemistry	4+0
	BOT 204F	Practical Sem IV	0+2
		BACHELOR OF SCIENCE	
THIRD YEAR		**Semester-V**	
	BOT 301F	Cell Biology, Genetics and Molecular Biology	4+0
	BOT 302F	Plant Physiology	4+0
	BOT 303F	Practical Sem V	0+2
		Semester-VI	
	BOT 304F	Cytogenetics, Biostatistics, Plant Breeding	4+0
	BOT 305F	Ecology & Environment	4+0
	BOT 306F	Practical Sem VI	0+2
FOURTH YEAR		***BOTANY HONOURS COURSE***	
		Semester- VII	
	BOT 401F	Phytogeography and Plant Resorce Utilization	4+0
	BOT 402F	Ethnobotany and Pharmacognosy	4+0
	BOT 403F	Environment Management and Climate Change	4+0
	BOT 404F	Utilization and Management of Aquatic Algal Resources	4+0
	BOT 405F	Practical Sem VII	0+4
		Semester -VIII	
	BOT 406F	Biofertilizers and Biopesticides	4+0
	BOT 407F	Nursery and Gardening	4+0
	BOT 408F	Mushroom Cultivation	4+0
	BOT 409F	Landscaping Floriculture	4+0
	BOT 410F	Practical Sem VIII	0+4
	OR	***BOTANY HONOURS COURSE WITH RESEARCH*** **(For Students who secured 75% Marks in First Six Semesters)**	
		Semester- VII	
	BOT 401F	Phytogeography and Plant Resource Utilization	4+0
	BOT 402F	Ethnobotany and Pharmacognosy	4+0
	BOT 403F	Environment Management and Climate Change	4+0
	BOT 404F	Utilization and Management of Aquatic Algal Resources	4+0
	BOT 405F	Practical Sem VII	4+0
		Semester –VIII	
	BOT 411F	Bioinformatics and Computer Application	4+0
	BOT 412F	Genetic Engineering and Tissue Culture	4+0
	BOT 413F	Research Project	12

SUBJECT: BOTANY

Subject prerequisites:

1. To study Botany, a student must have had the subject Biology/Biotechnology learnt at 10+2 level.
2. Keen interest in plants and plant-related research, Potential in mathematics, biology and chemistry
3. Skills and aptitude for scientific study and research
4. Creativity and good comprehension while working on scientific procedures and research
5. Computer aptitude.

COURSE INTRODUCTION

The new curriculum of B.Sc. in Science (Botany) offers essential knowledge and technical skills to study plants in a holistic manner. Students would be trained in all areas of plant biology using a unique combination of core, elective and vocational papers with significant inter-disciplinary components.

Students would be exposed to cutting-edge technologies that are currently used in the study of plant life forms, their evolution and interactions with other organisms within the ecosystem. Students would also become aware of the social and environmental significance of plants and their relevance to the national economy.

B.Sc. Botany Programme covers academic activities within the classroom sessions along with practical concepts at laboratory sessions. Infield, outstation activities and projects are also required to be organized for real-life experience and learning.

Candidates who have curiosity in plants kingdom, ecosystem, love exploring exotic places and wish to work as researchers or professions like Botanist, Conservationist, Ecologist, etc. can choose B.Sc. Botany course.

Programme outcomes (POs):

Transformed curriculum shall develop educated outcome-oriented candidature, fostered with discovery-learning, equipped with practice & skills to deal practical problems and versed with recent pedagogical trends in education including e-learning, flipped class and hybrid learning to develop into responsible citizen for nation-building and transforming the country towards the future with their knowledge gained in the field of plant science.

PO 1	CBCS syllabus with a combination of general and specialized education shall introduce the concepts of breadth and depth in learning
PO2	Shall produce competent plant biologists who can employ and implement their gained knowledge in basic and applied aspects that will profoundly influence the prevailing paradigm of agriculture, industry, healthcare and environment to provide sustainable development.
PO 3	Will increase the ability of critical thinking, development of scientific attitude, handling of problems and generating solutions, improve practical skills, enhance communication skill, social interaction, increase awareness in judicious use of plant resources by recognizing the ethical value system.
PO 4	The training provided to the students will make them competent enough for doing jobs in Govt. and private sectors of academia, research and industry along with graduate preparation for national as well as international competitive examinations, especially UGC-CSIR NET, UPSC Civil Services Examination, IFS, NSC, FCI, BSI, FRI etc.
PO 5	Certificate and diploma courses are framed to generate self- entrepreneurship and self-employability, if multiexit option is opted.
PO 6	Lifelong learning be achieved by drawing attention to the vast world of knowledge of plants and their domestication.

Programme specific outcomes (PSOs):

B.Sc. I Year

This Programme imparts knowledge on various fields of plant biology through teaching, interactions and practical classes. It shall maintain a balance between the traditional botany and modern science for shifting it towards the frontier areas of plant sciences with applied approach. This syllabus has been drafted to enable the learners to prepare them for self-entrepreneurship and employment in various fields including academics as well as competitive exams. Students would gain wide knowledge in following aspects:

1. Diversity of lower plants and microbes, their habitat, morphology, architecture and reproduction.
2. Diversity of thallophytes, pteridophytes and Gymnosperm
3. Economic value of plants and their use in Human Welfare.

This course provides a broad understanding of identifying, growing and using plants.This course is primarily aimed to introduce people to the richness of plant diversity found in surrounding areas. Lecture sessions are designed to cover fundamental topics concerning classification of plants and their utilization required for understanding the flora and vegetation. Practical sessions are organized following theory for easy understanding of the various parts of the plants, structural organization of floral parts and diversity therein. Participants are taken to different locations covering a variety of habitats and forest types to acquaint them with the native flora. in the long run, will contribute towards building momentum for people's participation in environmental conservation without compromising on academic rigor and our rich wealth of knowledge inherited over generations.

1. The course will cover conventional topics in Field Botany like Evolutionary History & Diversity ofplants, Complete

Morphology, Nomenclature of plants, Systems of Classification, Keys toimportant Families of Flowering Plants, Field Data Collection & Herbarium Techniques.

2. The course is designed to become a commercial crop grower, florist, protected cultivator, greenbelt plant advisor to industries, pharmacologist & taxonomist.

Programme specific outcomes (PSOs):
B.Sc. II Year

This Programme imparts knowledge on various fields of plant biology through teaching, interactions and practical classes. It shall maintain a balance between the traditional botany and modern science for shifting it towards the frontier areas of plant sciences with applied approach. This syllabus has been drafted to enable the learners to prepare them for self-entrepreneurship and employment in various fields including academics as well as competitive exams. Students would gain wide knowledge in following aspects:

1. Diversity of plants and microbes, their habitat, morphology, architecture and reproduction.
2. Plant disease causing microbes, symptoms & control.
3. Different aspects of plants Biochemistry and diagnostic techniques

Programme specific outcomes (PSOs):
B.Sc. III Year / Bachelor of Science

The learning outcomes of a three years graduation course are aligned with programme learning outcomes but these are specific to-specific courses offered in a program. The core courses shall be the backbone of this framework whereas discipline electives, generic electives and skill enhancement courses would add academic excellence in the subject together with a multi-dimensional and multidisciplinary approach.

1. Understanding of plant classification systematics, evolution, ecology, developmentalbiology, physiology, plant interactions with microbes and insects, morphology, anatomy, reproduction, genetics and molecular biology of various life-forms.
2. This course is suitable to produce expertise in conservation biology like ex-situ conservation, response to habitat change, genotype characterization and reproductive biology.
3.Understanding of various analytical techniques of plant sciences, use of plants asindustrial resources or as a human livelihood support system and is well versed with the use of transgenic technologies for basic and applied research in plants.
4. Understanding of various life forms of plants, morphology, anatomy, reproduction, genetics, microbiology, molecular biology, recombinant DNA technology, transgenic technology and use of bioinformatics tools and databases and the application of statistics to biological data**.**
5. Entrepreneurship Skill Development, Understand the issues of environmental contexts and sustainable development, Inculcation of human values,
6. Strengthen mathematical and computational skills. Enable students to use ICT&AI effectively.
7. Develop good skills in the laboratory such as observation and evaluation by the use of modern tools and technology.

Programme specific outcomes (PSOs):
B.Sc. IV Year / Botany Hons.

The learning outcomes of afour years graduation course are aligned with programme learning outcomes but these are specific to-specific courses offered in a program. The core courses shall be the backbone of this framework whereas applied courses of relevant thrust areas will enable the students to venture into new vocational areas. The core papers are applied in nature based on basic knowledge gained in earlier semesters. These include use of plants in medicines, in industries, as food, feed, drugs, nutraceuticals. It wil strengthen computational skills of the students as well as introduce them to bioinformatics with better understanding of data analysis in biological sciences. this course enables them to understand environment sustainable goals , environmental ethics and its role in various fields. The course will add additional knowledge towards lake management and a entrepreneurial green house management course.

Year: I	Semester: I	Code:**BOT10F**
Paper: Plant Biodiversity-I		
Theory : Core	Total Credit: 4+0	

Course outcomes:
After the completion of the course the students will be able to:
1. Develop understanding about the classification and diversity of different microbes including viruses, Algae, Fungi & Lichens & their economic importance.
2. Develop conceptual skill about identifying microbes,pathogens,biofertilizers & lichens
Develop critical understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms

Unit	Topic	No. of Lectures
I	Algae: General characteristics, life cycle and classification, Range of thallus organization in algae, pigment diversity, reserve food materials. Economic importance of algae: role of algae in soil fertility, commercial products from algae–biofuel, phycocolloids and cosmetics.	
II	Reproduction, classification and life cycle of *Nostoc, Chlorella*, *Volvox, Oedogonium, Chara, Sargassum, Ectocarpus, Navicula* and *Polysiphonia.*	
III	Fungi: General characteristics, nutrition, life cycle, economic importance and classification of fungi upto class. Heterothallism, Physiological specialization, heterokaryosis and Parasexuality. Lichens.	
IV	Distinguishing characters of Myxomycota: General characters of Mastigomycotina, Zygomycota: *Rhizopus,* Ascomycota:*Saccharomyces, Penicillium, Peziza.*Basidiomycotina:*Puccinia, Agaricus;* Deuteromycotina:*Fusarium, Alternaria*.	
V	Bryophytes: General characteristics, adaptations to land habit, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of *Riccia*, *Marchantia*,*Anthoceros and Sphagnum*. (Developmental details not to be included). Economic importance of bryophytes.	
VI	Pteridophytes : General characteristics, Early land plants (*Rhynia*). Classification (up to family) with examples, Heterospory and seed habit, stelar evolution, economic importance of Pteridophytes.	
VII	Gymnosperms: Classification and distribution, Salient features of Cycadales, Ginkgoales, Coniferales and Gnetales, their examples, structure and reproduction; economic importance	
VIII	Palaeobotany: General account of Cycadofilicales, Bennettitales and Cordaitales; Geological time scale; Brief account of process of fossilization & types of fossils and study techniques; Contribution of Birbal Sahni.	

Year: I	Semester: I	Code:**BOT 102F**
Practicals	Credits; 0+2	

		No. of Lectures
	Algae: Type study of algae: Cyanophyceae –*Spirullina, Gloeotrichia, Nostoc. Oscillatoria.* Chlorophyceae - *Chlorella*, *Volvox, Oedogonium, Cladophora,*and *Chara.* Xanthophyceae – *Vaucheria.* Bacillariophyceae – *Navicula*, *Pinnularia.* Phaeophyceae – *Sargassum,* Rhodophyceae – *Polysiphonia.*	
	Fungi and Lichens: 1. Isolation of different fungi: Saprophytic, Coprophilous, Keratinophilic. 2. Identification of fungi by lactophenol cotton blue method. *Rhizopus, Saccharomyces, Penicillium, Peziza, Ustilago, Puccinia; Fusarium,Curvularia, Alternaria.* 3. *Agaricus*: Specimens of button stage and fullgrown mushroom; Sectioning of gills of *Agaricus*.. Lichens: crustose, foliose and fruticose specimens.	
	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). *Sphagnum*- morphology, W.M. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, L.S. capsule and protonema.	
	Pteridophytes:*Lycopodium*: Habit, stem T. S. stobilus 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. and V. S. of strobilus. *Marsilea* and *Azolla* – Habitat & its structure	
	Gymnosperms : 1. *Cycas* – seedling, coralloid root and coralloid root T. S., T. S. of leaflet and Rachis, micro and megasporophyll, male cone V. S., microsporophyll T. S. entire and V. S. of ovule.*Pinus* - Branch of indefinite growth, spur shoot, T. S of old stem and needle R.L.S and T. L. S. of stem, male and female cone, V.S. of male and female cone. 2. *Ephedra, Gnetum and Ginkgo* &*Thuja*: 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.	
	Palaeobotany & Palynology 1. Morphology of *Rhynia* and fossils gymnosperms & other groups. 2. Visit Birbal Sahni Institute of Palaeosciences or virtual conference with their scientists to learn fossilization. 3. Mark and know about Indian geographical sites rich in plant fossils.	
	Commercial Uses and Production technology 1. *Azolla* production 2. Production technology of Resins 3. Production and propagation of Ornamental *Pteris*, Cycadales, Coniferales for landscaping. 4. Lab method for qualitative testing/ extraction of Ephedrine ,Taxol and *Thuj*a oil.	

Year: I	Semester: II	Code:**BOT103F**
Paper: Plant Biodiversity-II		
Theory Core		Credits: 4+0

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

- Understand morphology, anatomy, reproduction and developmental changes therein through typological study and
- create a knowledge base in understanding the basis of plant diversity, economic values & taxonomy of plants Understand the details of external and internal structures of flowering plant
- To gain an understanding of the history and concepts underlying various approaches to plant taxonomy and classification.
- To learn the major patterns of diversity among plants, and the characters and types of data used to classify plants. To compare the different approaches to classification with regard to the analysis of data.
- To become familiar with major taxa and their identifying characteristics, and to develop in depth knowledge of the current taxonomy of a major plant family.
- To discover and use diverse taxonomic resources, reference materials, herbarium collections, publications.

Unit	Topic	No. of Lectures
I	Angiosperm Morphology(Stem, Roots, Leaves & Flowers, Inflorescence) Morphology and modifications of roots; stem, leaf and bud. Types of inflorescences; flowers, flower parts, fruits and types of placentation; Definition and types of seeds.	
II	Plant Anatomy: Meristematic and permanent tissues, Organs (root, stem and leaf). Apical meristems & theories on apical organization - Apical cell theory, Histogen theory, Tunica -Corpus theory. Secondary growth - Root and stem- cambium (structure and function) annular rings, Anomalous secondary growth - *Bignonia, Boerhaavia, Dracaena,Nyctanthes*	
III	Reproductive Botany: Plant Embryology, Structure of microsporangium, microsporogenesis, Structure of megasporangium and its types, megasporogenesis, Structure and types of female gametophyte, types of pollination, Methods of pollination, Germination of pollen grain, structure of male gametophyte, Fertilization, structure of dicot and monocot embryo, Endosperm, Double fertilization, Apomixis and polyembryony.	
IV	Palynology: Pollen structure, pollen morphology, pollen allergy, Applied Palynology: Basic concepts, Palaeopalynology, Aeropalynology, Forensic palynology, Role in taxonomic evidences.	
V	Taxonomic Resources & Nomenclature Components of taxonomy (identification, nomenclature, classification) ; Taxonomic resources: Herbarium- functions & important herbaria, Botanical gardens, Flora, Keys- single access and multi-access. Principles and rules of Botanical Nomenclature according to ICN (ranks and names; principle of priority, binomial system; type method, author citation, valid-publication).Types of classification:	

	Artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series) angiosperm phylogeny group (APG IV) classification.	
VI	Identification of Angiospermic families -I: A study of the following families with emphasis on the morphological peculiarities and economic importance of its members (based on Bentham & Hooker's system) Ranunculaceae, Papaveraceae, Malvaceae, Rutaceae, Fabaceae, Myrtaceae, Cucurbitaceae, Rubiaceae, Asteraceae, Apocynaceae, Acanthaceae, Asclepiadaceae, Solanaceae.	
VII	Identification of Angiospermic families -II: A study of the following families with emphasis on the morphological peculiarities and economic importance of its members (based on Bentham & Hooker's system)-Amaranthaceae, Euphorbiaceae, Apiaceae, Lamiaceae, Orchidaceae, Liliaceae, Musaceae, Poaceae.	
VIII	Modern trends in Plant taxonomy: Brief idea on Phenetics, Biometrics, Cladistics (Monophyletic, polyphyletic and paraphyletic groups; Plesiomorphy and apomorphy). TOOLS & SOFTWARES IN PLANT IDENTIFICATION: GIS (i) Patterns(ii) Features (iii) Quantities Digital Taxonomy (e-flora), Description Language for taxonomy – DELTA,internet directory for botany.	

Year: I	Semester: II	Code:**BOT104F**
Practicals	Credits: 0+2	

		No. of Lectures

Angiosperm Morphology

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

Plant Anatomy:

Normal & Anomalous secondary thickening - *Bignonia, Dracaena, Boerhaavia diffusa, Nyctanthes*

Study of primary and secondary growth in the 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.

Reproductive Botany

1. Structure of anther, microsporogenesis and pollen grains
2. Structure of ovule and embryo sac development (through slides).
3. Study of embryo development in monocots and dicots.
4. Vegetative propagation by means of cutting, budding and grafting exercises.
5. Study of seed germination.
6. Study of pollen morphology of the following plants –*Hibiscus, Vinca, Balsam, Ixora, Crotalaria, Bougainvillea* by microscopic observation.
   Calculation of pollen viability percentage using in vitro pollen germination techn

Herbarium: Plant collecting, Preservation and Documentation: Stepwise Practicing Herbarium techniques: (a) FIELD EQUIPMENTS, Global Positioning System (GPS) instrument & Collection of any wild 25 plant specimens(b)Learn to handle Herbarium making tools (c) Pressing and

Drying of collected plant specimens (d) Special treatments for all varied groups of plants (e) Mount on standard herbarium sheets (f) Label them using Standard method (g) Organize them and give Index Register Number
Taxonomic Identification using plant structure Classify 25 plants on the basis of Taxonomic description (Plant Morphology, Anatomy, Reproductive parts, Habit, adaptation anomalies) according to Bentham and Hooker natural system of classification in the following families: Malvaceae, Fabaceae (Papilionaceae), Solanaceae, Scrophulariaceae, Acanthaceae, Labiatae (Lamiaceae), Rubiaceae.
Identification during excursions: (a) Conducting Spot identification (Binomial, Family) of common wild plants from families included in the theoretical syllabus (list to be provided) and making FIELD NOTE BOOK and filling Sample of a page of field-book, used in Botanical Survey of India.
Botanical Nomenclature & reporting Method: (a) Give nomenclature to collected plants as per ICN rules and prepare labels as per BSI (b) Author Citation, Effective Publication and Principle of Priority: To show a specimen paper on Basic structure of a taxonomic Research published on a new species in taxonomic journal

Year: II	Semester: III	**Code: BOT 20F**
Paper: Microbiology and Plant Pathology		
Theory Core	Credits 4+0	

Course outcomes:
After the completion of the course the students will be able to:
1. Develop understanding about the classification and diversity of bacteria their economic importance.
2. Develop conceptual skill about identifying microbes,pathogens,
3. Gain knowledge about developing commercial enterprise of microbial products.
4. Learn host –pathogen relationship and disease management.
5. use of microbes in industries

Unit	Topic	No. of Lectures
I	Viruses: general characteristics, viral culture, Structure of viruses, Bacteriophages, Structure of T4 &, λ-phage; Lytic and Lysogenic cycles, viroid, Prions & mycoplasma& phytoplasma, Actinomycetes & plasmids and their economic uses.	
II	Bacteria: Cell structure of Eukaryotic and prokaryotic cells, Gram positive and Gram-negative bacteria, Structure of a bacteria; Bacterial Chemotaxis, Bacterial Growth curve, factors affecting growth of microbes; measurement of growth; Batch culture, Synchronous growth of microbes; Sporulation and recombination in bacteria.	
III	Food Microbiology: Food spoilage, food preservation, fermented foods, food borne pathogens, single cell protein (SCP)	
IV	Agricultural Microbiology: biofertilizers, biopesticides, biological nitrogen fixation by algae and bacteria and Plant Growth Promoting Rhizobacteria (PGPR), Mass production of bacterial biofertilizers, blue green algae, *Azolla* and *mycorrhiza*.	
V	Industrial Microbiology: Production of antibiotics, enzymes, alcoholic beverages and organic acids.	
VI	Water Microbiology: Microbiology of water, water born diseases, water purification, waste water and sewage disposal, bioremediation	
VII	Plant Pathology Disease concept, Symptoms, Etiology & causal complex, Primary and secondary inoculums, Infection, Pathogenicity and pathogenesis, Koch's Postulates. Mechanism of infection, Disease cycle (monocyclic, polycyclic and polyetic). Phytoimmunology (plant defense mechanism)	
VIII	Diseases and Control Symptoms, Causal organism, Disease cycle and Control measures of –Late Blight of Potato, False Smut of Rice/ Brown spot of rice and	

	'White rust of Crucifers, Red Rot of Sugarcane, Wilting of Arhar, Mosaic diseases on tobacco and cucumber, yellow vein mosaic of bhindi; Citrus Canker, Little leaf of brinjal; Damping off of seedlings, Disease management: Quarantine, Chemical, Biological, Integrated pest disease management, fungicides- Bordeaux mixture, Lime Sulphur, Tobacco decoction, Neem cake & oil.	

Year: II	Semester: III	Code:**BOT202F**
Practicals	Credits 0+2	

		No. of Lectures
	Microbiology • Isolation of bacteria. • Identification of bacteria. • Staining techniques: Gram's, Negative, Endospore, Capsule and Cell Wall. • Cultural characteristics of bacteria on NA. • Pure culture techniques (Types of streaking). • Biochemical characterization:IMViC, Carbohydrate fermentation test, Mannitol motility test, Gelatin liquefaction test, Urease test, Nitrate reduction test, Catalase test, Oxidase test. • Isolation of nitrogen fixing bacteria from root nodules of legumes. • Enumeration of rhizosphere to non rhizosphere population of bacteria. • Isolation of antagonistic Pseudomonas from soil. • Microscopic observations of root colonization by VAM fungi. • Isolation of Azospirillum sp. from the roots of grasses. • Isolation of phyllosphere microflora. • Isolation of P solubilizing microorganisms. • Wine production. • Isolation of lactic acid bacteria from curd. • Isolation of lipolytic organisms from butter or cheese. • Immobilized bacterial cells for production of hydrolytic enzymes. • Enzyme production and assay – cellulase, protease and amylase. • Immobilization of yeast. • Isolation of cellulolytic and anaerobic sulphate reducing bacteria. • Isolation and characterization of acidophilic, alkalophilic and halophilic bacteria. • Cultivation of Spirulina, & Chlorella in lab for biofuel. • Visit to NBAIM, Mau, Varanasi(Kashi)/ IMTECH (Institute of Microbial Technology),Chandigarh for viewing Culture Repository. • Visit to biofertilizers and biopesticides unit to understand about the Unit operation procedures. • Alcohol production. from Sugarcane Juice.	
	Plant Pathology • Preparation of fungal media (PDA) &Sterilization process. • Isolation of pathogen from diseased leaf.	

	Identification: Pathological specimens of Brown spot of rice, Bacterial blight of rice, Loose smut of wheat, Stem rot of mustard, Late blight of potato; Slides of uredial, telial, pycnial& aecial stages of *Puccinia*,Few viral and bacterial plant diseases.

Year: II	Semester: IV	**Code: BOT 203F**
Paper: Plant Biochemistry		
Theory core	Credits: 4+0	

Course outcomes:
After the completion of the course the students will be able to:
1. different aspects of Biochemistry
2. Learn basic biomolecules, structure, physiological functions
3. Assimilate Knowledge about Biochemical constitution of plant diversity.
4.learn about secondary metabolites and various biochemical techniques

Unit	Topic	No. of Lectures
I	Carbohydrates: Nomenclature and classification; Role of monosaccharides (glucose, fructose, sugar alcohols – mannitol); Disaccharides (sucrose, lactose), Oligosaccharides and polysaccharides (structural-cellulose, hemicelluloses, pectin,; storage – starch, inulin).	
II	Lipids: Storage lipids, fatty acids- structure and functions, Structural lipids (Membrane lipids): Phosphoglycerides, Shingolipids, sterols.	
III	Proteins: Structure of amino acids; Peptide bonds; Levels of protein structure-primary, secondary, tertiary and quaternary; Isoelectric point; Protein denaturation and biological roles of proteins.	
IV	Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleic acids,Nucleic acid denaturation and re-naturation.	
V	Enzymes: Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; mechanism of action (activation energy, lock and key hypothesis, induced- fit theory),	
VI	Enzyme inhibition- irreversible and reversible inhibition (competitive, non-competitive, and uncompetitive inhibition), factors affecting enzyme activity, Allosteric enzymes, and cooperativity effect in allosteric proteins.	
VII	Secondary Metabolites: Structure and functions of terpenes, phenolics and alkaloids. Industrial utilization of secondary metabolites.	
VIII	Biochemical techniques: different types of chromatographic techniques, based on ion exchange and affinity, electrophoresis, isoelectric focusing, MALDI-TOF, Western blot, SDS-PAGE,centrifugation, spectrophotometry and protein sequencing.	

Year: II	Semester: IV	**Code: BOT 204F**
Practicals	Credits :0+2	

		No. of Lectures
	Techniques for biochemical analysis 1. Weighing and Preparation of solutions -percentage, molar & normal solutions, dilution from stock solution etc. 2. Separation of amino acids by paper chromatography. 3. Detection of organic acids: citric, tartaric, oxalic and malic from laboratory samples., 4. Qualitative Analysis of carbohydrates, 5. Estimation of reducing sugar by anthrone method, 6. Qualitative Analysis of Lipids 7. Qualitative analysis of Amino acids and Proteins 8. Quantitative Analysis of Nucleic Acids, 9. Analysis of dietary supplements, nutraceuticals & antioxidants, Testing of adulterants in food items. • A basic idea of chromatography: Principle, paper chromatography and column chromatography; demonstration of column chromatography.	

Year: III	Semester: V	**Code: BOT 301F**
Paper-I: Cell Biology, Genetics and Molecular Biology		
Theory core	Credits: 4+0	

Course Outcome:
After the completion of the course the students will be able to:
1. various aspects of cell and cellular organization, chromosomes
2. concepts of mendel principles of genetics and inheritance
2. Understand nucleic acids, organization of DNA in prokaryotes and Eukaryotes, DNA replication mechanism, genetic code and transcription process.
3. Know about Processing and modification of RNA and translation process, function and regulation of expression.

Unit	Topic	No. of Lectures
I	Cell biology Structure and function of cell wall, plasma membrane, ribosomes, Endoplasmic reticulum, golgi apparatus, mitochondria, chloroplast, lysosomes, peroxisomes and cell inclusions - Organization of nucleus: nuclear envelope, nucleoplasm and nucleolus.	
II	Chromosomal nomenclature- chromatids, centromere, telomere, satellite, secondary constriction.Organization of chromosomes- Nucleic acid and histones- types and classification.	
III	Lampbrush chromosomes and polytene chromosomes- Karyotype and idiogram.Cell cycle: G0, G1, S and G2 phases – mitosis, amitosis and meiosis. Cyclin-dependent protein kinases (only brief introduction)	
IV	Genetics Mendel's principles of genetics, chromosome theory of inheritance, crossing over and linkage; Incomplete dominance and codominance; Interaction of genes; Extra-nuclear Inheritance, Sex chromosomes and Sex determination in plants.	
V	Molecular Biology Miescher to Watson and Crick- historic perspective, Griffith's and Avery's transformation experiments, Hershey-Chase, bacteriophage experiment, DNA structure, types of DNA, types of genetic material.	
VI	DNA replication in prokaryotes and eukaryotes, Ø (theta) mode of replication, replication of linear, dsDNA, replicating the 5´end of linear chromosome including replication enzymes.	
VII	Types of structures of RNA (mRNA, tRNA, rRNA), RNA polymerase- various types; Translation, (Prokaryotes and eukaryotes), genetic code. Regulation of gene expression in Prokaryotes: *lac* operon; and in eukaryotes.	

VIII	Blotting techniques: Northern and Southern blotting, DNA fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR.	

Year: III	Semester: V	**Code: BOT 302F**
Paper-II: Plant Physiology		
Theory core	Credits: 4+0	

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

1. various plant physiological processes
2. Plant nutrition and deficiency, translocation
3. Respiration and photosynthesis in plants
4. Plant hormones and and sensory phobiology

Unit	Topic	No. of Lectures
I	Plant water relation: Structure and properties of water, diffusion and osmosis, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.	
II	Mineral Nutrition: Criteria of essentiality of elements; Role of essential elements; Symptoms of mineral deficiency in major crops, Transport of ions across cell membrane, active and passive transport. Nitrogen assimilation.	
III	Translocation in phloem:, Composition of phloem sap, girdling experiment; Pressure flow model, apoplastic and symplastic phloem loading and unloading.	
IV	Photosynthesis: Pigments involved in photosynthesis, action spectra and enhancement effect, Photosystems, Electron transport chain in chloroplast and Photophosphorylation, C3 & C4 photosynthesis, CAM- Plants.	
V	Respiration: Glycolysis, Krebs cycle, fate of pyruvate- aerobic and anaerobic respiration and fermentation, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of Krebs cycle, mitochondrial electron transport system, oxidative phosphorylation, ATP-Synthetase, chemiosmotic mechanism, P/O ratio, cyanide-resistant respiration, factors affecting respiration.	
VI	Lipid Metabolism: Synthesis and breakdown of triglycerides, oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilization of lipids during seed germination, β-oxidation.	
VII	Phytohormones and Seed Physiology: Developmental roles of phytohormones- (auxins, gibberellins, cytokinins, ABA, ethylene.), Seed physiology & Dormancy, Vernalization.	

VIII	Sensory Photobiology: Photoperiodism (SDP, LDP, day neutral plants); Phytochrome (discovery and structure), red and far red-light responses on photomorphogenesis.	

Year: III	Semester: V	**Code: BOT 303F**
Practicals	Credits: 0+2	
		No. of Lectures

Cell biology

1. Study of plant cell structure with the help of epidermal peal mount of Onion/Rhoeo/Crinum.
2. Measurement of cell size by the technique of micrometry.
3. Counting cells per unit volume with the help of haemocytometer (Yeast/pollen grains).

Determination of mitotic index and frequency of different mitotic stages in pre-fixed root tips of Allium cepa.

Genetics

1. Monohybrid cross (Dominance and incomplete dominance)
2. Dihybrid cross (Dominance and incomplete dominance)
3. Gene interactions (All types of gene interactions mentioned in the syllabus)
    a. Recessive epistasis 9: 3: 1.
    b. Dominant epistasis 12: 3: I
    c. Complementary genes 9: 7
    d. Duplicate genes with cumulative effect 9: 6: 1
    e. 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.

Genetic material

1. Instruments and equipments used in molecular biology.
2. Preparation of LB medium and cultivating E.coli on it.
3. Isolation of Genomic DNA
4. Isolation of DNA from plants
5. Examination of the purity of DNA by agarose gel electrophoresis.
6. Quantification of DNA by UV-spectrophotometer
7. Estimation of DNA by diphenylamine method.

Plant water relation, Mineral Nutrition and translocation in phloem

1. Determination of osmotic potential of plant cell sap by plasmolytic method using leaves of Rhoeo / Tradescantia.
2. Osmosis – by potato osmoscope experiment
3. Effect of temperature on absorption of water by storage tissue and determination of Q10.
4. Experiment to demonstrate the transpiration phenomenon with the bell jar method
5. Experiment for demonstration of Transpiration by Four-Leaf Experiment:
6. Structure of stomata (dicot & monocot)
7. Determination of rate of transpiration using cobalt chloride method.
8. Experiment to measure the rate of transpiration by using Farmer's Potometer
9. Experiment to measure the rate of transpiration by using Ganong's potometer
10. Effect of Temperature on membrane permeability by colorimetric method.

Study of mineral deficiency symptoms using plant material/photographs.

Photo Synthesis & Respiration

- Separation of plastidial pigments by solvent and paper chromatography.

- Estimation of total chlorophyll content from different chronologically aged leaves (young, mature and senescence) by Arnon method.
- Effect of HCO_3 concentration on oxygen evolution during photosynthesis in an aquatic plant and to find out the optimum and toxic concentration (either by volume measurement or bubble counting).
- Measurement of oxygen uptake by respiring tissue (per g/hr.)
- Determination of the RQ of germinating seeds.

Effect of light intensity on oxygen evolution in photosynthesis using Wilmott' bubble

Plant Development, Movements, Dormancy & Responses

1. Geotropism and phototropism — Klinostàt
2. Hydrotropism
    a. Measurement of growth — Arc and Liver Auxonometer
3. To study the phenomenon of seed germination (effect of light).
4. To study the induction of amylase activity in germinating grains.
5. Test of seed viability by TTC method.

Year: III	Semester: VI	**Code: BOT304F**

Paper-I: Cytogenetics, Biostatistics, Plant Breeding

Theory core	Credits:4+0

Course Outcome:

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

1. Cytogenetics in Plant sciences,
2. Plant breeding and its role in crop improvement
3. Basics of Biostatistics and its use data analysis

Unit	Topic	No. of Lectures
I	Cytogenetics Variation in Chromosome number (Numerical aberrations)- anueploidy and Euploidy-haploidy, polyploidy- significance (Structural aberrations) - deletion, duplication, inversion and translocation.	
II	Methods of creating various ploidy levels, ways to use euploid and aneuploids. Examples of polyploid crops.	
III	Plant Breeding Incompatibility, male sterility, hybridization- inter generic, inter specific, and inter varietal hybridization with examples, emasculation, bagging, pollination.	
IV	Selection - mass selection, pure line selection and clonal selection. Genetic basis of selection methods, Introductory concepts of -Breeding for pest, pathogenic diseases and stress resistance.	
V	Composite and synthetic varieties, Heterosis and its exploitation in plant breeding, types of heterosis, basis of heterosis.	
VI	Mutation breeding, physical and chemical mutagens, mutagenic treatment, procedure of mutation breeding. Realeased mutant varieties.	
VII	Biostatistics: Definition, statistical methods, basic principles, variables-measurements, functions, limitations and uses of statistics. Biometry: Data, Sample, Population,random sampling.	
VIII	Frequency distribution- definition only, Central tendency– Arithmetic Mean, Mode and Median; Measurement of	

	dispersion–Coefficient of variation, Standard Deviation, Standard error of Mean; Test of significance: chi- square test for goodness of fit.	

Year: III	Semester: VI	**Code: BOT 305F**
Paper-II: Ecology and Environment		
Theory core	Credits: 4+0	

Course outcomes:

1. acquaint the students with complex interrelationship between organisms and environment;
2. make them understand methods for studying vegetation, community patterns and processes, ecosystem functions, and principles of phytogeography.
3. This knowledge is critical in evolving strategies for sustainable natural resource management and biodiversity conservation

Unit	Topic	No. of Lectures
I	Ecology and Ecosystems Definition of Ecology, Ecological Factors, Positive and negative interactions. Ecosystem-Concept of an ecosystem-structure and function of an ecosystem. Abiotic and biotic components,	
II	Types of ecosystems: terrestrial and aquatic acosystems- forest ecosystem, grasslands, deserts,freshwater and marine ecosystems, agroecosystems. Population and community ecology (brief introduction).	
III	Food chains and food webs, ecological pyramids, productivity of different ecosystems, primary productivity (gross and net primary productivity), secondary productivity, flow of energy in an ecosystem.	
IV	Ecological Adaptations– Hydrophytes, Xerophytes, Halophytes, Epiphytes. Ecological Succession-definition and types. Processes (autogenic,allogenic,autotrophic,heterotrophic,primary & secondary), Hydrosere and Xerosere.	
V	Soil Formation, Properties & Conservation Soil: Origin, Formation, composition, Soil types, Soil Profile, Soil Microorganisms, soil processes, Soil Erosion, Biogeochemical cycles of carbon, water, Soil Conservation: Biological– Contour farming, Mulching, Strip cropping, Terracing and Soil reclamation.	

VI	Biodiversity and its Conservation: Definition -genetic, species and ecosystem diversity.Value of biodiversity:hotspots of biodiversity threats to biodiversity. Endemic and endangered species of plants in India.	
VII	Species extinction: local extinction, ecological extinction, biological extinction (natural extinction, mass extinction, major extinction, man-made or sixth extinction), extinction vortex.	
VIII	*Ex-situ* and *in-situ* conservation, IUCN status categories of species, Red data book, Role of Seed Bank and Gene Bank, valuing plant resources,ecotourism, Role of BSI.	

Year: III	Semester: VI	**Code: BOT 306F**
Practicals	Credits: 0+2	
		No. of Lectures
	Biostatistics: • Univariate analysis of statistical data: Statistical tables, mean, mode, median, standard deviation and standard error (using seedling population / leaflet size). • Calculation of correlation coefficient values and finding out the probability. 3.Determination of goodness of fit in Mendellian and modified mono-and dihybrid ratios (3:1, 1:1, 9:3:3:1, 1:1:1:1, 9:7, 13:3, 15:1) by Chi-square analysis and comment on the nature of inheritance. • Computer application in biostatistics - MS Excel and SPSS	
	Ecology &Environment 1. Ecological Adaptations: Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites 2. Study of morphological adaptations of hydrophytes and xerophytes (four each). 3. Study of biotic interactions of: Stem parasite (Cuscuta), Root parasite (Orobanche) Epiphytes, Predation (Insectivorous plants). 4. Observation and study of different ecosystems mentioned in the syllabus. Field visit to familiarize students with ecology of different sites	
	Soil Formation, Properties & Conservation 1. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper) 2. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.	

	3. Determination of organic matter of different soil samples by Walkley & Black rapid titration method. 4. Soil Profile study 5. Soil types of India-Map	
	Biodiversity • 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 excursion/field visit).	

Year: IV	Semester: VII	**Code: BOT 401F**
Paper-I: Phytogeography and Plant Resorce Utilization		
Theory core	Credits: 4+0	

Course Outcome:
After the completion of the course the students will be able to:
- Basic concepts of plant distribution, phytogeopgraphy
- Use of plants as food, medicine, commercial products

Unit	Topic	No. of Lectures
I	Introductory concepts of biogeographic regions of India and world, Agroecological and floristic zones of India. Natural vegetation of India, static and dynamic plant geography,	
II	Basic principles governing geographical distribution of plants, Vegetational types in Uttar Pradesh. Centers of diversity of plants, origin of crop plants.Concept of sustainable development.	
III	Study of the plants with Botanical names, Family, part used, and economic uses yielding Edible & essential oils; Sugar, Starch; Fibers; Paper, Fumitories & Masticatories, Rubber,Dyes, Timber,biofuel crops.	
IV	Major cereal crops, millets, major vegetable crops, plantation crops, spices	

Year: IV	Semester: VII	**Code:BOT 402F**
Paper-II: Ethnobotany and Pharmacognosy		
Theory core	Credits: 4+0	

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

1. Ethnobotany and its use in human welfare
2. Ethnobotanical aspect of conservation and management of plant resources
3. Preparation of drugs and commercialization

Unit	Topic	No. of Lectures
I	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).	
II	Study of common plants used by tribes. 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.	
III	Preparation of drugs for commercial market - Organoleptic evaluation of drugs, Microscopic evaluation of drugs-, Physical evaluation of drugs. Sources of crude drugs– roots, rhizome, bulb, corm, leaves, stems, flowers, fruits and seeds.	
IV	Collection of wild herbs, Hydrotherapy or Herbal bath - Herbal oils - Liquid extracts or Tincture - Poultices - Salves - Slippery elm slurry and gruel - Suppositories - Teas. Glycosides and Flavonoids and therapeutic applications. Anthocyanins and Coumarins and therapeutic applications, Volatile oils and and Alkaloids and pharmacological activities.	

Year: III	Semester: VII	**Code: BOT 403F**

Paper-III: Environment Management and Climate Change

Theory core	Credits: 4+0

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

- Sustainable development of natural resources
- Environmental audit & Sustainability
- Pollution,Waste management, environmental ethics

Unit	Topic	No. of Lectures
I	Natural resources & Sustainable utilization: Land Utilization, Soil degradation and management strategies; Restoration of degraded lands. Wetlands; Threats and management strategies, Ramsar sites, Forests: Major and minor forest products; Biological Invasion, Energy: Renewable and non-renewable sources of energy, contemporary practices in resource management.	
II	Environmental audit & Sustainability Introductory concepts of environmental audit; Guidelines of environmental audit; Concept of energy and green audit, Concept of Sustainable Agriculture; India's environment action programme: issues, approaches and initiatives towards Sustainability; Sustainable development in practice.	
III	Pollution,Waste management & Circular Economy Environmental pollution, Environmental protection laws, Bioremediation, Activated Sludge Process (ASP) – Trickling Filters – oxidation ponds, fluidized bed reactors, membrane bioreactor, digesters, fixed film reactors, bioscrubbers, biotrickling filters; case study: Ganga 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.	
IV	Environmental ethics, Carbon Credits & Role of GIS Introduction to 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. Applications and case studies of remote sensing and GIS in land use planning, forest resources & agriculture studies.	

Year: IV	Semester: VII	**Code: BOT 404F**
Paper-IV: Utilization and Management of Algal Resources		
Theory core	Credits: 4+0	

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

- Students would be able to utilize and management of aquatic algal resources.
- Bioprospection of algal resources.
- UnderstandAlgal culturing process.

Unit	Topic	No. of Lectures
I	An overview of algal resources, ecological services by algae, role of algae in fisheries, aquaculture of algae-batch and mass cultivation, selection of culture medium, isolation and maintenance of algal cultures, water quality for algal culture.	
II	Bio-prospecting of algal resources for value added compounds/products, single cell protein, pharmaceuticals and nutraceuticals, biofuels, food and feed, algal compounds in cosmetics, bioremediation through algae, algae as bioi-indicator of pollution.	
III	Value addition through food chain, utilization of algae in aquaculture, impact of habitat degradation on algal resources, wastewater utilization for algal cultivation.	
IV	Application of algal density in identifying potential fishing zones, role of algae in global warming mitigation. Exotic algal species, algal blooms, algal toxins and fisheries. Control of algal bloom.	

Year: IV	Semester: VII	**Code: BOT 405F**
Practicals	Credits: 0+4	

	Phytogeography: • Marking of vegetation types of India, World & Uttar Pradesh on maps • Phytogeographical areas of India
	Economic Botany &Microtechnique: • Cereals: Wheat (habit sketch, L.S./T.S. of grain, starch grains, micro-

	chemical tests); rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests) • Legume: Pea or ground nut (habit, fruit, seed structure, micro-chemical tests) • Source of sugars and starches: Sugarcane (habit sketch; cane juice- micro-chemical tests); potato (habit sketch, tuber morphology, T.S. of tuber to show localization of starch grains, W.M. of starch) grains, micro-chemical tests. • Tea- tea leaves, tests for tannin • Mustard- plant specimen, seeds, tests for fat in crushed seeds • Timbers: section of young stem. • Jute- specimen, transverse section of stem, tests for lignin on T.S. of stem and study of fiber following maceration technique. Study of specimens of economic importance mentioned in Unit I-& II
	Cultivating Medicinal and aromatic plants & Essential oil extraction Lemon grass/ Neem/ Zinger /Rose/Mint
	Ethnobotany • Study of common plants used by tribes. *Aegle marmelos, Ficus religiosa, Cynodon dactylon.* • Visit a tribal area and collect information on their traditional method of treatment using crude drugs. • Familiarize with at least 5 folk medicines and study the cultivation, extraction and its medicinal application. • Observe the plants of ethnobotanical importance in your area. Visit to an Ayurveda college or Ayurvedic Research Institute / Hospital
	Instrumentation and herbal Preparations • Develop Capsules of herbs/ Develop Herbal oils/ Develop Poultice/cream Analyse some active ingredients using chromatography /Spectrophotometry
	Phytochemistry: • Determination of the percentage of foreign leaf in a drug composed of a mixture of leaves. • Dimensions of Calcium oxalate crystals in powdered crude drug. • Preliminary phytochemical tests for alkaloids, terpenoids, glycosides, volatile oils, tannins & resins. Any 5 herbal preparations.
	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 chloride and dissolved oxygen content in water sample • Comparative anatomical studies of leaves form polluted and less polluted areas. • Measurement of dissolved O2 by azide modification of Winkler's method. • Determination of dissolved oxygen of water samples from polluted and unpolluted sources. • Microbiological assessment of drinking water using MPN technique- water from well, river, water supply department and packaged drinking water • Making kitchen waste from compost/vermicompost by Enzymes/Bio decomposer/ Whey with dung. Climate Change, Carbon Credits & Role of GIS • Conducting Waste Audit of your Institution -Demo • 2. Green auditing of the College/University –Demo

	• Water testing in green house • Types of substrates used in greenhouse • Study of local fresh water body for hydrophytic biodiversity Water analysis of local fresh water bodies
	Algal Resources: Identification and documentation of algae from freshwater habitats (local), techniques for algal cultivation and maintenance of pure cultures, Spirulina and Chlorella Cultivation, extraction of pigments from algae (carotenoids and phycocyanin), heavy metal removal by algae.

Year: IV	Semester: VIII	**Code: BOT 406F**
Paper-I: Biofertilizer and Biopesticides		
Theory core	Credits: 4+0	

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

- Know about biofertilizers and thei application in crop fields.
- Know about practical application of PGPR (plant growth promoting rhizobacteria).

Unit	Topic	No. of Lectures
I	General account of microbes used as biofertilizers-PGPR, nitrogen fixing bacteria, algae and mycorrhizae.	
II	Isolation of PGPR and mass multiplication, *Azospirillum Azotobacter*-classification and characteristics, crop response to *Azotobacter* inoculums etc. Cyanobacteria, Azolla and *Anabaena azollae* association, biological nitrogen fixation, Azolla in rice cultivation.	
III	Mycorrhizal association, types of mycorrhizal association, phosphorus nutrition, Biocompost making methods from agricultural and industrial wates, types and methods of vermicomposting.	
IV	Biopesticides: basic concepts, bacterial and fungal biopesticides, botanical pesticides and their application.	

Year: IV	Semester: VIII	**Code: BOT 407F**
Paper-II: Nursery and Gardening		
Theory core	Credits: 4+0	
Course Outcome:		

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

- Understand scope of Nursery and gardening
- Know about vegetative propagation

Unit	Topic	No. of Lectures
I	Scope and objectives of nursery, infrastructure for nursery. Planning and seasonal activities. Planting-direct seeding and transplants.	
II	Structure and types of seeds, seed dormancy-causes and methods of breaking dormancy, seed storage.	
III	Vegetative propagation-cutting, selection of cutting, treatment of cutting. Rooting medium and planting of cuttings. Hardening of plants-green house, mist chamber, shade house and glass house.	
IV	Gardening-objectives and scope, different types of gardening-landscape and home gardening, parks and its components-plant materials and design. Gardening operations-soil laying, manuring, watering, management of pests and diseases and harvesting.	

Year: IV	Semester: VIII	**Code: BOT 408F**
Paper-III: Mushroom Cultivation		
Theory core	Credits: 4+0	

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

- Basics of mushroom cultivation.
- Cultivation of Button, Oyster and Straw Mushrooms.

Unit	Topic	No. of Lectures
I	Cultivation system, farm design, Compost and composting-fundamentals of cultivation system, principles of mushroom farm layout-location of building plot, design of farm, bulk chamber, composting platform, equipments and facilities.	
II	Machinery required for compost making, materials for compost preparation. Methods of composting-long method of composting and short method of composting.	
III	Spawn and Spawning-Facilities required for spawn preparation, preparation of spawn substrate, preparation of pure culture, media used in raising pure culture, storage of spawn.	
IV	Cultivation of Button, Oyster and Straw Mushrooms-collection of raw materials, compost and composting, spawn and spawning, cropping and crop management, picking and packing. Nutrient Profile of Mushroom-protein, amino acids, calorific values, carbohydrates, fats, vitamins and minerals.	

Year: IV	Semester: VIII	**Code: BOT 409F**
Paper-IV: Landscaping Floriculture		
Theory core	Credits: 4+0	

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

- Understand basic concept of floriculture.
- Initiate commercial floriculture- a start-up.

Unit	Topic	No. of Lectures
I	Ornamental plants-flowering annuals, herbaceous perennials, divine vines, shade and ornamental trees, ornamental bulbous and foliage plants, cacti and succulents, palms and cycads, ferns and selaginellas. Cultivation of plants in pots, indoor gardening and bonsai.	
II	Principles of garden design-English, Italian, French, Persian, Mughal and Japanese gardens, features of garden (garden wall, fencing, steps, hedge, edging, lawn, flower, beds, shrubbery, borders, water garden), some famous gardens of India.	
III	Landscaping places of public importance-landscaping highways and educational institutions.	
IV	Commercial floriculture- factors affecting flower production, production and packaging of cut flowers(Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolous, Marigold, Rose, Lilium and Orchids). Diseases and pests of ornamental plants.	

Year: IV	Semester: VIII	**Code: BOT 410F**
Practicals	CREDIT 0+4	
	• Collection of biofertilizers, field application of biofertilizers. • Isolation and inoculums productionof VAM. • Cultivation of different vegetables. • Field visit of green houses, parks and glass houses. • Visit to relevant Labs and field visit (involved in mushroom cultivation). • Visit to Nurseries and cultivation of different plants in pots.	No. of Lectures

Year: IV	Semester: VII	**Code: BOT 411F**
Paper-IV: Bioinformatics and Computer Application		
Theory core	Credits: 4+0	

Course Outcome:

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

- Learn fundamentals of computer application and Bioinformatics
- Learn about biological databases and their use
- Learn about phylogentic analysis and its importance

Unit	Topic:	No. of Lectures
I	Computer fundamentals: MS Office: PPT, Microsoft Excel, data entry, graphs, aggregate functions, formulas and functions, number systems, conversion devices, secondary storage media. GPS tagging, Plant Identification Apps, programming languages in bioinformatics, role of supercomputers in biology. Historical background. Scope of bioinformatics - Genomics, Transcriptomics, Proteomics, Metabolomics, Molecular Phylogeny, and computer aided Drug Design (structure based and ligand based approaches), Systems Biology and Functional Biology. Applications and Limitations of bioinformatics.	
II	Biological databases : Introduction to biological databases - primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss-Prot, TrEMBL, PDB), metabolic pathway database (KEGG, EcoCyc, and MetaCyc), small molecule databases (PubChem,)	
III	Data Generation and Data Retrieval : Generation of data (Gene sequencing, Protein sequencing, Mass spectrometry, Microarray), Sequence submission tools (BankIt, Sequin, Webin); Sequence file format (flat file, FASTA, GCG, EMBL, Clustal, Phylip, Swiss-Prot); Sequence annotation; Data retrieval systems (SRS, Entrez).	

IV	Phylogenetic analysis : Introductory concepts of -Similarity, identity and homology, Alignment – local and global alignment, pairwise and multiple sequence alignments, alignment algorithms. Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA); Phylogenetic analysis: Construction of phylogenetic tree, dendrograms, methods of construction of phylogenetic trees.	

Year: IV	Semester: VII	**Code: BOT 412F**

Paper-III: Genetic Engineering and Plant Tissue Culture

Theory core	Credits: 4+0

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

- Process of gene cloning
- Use of recombinant technology in crop improvement
- Plant morphogenesis
- Basics of plant tissue culture

Unit	Topic	No. of Lectures
I	Gene cloning- cutting and joining of DNA molecules- restriction endonucleases, DNA ligase, cloning vectors (plasmids, cosmids, bacteriophage, YAC and BAC), , gene libraries	
II	Gene transfer methods, marker genes-reporter genes, selectable markers, Transgenic in crop improvement-pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (FlavrSavr tomato, Golden rice)	
III	Cytodifferentiation, organogenic differentiation, types of culture-seed culture, embryo culture, organ culture, callus culture Cell culture, cell suspension cultures,,Micropropagation, *in vitro* production of haploids.	
IV	Protoplast isolation, somatic hybridization, somaclonal variation-basis of somaclonal variation, plant secondary metabolites production, cryopreservation.	

Year: IV	Semester: VIII	**Code: BOT 413F**

Research Project	CREDIT 12

	According to relevant needs.	No. of Lectures