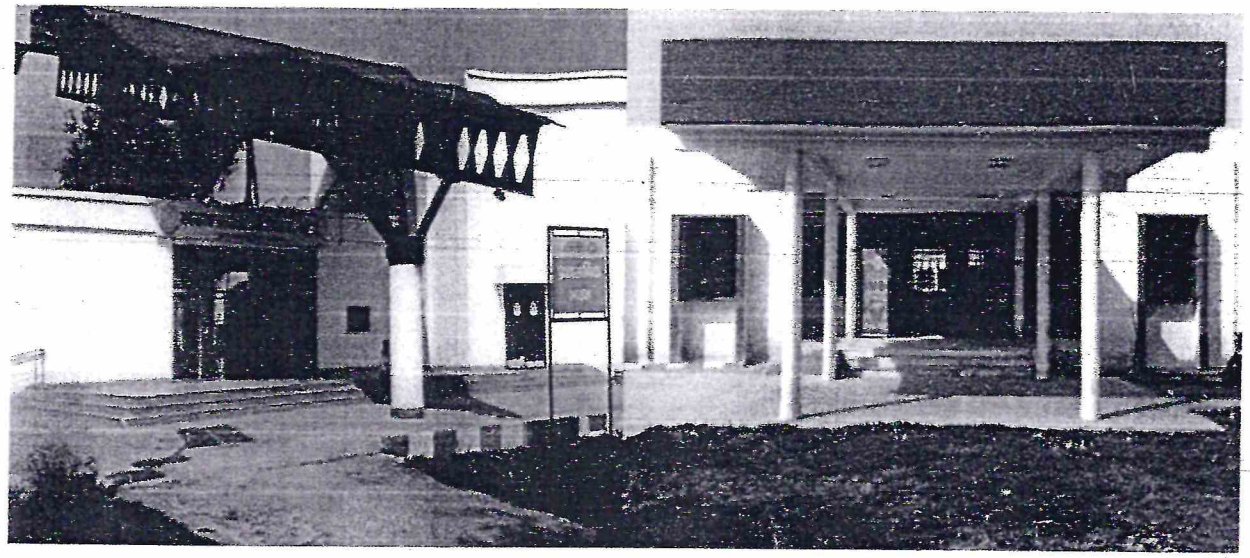
जननायक चन्द्रशेखर विश्वविद्यालय, बलिया
Jananayak Chandrashekhar University, Ballia

(A State University established under the Uttar Pradesh University Act 1973)

Curriculum in Accordance with National Education Policy – 2020

Programme Name: Undergraduate
Subject: Botany



Department of Botany
Jananayak Chandrashekhar University, Ballia

External Experts
Prof. A.K. Mishra, BHU
&
Prof. S.K. Dubey, BHU
has given their acceptance online

(Head & Convener)

जननायक चन्द्रशेखर विश्वविद्यालय, बलिया

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Structure for Four Years Undergraduate Programme in accordance with National Education Policy – 2020 and Common Minimum Syllabus

BOTANY

Semester-wise Title of the Papers

Year	Sem	Course Code	Paper Title	Theory/ Practical	Credits	Total Credits
1st	I	B040101T	Microbiology & Plant Pathology	Theory	4	6
		B040102P	Techniques in Microbiology & Plant Pathology	Practical	2	
	II	B040201T	Archegoniates & Plant Architecture	Theory	4	6
		B040202P	Land Plants Architecture	Practical	2	
2nd	III	B040301T	Flowering Plants Identification & Aesthetic Characteristics	Theory	4	6
		B040302P	Plant Identification technology	Practical	2	
	IV	B040401T	Economic Botany, Ethnomedicine & Phytochemistry	Theory	4	6
		B040402P	Commercial Botany & Phytochemical Analysis	Practical	2	
3rd	V	B040501T	Plant Physiology, Metabolism & Biochemistry	Theory	4	14
		B040502T	Molecular Biology & Bioinformatics	Theory	4	
		B040503P	Experiments in physiology, Biochemistry & molecular biology	Practical	2	
		B040504MR	Minor Research Project – I (MRP)	Minor Project	4	
	VI	B040601T	Cytogenetics, Plant Breeding & Nanotechnology	Theory	4	14
		B040602T	Ecology & Environment	Theory	4	
		B040603P	Cytogenetics, Conservation & Environment management	Practical	2	
		B040604MR	Minor Research Project – II (MRP)	Minor Project	4	
4th	VII	B040701T	Plant Virology and Bacteriology	Theory	4	24
		B040702T	Mycology	Theory	4	
		B040703T	Phycology and Lichens	Theory	4	
		B040704T	Bryology	Theory	4	
		B040705P	Practical - Based on Paper BOT101 to 104	Practical	4	
		B040706R	Research Project – I	Project	4	
	VIII	B040801T	Pteridology	Theory	4	24
		B040802T	Gymnosperms and Palaeobotany	Theory	4	
		B040803T	Angiosperms: Taxonomy, Morphology and Economic Botany	Theory	4	
		B040804T	Ecology, Biodiversity and Plant-Soil Relationship	Theory	4	
		B040805P	Based on Paper BOT 201 to 204	Practical	4	
		B040806R	Research Project – II	Project	4	

Note:

- **The student shall prepare a Minor Research Project (MRP) in any of the two subjects taken in the 5th and 6th Semester (3rd Year) of Graduation. The MRP shall be submitted and evaluated in the 6th Semester and it is of 8 credits (4 in Semester V and 4 in semester VI) and 100 marks.**
- **The student shall prepare a Research Project in the 7th and 8th Semesters (4th Year) of Graduation. The MRP shall be submitted and evaluated in the 8th Semester and it is of 8 credits (4 in Semester VII and 4 in semester VIII) and 100 marks.**

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Programme: BSc
Subject: Botany

Syllabus

Semester	I	
Course Code	B040101T / Paper-I	
Course Title	**Microbiology and Plant Pathology**	
Credit	4	Maximum Marks: 75 (50 External + 25 Internal)

Course Objective:
To impart knowledge on the microbial techniques, microbial diversity, structure and reproduction of microbes, plant disease causing microbes and control, and applied microbiology.

Learning Outcomes: After successful completion of the syllabus, learners will be able to:

- Understand the microbial diversity, the microbial techniques and their structure and reproduction.
- Gain knowledge about economic importance and developing commercial enterprise of microbial products.
- Learn host-pathogen relationship and disease management.

Unit	Course Content
I	**Microbial Techniques & instrumentation** Microscopy – Light, phase contrast, electron microscopy, sample preparation for electron microscopy. Common equipment's of microbiology lab and principle of their working– Autoclave, oven, laminar air flow, centrifuge, spectrophotometry.
II	**Microbial world** History and scope of Microbiology. Structure of a bacteria cell, Bacterial Growth curve and measurement, factors affecting growth of microbes, Batch culture. Genetic recombination in bacteria (transformation, conjugation and transduction). Bacterial Chemotaxis and Quorum sensing. General characteristics and structure of viruses, Structure of Bacteriophages, T4 and λ-phage; Lytic and Lysogenic cycles. Viroids, Prions, Mycoplasma and phytoplasma.
III	**A. Phycology** Classification (Fritsch's system) of algae and general characteristics of major classes. Cyanophyceae – *Nostoc*, Chlorophyceae – *Volvox* and *Oedogonium*, Phaeophyceae – *Ectocarus* and *Sargassum*, Rhodophyceae *Polysiphonia*. Economic importance of algae. **B. Mycology, Mushroom, Lichens and Mycorrhiza** Classification (Ainsworth's system) of fungi and general characteristics of sub-divisions. Zygomycotina – *Rhizopus*, Ascomycotina – *Saccharomyces*, Basidiomycotina – *Ustilago* and *Puccinia*, Deuteromycotina – *Fusarium* and *Alternaria*. Economic importance of fungi, Heterothallism, Parasexuality, Mushroom, Lichens and Mycorrhiza.
IV	**A. Plant Pathology, Disease and control** Disease concept, Symptoms, Koch's Postulates, Mechanism of infection and Disease cycle. Defense mechanism with special reference to Phytoalexin; Resistance- Systemic acquired and induced systemic. General symptoms, Causal organism, Disease cycle and control measures of following plant disease - late blight of potato, black stem rust of wheat, citrus canker, little leaf of brinjal and mosaic of tobacco. Disease management; Quarantine, Chemical, Biological, and Integrated pest disease management. **B. Applied Microbiology** Microorganism and production of antibiotics and alcoholic beverages. Mass production of bacterial biofertilizers. Plant growth promoting rhizobacteria and biopesticides- *Trichoderma* sp., Single cell proteins. Microbiology of biosensors, Bioremediation, Production of biofuels and Biodegradation of pollutants. Fermentation and fermenters.

References:

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- Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology (4th ed.). John Wiley & Sons.
- Aneja, K. R. (1993). Experiments in Microbiology, Pathology and Tissue Culture, Vishwa Prakashan, New Delhi.
- Basu, A. N. (1993). Essentials of Plant Viruses, Vectors and Plant diseases, New Age International, New Delhi.
- Chopra. G. L. (1984). A text book of Algae, Rastogi publications, Meerut, India.
- Dubey, R. C. and Maheshwari. D.K. (2012). Practical Microbiology, S. Chand & Company, Pvt. Ltd., New Delhi.
- Fritsch, R. E. 1977. Structure and Reproduction of Algae, Cambridge University Press, London.
- Kumar, H.D. (1999). Introductory Phycology (2nd ed.). Affiliated East-West Press, Delhi.
- Pandey B.P. (2001). College Botany Volume 1, S Chand & Company Pvt. Ltd, New Delhi.
- Pelczar, M.L., Chan, E.C.S., and Krieg, N.R. (1963), Microbiology, Tata McGraw-Hill, New Delhi.
- Reven, F.H., Evert, R. F., Eichhorn, S.E. (1992). Biology of Plants. New York, NY: W.H. Freeman and Company.
- Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
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- Sharma, P. D. (2012) Microbiology and Plant Pathology, Rastogi Publication Pvt Ltd., Meerut, India.
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- Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction (10th ed.), Pearson, U.S.A.
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Programme: BSc
Subject: Botany

Syllabus

Semester	I	
Course Code	B040102P / Paper-II (Practical)	
Course Title	**Techniques in Microbiology & Plant Pathology**	
Credit	2	Maximum Marks: 25

Course Objective:
To impart knowledge on the instruments, techniques, lab etiquettes and good lab practices for working in a microbiology laboratory and applied microbiology.

Learning Outcomes: After successful completion of the syllabus, learners will be able to:

- Develop skills for identifying microbes and using them for Industrial, Agriculture and Environment purposes.
- 3. Perform field and laboratory experiments in Microbiology & Pathology.
- Learn to identify Algae, Lichens and plant pathogens along with their Symbiotic and Parasitic associations.
- Initiate his own Plant & Seed Diagnostic Clinic.
- Start own enterprise on microbial products.

Unit	Course Content (three from each unit depending upon facilities)
I	**A. INSTRUMENTS, TECHNIQUES:** 1. Laboratory safety and good laboratory practices; 2. Principles and application of Laboratory instruments-microscope, incubator, autoclave, centrifuge, LAF, filtration unit, shaker, pH meter; 3. Cleaning and Sterilization of glassware. **B. ISOLATION AND IDENTIFICATION OF BACTERIA:** 1. Preparation of media- Nutrient Agar and Broth; 2. Inoculation and culturing of bacteria in Nutrient Agar and Nutrient Broth; 3. Preparation of agar slant, stab, agar plate; 4. Isolation and identification of bacteria; 5. Gram Staining techniques:
II	**A. MYCOLOGICAL:** 1. Isolation and identification of different fungi lactophenol cotton blue. 2. *Rhizopus*, *Saccharomyces*, *Penicillium*, *Peziza*, *Ustilago*, *Puccinia*, *Fusarium*, *Curvularia*, *Alternaria*, *Agaricus*: Specimens of button stage and full-grown mushroom; Sectioning of gills of *Agaricus*. 3. Lichens: crustose, foliose and fruticose specimens **B. PHYCOLOGICAL STUDY:** Type study of algae: **Cyanobacteria**– *Spirullina*, *Nostoc*; **Chlorophyceae**- *Chlorella*, *Volvox*, *Oedogonium*, *Cladophora* and *Chara*; **Xanthophyceae**– *Vaucheria*; **Bacillariophyceae**- *Pinnularia*; **Phaeophyceae**– *Sargassum;* **Rhodophyceae**- *Polysiphonia*
III	**A. EXPERIMENTAL PLANT PATHOLOGY AND** 1. Preparation of fungal media (PDA) &Sterilization process. 2. 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. **B. APPLIED MICROBIOLOGY 1** 1.Isolation of nitrogen fixing bacteria from root nodules of legumes. 2. Enumeration of rhizosphere to non rhizosphere population of bacteria. 3. Isolation of antagonistic Pseudomonas from soil. 4. Microscopic observations of root colonization by VAM fungi. 5. Isolation of Azospirillum sp. from the roots of grasses.
IV	**A. Applied Microbiology 2** 1. Wine production. 2. Isolation of lactic acid bacteria from curd. 3. Isolation of lipolytic organisms from butter or cheese. 4. Immobilized bacterial cells for production of hydrolytic enzymes. 5. Enzyme production and assay - cellulase, protease and amylase. 6. Immobilization of yeast. 7. Cultivation of Spirulina, & Chlorella in lab for biofuel 8. Visit to NBAIM, Mau, Varanasi (Kashi)/IMT, Chandigarh for viewing Culture Repository 9. Visit to biofertilizers and biopesticides unit to understand about the Unit operation

References:

- Aneja, K. R. (1993). Experiments in Microbiology, Pathology and Tissue Culture, Vishwa Prakashan, New Delhi.
- Dubey, R. C. and Maheshwari. D.K. (2012). Practical Microbiology, S. Chand & Company, Pvt. Ltd., New Delhi.
- Kodo,C.I. and Agarwal, H.O.(1972).Principles and techniques in Plant Virology, Van Nostrand, Reinhold Company,New York.
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Programme: BSc
Subject: Botany

Syllabus

Semester	II	
Course Code	B040201T / Paper-I	
Course Title	**Archegoniates and Plant Architecture**	
Credit	**4**	Maximum Marks: 75 (50 External + 25 Internal)

Course Objective:
To impart knowledge on origin, evolution, structure, reproduction and interrelationship between lower Archegoniates and higher group of plants.

Learning Outcomes: After successful completion of the syllabus, learners will be able to:

- Develop critical understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms.
- Understand plant evolution and their transition to land habitat.
- Understand morphology, anatomy, reproduction and developmental changes in Angiosperms

Unit	Course Content
I	**A. Introduction to Archegoniates & Bryophytes** Unique features of archegoniates, Bryophytes: General characteristics, adaptations to land habit, Range of thallus organization. Classification (up to Orders). Salient features of 3 classes Hepaticopsida, Anthocerotopsida and Bryopsida with examples. Economic importance of bryophytes. **B. Pteridophytes** General characteristics, Early land plants (*Rhynia*). Classification (up to family), Heterospory and seed habit, stelar evolution, economic importance of Pteridophytes
II	**A. Gymnosperms** Classification and distribution of Gymnosperms; Salient features of Cycadales, Ginkgoales, Coniferales and Gnetales, their examples, structure and reproduction; economic importance **B. Palaeobotany** Geological time scale. Brief account of process of fossilization and types of fossils. Contribution of Birbal Sahni.
III	**A. 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. **B. Plant Tissue System:** **Meristematic and permanent tissues.** Cambium (structure and function). Secondary growth in Root and stem. Anomalous secondary growth with special reference to *Bignonia, Boerhaavia, Dracaena, Nyctanthus*
IV	**A. Reproductive Botany** Structure of microsporangium, microsporogenesis. Structure of megasporangium and its types, megasporogenesis. Structure and types of female gametophyte. General account of pollination, structure of male gametophyte. Double fertilization, structure of dicot and monocot embryo. Endosperm. Apomixis and polyembryony. B. **Palynology**: Pollen structure, pollen morphology.

References:

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- Singh, V., pande, P.C. and Jain, D.K (2022). Botany: Archegoniates and Plant Architecture. Rastogi Publication, Meerut

Programme: BSc
Subject: Botany

Syllabus

Semester	II	
Course Code	B040202P / Paper II(Practical)	
Course Title	Land Plants Architecture	
Credit	2	Maximum Marks: 25

Course Objective:
To impart knowledge on origin, evolution, structure, reproduction and interrelationship between lower Archegoniate and higher group of plants.

Learning Outcomes: After successful completion of the syllabus, learners will be able to:

- Develop critical understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms.
- Understand plant evolution and their transition to land habitat.
- Understand morphology, anatomy, reproduction and developmental changes in Angiosperms

Unit	**Course Content** (three from each unit depending upon facilities)
I	**A. Bryophytes:** 1.*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). 2. *Sphagnum*- morphology, W.M. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing Antheridial and Archegonial heads, L.S. capsule and protonema. **B. Pteridophytes**: 1. *Lycopodium*: Habit, stem T. S., strobilus V. S., 2. *Selaginella*: Habit, rhizophore T. S., stem T. S, axis with strobilus, V.S. of strobilus, Megasporophyll and microsporophyll. 3.*Equisetum*: Habit, rhizome and stem T.S. and V. S. of strobilus. 4.*Azolla*: Habitat & its structure
II	**A. Gymnosperms:** 1. *Cycas* – Coralloid root and coralloid root T. S., T. S. of leaflet and Rachis, micro and mega sporophyll, male cone V. S., micro sporophyll T. S., entire and V. S. of ovule. 2. *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. 3. *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. **B. Palaeobotany & Palynology:** 1. Morphology of *Rhynia* and fossils gymnosperms & other groups 2. Visit to Birbal Sahni Institute of Palaeobotany or virtual conference with their scientists to learn fossilization 3. Mark and know about Indian geographical sites rich in plant fossils
III	**A. Angiosperm Morphology:** 1. Study of Morphology and modifications of roots; Stem, leaf and bud. 2. Study Types of inflorescences; flowers, flower parts, fruits, ovules and types of placentation. **B. Plant Anatomy:** 1. Normal & Anomalous secondary growth - *Bignonia*, *Dracaena*, *Boerhavia*, *Nyctanthus* 2. Study of structure of stomata.
IV	**A. Reproductive Botany and** 1. Structure of anther, microsporogenesis and pollen grains 2. Structure of ovule (through slides). 3. Study of embryo 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. 7. Calculation of pollen viability percentage using in vitro pollen germination techniques. **B. Commercial Uses and Production technology:** *Azolla* production

References:

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- Kumar, S. and Kashyap, S.R. (2003). Manual of Practical Algae. Campus Books International, New Delhi.
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- Pandey, B.P., and Trivedi, P.S. (1997). Botany Vol. II. Vikas Publishing House, New Delhi.
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Programme: BSc
Subject: Botany

Syllabus

Semester	Semester: III	
Course Code	B040301T / Paper-I	
Course Title	**Flowering Plants Identification & Aesthetic Characteristics**	
Credit	4	Maximum Marks : 75 (50 External + 25 Internal)

Course Objective:
To create well-rounded individuals who can confidently identify flowering plants, appreciate their beauty, understand their ecological importance, and contribute to the conservation and cultivation of these plants in various fields.

Learning Outcomes: After successful completion of the syllabus, learners will be able to:

- To understand 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 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.
- To promote a career in plant nursery establishment or landscaping business or plantation consultancy firm

Unit	Course Content
I	**(A) Taxonomic Resources & Nomenclature** Components of taxonomy (identification, nomenclature, classification); Taxonomic resources: Herbarium, Botanical gardens, Flora, Keys. Botanical Nomenclature- Principles and rules of ICN (Principle of priority, binomial system; type method, author citation, valid-publication).
	(B) Types of classification & Evidences Artificial, natural and phylogenetic. Bentham and Hooker (upto series), Angiosperm Phylogeny Group (APG III) classification. Taxonomic evidences from cytology, phytochemistry, & Molecular biology data (Protein and Nucleic acid homology).
II	**(A) 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, Cucurbitaceae, Asteraceae, Apocynaceae, Asclepiadiaceae, Solanaceae.
	(B) 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, Orchidaceae, Liliaceae, Arecaceae, Poaceae.
III	**(A) Modern trends in Plant taxonomy** Phenetics and Cladistics: Brief idea on Phenetics, Numerical taxonomy- methods, Operational Taxonomic Units, Monophyletic, polyphyletic and paraphyletic groups.
	(B) Tools & Softwares in plant identification GIS (Mapping of (i) Patterns (ii) Features (iii) Quantities 0P02.010H11YLIP - Free Phylogenetic Software, Digital Taxonomy, DEscription Language for TAxonomy – DELTA, Internet directory for botany
IV	**(A) Computer Applications** Introduction to Computers – classification, computer generation, software and hardware, operating systems, personal, mini, main frame and super computers, characteristics and application, computer memory and its types, data representation and storage. Microsoft excel, data entry, graphs, and aggregate functions.
	(B) Aesthetic Characteristics of Plants Aesthetic characteristics of plants, English, Mughal and Japanese gardens; Features of a garden (Garden wall, Hedge, Lawn, Trees, shrubs and shrubberies, climbers and creepers, flower beds, borders, water garden). Some famous gardens of India. Conservatory, green houses, Indoor garden, Roof garden, Topiary, Bonsai.

References:

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- Bole, P. V. and Vaghani, Y. (1986) Field guide to the common trees of India. Oxford University Press; Bombay.
- Brandis, D. (1906) Indian Trees (London, 5th edition. 1971). International Book Distributors; Dehra Dun.
- Davis, P. H. and V. H. Heywood. (1963). Principles of Angiosperm Taxonomy. Oliver and Boyd, London.
- Dutta A.C. (2016). Botany for Degree Students. Oxford University Press.
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Programme: BSc
Subject: Botany

Syllabus

Semester	III	
Course Code	B040302P / Paper II (Practical)	
Course Title	Plant Identification technology	
Credit	2	Maximum Marks : 25

Course Objective:
To impart knowledge on the Plant collection , preservation and identification.

Learning Outcomes: After successful completion of the syllabus, learners will be able to:

- Learn how plant specimens are collected, documented, and curated for a permanent record.
- Gain experience with the various tools and means available to identify plants.
- To recognize common and major plant families.
- Understand aesthetic characters of flowering plants by making-landscapes, gardens, bonsai, miniatures.

Unit	Course Content (three from each section per unit depending upon facilities)
I	**A. 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 **B. Taxonomic Identification using plant structure:** Classify 25 plants (Compulsory) on the basis of Taxonomic description (Plant Morphology, Anatomy, Reproductive parts, Habit, adaptation anomalies) according to Bentham & Hooker's system of classification in the following families: Malvaceae, Fabaceae (Papilionaceae), Cucurbitaceae, Solanaceae, Acanthaceae, Asteraceae, Apocynaceae, Labiatae (Lamiaceae), Asclepiadaceae, Euphorbiaceae, Poaceae.
II	**A. 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; **b.** Describe/compare flowers in semi-technical language giving V.S. of flowers, T.S. of ovaries, floral diagrams and Floral Formulae. Identify and assign them to their respective families giving reasons. **B.** Collection, Preservation And Storage Of Algae, Fungi, Bryophytes, Pteridophytes (Two each).
III	**A. 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. **B. COMPUTERS-** a. Learning to use EXCEL Microsoft PowerPoint and Word., WORKING WITH FOLDER AND WINDOWS UTILITY, CREATE AND MANAGE FILES AND FOLDER TREE; b. Practice browsing of different sites using search engine. practice and understand different E-Mail services –Outlook, Yahoo mail, rediffmail etc. Practice Creating E-Mail accounts, Sending, Receiving & Storing of mails; c. Create and Participate in virtual conferencing in an interactive Zoom Meeting
IV	**A. Computer Application in taxonomy-** a. Use Taxonomic Softwares (Dichotomous Key); b. Practicals on Phylogenetic analysis; c. Make line drawing of Plants for description; d. Using of plant identification apps on android phones. **B. Create following-** a. Bonsai of any plant; b. Develop a miniature garden; c. Draw Layouts of various types of gardens.

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जननायक चन्द्रशेखर विश्वविद्यालय, बलिया

Jananayak Chandrashekhar University, Ballia

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Programme: BSc
Subject: Botany

Syllabus

Semester	IV	
Course Code	B040401T / Paper-I	
Course Title	**Economic Botany, Ethnomedicine and Phytochemistry**	
Credits	4	Maximum Marks : 75 (50 External + 25 Internal)

Course Objective:
To impart knowledge on the general uses of plants, protected cultivation, ethnobotany, traditional knowledge, IPR, medicinal plants in the Indian traditional medicines and to explore employability with this knowledge.

Learning Outcomes: After successful completion of the syllabus, learners will be able to understand:

- The uses of plants and in the special context of 'one plant-one employment'.
- The concept and importance of Protected Cultivation, Ethnobotany, Traditional Knowledge and IPR.
- The importance of medicinal plants, their traditional uses and their use in the Indian System of Medicine.

Unit	Course Content
I	**A. Origin and domestication of cultivated plants** Centers of diversity of plants, origin of crop plants; domestication and introduction of crop plants. Cultivation; production and uses of wheat and chickpea. **B. Botany of oils, fibres, timber yielding plants and dyes** Study of the plants with botanical names, family, part used, and economic uses yielding edible oils, essential oils, fibers, timber and dyes.
II	**A. Commercial production of flowers, vegetables, and fruits** Commercial greenhouse cultivation of flowers (gerbera, gladiolus), vegetable (tomato, cucumber), and fruits (strawberry, grapes) using hydroponics. **B. IPR and traditional knowledge** Concept and types of IPR; TRIPS, WIPO, TIFAC and NRDC; traditional knowledge, protection of traditional knowledge and TKDL.
III	**A. Ethnobotany** Introduction to ethnobotany; methods of ethnobotanical studies; introductory knowledge of Indian systems of medicine (Siddha, Ayurveda and Unani); AYUSH, NMPB, CIMAP and CARI. **B. Medicinal aspects** Study of common plants used by tribes (*Aegle marmelos, Ficus religiosa, Cynadon dactylon, Eclipta alba* and *Trichopus zeylanicus*); sacred groves; Common medicinal plants in primary health care: *Tinospora, Acorus, Ocimum,* Turmeric and Aloe; Indian Pharmacopeia Commission.
IV	**A. Pharmacognosy** Concept of pharmacognosy; preliminary knowledge of the methods of evaluation of crude drugs; application of the drug from *Adhatoda vasica, Andrographis paniculata, Azadirachta indica, Coriandrum sativum, Datura metal, Eclipta alba, Emblica officinalis, Ricinus communis, Vinca rosea and Zingiber officinale.* **B. Herbal preparations & phytochemistry** Types of herbal drug preparations; glycosides and flavonoids, anthocyanins and coumarins, carotenoids and alkaloids and their therapeutic applications.

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जननायक चन्द्रशेखर विश्वविद्यालय, बलिया

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Programme: BSc
Subject: Botany

Syllabus

Semester	IV	
Course Code	B040402P / Paper II (Practical)	
Course Title	Commercial Botany & Phytochemical Analysis	
Credits	2	Maximum Marks: 25

Course Objective:
To impart knowledge on the general uses of plants, protected cultivation, ethnobotany, traditional knowledge, IPR, medicinal plants in the Indian traditional medicines and to explore employability with this knowledge.

Learning Outcomes: After successful completion of the syllabus, learners will be able to understand:

- Know about the commercial products produced from plants.
- Gain the knowledge about cultivation practices of some economic crops.
- Understand about the ethnobotanical details of plants.
- Learn about the chemistry of plants &herbal preparations
- Become a protected cultivator, aromatic oil producer, Pharmacologist or quality analyst in drug company.

Unit	Course Content (three from each section of unit depending upon facilities)
I	**A. Economic Botany & Microtechniques:** a.Cereals: Wheat and Rice (habit sketch, L.S./T.S. of grain, starch grains, micro-chemical tests); b.Legume: Pea or ground nut (habit, fruit, seed structure, micro-chemical tests); c.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; d.Tea- tea leaves, tests for tannin; e. Mustard- plant specimen, seeds, tests for fat in crushed seeds; f.Timbers: section of young stem; g.Fibre-Jute- specimen, transverse section of stem, tests for lignin on T.S. of stem and study of fiber following maceration technique. **B. Commercial Cultivation:** a.Field visit to Green houses for understanding Floriculture & vegetables production; b.Development of hydroponics nutrient solutions & running models for cultivation of Vegetables; c.Development of hydroponics nutrient solutions & running models for cultivation of fodder
II	**A. Cultivating Medicinal and aromatic plants & Essential oil extraction:** Lemon grass/ Neem/ Zinger /Rose/Mint **B. Documentation from Traditional Knowledge Digital Library:** a. Mark the Geographic Indications on Map; b. Understand –Nakshtra Vatika, Navgrah vatika and develop in your college; c. To extract the names of the plants and Botanical uses depicted in our epics.
III	**A.Ethnobotany:** a. Study of common plants used by tribes. *Aegle marmelos*, *Ficus religiosa*, *Cynadon dactylon*;b. Visit a tribal area and collect information on their traditional method of treatment using crude drugs; c.Familiarize with at least 5 folk medicines and study the cultivation, extraction and its medicinal application; d.Observe the plants of ethno botanical importance in your area; e. Visit to an Ayurveda college or Ayurvedic Research Institute / Hospital **B. Instrumentation and herbal Preparations:** Develop Capsules of herbs/Develop Herbal oils/Develop Poultice/cream Analyse some active ingredients using chromatography /Spectrophotometry
IV	**A. Pharmacognosy-** Organoleptic studies of plants mentioned in the theory: a. Morphological studies of vegetative and floral parts. b. Microscopic preparations of root, stem and leaf. c. Stomatal number and stomatal index. c. Vein islet number. d. Palisade ratio. e. Fibres and vessels (maceration). f. Starch, Proteins and lipid test **B. Phytochemistry**: a. Determination of the percentage of foreign leaf in a drug composed of a mixture of leaves. b. Dimensions of Calcium oxalate crystals in powdered crude drug. c. Preliminary phytochemical tests for alkaloids, terpenoids, glycosides, volatile oils, tannins & resins. d. Any 5 herbal preparations.

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Programme: BSc
Subject: Botany

Syllabus

Semester	V	
Course Code	B040501T / Paper-I	
Course Title	**Plant Physiology, Metabolism & Biochemistry**	
Credit	4	Maximum Marks: 75 (50 External + 25 Internal)

Course Objective:
To impart knowledge on physiological and metabolic processes in plants.

Course outcomes: After the completion of the course the students will be able to:
- Understand the role of physiological and metabolic processes for plant growth and development.
- Learn the symptoms of mineral deficiency in crops and their management.
- Assimilate knowledge about biochemical constitution of plant diversity.
- Know the role of plants in development of natural products, nutraceuticals, dietary supplements, antioxidants

Unit	Course Content
I	**A. Plant water relation, Mineral Nutrition, Transpiration and translocation in phloem** Properties of water, plant water relation, transport across cell membranes, transpiration and its significance; Factors affecting transpiration, role of essential elements, symptoms of mineral deficiency in plants, translocation of photosynthates in phloem. **B. Carbon Oxidation** Aerobic and anaerobic respiration, Glycolysis, oxidative decarboxylation of pyruvate, Krebs cycle, mitochondrial electron transport, oxidative Phosphorylation, pentose phosphate pathway, factors affecting respiration.
II	**A. Nitrogen Metabolism** Biological nitrogen fixation in legumes and non-legumes. Physiology and biochemistry of nitrogen fixation, Ammonia and nitrate assimilation **B. Lipid Metabolism & Photosynthesis** Lipid Metabolism: Synthesis and breakdown of triglycerides, glyoxylate cycle. Photosynthesis: Pigments, Action and absorption spectra, light reactions, electron transport system and Photophosphorylation, C3, C4 and CAM cycle and their Significance.
III	**A. Plant Development, Movements, Dormancy & Responses** Developmental roles of phytohormones (auxins, gibberellins, cytokinins, ABA, ethylene.) autonomic and paratonic movements, Photoperiodism, phytochrome, photomorphogenesis, seed dormancy, vernalization and senescence **B. Biomolecules** *Carbohydrates:* Nomenclature and classification; Role of monosaccharides (glucose, fructose); Disaccharides (sucrose, maltose,) and polysaccharides (cellulose, starch). *Lipids*: Classification, structure and functions of lipids, phosphoglycerides, prostaglandins and lipid micelles,
IV	**A. Proteins**: Structure of amino acids; Peptide bonds; Levels of protein structure-primary, secondary, Ramachandran plot, tertiary and quaternary; Isoelectric point; Protein denaturation and biological roles of proteins. **Nucleic acids:** Components of nucleic acids, Types, structure and functions of nucleic acids, Nucleic acid denaturation and renaturation **B. Enzymes:** Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; mechanism of action (activation energy, lock and key hypothesis, induced- fit theory), enzyme inhibition and factors affecting enzyme activity, Allosteric enzymes & Abzymes. nutraceuticals, antioxidants.

Suggested Readings:

- Buchanon, Gruissen and Jones. (2000). Plant Physiology & Biochemistry: Biochemistry and Molecular Biology of plants, I.K. International.
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Programme: BSc
Subject: Botany

Syllabus

Semester	V	
Course Code	B040502T / Paper-II	
Course Title	**Molecular Biology & Bioinformatics.**	
Credit	4	Maximum Marks : 75 (50 External + 25 Internal)

Course Objective:
To impart knowledge of molecular biology, techniques of genetic engineering and working knowledge in bioinformatics.

Learning Outcomes: After successful completion of the syllabus, learners will be able to:

- Understand organization of DNA in prokaryotes and Eukaryotes, its replication and transcription.
- Know about Processing and modification of RNA and translation process, function and regulation of expression.
- Know about elementary genetic engineering and biotechnology.
- Gain working knowledge of the practical and theoretical concepts of bioinformatics.

Unit	Course Content
I	**A. Genetic material:** 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. DNA replication (Prokaryotes and eukaryotes): bidirectional replication, semi–conservative, semi discontinuous, RNA priming, Ø (theta) mode of replication, replication of linear, dsDNA, replicating the 5' end of linear chromosome including replication enzymes. **B. Transcription & Regulation of gene expression:** 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 Tryptophan operon; and in Eukaryotes
II	**A. Principles & Techniques of genetic engineering:** Recombinant DNA technology; Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR. Hybridoma and monoclonal antibodies, ELISA and Immunodetection. **B. Applications of Genetic engineering** Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Role of transgenics in bioremediation (Superbug); Industrial enzymes (Aspergillase, Protease, Lipase); Genetically Engineered Products, Biosafety concerns.
III	**A. Bioinformatics and its applications:** Bioinformatics and its scope: Genomics, Transcriptomics, Proteomics, Metabolomics, Molecular Phylogeny, computer aided Drug Design (structure based and ligand-based approaches), Systems Biology and Functional Biology. Applications and Limitations of bioinformatics. **B. Biological databases:** Introduction to biological databases - primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, SwissProt, TrEMBL, PDB), metabolic pathway database (KEGG, EcoCyc, and MetaCyc), small molecule databases (PubChem)
IV	**A. Data Generation and Data Retrieval:** Generation of data, Sequence submission tools (BankIt, Sequin, Webin); Sequence file format (flat file, FASTA, GCG, EMBL, Clustal, Phylip); Sequence annotation; Data retrieval systems (SRS, Entrez) **B. Phylogenetic analysis:** Similarity, identity and homology, Alignment – local and global alignment, pairwise and multiple sequence alignments. Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA); Phylogenetic analysis: Construction of phylogenetic tree and analysis.

References:

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Programme: BSc
Subject: Botany

Syllabus

Semester	V	
Course Code	B040503P / Paper III (Practical)	
Course Title	**Experiments in physiology, Biochemistry & molecular biology**	
Credit	2	Maximum Marks: 50

Course Objective:
To impart knowledge of molecular biology, techniques of genetic engineering and working knowledge in bioinformatics.

Learning Outcomes: After successful completion of the syllabus, learners will be able to:

- Know and authentic the physiological processes undergoing in plants along with their metabolism
- Identify Mineral deficiencies based on visual symptoms
- Understand and develop skill for conducting molecular experiments for genetic engineering

Unit	Course Content (Perform any five from unit based on facility)
I	**A. 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. 11. Study of mineral deficiency symptoms using plant material/photographs. **B. Nitrogen Metabolism, Photosynthesis & Respiration:** 1. A basic idea of chromatography: Principle, paper chromatography and column chromatography; demonstration of column chromatography. 2. Separation of Chloroplastic pigments by solvent and paper chromatography. 3. Estimation of total chlorophyll content from different chronologically aged leaves (young, mature and senescence) by Arnon method. 4. Effect of HCO3 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). 5. Measurement of oxygen uptake by respiring tissue (per g/hr.) 6.Determination of the RQ of germinating seeds. 7. Effect of light intensity on oxygen evolution in photosynthesis using Wilmott' bubbler
II	**A. Plant Development, Movements, Dormancy & Responses:** 1. Experiments on 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. 6. To study the effect of different concentrations of IAA on Avena coleoptile elongation (IAA bioassay) **B. 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 10. Testing of adulterants in food items.

III	**A 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. **B. Preparation of models/ charts:** 1. Study of experiments establishing nucleic acid as genetic material (Avery et al., Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments) through photographs 2. Numericals based on DNA re-association kinetics (melting profiles and Cot curves) 3. Study of DNA replication through photographs: Modes of replication - Rolling circle, Theta and semi-discontinuous; Semiconservative model of replication (Messelson and Stahl's experiment); Telomerase assistedend-replication of linear DNA 4. Study of structures of: tRNA (2D and 3D); prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs 5. Study of the following through photographs: Assembly of Spliccosome machinery; Splicing mechanism in group I & group II introns; Ribozymes and Alternative splicing 6. Understanding the regulation of lactose (lac) operon (positive & negative regulation) and tryptophan (tryp) operon (Repression and De-repression & Attenuation) through photographs. 7. Understanding the mechanism of RNAi by photographs
IV	**A. Genetic Engineering:** 1.Isolation of protoplasts. 2. Construction of restriction map of circular and linear DNA from the data provided. 3. Isolation of plasmid DNA. 4. Restriction digestion and gel electrophoresis of plasmid DNA (demonstration/ photograph). 5. Calculate the percentage similarity between different cultivars of a species using RAPD profile. Construct a dendrogram and interpret results. 6. Agarose gel analysis of plasmid DNA 7. Restriction digestion of plasmid DNA -Demonstration of PCR **B. Applications of Genetic engineering:** 1. ELISA Test, 2. Viability tests of cells 3. Study of methods of gene transfer through photographs: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment. 4. Study of steps of genetic engineering for production of Bt cotton, Golden rice, FlavrSavr tomato through photographs.

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Programme: BSc
Subject: Botany

Syllabus

Semester	VI	
Course Code	B040601T / Paper-I	
Course Title	**Cytogenetics, Plant Breeding & Nanotechnology**	
Credit	4	Maximum Marks: 75 (50 External + 25 Internal)

Course Objective:
To impart knowledge on chromosomes, plant breeding and statistical procedures, techniques and applications of plant tissue culture, nanotechnology, artificial intelligence and digital technologies and their applications in botany.

Learning Outcomes: After successful completion of the syllabus, learners will be able to:

- To analyze and interpret chromosome structures and to identify genetic abnormalities.
- To understand genetic basis of diseases, useful particularly for careers in medical genetics and genetic counseling.
- To understand the method plant breeding for improving crop quality and yield.
- To study nanotechnology and its applications for the careers in healthcare, electronics, and materials development

Unit	Course Content
I	**C. Cell biology** Structure and function of cell and cell organelles, Organization of nucleus and nucleolus, chromatids, centromere, telomere, satellite, secondary constriction, Organization of chromosomes, Lampbrush chromosomes and polytene chromosomes, Karyotype and ideogram, Cell cycle, open and closed mitosis, meiosis **D. Genetics** Euploidy and aneuploidy, deletion, duplication, inversion and translocation, polyploidy- significance, Chromosome theory of inheritance, crossing over and linkage, Incomplete dominance and codominance, Interaction of Genes, Extra-nuclear Inheritance, Linkage, crossing over, Patterns of Sex determination in plants
II	**E. Plant breeding** Procedure of introduction – Acclimatization – Achievements, mass selection, pure line selection and clonal selection, Hybridization procedure, inter-generic, inter-specific, inter-varietal hybridization, Composite and synthetic varieties, Male sterility, Heterosis, Mutation, Molecular Breeding, achievements in India, Breeding for pest, pathogenic diseases and stress resistance **F. Biostatistics** Definition, statistical methods, basic principles, variables- measurements, functions, Data, Sample, Population, random sampling, Frequency distribution, 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, SPSS
III	**G. Plant tissue culture** Principles, components and techniques of in vitro plant cultures, Callus cultures, Cell culture, Cell suspension cultures, Embryogenesis and organogenesis, Protoplast – isolation, culture and application, Protoplast fusion and somatic hybridization, Somaclonal variation, Plant secondary metabolites production. **H. Nanotechnology** Fundamentals of nanoscale self-assembly process involved in Nucleic acid (DNA and RNA), Proteins, Enzymes, Cell membrane, Liposomes and assembly of microorganisms (virus), Nano-particles synthesis, biological synthesis of Nanoparticles, Advantages and applications of biologically synthesized nanomaterials, Biomineralization, Magnetosomes, Nano-pesticides, Nano-fertilizers, Nano-sensors
IV	**I. Artificial Intelligence in Plant Sciences** Big Data Analytics, 3-D Printing, Algorithms of Machine Learning, Expert systems and Fuzzy logic, Agents and Robotics, IoT Sensors, Object Image capture & analysis, Artificial Neural Networks in Plant Science. **J. Introduction to use of Digital technologies – AI, IoT & ICT in Botany** Educational software – INFLIBNET, NICNET, BRNET, Google scholar, Science direct, Resource management, Weather forecasting, IoT Database management, IoT Graphical user interface, ICT Applications for different crops and horticulture

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Programme: BSc
Subject: Botany

Syllabus

Semester	VI	
Course Code	B040602T / Paper-II	
Course Title	Ecology & Environment	
Credit	4	Maximum Marks: 75 (50 External + 25 Internal)

Course Objective:
To understand the ecological concepts, ecosystems, populations, communities, and the interactions and to raise awareness about contemporary environmental issues such as climate change, habitat loss, pollution, and biodiversity loss.

Learning Outcomes: After successful completion of the syllabus, learners will be able to:
- Acquaint the students with complex interrelationship between organisms and environment;
- Understand methods to study vegetation, community patterns and processes, ecosystem functions, and phytogeography.
- To apply the knowledge in evolving strategies for sustainable natural resource management and biodiversity conservation.

Unit	Course Content
I	**Natural Resources & Sustainable Utilization** Natural resources: definitions and types; land resources: land utilization, land degradation and management strategies; wetlands: definitions, importance, threats and management strategies, Ramsar sites: forests resources: major and minor forest products, depletion and management strategies; energy resources: renewable and non-renewable; Contemporary practices in resource management: EIA, PRA, carbon footprint. **Ecology & Ecosystem:** Ecology: definitions, ecological factors; population: characteristics and dynamics, species interaction, ecotype, indicator species; community: characteristic and dynamics (succession), hydrosere, xerosere, habitat and niche; ecosystem: concept, structure, function, and types; food chains, food webs, ecological pyramids; production and productivity; ecological adaptation.
II	**Soil Formation, Properties & Conservation** Soil: origin, formation, composition, types, profile; soil erosion; soil conservation methods; biogeochemical cycles; watershed management; soil reclamation. **Biodiversity and its conservation:** Biodiversity: concept, types (genetic, species, and ecosystem diversity) and values (social, ethical, aesthetic and option values); threats to biodiversity; hot and hottest spots; endangered plants in India; conservation of biodiversity: ex-situ and in-situ conservation; botanical gardens, sanctuaries, national parks, and biosphere reserves; red data book; seed bank, gene bank, ecotourism, NBPGR, BSI.
III	**Phytogeography:** Static and dynamic phytogeography; basic principles of dynamic phytogeography; endemism; plant migrations and barriers; botanical regions of India. **Environmental Audit & Sustainability** Environmental audit: concept, methods and some industrial case studies; environmental standards: ISO 14000 series; scheme of labelling of environment friendly products (Ecomark); life cycle analysis; energy and green audit; sustainable development: concept, SDGs.
IV	**Pollution, Waste management & Circular Economy** Environmental pollution: definitions, types, causes and effects; pollution control measures: educational, technological and legal; bioremediation; solid-waste management, climate change, global warming, acid rain and ozone layer depletion; GAP; circular economy and sustainability. **Environmental Ethics, Carbon Credits & Role of GIS** Concept of carbon credit and carbon sequestration; GPS: concept and applications; GIS: definitions and components; remote sensing and GIS in land use planning, forest resources & agriculture studies.

References:

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Programme: BSc
Subject: Botany

Syllabus

Semester	VI	
Course Code	B040603P / Paper III (Practical)	
Course Title	**Lab on Cytogenetics, Conservation & Environment management**	
Credit	2	Maximum Marks: 50

Course Objective:
To understand the ecological concepts, ecosystems, populations, communities, and the interactions and to raise awareness about contemporary environmental issues such as climate change, habitat loss, pollution, and biodiversity loss.

Learning Outcomes: After successful completion of the syllabus, learners will be able to:

- Perform all experiments related to the semester-i.e. Plant tissue cultured plants, conducting breeding on field, conserving and depolluting the environment.
- Get employment in environment impact assessment companies & start his own venture
- Apply the knowledge in evolving strategies for sustainable natural resource management and biodiversity conservation.

Unit	Course Content (Any five practical from each Unit)
I	**A. 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); 4. Study of different mitotic stages in pre-fixed root tips of Allium cepa. **B. 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; b. Dominant epistasis; c. Complementary genes; d. Duplicate genes with cumulative effect; e. Inhibitory genes; **4.** Observe the genetic variations among inter and intra specific plants. **5.** Demonstration of Breeding Techniques-Hybridization, case studies of mutation, polyploidy, emasculation experiment
II	**A. Biostatistics: 1.** Univariate analysis of statistical data: Statistical tables, mean, mode, median, standard deviation and standard error (using seedling population / leaflet size). 2.Calculation of correlation coefficient values and finding out the probability. **3.** Determination of goodness of fit in Mendelian 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. **4.** Computer application in biostatistics - MS Excel and SPSS. **B. Plant tissue culture:1.** Familiarization of instruments and special equipment used in the plant tissue culture experiments; **2.** Preparation of plant tissue culture medium, and sterilization, Preparation of stock solutions of nutrients for MS Media; **3.** Surface sterilization of plant materials for inoculation (implantation in the medium); **4.** Micropropagation of potato/tomato/ - Demonstration; **5.**Protoplast isolation and culturing – Demonstration
III	A. **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. **5.** Field visit to familiarize students with ecology of different sites. **B. 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-On Map.
IV	**A. Biodiversity and Phytogeography:** 1. 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). 2. Marking of vegetation types of India, World & Uttar Pradesh on maps. 3. Phytogeographical areas of India. **B. Pollution &Waste management:** 1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter. 2.Estimation of chloride and dissolved oxygen content in water sample. 3.Comparative anatomical studies of leaves form polluted and less polluted areas. 4. Measurement of dissolved O2 by azide modification of Winkler's method. 5.Determination of dissolved oxygen of water samples from polluted and unpolluted sources. 6.Microbiological assessment of drinking water using MPN technique- water from well, river, water supply department and packaged drinking water. 7. Making kitchen waste from compost/vermicompost by Enzymes/Bio decomposer/ Whey with dung. **C. Climate Change, Carbon Credits &Role of GIS:** 1. Conducting Waste Audit of your Institution -Demo; 2. Green auditing of the College/University -Demo

References:

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Programme: BSc
Subject: Botany

Syllabus

Semester	VII	
Course Code	B040701T /Paper-I	
Course Title	**Plant Virology & Bacteriology**	
Credit	4	Maximum Marks: 75 (50 External + 25 Internal)

Course Objective:
To understand the complexity of nature and society, this in turn provides different health, environmental, social, cultural, industrial and economic benefits of microbes.

Learning Outcomes: After successful completion of the syllabus, learners will be able to:

- Learn about viruses and bacteria are most famous for their ability to cause disease.
- Understand about microorganisms which are also vital to agriculture, industry and ecology.
- Uunderstand that life on Earth would not survive without microorganisms.

Unit	Course Content
I	– History of virology. – Nature, morphology and genome organization of plant viruses. – Nomenclature and classification of plant viruses. – Morphological, anatomical, and biochemical changes in virus-infected plants. – Transmission of plant viruses and their relationship with vectors. – Methods to control plant-virus diseases.
II	– Replication of plant viruses. – Structure and replication of viroids, virusoids and prions. – Structure and replication of bacteriophages: lytic and lysogenic cycles. – Technique in plant virology: – Detection: Indicator plants, serological methods, molecular methods. – Purification: culture and extraction. – Electron microscopy.
III	– History of bacteriology. – Classification of bacteria based on Bergey's Manual of Systematic Bacteriology (2nd Edition): Archaea, Proteobacteria, Firmicutes, Other gram-negative bacteria, and actinobacteria. – Structure and reproduction of bacteria. – Bacterial genetics: genome structure (chromosomal and extra-chromosomal) and recombination. – A general account of Phytoplasma, iii. Economic importance of bacteria.
IV	– Bacterial nutrition: types and their metabolism. – Role of bacteria in nutrient cycling in nature. – Bacterial staining: requirements, types and methods. – Sterilization: physical and chemical methods; antibiotics and their mode of action. – ii. Bacterial culture: requirements, types and methods; isolation; culture media; growth curves. iii. Fermentation in bacteria; bioreactor.

References:

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- Mahapatra, P.K. (2008). Textbook of Environmental Microbiology. IK International Publishing House Pvt. Ltd., New Delhi.
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Programme: BSc
Subject: Botany

Syllabus

Semester	VII	
Course Code	B040702T / Paper-II	
Course Title	Mycology	
Credit	4	Maximum Marks: 75 (50 External + 25 Internal)

Course Objective:
To learn about the world of fungi and understand the economic and pathological nature of fungi.

Learning Outcomes: After successful completion of the syllabus, learners will be able to:

- Discuss the importance of fungi in various ecological roles.
- Understand how fungi impact human affairs.
- Discuss the characteristics of the major classes and orders within the fungal kingdom.
- Identify the major families and certain species of mushrooms and other macro-fungi.
- Demonstrate a working knowledge of how fungi grow and reproduce, and where and how they can be isolated.

Unit	Course Content
I	– History of mycology. – Thallus organization, cell ultrastructure; cell wall composition; nutrition for growth and reproduction. – Mode of Reproduction; sex hormones in fungi. – History of classification of fungi. – Classification of fungi based on Alexopoulus and Mims (1979). – Status of fungi.
II	– Fossil fungi. – Heterokaryosis; parasexuality; heterothallism. – Fungi as Biocontrol agents and its mechanism. – Fungal ecology. – Isolation and culture of fungi – Economic importance of fungi
III	– Characteristic features, phylogeny, and interrelationships of principal orders of the classes of fungi. – Study of genera: **Myxomycetes**– *Stemonitis*; **Chytridiomycetes**– *Synchytrium*; **Oomycetes** – *Saprolegnia, Phytophthora*; **Zygomycetes** – *Pilobolus*
IV	– Study of genera: Ascomycetes – *Taphrina*, *Saccharomyces*, *Penicillium* – Study of genera: Basidiomycets– *Puccinia*, *Melampsora*, *Ustilago*; – Deuteromycetes– *Fusarium*, *Alternaria*

References:

- Alexopoulus, C.J. and Mims, C.W. (1979). Introductory Mycology, 3rd Edition, John Wiley & Sons, Inc., New York.
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Programme: BSc
Subject: Botany

Syllabus

Semester	VII	
Course Code	B040703T / Paper-III	
Course Title	Phycology & Lichens	
Credit	4	Maximum Marks: 75 (50 External + 25 Internal)

Course Objective:
To learn why algae and Lichen are included in the plant kingdom and their economic importance

Learning Outcomes: After successful completion of the syllabus, learners will be able to:

- Gain adequate knowledge on comparative account of various algal divisions.
- Study and impart knowledge about the occurrence, distribution, structure and life history of lower plants such as algae and lichens.
- Learn the phylogeny and evolutionary concepts in lower group of organisms.
- Use the knowledge of this course for industrial production of many substances like agar-agar (used in ice creams and one of the components of culture media).

Unit	Course Content
I	– History of phycology – Thallus organization, cell ultrastructure; cell wall composition; nutrition; growth – Reproduction; spores; life cycles in algae; – Classification of algae: history and present status – Evolutionary trends in algae – Fossil algae
II	– Algal ecology – Isolation and culture of algae – Economic importance of algae – Characteristic features, phylogeny, and interrelationships of principal orders of the classes of algae (Fritsch, 1945).
III	– Study of genera: Chlorophyceae – *Eudorina, Chlorella, Ulva, Cladophora, Fritschiella, Bulbochaete, Zygnema, Caulerpa, Nitella.* – Study of genera: Xanthophyceae – *Botrydium;* Bacillariophyceae – *Navicula* Phaeophyceae – *Dictyota, Laminaria, Fucus;* Cyanophyceae – *Gloeotrichia, Stigonema;* Rhodophyceae – *Gelidium, Gracilaria*
IV	– History of Lichenology – Classification and distribution – Structure and reproduction of lichens – Ecology, physiology and chemistry of lichens – Isolation of symbionts and synthesis of thallus – Economic importance of lichens

References:

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- Round, F.E. (1986). The Biology of Algae. Cambridge University Press, Cambridge.
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Programme: BSc
Subject: Botany

Syllabus

Semester	VII	
Course Code	B040704T / Paper-IV	
Course Title	Bryology	
Credit	4	Maximum Marks: 75 (50 External + 25 Internal)

Course Objective:
To develop understanding about the diversity, identification, classification and economic importance of these lower and first land plants.

Learning Outcomes: After successful completion of the syllabus, learners will be able to:

- Identify the main characteristics of bryophytes.
- Discuss the distinguishing traits of liverworts, hornworts, and mosses.
- Know about development of land adaptations in the bryophytes.
- Describe the events in the bryophyte lifecycle.

Unit	Course Content
I	– History of Bryology – Classification of bryophytes: history and present status – Geographical distribution of bryophytes with special reference to India – Range of gametophytic structure in bryophytes – Range of sporophytic structure in bryophytes – Reproductive biology of bryophytes
II	– Fossil bryophytes – Origin and evolution of principal classes of bryophytes – Evolution of sporophyte in bryophytes – Economic importance of bryophytes – Ecology and physiology of bryophytes – Axenic culture of bryophytes
III	– Characteristic features of principal orders of the class Hepaticopsida. – Study of genera: *Calobryum*, *Porella*, *Plagiochasma* – Characteristic features of principal orders of the class Anthocerotopsida. – Study of genera: *Anthoceros*, *Notothylas*
IV	– Characteristic features of principal orders of the class Bryopsida. – Peristome structure and its significance in the classification of mosses – Study of genera: *Sphagnum*, *Andraea*, *Polytrichum*, *Takakia*

References:

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Programme: BSc
Subject: Botany

Syllabus

Semester	VII	
Course Code	B040705P / Paper V	
Course Title	Practical	
Credit	4	Maximum Marks: 100 (75 External + 25 Internal)

Course Objective:
To gain practical knowledge of microbial flora isolation and culture and to understand about lower group of plants.

Learning Outcomes: After successful completion of the syllabus, learners will be able to:
- Handle different instruments used in Microbiology.
- Isolate and culture different microbes.
- Understand and identify common Fungal diseases.
- Understand and identify lower group of plants like Algae and Bryophytes.

Unit	Course Content
I	**Paper I- Plant Virology and Bacteriology** 1. Preparation of Nutrient media and sterilization technique 2. Gram's staining of bacteria 3. Inoculation techniques for growth of bacterial population 4. Isolation of microorganisms from different natural sources- soil, water and sewage 5. Bacteriological examination of water, milk and milk product 6. Symptomatology of virus
II	**Paper II- Mycology** 1. Study of following genera of fungi- (On the availability of material) *Synchitrium, Saprolegnia, Phytophthora, Pythium, Taphrina, Penicillium, Phyllactinia, Puccinia, Melampsora, Ustilago, Colletotrichum, Alternaria, Cercospora,* 2. Isolation and culture of fungi 3. Herbarium (Plant / plant parts with fungal diseases)
III	**Paper III- Phycology and Lichen.** 1. Study of following genera *Eudorina, Chlorella, Ulva, Cladophora, Fritschiella, Bulbochaete, Zygnema, Caulerpa, Nitella, Gloeotrichia, Stigonema, Botrydium, Navicula, Ectocarpus, Dictyota, Laminaria, Batrachospermum, Gelidium, Polysiphonia, Gracilaria* 2. External morphology and preparation of slides of Lichens
IV	**Paper IV- Bryology** 1. Study and Identification of following genera with suitable preparation *Plagiochasma, Porella, Anthoceros, Notothylas, Sphagnum, Polytrichum*

References:
- As mentioned in theory papers.

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Subject: Botany

Syllabus

Semester	VIII	
Course Code	B040801T / Paper-I	
Course Title	Pteridology	
Credit	4	Maximum Marks: 75 (50 External + 25 Internal)

Course Objective:
To impart knowledge about the general characters, classification, distribution, morphology, anatomy, reproduction, life cycle and economic importance of Pteridophytes.

Learning Outcomes: After successful completion of the syllabus, learners will be able to:
- Understand the morphological diversity of Pteridophytes.
- Understand the economic importance of the Pteridophytes.
- Know the evolution of Pteridophytes.

Unit	Course Content
I	– General characters of Pteridophytes – Classification of Pteridophytes. – Ecology and distribution of Pteridophytes. – Origin and evolution of Pteridophytes. – Telome theory and evolution of stellar system. – Heterospory, seed habit, Apogamy and Apospory. – Physiology of germination of spores and development of fern prothallus.
II	– Classification, distribution, morphology, life history and phylogeny of Psilophyta with special reference to genera- *Rhynia, Psilotum* – Classification, distribution, morphology, life history and phylogeny of Lycophyta with special reference to genera: *Lycopodium, Selaginella, Isoetes*
III	– Classification, distribution, morphology, life history and phylogeny of Sphenophyta with special reference to genera- *Sphenophyllum, Equisetum, Calamites* – Classification, distribution, morphology, life history and phylogeny of Filicophyta with special reference to genera- *Ophioglossum, Osmunda*
IV	– Classification, distribution, morphology, life history and phylogeny of Filicophyta with special reference to genera- *Pteris, Adiantum, Cyathea, Marsilea, Azolla*

References:

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Subject: Botany

Syllabus

Semester	VIII	
Course Code	B040802T / Paper-II	
Course Title	Gymnosperms & Palaeobotany	
Credit	4	Maximum Marks: 75 (50 External + 25 Internal)

Course Objective:
To impart knowledge about the general characters, classification, distribution, morphology, anatomy, reproduction, life cycle and economic importance of Gymnosperms.
To understand about Paleobotany.

Learning Outcomes: After successful completion of the syllabus, learners will be able to:

- Understand the type of seeds produced by gymnosperms, as well as other characteristics of gymnosperms
- Know which period saw the first appearance of gymnosperms and explain when they were the dominant plant life on
- earth.
- Enlist the groups of modern-day gymnosperms and provide examples of each.
- Understand about significance of Paleobotany and its applications.

Unit	Course Content
I	– General characteristics of Gymnosperms. – Classification of Gymnosperms. – Distribution of Gymnosperms with special reference to India. – Origin and evolutionary tendencies in Gymnosperm. – Cytology of Gymnosperms – iii. Economic importance of Gymnosperms
II	– Study of morphology, structure, life history, interrelationship and phylogeny of – class Cycadopsida with special reference to the following extinct and extant genera: *Glossopteris, Zamia.* – *Williamsonia, Cycadeoidea* (*Bennittites*), *Pentoxylon.*
III	– Study of morphology, structure, life history, interrelationship and phylogeny of – class Coniferopsida with special reference to the following extinct and extant genera: – *Cordaites, Ginkgo.* – *Araucaria, Thuja, Taxus.*
IV	– Study of morphology, structure, life history, interrelationship and phylogeny of – class Gnetopsida with special reference to the following extant genera: *Ephedra, Gnetum, Welwitschia* – Palaeobotany – Types of Fossils, their methods of preservation and methods of study. – Applied Palaeobotany: Carbon dating, palaeobotany of coal and petroleum, palynology. – Study of Indian Fossil Flora: Gondwana Flora, The Rajmahal Flora, Deccan – Intertrappean Flora.

References:

- Beck, C.B. (2006). Origin and Evolution of Gymnosperm. Columbia University Press.
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- Chamberlain, C.J. (1998). Gymnosperms Structure & Evolution. CBS Publisher & Distributors, New Delhi.
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Programme: BSc
Subject: Botany

Syllabus

Semester	VIII	
Course Code	B040803T / Paper-III	
Course Title	**Angiosperms: Taxonomy, Morphology & Economic Botany**	
Credit	4	Maximum Marks: 75 (50 External + 25 Internal)

Course Objective:
To provide a convenient method of classifying the flora and identification of plants.

Learning Outcomes: After successful completion of the syllabus, learners will be able to:
- Develop understanding of plant morphology, terminologies and identifying morphological peculiarities.
- Understand the systems of classification of angiosperms, nomenclature and interdisciplinary approaches.
- Recognize members of the major angiosperm families by identifying their diagnostic features and economic importance.
- Evaluate the economically important selected angiosperms.

Unit	Course Content
I	**Taxonomy** – History of plant taxonomy; Systems of Classification: History, outlines, basis, merits and demerits of following classifications- Bentham and Hooker, Hutchinson, Takhtajan, Cornquist – ICBN - History, Principles and Application. – Field and herbarium techniques. – Herbaria and Botanical Gardens of India and World, Organisation and activities of BSI. – Taxonomy as a synthetic discipline, Modern trends of taxonomy: Morphology, Cytology, Nucleic Acid Hybridization, Chemotaxonomy, numerical taxonomy and serotaxonomy.
II	– General knowledge of the distinguishing features of the following **Dicot** families with special reference to best flora: – **Polypetalae** - Ranunculaceae, Capparaceae, Caryophyllaceae, Tiliaceae, Rutaceae, Rosaceae, Fabaceae, Mimosaceae, Caesalpiniaceae, Moraceae, Myrtaceae, Cucurbitaceae, Apiaceae. – **Gamopetalae** - Rubiaceae, Asteraceae, Asclepiadaceae, Scrophulariaceae, Acanthaceae, Verbenaceae, Lamiaceae – **Monochlamydeae** - Amaranathaceae, Polygonaceae, Euphorbiaceae,.
III	– General knowledge of the distinguishing features of the following: **Monocot** families with special reference to best flora: Orchidaceae, Liliaceae, Zingiberacea, Commelinaceae, Arecaceae, Cyperaceae, Poaceae. **Morphology:** – Phylogeny and interrelationship of Angiosperm; – Morphology of flower with special reference to the morphology of carpel and inferior ovary.
IV	**Economic Botany** – Scope of economic botany, study of economically important plants and plant products. – Forest Products: a) Wood, Timber and Lumber. b) Resins, gum, tanning, material and cork. c) Rubber and other latex products. – Textile plants and products: A general account. – A general account of fumitories, masticatories, narcotics and insecticides as plant products. – Important medicinal plants and products

References:

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Programme: BSc
Subject: Botany

Syllabus

Semester	VIII	
Course Code	B040804T / Paper-IV	
Course Title	**Ecology, Biodiversity and Plant-Soil Relationship**	
Credit	4	Maximum Marks: 75 (50 External + 25 Internal)

Course Objective:
to understand the nature of environmental influences individual organisms, population and communities.

Learning Outcomes: After successful completion of the syllabus, learners will be able to:
- Identify soil types and know ways to conserve the soil, as well as to reduce soil erosion.
- Understand functional traits on population, community and landscape level interactions between plants and the biotic and abiotic environment.
- Understand diversity and distribution, restoration of plant communities and conservation of plants.

Unit	Course Content
I	– Plant Ecology and its scope. – Autecological studies, gene ecology with emphasis on Indian work – Plant communities: characteristics and its classification. – Life-forms. – Plant community dynamics and development: succession and climax. – Population ecology. – Ecological niche.
II	– Study of different types of Ecosystems. – Ecological energetic. – Biogeochemical cycles in ecosystem with special reference to Carbon and Nitrogen – Production ecology, measurement of primary productivity. – Ecological adaptation of plants in different ecosystems. – Environmental pollution and its consequences
III	**Biodiversity and its conservation:** – Introduction to Biodiversity. – Levels of Biodiversity: Genetic species community and Ecosystem. – Mega diversity Zones and Hot spots. – Threats to Biodiversity: Causes of Biodiversity loss species extension. – Red Data Book. IUCN threat categories. – Strategies for Biodiversity conservation: ***in-situ*** and ***ex-situ*** conservation.
IV	**Plant-soil relationship** – Soil: its origin, formation and development. – Soil profile. – Soil properties in relation to plant growth. – Soil types of India with special reference to U.P. – Soil erosion: its causes and effects on environment. – Methods of soil conservation

References:

- Ambasht, R.S. & Ambasht, N.K. (2008). A Text Book of Plant Ecology. CBS Publishers Ltd., N.Delhi.
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Subject: Botany

Syllabus

Semester	VIII	
Course Code	B040805P / Paper-V	
Course Title	Practical	
Credit	**4**	Maximum Marks: 100 (75 External + 25 Internal)

Course Objective:
To impart practical knowledge of studying structures of different plant groups as Pteridophytes, Gymnosperms and Angiosperms.

Learning Outcomes: After successful completion of the syllabus, learners will be able to:

- Understand plant diversity of Pteridophytes and Gymnosperms, as well as evolutionary trends.
- Describe locally available plants and their taxonomic classification.
- Understand the concept of ecosystem, Ecological adaptations and importance of environmental awareness.

Unit	Course Content
I	**Paper I- Pteridology** 1. Monographic study of the sporophyte body of the following: *Lycopodium, Selaginella, Sphenophyllum, Equisetum Calamites, Ophioglossum, Osmunda, Pteris, Adiantum, Cyathea, Marsilea, Azolla*
II	**Paper II- Gymnosperms and Palaeobotany** 1. A study of representative types: *Zamia, Ginkgo, Araucaria, Thuja, Taxus, Ephedra, Gnetum* 2. Study of fossils and fossils slides
III	**Paper III- Angiosperms: Taxonomy, Morphology and Economic Botany** 1. Description of local plant in semi technical language 2. Identification of Angiospermic plants of known family up to the level of genus and species with the help of flora 3. Study of all economically important plants and their products included in syllabus **Note:** Compulsory excursion- Students have to collect and submit at least 100 plants properly pressed, mounted and arranged according to Bentham and Hooker's classification on Herbarium sheets.
IV	**Paper IV- Ecology and Plant soil Relationship** 1. Autecology observations on selected plant species 2. Study of the vegetation by: i. Transect method, ii. Quadrate method, and iii. Point method 3. Study of the environmental factors: i. Climatic factors and their measurement, ii. Edaphic factors, mineral composition of soil, pH, soil profile, moisture content,nitrate, calcium, carbonate, and iii. Water Analysis 4. Measurement of Biomass

References:

- As mentioned in theory papers.