Bot/PB/274

CHAUDHARY CHARAN SINGH UNIVERSITY, MEERUT

Proceedings of the meeting of Board of Studies in Botany held on 13.08.2025

A meeting of Board of Studies (University Campus) in the subject of Botany in Chaudhary Charan Singh University, Meerut was held on August 13, 2025 at 11.30 a.m. in hybrid mode. The following members were present:

1.	Prof. Jaimala	Dean, Science faculty
2.	Dr. Ramakant	Convener-I
3.	Prof. Vijai Malik	Member
4.	Prof. Sheesh Pal Singh	Convener-II
5.	Smt. Nirlep Kaur	Member
6.	Dr. Anita Pawar	Member
7.	Prof. Rajesh Tandon	External Expert
8.	Prof. A. N. Singh	External Expert
9.	Prof. A. K. Mishra	External Expert (Online present)
10.	Dr. M. P. Tyagi (Retd.)	Principal (Online present)
11.	Prof. Dinesh Kumar Sharma	Professor/Director of Research Institute

The Board met for the formulation of the syllabus of the subject Botany for B.Sc. (H) courses. The Board unanimously prepared and approved the syllabus for the same after thorough discussions. The courses are applicable to the university campus. A copy of the finalized syllabus is enclosed herewith.

(Prof. Rajesh Tandon) 13/8/25
External Expert

(Prof. A. N. Singh) 13/08/2025
External Expert

(Prof. A. K. Mishra)*
External Expert

Nirlep Kaur 13/08/2025
(Smt. Nirlep Kaur)
Member

(Dr. Anita Pawar) 13/08/25
Member

V. Malik
(Prof. Vijai Malik)
Member

*(Dr. M. P. Tyagi (Retd.)
Principal

(Prof. Dinesh Kumar Sharma)
Prof./Director of Research Institute

13-08-2025
(Prof. Jaimala)
Dean, Science faculty

(Dr. Ramakant) 13/8/25
Convener-I

13/08/2025
(Prof. Sheesh Pal Singh)
Convener-II

Hon'ble Vice Chancellor

Kindly allow the enclosed syllabus to put in Academic Council for approval and to implement from the session 2025-2026.

(Hon'ble Vice Chancellor)

*Joined online

Enclosure/Annexure 1

Chaudhary Charan Singh University, Meerut

Syllabus of B.Sc. (Botany Honours); CBCS
(Hybrid mode BoS held on 13-08.2025; effective from 2025-2026 onwards)
(For Second Year of UG)
(As per guidelines of U.P. Government in accordance with
National Education Policy-2020 *w.e.f.* the session 2025-2026)
(For University Campus)

Subject: B.Sc. Botany (Honours) Semester III		
Course Code :	Core Course IX: Plant Physiology	
Objectives: To study plant physiology, plant-cell-water relation, role of hormones, PGRs and effect of stress conditions on plants. **Course Outcome:** After the completion of the course the students will be able to understand: 1. plant water relation and solute transport and its mechanism. 2. mineral nutrition, plant growth and development, and the impact of environmental factors on plants. 3. plant hormones and plant growth regulator and their mechanism. 4. effect of light on plant physiological processes. 5. plant life under various type of stress conditions. 6. develop practical skills in conducting experiments and analysing data related to these processes.		
Credits: 5	Core course	
Max Marks: 100 (25+75)	Min. Passing Marks: 36	
Total no of Lectures-Tutorials-Practical`s (in hours per week):3-0-0		
Unit	**Topic**	**No. of Lectures (45 hrs)**
I	**Water soil-plant relations:** Colloidal systems. Water as a universal solvent, osmosis, osmotic pressure, diffusion, diffusion pressure deficit, wall pressure, turgor pressure, water potential, osmotic potential. Active and passive absorption of water. Factors affecting water absorption. Role of micro and macro mineral nutrients, their physiological functions and deficiency symptoms. Hydroponics.	10
II	**Driving forces and resistances in transpiration:** stomatal movement mechanism. Ascent of sap. Translocation of solutes in plants: Stress Physiology: Plant response to biotic and abiotic stresses, mechanism of stress tolerance, HR and SAR, water deficit and drought resistance mechanism of salinity, metal toxicity, freezing, heat and oxidative stress resistance.	10
III	**Plant Hormones and Growth Regulators:** Physiological role, mechanism of action, bioassay and practical applications of Auxins, Gibberellins and Cytokinins; PGRs: Structure and functions of ABA, Ethylene, Ascorbic Acid, Brassinosteroids, Polyamines, Jasmonic acid and Salicylic acid.	10
IV	**Sensory photobiology**: Overview of phytochromes, cryptochromes and phototropins. Photoperiodism; Photoinduction and vernalization, Role of florigen, vernalin, and phytochrome.	08
V	**Dormancy:** Dormancy of seeds and buds, gene expression during dormancy. Seed germination, mobilization of reserved food material. Endogenous rhythms. Plant movements. Ageing and Senescence.	07

Essential Readings:

1. Srivastava, H.S. (2005). Plant Physiology, Biochemistry and Biotechnology ; Author, Publisher, Rastogi Publications, Meerut
2. Srivastava, H.N. (2022). Textbook of Plant Physiology. Rastogi Publications, Meerut

3. Jain, V.K. (2018) Fundamentals of Plant Physiology (19th Edition). S. Chand Publishing, New Delhi

Suggested Readings:

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U. S.A. 4th edition.
2. Bajracharya, D. (1999). Experiments in Plant Physiology-A Laboratory Manual. Narosa Publishing House, New Delhi.
3. Verma, S.K. and Verma, M. (1995). A Textbook of Plant Physiology, Biochemistry and Biotechnology, S.Chand publications, New Delhi
4. Salisbury, F.B. and Ross, C.W. (1992) Plant Physiology. 4th Edition, Wadsworth Publishing, Belmont, 357-381.
5. Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A. (2015). Plant Physiology and Development (6th Edition). 33 Sinauer Associates Inc. USA.

Subject: B.Sc. Botany (Honours) Semester III		
Course Code :	**Core Course X: Plant Taxonomy**	
Objectives: To study classification, nomenclature and phylogenetics of higher Plants. **Course Outcome:** After the completion of the course , students will be able to: 1. apply ICN rules to correctly identify, name, and classify plant taxa. 2. differentiate between artificial, natural, and phylogenetic classification systems. 3. identify and describe major angiosperm families with their economic importance. 4. apply interdisciplinary approaches in studying plant taxonomy		
Credits:3	Core Elective	
Max Marks: 100 (25+75)	Min. Passing Marks: 36	
Total no of Lectures-Tutorials-Practical's (in hours per week):3-0-0		
Unit	**Topic**	**No. of Lectures (45hrs)**
I	**Taxonomic Resources and Nomenclature** Components of taxonomy (identification, nomenclature, classification); Phases of taxonomy. **Taxonomic resources:** Herbarium methodology and Important herbaria, Botanical gardens, Artificial Keys. **Nomenclature: Binomial nomenclature,** Principles and rules of Botanical Nomenclature according to ICN (Taxonomic ranks and taxa; type method, principle of priority, author citation, Effective and valid publication).	10
II	**Systems of classification** **Outlines of Artificial system-** Carl Linnaeus; **Natural system-** Bentham and Hooker; **Phylogenetic system-** Engler and Prantl, Hutchinson's System, Takhtajan System, and APG system.	05
III	**Identification of Angiospermic families-I** Floral Characteristics and economic importance of Plant families (based on Bentham and Hooker's system) Ranunculaceae, Papaveraceae, Malvaceae, Rutaceae, Fabaceae, Myrtaceae, Cucurbitaceae, Apiaceae, Rubiaceae & Asteraceae	10
IV	**Identification of Angiospermic families-II** Floral Characteristics and Economic importance of Plant families (based on Bentham and Hooker's system) Asclepiadaceae, Solanaceae, Acanthaceae, Lamiaceae,Amaranthaceae, Euphorbiaceae, Liliaceae, Musaceae & Poaceae.	10
V	**Approaches in Systematics** Concept of Character; Plesiomorphy and Apomorphy; homology and analogy, parallelism and convergence, monophyly, paraphyly, polyphyly, clades and grades. **Taxonomic evidence:** Morphology, cytology, and phytochemistry. **Phylogenetics:** Phenetics-Principles, steps, Selection of characters, Character coding, Character step matrix, Character x Taxon and Cladistics- Basics and Methodology. Internet directory for Botany & e-flora	10

Essential Readings:

1. Malik, V. Malik, P. & Dev, P. (2023). Flowering plant identification and Aesthetic characteristics. Pragati Publication, Meerut
2. Judd, W. S., Campbell, C. S., Kellogg, E. and Donogue, M. J. (2016). Plant Systematics: A Phylogenetic Approach. Sinauer Assoc., Inc.
3. Jones, Jr S. B. and Luchsinger, A. E. (1986). Plant Systematics. McGraw-Hill, Inc

Suggested Reading:

1. Dallwitz, M. J., Paine, T. A. and Zurcher, E. J. (2003). Principles of interactive keys.
2. http://delta-intkey.com
3. https://www.naace.co.uk/school-improvement/ict-mark/
4. https://www.socitm.gov.uk, (2002) Learning in the 21st century Executive briefing A
5. Socitm Insight publication, Socitm.
6. Stace, C. A. (1989). Plant Taxonomy and Biostatistics (2nd Ed.). Edward Arnold, London.
7. Stuessy, T. F. (1990). Plant Taxonomy. Columbia Univ. Press, New York, NY.
8. Singh, G. (1999). Plant Systematics: Theory and Practice. Oxford and IBH, New Delhi.
9. Jones, S. B. and Luchsinger, A.E. (1986). Plant Systematics, McGraw-Hill.
10. Judd, W. S., Campbell, C. S., Kellogg, E. and Donogue, M. J. (2016). Plant Systematics: A Phylogenetic Approach. Sinauer Assoc., Inc.
11. Radford, A.E. (1986). Fundamental of Plant Systeamtics. Harper and Row, Publisher, Inc.
12. Dutta A.C. (2016). Botany for Degree Students. Oxford University Press.
13. Davis, P. H. and Heywood, V. H.. (1963). Principles of Angiosperm Taxonomy. Oliver and Boyd, London.

Subject: B.Sc. Botany (Honours) Semester III		
Course Code :	Core Course XI: Genetics	
Objectives: To study the principles of inheritance, gene structure and function, chromosomal behaviour, and genetic variation. **Course Outcome:** The students will be able to understand 1. fundamental principles of Mendelian genetics. 2. mechanisms extrachromosomal (cytoplasmic) inheritance. 3. Interpretation of chromosomal aberrations and their phenotypic consequences. 4. Classify types of gene mutations and explain DNA repair mechanisms. 5. the difference between classical and molecular concepts of the gene and its structure and function.		
Credits:3	Core Elective	
Max Marks: 100 (25+75)	Min. Passing Marks: 36	
Total no of Lectures-Tutorials-Practical's (in hours per week):3-0-0		
Unit	**Topic**	**No. of Lectures (45 hrs)**
I	**Mendelian genetics and its extension** Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits, Penetrance and Expressivity, Polygenic inheritance.	10
II	**Extrachromosomal Inheritance** Chloroplast mutation: Variegation in Four O'clock plant; Mitochondrial mutations in yeast; Maternal effects-shell coiling in snail; Infective heredity- Kappa particles in Paramecium.	10
III	**Linkage, crossing over and chromosome mapping** Linkage and crossing over, cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Numericals based on gene mapping; Sex Linkage.	10
IV	**Variation in chromosome number and structure** Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy.	10
V	**Gene mutations** Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Detection of mutations: ClB method.	10

Essential Readings:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley and Sons, India.8thedition.
2. Gupta, P. K. (2025). Genetics. 5th edition. Rastogi Publications, Meerut
3. Singh, P. (2023). Elements of Genetics (6th Edition), Kalyani Publishers. Kolkatya

Suggested Reading:

1. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley and Sons Inc., India. 5thedition.

2. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. Benjamin
3. Cummings, U.S.A. 10th edition.
4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to GeneticAnalysis. W. H. Freeman and Co., U.S.A. 10th edition.
5. Peter J. Russell (1998). Genetics. Edition 5, illustrated. Publisher Benjamin/Cummings, Digitized 2010

Subject: **B.Sc. Botany (Honours) III semester**		
Course Code :	**Practical-3**	
Objectives: To learn about experiments of plant physiology, plant Taxonomy and Genetics. **Course Outcome:** The students will be able to develop experimental and research aptitude about plant physiology, Taxonomy and Genetics.		
Credits:3	Core Elective	
Max Marks: 100	Min. Passing Marks: 36	
Total no of Lectures-Tutorials-Practical's (in hours per week):0-0-6		

Unit	Topic	No. of Lectures (90hrs)
I	**Plant Physiology:** 1. Determination of osmotic potential of plant cell sap by plasmolytic method. 2. Determination of water potential of given tissue (potato tuber) by weight method. 3. Study of the effect of wind velocity and light on the rate of transpiration in excised twig/leaf. 4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte. 5. To calculate the area of an open stoma and percentage of leaf area open through stomata in a mesophyte and xerophyte (both surfaces). 6. To study the phenomenon of seed germination (effect of light). 7. To study the effect of different concentrations of IAA on Avena coleoptile elongation (IAA Bioassay). 8. To study the induction of amylase activity in germinating barley grains. **Demonstration experiments** 1. Suction due to transpiration. 2. Fruit ripening/Rooting from cuttings. 3. Bolting experiment/Avena coleptile bioassay.	30
II	**Plant Taxonomy:** 1. Classify at least 25 plants on the basis of Taxonomic description according to Benthamand Hooker system of classification in the following families: Ranunculaceae, Malvaceae, Rutaceae, Fabaceae, Myrtaceae, Cucurbitaceae, Rubiaceae, Asteraceae, Apocynaceae, Solanaceae, Lamiaceae Euphorbiaceae, Liliaceae,Musaceae, and Poaceae. 2. Field excursions to study local flora. 3. To prepare flowering calendar for your area. 4. 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 5. Exercises based on principle of priority. 6. Exercises bases on new combination. 7. To translate protologue from Latin to English using Species Plantarum 8. To identify plants used during Vedic period. 9. Cladograms construction based on given data. 10. Preparation of Artificial keys.	30

	11. Make line drawing of Plants for description. 12. Phylogenetic Software: PAUP and MESQUITE, Description Language for Taxonomy – DELTA	
III	**Genetics:** 1. Mitosis & Meiosis through temporary squash preparation. 2. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square analysis. 3. Chromosome mapping using test cross data. 4. Pedigree analysis for dominant and recessive autosomal and sex linked traits. 5. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4) 6. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.	30

Subject: **B.Sc. Botany (Honours) III semester**		
Course Code :	**MNGEC III : Morphology of Angiosperms**	
Objectives: To study the morphology and identification of Angiosperms. **Course Outcome:** The students will be able to **1.** identify and describe angiosperm families with their economic importance. **2.** apply interdisciplinary approaches in studying plant taxonomy 3. apply ICN rules to correctly identify, name, and classify plant taxa. **4.** differentiate between artificial, natural, and phylogenetic classification systems		
Credits: 4		Core Elective:
Max Marks: 100 (25+75)		Min. PassingMarks:36
Total no of Lectures-Tutorials-Practical's (in hours per week):4-0-0		

Unit	Topic	No. of Lectures (60 hrs)
I	**Introduction to Plant Morphology and root morphology**: Introduction, Definition; Types of morphology – Descriptive and Interpretative. Importance of Morphology. **Root Morphology:** Structure, Types of root, Modifications of roots.	10
II	**Stem Morphology and Leaf Morphology:** **Stem Morphology:** Structure, Types and modifications of stems **Leaf Morphology:** Structure, Parts, Surface, Venation, Phyllotaxy, Leaf duration ; Types of leaves ; Leaf Modifications and functions	20
III	**Morphology of Inflorescence:** Definition, Parts of Inflorescence. Types of Inflorescence; Racemose, Cymose and (c) Special Types	10
IV	**Morphology of Flower:** Definition, typical structure of flower. Types of flowers based on Symmetry, Insertion of floral whorls on thalamus. Floral whorls Calyx, Modifications of calyx; Corolla Polypetalous, Gamopetalous, Perianth: tepals, number, cohesion, modifications – sepaloid and petaloid tepals. Aestivation– Definition; aestivation in calyx, corolla and perianth; types of aestivation; Androecium: Stamen, Structure of stamen; Cohesion and Adhesion; Gynoecium: Carpel / Pistil; structure of carpel; Types of gynoecium based on carpel number and fusion; Placentation- Definition; types – Marginal, Parietal, Axile, Free-central, Basal, superficial.	15
V	**Morphology of Fruit and Seed**: Fruit: Definition and parts of fruit. Types of fruits **Seed:** Definition, Parts of typical seed. Morphology of Monocot and Dicot seeds	05

Essential Readings:

1. Singh, V. and Jain, D.K. (2010). Taxonomy of Angiosperms. Rastogy Publications, Meerut.
2. Singh, V., Pande, P.C., and Jain, D.K. (2011). A Text Book of Botany: Angiosperms. Rastogy Publications, Meerut.
3. Verma, B. K. (2011). Introduction to taxonomy of Angiosperms. Phi Learning Private Limited, New Delhi

Suggested Reading:

1. Eames, E.J. (1983). Morphology of Vascular Plants. Standard University Press.
2. Gangulee and Kar (2006). College Botany. New Central Book Agency (P.) Ltd. Kolkata.

3. Naik, V.N. (1994). Taxonomy of Angiosperms. Tata McGraw Hill Publishing Comp., New Delhi.
4. Pandey, B.P. (2001). Taxonomy of Angiosperms, S. Chand Publishing, New Delhi

Subject: B.Sc. Botany (Honours) Semester III	
Course Code :	SEC III : Programming for Biologist

Objectives: To study the basics of programming languages and their relevance to biology.

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

1. use the Linux command-line interface and perform essential file operations.
2. write and execute Python by integrating R scripts for data manipulation, analysis, and visualization of biological data.
3. develop proficiency in utilizing relevant bioinformatics libraries, packages, and tools.
4. apply programming skills to solve biological problems and complete practical projects and case studies

Credits:3	Core Elective
Max Marks: 100 (25+75)	Min. Passing Marks: 36

Total no of Lectures-Tutorials-Practical's (in hours per week):1-0-2

Unit	Topic	No. of Lectures (45hrs)
I	**Fundamentals of programming** Overview of programming languages in bioinformatics: Linux, R, Python- Linux Fundamentals: Introduction to the Linux operating system, Basic and advanced commands, file manipulations.	1T+2P
II	**R and Python syntax and packages** R Fundamentals: Introduction to R syntax and data structures, Data manipulation and transformation, Statistical analysis and visualization, Bioconductor packages for genomics analysis- Python Fundamentals: Introduction to Python syntax and data structures, File handling and data input/output, Control structures and loops, Functions and modules-packages: Biopython, Bioconda, Scipy, NumPy, Pandas, Matplotlib, Seaborn, BioPandas, PySCeS, Scikitbio and etc	5T+10P
III	**Integrating Python and R for bioinformatics applications** Interfacing Python and R, Integrating Python libraries with R Advanced Topics and Applications: Introduction to machine learning in bioinformatics using Python.	5T+10P
IV	**Hands-on Training and project** Applying programming skills to solve biological problems: Hands-on projects and case studies.	4T+8P

Essentials Readings:

1. Shotts, W. (2019). The Linux Command Line, 2nd Edition: A Complete Introduction. United States: No Starch Press.
2. Bassi, S. (2018). Python for Bioinformatics. 2nd Edn United Kingdom: CRC Press, Taylor and Francis Group.
3. Jones, M. (2016). Effective Python Development for Biologists: Tools and Techniques for Building Biological Programs. 2nd Edn, United Kingdom: CreateSpace Independent Publishing Platform,

Suggested Readings:

1. Çetinkaya-Rundel, M., Wickham, H., Grolemund, G. R (2023). For Data Science: Import, Tidy, Transform, Visualize, and Model Data. (n.p.) 3rd Edn: O'Reilly Media.

2. Antao, T.(2022). Bioinformatics with Python Cookbook: Learn how to Use Modern Python Bioinformatics Libraries and Applications to Do Cutting-edge Research in Computational Biology. 3rdEdn, United Kingdom: Packt Publishing
3. Alexander Z., Ion M. (2008). Bioinformatics Algorithms: Techniques and Applications. 1stEdn,United Kingdom: Wiley
4. Buffalo, V. (2015). Bioinformatics Data Skills: Reproducible and Robust Research with Open Source Tools. 1st Edn, United States: O'Reilly Media,.
5. Model, M. L.(2010). Bioinformatics Programming Using Python. India 2nd Edn, Shroff Publishers

Subject:B.Sc.Botany (Honours) IV semester	
Course Code :	**Core Course XII: Economic Botany and Pharmacognosy**

Objectives: To study the diversity of economically important plant resources and their product use ranging from traditional to commercial applications.

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

1. understand the origin, centres of diversity, domestication, and introduction of major cultivated plants including cereals and millets.
2. identify key economic plants (legumes, spices, oils, fibers, timber, dyes) with their botanical names, families, parts used, and uses.
3. explain the concept, history, methods, and importance of ethnobotany, especially in relation to Indian tribal medicinal practices.
4. describe the history, principles, and methods of pharmacognosy, including evaluation techniques for crude drugs.
5. conduct pharmacognostic studies on selected medicinal plants and recognize their active and inert constituents.

Credits:3	Core Elective
Max Marks: 100 (25+75)	Min. Passing Marks: 36

Total no of Lectures-Tutorials-Practical's (in hours per week):3-0-0

Unit	Topic	No. of Lectures (45hrs)
I	**Origin and domestication of cultivated plants** **Center of origin:** Centers of diversity of plants, Criteria for center of origin, Vavilov and His contribution, Types of centers of diversity of crop plants, vavilovian centers, Megagene centers. Domestication and introduction of crop plants.	05
II	**Cereals and Millets:** Origin and evolution, Botanical characteristics, cultivation, production and uses of wheat, rice, maize, oat, and major millets.	05
III	**Botany of legumes, Spices, oils, Fibers, timber yielding plants and dyes** Study of the plants with Botanical names, Family, part used, and economic uses of legumes; Spices; Edible and essential oils; Sugar, Starch; Fibers; Paper; Fumigatories and Masticatories; Rubber; Dyes; Timber; beverages; biofuel crops.	10
IV	**Ethnobotany and Literature Resources** **Ethnobotany:** What is Ethnobotany? History of Ethnobotany, Ethnobotanical Literature, Methodologies of ethnobotanical research, Importance of Ethnobotany in Indian System of Medicine (Siddha, Ayurveda and Unani). **Tribes:** clan and tribe, Characteristics of Tribes, Tribes in India, Tribal knowledge towards disease diagnosis, treatment. **Plants used by tribes:** *Aegle marmelos, Eclipta alba, Emblica officinalis*, Ficus religiosa, *Oxalis corniculata, Rauvolfia serpentina*. Contribution of S.K. Jain.	15
V	**Pharmacognosy** History of Pharmacognosy, Preparation of drugs for commercial market, Organoleptic evaluation of drugs, Macroscopic and Microscopic evaluation of drugs, Physical evaluation of drugs, Constituents of drugs: Active and inert constituents of drugs; Classification of natural drug; Crude drugs, Sources of	15

	crude drugs – roots, rhizome, bulb, corm, leaves, stems, flowers, fruits and seeds. Pharmacognostic studies of *Adhatoda vasica, Azadirachta indica, Emblica officinalis, Ocimum temuiflorum, Ricinus communis, and Zingiber officinale.*	

Essential Readings:

1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
2. Kokate, C. and Gokeale, S.B. (2020). Pharmacognosy- Nirali Prakashan, New Delhi.
3. Wallis, T. E. (1946). Text book of Pharmacognosy, J and A Churchill Ltd.

Suggested Readings:

1. Sambamurthy, A.V.S.S. and Subrahmanyam, NS (2000). Economic Botany of Crop Plants. Asiatech Publishers. New Delhi.
2. Malik, V. and Malik, P. (2023). Economic Botany, Ethnomedicine and Phytochemistry byPragati Publication, Meerut.
3. Hanan, J. J. (1997). Greenhouses: Advanced Technology for protected horticulture.CRC Press.
4. Joshi, S. G. (2000). Medicinal Plants. Oxford and IBH, New Delhi.
5. Farooqui, A. A. and Sreeraman, B. S. (2001). Cultivation of medicinal and aromatic crops. Universities Press.
6. Harborne, J. B. (1998). Phytochemical methods – a guide to modern techniques of plant analysis 3rd edition, Chapman and Hall.
7. Kalsi, P. S. and Jagtap, S. (2012). Pharmaceutical medicinal and natural product chemistry. N.K. Mehra for Narosa Publishing House Pvt. Ltd. New Delhi.

Subject: B.Sc. Botany (Honours) Semester IV		
Course Code :	Core Course XIII: Molecular Biology	
Objectives: To study the structure, synthesis and functional interaction of nucleic acids and proteins in relation to regulation of life processes like gene expression and inheritance pattern. **Course Outcome:** After completion of the program, the students will be able to: 1. understand nucleic acids, organization of DNA in Prokaryotes and Eukaryotes, DNA replication mechanism, genetic code and transcription process. 2. Know about the processing and modification of RNA and translation process, function and regulation of expression.		
Credits:3	Core Elective	
Max Marks: 100 (25+75)	Min. Passing Marks:36	
Total no of Lectures-Tutorials-Practical's (in hours per week):3-0-0		

Unit	Topic	No. of Lectures (45hrs)
I	**Structure of Genetic Material** Discovery of nucleic acids, DNA as genetic material, Structure of DNA and RNA, and their forms, Packaging of DNA, Central Dogma of Molecular Biology.	05
II	**Replication** Models of DNA replication, DNA, polymerases, replication origin, replication fork, Molecular Mechanism of DNA, replication in prokaryotes and eukaryotes, Fidelity of DNA replication, Telomeric DNA replication and telomerase. Telomere replication and cell proliferation, DNA damage and repair mechanisms, Transpositions and mechanisms of transposition.	10
III	**Gene Transcription and RNA Modification** Mechanism of transcription in bacteria, Mechanism of transcription in eukaryotes RNA modification: split genes, hnRNA, capping, tailing, splicing, spliceosome, ribozymes, Alternate splicing, RNA editing, Genetic Code: Discovery, cracking of genetic code, and properties	10
IV	**Translation (Protein synthesis)** Relationship between gene and proteins, Structure and function of tRNA, aminoacyl-tRNA synthetases, second half of genetic code. Ribosome: Structure and Assembly, Translation in prokaryotes and eukaryotes: Initiation, elongation and termination.	10
V	**Regulation of Gene Expression** Constitutive genes and necessity of regulation of gene expression, levels of regulation of gene expression, Regulation of gene expression in bacteria: Enzyme adaptation, lac-operon, trp-operon, attenuation, antisense RNA, Regulation of gene expression in λ-phage: Lytic and lysogenic cycle, Regulation of gene expression in eukaryotes: Regulatory transcription factors (RTFs) and their role in gene regulation, chromatin remodelling, histone variations and modifications, DNA methylation, regulation of mRNA processing, mRNA stability, miRNA or siRNA	10

Essential Readings:

1. Gerald Karp, Janet Iwasa, Wallace, Marshall (2021). Karp's Cell and Molecular Biology

(Ninth Edition). Willey
2. Bruce Alberts, Rebecca Heald, Alexander Johnson, David Morgan, Martin Raff, Keith Roberts and Peter Walter (2022). Alberts Molecular Biology of the Cell 7th Edition. Garland Science, Taylor and Francis.
3. Geoffrey, M. Cooper (2018). The Cell a Molecular Approach (8th Ed.) Sinauer Associates.

Suggested Readings:

1. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R. (2008). Molecular Biology of the Gene 6th edition. Cold Spring Harbour Lab. Press, Pearson Pub.
2. Snustad, D. P and Simmons, M. J. (2015). Principles of Genetics 7th Edition, John Wiley and Sons. Inc.
4. Robert J Brooker (1999). Genetics: Analysis and Principles (Sixth Edition). Mc Graw Hill Education.
5. Russell, Peter J. (2014). IGenetics: A Molecular Approach (Third Edition). Pearson Education Limited.

Subject: B.Sc. Botany (Honours) Semester IV		
Course Code :	Core Course XIV: Plant Ecology	
Objectives: To study the components of ecosystem, structure and function of different types of ecosystem. **Course Outcome:** 1. Ability to demonstrate comprehensive understanding of the ecosystem. 2. Ability to describe the ecosystem dynamics. 3. To understand how ecology helps to manage natural resources and sustainability.		
Credits:3		Core Elective
Max Marks:100 (25+75)		Min. Passing Marks:36
Total no of Lectures-Tutorials-Practical's (in hours per week):3-0-0		

Unit	Topic	No. of Lectures (45hrs)
I	**Introduction:** Definition and scope of ecology, Levels of ecological organization: autecology, synecology, ecosystem, biome, biosphere, Abiotic vs. biotic factors, Levels of organization.	10
II	**Abiotic factor:** Soil profile; Role of climate in soil development. Different types of soils, Soil erosion and conservation. Soil moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Light, temperature, and wind.	10
III	**Biotic factors:** Producers, Consumers and different trophic levels, Population ecology, Characteristics and Dynamics. Ecological Speciation, Concept of ecological amplitude; Habitat and niche; Ecotone and edge effect; ecotypes and ecades.	10
IV	**Ecosystems:** Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids, Functional aspects of ecosystem, Principles and models of energy flow; succession – processes, types; climax concepts and adaptations.	10
V	**Ecosystem Productivity and Biomes:** Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of C, N, and P. Brief description of major terrestrial biomes (one each from tropical, temperate and tundra).	5

Essential Readings

1. Odum, E.P. (2005). Fundamentals of ecology, 5th edition. Cengage Learning India Pvt. Ltd., New Delhi.
2. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
3. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.

Suggested Readings

1. Sharma, P.D. (2010). Ecology and Environment (8th edition). Rastogi Publications, Meerut
2. Kormondy, E.J. (1996). Concepts of ecology (4th Edition). PHI Learning Pvt. Ltd., Delhi
3. Manahan S. E. (2006). Environmental Science and Technology-A sustainable approach to Green Science and Technology, Taylor and Francis

Subject: **B.Sc. Botany (Honours) Semester IV**		
Course Code :	**Practical-4**	
Objectives: To learn about experiments of Economic Botany, Pharmacognosy, Molecular Biology and Ecology. **Course Outcome:** To develop experimental and research aptitude about plant resource utilization at various levels, use of plants in Pharmacognosy, gene expression pattern and Ecological processes. (Minimum 10 experiments each)		
Credits:3	Core Elective	
Max Marks: 100 (25+75)	Min. Passing Marks:36	
Total no of Lectures-Tutorials-Practical's (in hours per week):0-0-6		
Unit	**Topic**	**No. of Lectures (90hrs)**
I	**Economic Botany and Pharmacognosy:** 1. Cereals: Wheat and Rice (Habit Sketch, L.S/T.S. grain, W.M. starch grains, Micro-chemical tests). Millets - Pearl Millet, Finger Millet and Pseudocereals - Amaranth Grain, Quinoa (specimens/digital resources and grains). 2. Legumes: Chickpea, pigeon pea (Habit, fruit, seed structure, Micro-chemical tests). 3. Sugars and Starches: Sugarcane (Habit Sketch, Products and By-products, Cane Juice, Micro chemical tests); Potato (Habit Sketch, Tuber morphology, T.S. tuber to show localization of starch grains, W.M. starch grains, Micro-chemical tests). 4. Spices: Clove, Black pepper (Habit and sections L.S./T.S.), Saffron, fennel (specimen/digital resources) 5. Beverages: Tea (plant specimen, tea leaves), Coffee (plant specimen, beans) 6. Fibres: Jute (specimens/digital resources of *Corchorus capsularis* and *C. olitorious*, T.S. stem, test for cellulose and lignin on section of stem and fibre). Cotton (specimen, W.M. seed to show lint and fuzz; W.M. fibre and test for cellulose) 7. Oil-Yielding Plants: Fatty Oils: Groundnut (Habit-specimen, Fruit, seeds, Microchemical Tests), Coconut-Habit (photograph), Fruit, T.S. nut, Mustard - (Habit- specimen, Fruit, seeds); Essential Oils: Habit Sketch of Rose, Jasmine, Vetiver, Sandalwood and Eucalyptus (specimens/photographs) 8. Drug-Yielding plants: Habit - Fever Bark Tree, Poppy, Foxglove and Cannabis (Specimens/ Photographs) 9. Tobacco: *Nicotiana tabacum* and *N. rustica* (specimens/photographs), Tobacco Products 10. Petro-crops: *Saccharum officinarum* , Jatropha sp.	30
II	**Molecular Biology:** 1. Isolation of genomic DNA from *E. coli* (DH5α) cells. 2. Isolation of DNA from plants. 3. Instruments and equipment used in molecular biology. 4. Separation and visualize Genomic DNA bands by Agarose gel electrophoresis. 5. Isolation of plasmid DNA from bacterial cells.	30

	6. Isolation of total RNA from the given bacterial culture. 7. separation of and visualize RNA bands by Agarose gel electrophoresis. 8. Determination of the amount, concentration and purity of the given RNA sample. 9. To digest the pUC18 DNA with EcoRI Hind III enzyme 10. Separation of DNA through 12% PAGE 11. Quantification of DNA by UV-spectrophotometer 12. Estimation of DNA by diphenylamine method.	
III	**Ecology:** 1. Determination of pH of various soil and water samples. 2. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from contrasting soil habitats. 3. Determination of organic matter of different soil samples. 4. To determine and compare bulk density, porosity and rate of infiltration of water in different soils. 5. Determination of dissolved oxygen of water samples from polluted and unpolluted sources. 6. Study of morphological features of hydrophytic and xerophytic plants (four each). 7. Determination of minimal quadrat size for the study of herbaceous vegetation in the University campus, by species area curve method (species to be listed). 8. Field visit to familiarise students with ecology of different sites.	30

Subject : B.A./B.Com./B.Sc. Semester IV	
Course Code : MDSGEC-IV :: Organic Farming	
Course Objectives: To develop awareness about organic farming with the knowledge and skills necessary to practice sustainable agriculture and the production of healthy, organic food.	
Course outcomes: 1. *Understanding organic principles:* Students will understand various principles, need and prospects of organic farming including the importance of sustainability, biodiversity and ecological balance. 2. *Practical skill:* Students will gain experience through field/farm visits or practical exercises to apply their knowledge in a real-world setting. 3. *Soil health and fertility:* Learners will explore the significance of soil health in organic farming and various methods to enhance soil fertility through composting and crop rotation.	
Credits: 4	Core Compulsory Theory
Max. Marks : 100 (25+75)	Min. Passing Marks :50
Total no of Lectures-Tutorials-Practicals (in hours per week): 4-0-0	

Unit	Topic	No. of Lectures (60 hrs)
I	**Introduction to organic farming:** Organic farming - concept, characteristics, significance, organic ecosystem, scope of organic farming (National, State and Regional level); Organic Certification- Certification Process, Product Labeling; Regulatory Mechanisms for Organic Certification in India.	12
II	**Organic farm management:** Preparation of seed bed, manuring, sowing, watering and raising of seedling; Role of soil in organic farming; Soil factors affecting plant growth: heat, water, humidity, pH and nutrition	12
III	**Organic manures:** Green manure – Method and types of composting, benefits & limitations; soil microorganisms and mycorrhiza and their significance; Humification;	12
IV	**Introduction to Biofertilizers:** Bio-fertilizers introduction, types of biofertilizers, Methods of Biofertilizer production (*Azospirillum, Azotobacter*) and its applications; Advantages and disadvantages of Biofertilizer.	12
V	**Crop management:** Cultural, Biological and Mechanical methods; Fundamentals of insect, disease and weed management under organic mode. Botanicals- pyrethrum, neem seed kernel extract, neem seed powder, soluble neem formulations, neem oil for pest & disease management.	12

Essential Readings:

1. Wayas, S.C., Wayas, S. and Modi, H.A. (1998) Bio-fertilizers and organic Farming, India: Akta Prakashan, Nadiad
2. Sathe, T.V. (2004). Vermiculture and Organic Farming. New Delhi, Delhi: Daya publishers.
3. Subba Rao, N.S. Soil Microbiology. New Delhi: Oxford & IBH Publishers, 2000. Print.

Suggested Readings:

1. Alexander Mc Gregor, Lynn Pugh and Jerry Larson (2009). Fundamental of Organic Farming and Gardening. Georgia Organics.
2. Ann Larkin Hansen (2010). The Organic Farming Manual (A Comprehensive Guide to Starting and Running a Certified Organic Farm). Storey Publishing LLC.
3. Peter V. Fossel (2007). Organic Farming: Everything You Need to Know. Voyageur Press.
4. Richard Wiswall (2009). Organic Farmer's Business Handbook: A Complete Guide to Managing Finances, Crops, and Staff and Making a Profit. Chelsea Green Publishing.

Subject: B.A./B.Com./B.Sc. IV Semester	
Course Code :	**SEC-IV:** *Spirulina* Cultivation

Course Objectives: The objective of this course is to make students aware about *Spirulina* and its cultivation techniques.

Course outcomes: After the completion of the course the students will be able to:
1. develop understanding about the nutrient supplements and its role in growth and development.
2. develop skill about *Spirulina* production Technology.

Credits: 2	
Max Marks: 100	Core Compulsory Theory
Total no of Lectures-Tutorials-Practicals (in hours per week): 1-0-2	Min. Passing Marks: 36

Unit	Topic	No. of Lectures (45hrs)
I	Nutrition: Macro and micro-nutrients and their source, protein, carbohydrates, minerals, anti-oxidants, vitamins.	1T+2P
II	Single Cell Protein (SCP) and their source; *Spirulina*: introduction, morphology, taxonomy and commercial strains	2T+4P
III	*Spirulina*: Isolation, purification, culture development. *Spirulina* cultivation in closed systems: Lab and Photobioreactors	3T+6P
IV	*Spirulina* cultivation in open systems: In homes, in raceway ponds. Mass multiplication of *Spirulina* and Quality control.	5T+10P
V	*Spirulina* based products development, Bio-fortification and value addition in dairy and food product by *Spirulina* and *Spirulina* entrepreneurs.	4T+8P

Essential Readings:

1. Becker, E. W. (1994). Microalgae: Biotechnology and Microbiology. Cambridge: Cambridge University Press
2. Shashikumar, K. and Shashikumar, R. (2012). Commercial production Methods of *Spirulina*. Publisher: LAP Lambert Academic Publishing

Suggested Readings

1. Dubey, R. C., Maheshwari D.K. (1999). A textbook of microbiology. S. Chand Publishing Company
2. Uba, K.I.N., Gaid, G.D., Perales, J.M.L., Bongga, F.C., Gaid, R.D. (2021). Culture of *Spirulina*: a manual on small-scale production. Mindanao State University at Naawan. Naawan, Philippines pp.1-32

Subject : B.A./B.Com./B.Sc. Semester IV	
Course Code :	**Value Addition Course-IV:** Plant Tissue Culture

Course Objectives: The objective of this course is to develop skill about application of plant tissue culture and its use in industries.

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

1. get familiarized with aseptic culture techniques
2. understood the micro propagation mechanism and its intricacies.
3. to establish a regeneration protocol using different explant material
4. to do mass propagation of true to type and disease free, quality medicinal plants/ornamental plants/fruit and forest trees through tissue culture.

Credits : 3	Core Compulsory Theory
Max Marks :	Min. Passing Marks :

Total no of Lectures-Tutorials-Practicals (in hours per week): 1-0-2

Unit	Topic	No. of Lectures (30 hrs)
I	Planning and organization of tissue culture laboratory; Basic techniques of plant tissue culture. Preparation of MS media and stock solutions. Induction and maintenance of callus and cell suspension culture. Differentiation organogenesis and embryogenesis. Soma clonal variations.	06
II	Suspension culture, Tissue culture techniques for haploid production and their application in agriculture. Meristem culture, clonal propagation, and virus resistant plants.	06
III	In-vitro Pollination, shotgun wedding, embryo rescue technique and embryo culture. Encapsulation of somatic embryos and shoot apices for artificial seeds. Cryopreservation techniques for germplasm conservation.	06
IV	Protoplast isolation, culture and regeneration. Somatic hybridization and selection mechanism for hybrids and cybrids, with special reference to crop plants.	06
V	Transgenic plants: Use of transgenic for – herbicides, insecticides, virus, drought, salinity and insect resistance; male sterility and restoration systems. Industrial application of plant tissue culture.	06

Essential Readings:

1. Bhojwani, S. S., & Razdan, M. K. (1986). Plant tissue culture: theory and practice. Elsevier.
2. Razdan, M. K. (2002). Introduction to Plant Tissue Culture, 2/E. Oxford and IBH publishing.
3. Gamborg, O., & Phillips, G. C. (Eds.). (2013). Plant cell, tissue and organ culture: fundamental methods. Springer Science & Business Media.

Suggested Readings:

1. Smith, R. H. (2012). Plant tissue culture: techniques and experiments. Academic press.
2. Taji, A., Dodd, W. A., & Williams, R. R. (1992). Plant tissue culture practice. University of New England.