

M.Sc. BOTANY

LOCF SYLLABUS 2026

(w.e.f. June 2026)



Department of Botany

School of Life Sciences

St. Xavier's College (Autonomous), Palayamkottai

Affiliated to Manonmaniam Sundaranar University, Tirunelveli

(Recognized as “College with Potential for Excellence” by UGC)

(Accredited with “A⁺⁺” Grade with a CGPA of 3.66/4 in IV cycle)

Tirunelveli – 627 002, Tamil Nadu, India

VISION

To mould young men and women as leaders in all walks of life so that they may serve the people especially the poor and the oppressed of our nation in truth, justice and love.

MISSION

To achieve a synthesis of academic excellence and the formation of character.

To ensure social justice through equity and access.

To include the excluded for empowerment.

To equip students with global competencies.

To engage in relevant research activities.

To promote Lab to Land through the Outreach Programme – Student Training and Action for Neighbourhood Development (STAND).

SCHOOLS OF EXCELLENCE WITH CHOICE-BASED CREDIT SYSTEM (CBCS)

ESSENTIAL FEATURES OF CBCS

Standardisation of degree courses to internationally accepted levels.

Focus on skill-based curriculum.

Emphasis on value education.

Institution - Industry collaboration.

Provision for earning more credits.

Development of communication skills.

POST GRADUATE COURSES

The existing PG curriculum was thoroughly upgraded based on the expectations of the academicians and the aspirations of the student community. The PG syllabus has two parts : Core and Elective. The minimum number of credits to be earned by a student is 100. The aim of the project work at the PG level is to develop the skill of solving problems and to promote research motivation. All the I-year PG students are offered one Value - Added Course and during their II year they are supposed to do one Extra Credit course outside their class hours to enhance their employability skills. However, during every semester, they are free to learn one ECC paper, offered by the respective departments.

CREDIT SYSTEM

The credit system at St. Xavier's College (Autonomous) assigns weightage to courses based on the hours allocated to each course. Typically, one credit is equivalent to one hour of instruction per week. However, credits are awarded regardless of actual teaching hours to ensure consistency and adherence to guidelines. The credits and hours allotted to each course within a programme are detailed in the Programme Pattern table. While the table provides a framework, there may be some flexibility due to practical sessions, field visits, tutorials, and the nature of project work. For postgraduate (PG) courses, students are required to accumulate a minimum of 100 credits, as stipulated in the programme pattern table. The total number of courses offered by the department is outlined in the Programme Structure.

OUTCOME-BASED EDUCATION (OBE)

Outcome-Based Education (OBE) is a student-centric teaching and learning methodology that focuses on measuring student performance through clearly defined outcomes. For St. Xavier's College, with its commitment to excellence and NAAC/NBA accreditation requirements, OBE is not just a regulatory expectation but a pathway to academic quality, global competitiveness, and improved employability of graduates.

We prepare students to meet future industry requirements and reinforce St. Xavier's College, Palayamkottai, as a leader in quality higher education. St. Xavier's College introduced OBE in 2018, and for the Attainment Calculation, we developed our own method in 2018. From the academic year 2025-26 onwards, in examinations, for each question we mark Course Outcome (CO), Competency and Performance Indicator, Programme Outcome / Programme Specific Outcome, Bloom's Revised Cognitive Level

and we follow the OBE procedure for the calculation of the Attainment of Outcome for each student, course, semester, programme.

EVALUATION PATTERN (PG)

CONTINUOUS INTERNAL ASSESSMENT

There is no internal minimum for any paper. However, Continuous Internal Assessment (CIA) is a mandatory requirement for all students. A student must take at least one CIA test out of two tests and must fulfil at least one mode of assessment among assignments, quizzes, seminars, etc.; otherwise, he/she will not be permitted to write the semester examination.

ALLOTMENT OF MARKS

S.No	Component	Marks Allotted
1	I CIA Test	70
2	II CIA Test	70
	Total	140

3. Average marks of CIA -1 and 2 will be converted to 70 marks
4. Assignment – 15 marks + *Viva voce* – 15 marks
5. Aggregate marks = 100

The total CIA marks of 140 will be converted to 70 marks. An additional 30 marks will be awarded through other internal assessment components.

The Continuous Internal Assessment (CIA) consists of two component tests, each carrying 15 marks (15 + 15).

The final internal assessment marks will be calculated out of 100 (70 + 30). The obtained marks will be **converted to 50 marks**.

QUESTION PATTERN FOR CIA AND SEMESTER EXAMINATIONS

PG Semester Examinations (3 Hours)

PART	TYPE	Mark Distribution	Total Marks
A	MCQ	10X1	10
B	ALL	5X3	15
C	Either/or	5X6	30
D	3 out of 5	3X15	45
		Total	100

SEMESTER (EXTERNAL) EXAMINATION

- The External Semester Examination will be conducted for **100 marks**.
- The obtained marks will be **converted to 50 marks**.

PG INTERNAL EXAMINATIONS (2 Hours)

PART	TYPE	Mark Distribution	Total Marks
A	MCQ	10X1	10
B	ALL	3X3	09
C	Either/or	3x7	21
D	3 out of 5	3X10	30
		Total	70

GRADING SYSTEM

Range of Marks	Letter Grade	Grade Point	Description
90-100	A+	9.0-10.0	Outstanding
80-89	A	8.0-8.9	Excellent
70-79	B+	7.0-7.9	Very Good
60-69	B	6.0-6.9	Good
50-59	U	5.0-5.9	Average
00-49	U	0	Reappear

Programme: M.Sc. Botany**Programme Code: PBO**

The Master's Programme in Botany is specially designed to equip and mould students fit for the current educational scenario. The programme aims to encourage students to take responsibility for developing themselves throughout their studies at our institution. It encourages students to reflect on the broader purpose of their education.

Programme Outcome, Programme Specific Outcome and Course Outcome

Students completing this programme will be able to present their core post-graduate discipline clearly and precisely, make abstract ideas precise by formulating them in the language of the specific discipline, describe related ideas from multiple perspectives and explain fundamental concepts. Completion of this programme will also enable the learners to join teaching profession, enhance their employability for government jobs, jobs in various other public and private enterprises.

Programme Outcomes:

PO1: Disciplinary Knowledge: Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form part of postgraduate programmes of study.

PO2: Critical Thinking: Capability to apply analytic thought to a body of knowledge; analyze and evaluate evidence, arguments, claims, beliefs based on empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following a scientific approach to knowledge development.

PO3: Problem Solving: Capacity to extrapolate from what one has learned and apply one's competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real-life situations.

PO4: Analytical & Scientific Reasoning: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples, and address opposing viewpoints.

PO5: Research-related skills: Ability to analyze, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence, and experiences from an open-minded and reasoned research perspective; develop a sense of inquiry and capability for asking relevant questions/problem arising / synthesising / articulating / ability to recognize cause and effect relationships / define problems. Formulate hypotheses, Test / analyze / Interpret the results and derive conclusions.

PO6: Self-directed & Lifelong Learning: Ability to work independently, identify and manage a project. Ability to acquire knowledge and skills, including "learning how to learn",

through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives.

Programme Specific Outcomes:

PSO1: Acquire good knowledge and understanding to solve specific theoretical & applied problems in different areas of the specific discipline of study.

PSO2: Understand, formulate, and develop arguments logically to address issues arising in social sciences, business and other context /fields.

PSO3: To prepare the students who will demonstrate respectful engagement with others' ideas, behaviours, beliefs and apply diverse frames of reference to decisions and actions. To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skills that will facilitate startups and high potential organizations. To encourage practices grounded in research that comply with employment laws, leading the organization towards growth and development

The students who are completing M. Sc. Programme in Botany will reflect the following graduate attributes.

1. Clear, comprehensive and advanced mastery in the field of Botany.
2. Understand the advanced areas of biological sciences with special reference to Botany and its applied branches.
3. Skill in practical work, experiments, use of biological tools and techniques
4. Expertise in statistical analyses of data for better interpretations and problem solving.
5. Confidence to apply the acquired knowledge in practical life to make our country self-reliant.
6. Ability to suggest innovative programs to care for nature and life for sustainable development.
7. Awareness to explore the intricacies of life forms at cellular, molecular and nano level.
8. Motivation and enthusiasm to appreciate the beauty of different life forms.
9. Inspiration to disseminate the concept of biodiversity conservation.
10. Problem-solving skills in students to carry out innovative research projects, thereby enkindling in them the spirit of knowledge creation.
11. Proficiency in the use of recent and advanced biological technologies
12. Ability to appreciate and practice ethical principles in research and studies in the field of biological science

M. Sc. COURSE PATTERN
(WITH EFFECT FROM JUNE 2026)

Semester	Part	Status	Subject Code	Title	Hours	Credits
I	A	Core - 1	26PBOC11	Plant Diversity-I: Algae, Fungi, Lichens and Bryophytes	5	4
		Core - 2	26PBOC12	Anatomy and Embryology of Angiosperms	5	4
		Core - 3	26PBOC13	Microbiology, Immunology and Plant Pathology	5	4
		Core - 4	26PBOC14	Research Methodology	6	4
		EC - 1	26PBOE11	Plant Diversity-I: Algae, Fungi, Lichens and Bryophytes Practical	3	2
		EC - 2	26PBOE12	Anatomy and Embryology of Angiosperms Practical	3	2
		EC - 3	26PBOE13	Microbiology, Immunology and Plant Pathology Practical	3	2
	Sub Total				30	22
II	A	Core - 5	26PBOC21	Taxonomy of Angiosperms And Economic Botany	5	4
		Core - 6	26PBOC22	Plant Diversity-II: Pteridophytes, Gymnosperms and Paleobotany	5	4
		Core - 7	26PBOC23	Ecology, Phytogeography and Conservation Biology	5	4
		Core - 8	26PBOC24	Biostatistics and Bioinformatics	6	4
	B	EC - 4	26PBOE21	Taxonomy of Angiosperms and Economic Botany Practical	3	2
		EC - 5	26PBOE22	Plant Diversity-II: Pteridophytes, Gymnosperms and Paleobotany Practical	3	2
		SEC - 1	26PBOS21	Ecology, Phytogeography and Conservation Biology – Practical	3	2
		Extension Activities		STAND (Students Training and Action Programme for Neighbourhood Development)		1

		Sub Total			30	23
III	A	Core - 9	26PBOC31	Cell Biology and Genetics	5	4
		Core -10	26PBOC32	Biochemistry & Biophysics	5	4
		Core -11	26PBOC33	Plant Biotechnology	5	4
		Core -12	26PBOC34	Phytochemistry and Pharmacognosy	6	4
		EC - 6	26PBOE31	Cell Biology and Genetics Practical	3	2
	B	EC - 7	26PBOE32	Biochemistry & Biophysics Practical	3	2
	A	SEC - 2	26PBOS31	Plant Biotechnology Practical	3	2
		Internship	26PBOI31	Carried out at summer vacation at the end of I year		2
		Sub Total			30	24
IV	A	Core – 13	26PBOC41	Plant Physiology	5	4
		Core – 14	26PBOC42	Molecular Biology and Genetic Engineering	5	4
		Core – 15	26PBOC43	Organic farming	4	4
	B	EC - 8	26PBOE41	Plant Physiology Practical	3	2
		Sec-4	26PBOS41	Molecular Biology and Genetic Engineering Practical	3	2
		Project	26PBOC44	Project with viva voce	10	6
		Sub Total			30	22
		Additional Compulsory Courses			120	91
		I Year (Value – Added Courses)				3
		II Year (Extra Credit Courses)				3
		MOOC / SSC				2
		Field Visit				1
		GRAND TOTAL			120	100

VALUE ADDED COURSES

Sem	Course Code	Title of the Course	Credits	Eligibility
I	26PBOCC1	Farm Sciences- Green Wealth	4	UG- Science Students
II	26PBOCC2	Herbal Technology	4	Any UG Students

EXTRA CREDIT COURSES

Sem	Course Code	Title of the Course	Credits	Eligibility
III	26PBOEC1	Secondary Plant Products and Fermentation Biotechnology	4	UG- Science Students
IV	26PBOEC2	Biopesticide Technology	4	UG-Science Students

SELF STUDY COURSES

Sem	Course Code	Title of the Course	Credits	Eligibility
III	26PBOSS1	Entrepreneurial Opportunities in Botany	2	UG- Science Students
IV	26PBOSS2	Forestry and Wood Technology	2	UG-Science Students

Online Courses:

1. Academic Writing–SWAYAMMOOCS
2. Advanced Microbiology–SWAYAMMOOCS
3. Food Microbiology -SWAYAMMOOCS

PLANT DIVERSITY- I
(Algae, Fungi, Lichens and Bryophytes)
(SUB. CODE: 26PBOC11)

SEMESTER - I	CORE – 1	HOURS -5	CREDITS - 4
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COURSE OUTCOMES:

CO1: Recall the diversity of the lower group of the plant kingdom. **(K1)**

CO2: Understand the process of evolution of various classes of plants of our planet. **(K2)**

CO3: Explain the morphological and anatomical characters of algae, fungi and bryophytes. **(K3)**

CO4: Apply the knowledge to identify the different species of algae, fungi and bryophytes **(K4)**

CO5: Classify the economic importance of the lower group of plants and compare the different varieties to be useful in human being **(K5)**

CO6: Justify the lower group of plants to sustain the human being day to day life. **(K6)**

UNIT: I Algae (15 hours)

Definition and concepts of plant diversity. Classification of algae by Fritsch (1945). Thallus organisation in algae. Algal pigments and food reserves and their importance in classification. Methods of reproduction in algae. Life-cycle patterns in Algae. Culture of microalgae and mariculture. Economic importance of Algae.

UNIT: II (15 hours)

General characteristics (morphology, anatomy, reproduction and life cycle pattern) in Cyanophyceae, Chlorophyceae, Phaeophyceae, and Rhodophyceae.

UNIT: III Fungi (15 hours)

Classification of fungi by Alexopoulos and Mims (1979). Thallus variation in fungi. Reproduction and life-cycle patterns in fungi. Sexuality in fungi - Parasexuality and Heterokaryosis. Sex hormones in fungi. Spores and spore dispersal mechanisms in major groups of fungi. Economic importance of fungi.

UNIT: IV (15 hours)

Structure and reproduction in Phycomycetes, Basidiomycetes, Ascomycetes and Deuteromycetes. **Lichens** - Classification by Miller (1984). General account on structure and reproduction. Economic importance of lichens.

UNIT: V Bryophytes (15 hours)

Classification by Rothmaler. Structural variations in the gametophytes and sporophytes of Sphaerocarpaceae, Marchantiales, Jungermanniales, Calobryales, Anthocerotales, Sphagnales, Polytrichales, and Bryales.

REFERENCES

Algae

1. **Chapman, V.J & Chapman, D. J.1960.** The Algae, ELBS & MacMillan, London,
2. **Fritsch, F. E. 1965 (Rep.).** Structure and Reproduction of the Algae. Vol. I &II. Cambridge Univ. Press.
3. **Kumar, H. D. 1990.** Introductory Phycology. Affiliated East West Press, NewDelhi.

4. **Prescott, G. W. 1969.** The Algae: A review. Bishen Singh & Mahendra Pal Singh, Dehradun.
5. **Round, E. E. 1973.** The Biology of the Algae. Edward Arnold Publishers, London.
6. **Sharma, O. P. 1986.** Textbook of Algae. Tata McGraw-Hill Publishing Co. New Delhi.

Fungi:

1. **Alexopoulos, C. J. & Mims, C. W. 1952.** Introductory Mycology, East Wiley Ltd. New Delhi.
2. **Bessy, E. A. 1971.** Morphology and taxonomy of fungi. Hafner Publication Company, New York.
3. **Bilgrami, K. S. & Verma, R. N. 1978.** Physiology of fungi. Vikas Publishing House, New York.
4. **Deacon, J. W. 1984.** Introduction to modern Mycology. Blackwell Science Publication. Oxford.
5. **Dubey, H. C. 1983.** Introduction to fungi. Vikas Publishing House, New Delhi.
6. **Smith, G. M. 1966.** Cryptogamic Botany. Vol I. Tata McGraw Hill, New Delhi.
7. **Srivastava, S. 1999.** Fungi. Pradeep Publications, Jalandhar.

Lichens:

1. **Hale, M. E. (Jr.). 1983.** The Biology of Lichens. Edward Arnold, Maryland.

Bryophytes:

- **Cavers, E. 1964 (Rep. 1981).** The interrelationships of the Bryophytes. Dawsons of Pall Mall, England.
- 2. **Chopra, R. N. & Kumar, P. K. 1988.** Biology of Bryophytes. Wiley Eastern Ltd. New Delhi.
- 3. **Prem Puri. 1981.** Bryophytes. Atma Ram & Sons, Delhi.
- 4. **Watson, E. V. 1964.** The structure and life of Bryophytes. Hutchinson & Co. London.

ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS
(SUB. CODE: 26PBOC12)

SEMESTER- I	CORE: 3	HOURS: 5	CREDITS: 4
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COURSE OUTCOMES:

By the end of the course, the students will be able to

CO1	Learn the structures, functions and roles of apical vs lateral meristems in monocot and dicot plant growth (K1 & K2).
CO2	Study the function and organization of woody stems derived from secondary growth in dicot and monocot plants (K1 & K4).
CO3	Apply their idea on sectioning and dissection of plants to demonstrate various stages of plant development (K2 & K6).
CO4	Understand the various concepts of plant development and reproduction (K3& K6).
CO5	Profitably manipulate the process of reproduction in plants with a professional and entrepreneurial mindset (K5).
CO6	Evaluate the Pollination biology and Fertilization process (K5).

Unit I-CELL WALL AND WOOD ANATOMY

(15 hours)

Morphological and physico-chemical changes; Plasmodesmata- types of pits – growth of cell wall – formation of intercellular spaces; Meristems: Classifications: Theories of shoot and root apices, Cytological zonation in shoot apex. Vascular Cambium: Composition and organisation – multiplicative and additive divisions. Xylem: Primary and secondary xylem – tracheary elements and vessels – vessel-less dicots – xylem rays and axial parenchyma of angiosperm wood; Dendrochronology – grain, texture and figure in wood; reaction wood; ring porous and diffuse porous wood. Phloem: Ultrastructure and ontogeny of sieve tube elements and companion cells. Evolution of tracheary elements.

Unit II - SECONDARY GROWTH

(15 hours)

Structure, organisation, and activity of phellogen. Polyderm and Rhytidem – wound periderm. Normal secondary thickening in Dicots; Anomalous secondary growth in Dicots (Amaranthaceae, Aristolochiaceae, Bignoniaceae, Piperaceae, Nyctaginaceae) and arborescent Monocots. Primary thickening in palms; Ontogeny of leaf, Structure and types of Stomata; Leaf abscission; Major nodal types; Nodal Anatomy. Kranz anatomy and its significance.

Unit III-MICROSPORANGIUM AND MALE GAMETOPHYTE

(15 hours)

Structure and development of Anther; Ultrastructure and physiology of anther tapetum; Male gametophyte; Palynology: Morphology and ultrastructure of pollen wall, pollen kit, pollen analysis, pollen storage, pollen sterility and pollen physiology.

Unit IV-MEGASPORANGIUM AND FEMALE GAMETOPHYTE

(15 hours)

Structure and development of Megasporangium; Types of ovules, Endothelium, obturator and nucellus. Megasporogenesis: Female gametophyte: Structure, types, haustorial behaviour, and Nutrition of embryo sacs. Fertilization: Double fertilization and triple fusion;

Unit V-POLYEMBRYONY

(15 hours)

Endosperm: Development of endosperm, types, physiological efficiency of endosperm haustoria and functions; Ruminant endosperm. Embryogeny: Development of monocot (Grass) and dicot (Crucifer) embryos. Causes of Polyembryony, classification, induction and practical application. Apomixis and its significance. Seed and Fruit Development and the Role of Growth Substances. Parthenocarpy and its importance.

Text Books

1. Bhojwani, S.S., Bhatnagar, S.P., and Dantu, P.K. 2015. The Embryology of Angiosperms (6th revised and enlarged edition). Vikas Publishing House, New Delhi.
2. Maheshwari, P. 1963. Recent Advances in Embryology of Angiosperms. Intl. Soc. Plant Morphologists, New Delhi.
3. Sharma, P.C. 2017. Textbook of Plant Anatomy. Arjun Publishing House, New Delhi.
4. Pandey, S.N and Ajanta Chandha. 2006. Plant Anatomy and Embryology. Vikas Publishing House Pvt. Ltd, New Delhi.
5. Narayanaswamy, S. 1994. Plant Cell and Tissue Culture. Tata McGraw-Hill Ltd., New Delhi.

REFERENCES

1. Bhojwani, S. S. & Bhatnagar, S. P. 2000. The Embryology of Angiosperms. McGraw-Hill.
2. Chandurkar, P, 1977. Plant Anatomy. Pergamon Press
3. Maheshwari, P. 1971. An Introduction to the Embryology of Angiosperms. Tata McGraw-Hill Publishing Co., New Delhi.
4. Pandey, S. N. & Chadha, A. Plant Anatomy and Embryology. Sangam Books Ltd.
5. Katherine Esau. 1953. *Plant Anatomy*, Wiley & sons.
6. Krishnamurthy, K.V. 1988. Methods in Plant Histochemistry. S. Viswanathan & Co., Madras.
7. Swamy, B.G.L and Krishnamurthy. K.V 1990. From Flower to Fruits, Tata – McGraw Hill Publishing Co Ltd, New Delhi.
8. Pullaiah, T., Lakshminarayana, K and Hanumantha Rao, B. 2006. Text Book of Embryology of Angiosperms. Regency Publications, New Delhi.
9. Bierhorst, D.W. 1971. Morphology of Vascular Plants. Macmillan Publishers, New York.
- Crang, R., Lyons-Sobaski, S and Wise, R. 2018. Plant Anatomy: A Concept-Based Approach to the Structure of Seed Plants. Springer International Publishing.
10. Cutler, D. F., Botha, T and Stevenson, D.W. 2008. Plant Anatomy: An Applied Approach. Blackwell Publishing, Malden, USA.
11. Eames, A.J and MacDaniels, L.H. 2013. Introduction to Plant Anatomy, 3rd Edition. McGraw-Hill Inc., US.

Web Resources

1. <https://www.ipni.org/>
2. <http://www.theplantlist.org/>
3. https://faculty.etsu.edu/liuc/plant_anatomy_sites.htm
4. http://aryacollegeludhiana.in/e_book/botany/plant_anatomy.pdf
5. <https://www.uou.ac.in/sites/default/files/slm/bscbo-202.pdf>

MICROBIOLOGY, IMMUNOLOGY AND PLANT PATHOLOGY

(Sub Code: 26 PBOC13)

SEMESTER – I	CORE-3	HOURS – 5	CREDITS – 4
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Course Outcomes:

Upon completion of the course, the students will be able to

CO1	Recognise the general characteristics of microbes, plant defence, and immune cells (K1).
CO2	Explain the stages in disease development and various defence mechanisms in plants and humans (K2).
CO3	Elucidate concepts of microbial interactions with plants and humans (K3).
CO4	Analyse the importance of harmful and beneficial microbes and the immune system (K4).
CO5	Determine and interpret the detection of pathogens and appreciate their adaptive strategies (K5 & K6).

Unit I- VIRUSES

(15 hrs)

Types of microorganisms. General characteristics of viruses, Morphological structure and Multiplication. Viruses of Eukaryotes – Animal & Plant viruses. Control of viral infections. Bacteriophages- types, replication of DNA and RNA phages -Lytic and Lysogenic cycle. Viroids and prions. Mycoplasma: Structure and classification.

Unit II-BACTERIA

(15 hrs)

General characteristics of bacteria. Classification of bacteria based on morphological, cultural, physiological and molecular characteristics. Bacterial growth – batch culture and continuous culture. Growth Curve, Factors affecting growth. Determination of bacterial growth – Direct method: Haemocytometer, Viable plate count; Indirect method: Turbidity. Nutritional types. Reproduction - Fission and sporulation, Genetic recombination- Transformation, Transduction and Conjugation. Isolation and cultivation of bacteria, maintenance of bacterial culture.

Unit III-APPLIED MICROBIOLOGY

(15 hrs)

Beneficial role of microbes – yoghurt, Olives, Cheese, Bread, Wine, Tempeh, Miso & Fermented green tea. Spoilage of fruits, vegetables, meats, poultry, eggs, bakery products, dairy products and canned foods. Microbial toxins - Exotoxin, Endotoxin & Mycotoxin. Action of Enterotoxin, Cytotoxin & Neurotoxin. Food Preservation – temperature, drying, radiation and chemicals. Soil Microbiology: Importance of Microbial flora of soil and factors affecting the microbial community in soil. Interaction among soil microbes (positive and negative interactions) & with higher plants (rhizosphere & phyllosphere). Covid. Environmental Microbiology: Microbiology of water and air. Waterborne diseases - diphtheria, chicken pox. Airborne diseases - Swine flu and Measles. Microbial degradation of chemical pesticides and hydrocarbons.

Unit IV-IMMUNOLOGY

(15 hrs)

Introduction; Immune System; Types of Immunity - Innate and Acquired. Immune Cells - Hematopoiesis, B and T lymphocytes. Adaptive immune system, Innate Immune system. Antigen: Definition, Properties and types. Antibody – Structure, types and function. Antigen-antibody

interactions: types- precipitation, Agglutination, Complement fixation. Vaccines – types and recombinant vaccines. Immunodiagnosis –Blood Grouping, Widal test, Enzyme-Linked Immunosorbent Assay (ELISA), Immunoelectrophoresis and Immunodiffusion.

Unit V-PLANT PATHOLOGY

(15 hrs)

History and significance of plant pathology. Classification of plant diseases, Symptomology (important symptoms of plant pathogens). Principles of plant infection –Inoculum, inoculum potential, Pathogenicity. Disease triangle. Host-parasite interrelationship and interaction. Causal agents of plant diseases - biotic causes (virus, mycoplasma, bacteria, fungi, nematodes, parasitic algae, angiospermic parasites); abiotic causes (Physiological, deficiency of nutrients & minerals and pollution). Mechanism of penetration- disease development of pathogen (colonization) and dissemination of pathogens. Role of enzymes and toxins in disease development. Defense mechanism of host – structural and biochemical defenses.

Principles of disease management – Cultural practices, physical, chemical and biological methods, disease controlled by immunization. Biocontrol - merits and demerits;

Plant quarantine and legislation. Integrated Pest Management system. Diagnostic technique to detect pest/pathogen infection - Immunofluorescence (IF).

Text Books

1. Singh, R.S. 2018. Introduction to Principles of Plant Pathology, 4th Edition.
2. Bilgrami, K.S and H.C. Dube. 2010 A text book of Modern Plant Pathology – Vikas Publishing House (P) Ltd., New Delhi
3. Mehrotra, R.S. and Aggarwal, A. 2017. Plant Pathology. McGraw Hill Publisher.
4. Dube, H.C. 2010. A text Book of Fungi, Bacteria and Viruses, 3rd Edition, Agrobios India, ISBN: 8188826383.
5. Vaman Rao, C. 2006. Immunology. 2nd Edition. Narosa Publisher.
6. Kenneth, M. 2017. Janeway's Immunobiology. 9th Edition. Garland Publisher.

Reference Books

1. Agrios, A.G. 2007. Plant Pathology, Elsevier. ISBN: 9780120445653.
2. Jeffery, C., Pommer Ville. 2014. Alcamos Fundalmedals of Microbiology. 10th Edition. Johnsand Bartlett Learning.
3. Pelczar, M. J. 2007. Microbiology. 35th Edition, Tata-McGraw Hill Publications, New York, ISBN: 0074623260.
4. Ravi Chandra, N.G. 2013. Fundamentals of Plant Pathology, Phi Learning, ISBN:812034703X.
5. Willie, J. and Sherwood, L. 2016. Prescott's Microbiology McGraw-Hill Education; 10th Edition, ISBN: 978-1259281594
6. Chaube, H.S. and Singh, R. 2015. Introductory Plant Pathology CBS Publishers, ISBN: 978-8123926704.
7. Rangasamy, G. 2006. Disease of Crop Plants in India (4th edition). Tata McGraw Hill New Delhi.
8. Mishra, A., A. Bohra and A. Mishra. 2011. Plant Pathology-Disease and Management. Agro Bios, Jodhpur.

Web Resources

1. <https://www.wileyindia.com/a-textbook-of-plant-pathology.html>
2. <https://www.britannica.com/science/plant-disease>.

3. <https://www.planetatural.com/pest-problem-solver/plant-disease/>
4. <https://www.elsevier.com/books/plant-pathology/agrios/978-0-08-047378-9>
5. <https://www.elsevier.com/life-sciences/immunology-and-microbiology/books>
6. <https://www.amazon.in/introduction-immunology-rafia-imran-ebook/dp/b09b66sd3j>.

RESEARCH METHODOLOGY

(Sub Code: 23PBOC14)

SEMESTER – I	CORE- 4	HOURS – 6	CREDITS – 4
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Course Outcomes:

Upon completion of the course, the students will be able to

CO1	Realize the need for centrifuges and chromatography and their uses in research (K1 & K2).
CO2	Learn the principles and applications of electrophoresis (K2 & K3).
CO3	Analyse the importance of research for the development of science and the welfare of human beings (K5 & K6)
CO4	Experiment with the knowledge of instrumentation in research projects (K3 & K4)
CO5	Apply the methodology of scientific writing in their projects (K4 & K5)

Unit I

(18 hours)

Research techniques: meaning and objectives, methods and approaches in research. Literature collection and citation: bibliography, bibliometrics (scientometrics): definition-laws - citations and bibliography - biblioscope - plagiarism - project proposal writing - dissertation writing - paper presentation (oral/poster) - E-learning tools- monograph - introduction and writing-Standard operating procedure (SOP) - introduction and preparation.

Unit II

(18 hours)

Microscopy: components of the microscope, Principles of microscopy – stereo, phase contrast and fluorescence, electron microscopy (TEM and SEM) principles, instrumentation and application. Microtechnique: fixatives, stains, dehydration and embedding – sectioning with rotary microtome and staining. Micrometry – principle and methods of measurement of plant cells. Photomicrography - principle and methods.

Unit III

(18 hours)

Spectroscopy: visible and ultraviolet spectrophotometry; Atomic absorption spectrophotometer: principle, working and its applications. Centrifugation: Principles, types and applications. Basic principles and applications of pH meter; pH metry: Principles, electrodes, measurement of pH, buffers and its uses.

Unit IV

(18 hours)

Chromatography – general principles, types– adsorption and partition chromatography. Thin Layer Chromatography, HPTLC, Gas Liquid Chromatography – High Performance Liquid Chromatography – principles and applications. Scintillation counter, GM Counter, Radioisotopes in biology, X-ray crystallography. NMR – principle, instrumentation, uses in plant biochemistry.

Unit V

(18 hours)

Electrophoresis principles and apparatus – vertical, horizontal and 2D – supporting media – agarose and polyacrylamide gels – detection, recovery and estimation of electrophorogram. Gel documentation system.

Molecular techniques: Principle and applications of Polymerase Chain Reaction – components in a PCR reaction – Inverse PCR, Reverse transcriptase mediated PCR (RT – PCR). Blotting techniques: Southern, Northern and Western Blotting.

Text Books

1. Veerakumari, L. 2017. Bioinstrumentation. MJP Publisher, India. p578.
2. Sree Ramulu, V.S.1988. Thesis Writing, Oxford& IBH Pub. New Delhi.
3. Gurumani, N. 2019. Research Methodology: For Biological Sciences, MP. Publishers
4. Keith Wilson & John Walker. 1997. Practical Biochemistry. IV Edition, Cambridge University Press.
5. David Plummer. 1987. An Introduction to Practical Biochemistry. Tata McGraw Hill.

Reference Books

1. Jayaraman, J. 2000. Laboratory manual of Biochemistry, Wiley Eastern Limited, New Delhi 110 002.
2. Mishra Shanthi Bhusan. 2015. Handbook of Research Methodology - A Compendium for Scholars & Researchers, Ebooks2go Inc.
3. Narayana, P.S.D. Varalakshmi, T. Pullaiah. 2016. Research Methodology in Plant Science, Scientific Publishers, Jaipur, Rajasthan.
4. Bryan C Williams and Keith Wilson. 1983. A Biologist's Guide to Practical Techniques of Practical Biochemistry. Second Edition. Edward Arnold Publications.
5. Stock R and Rice C.B.F. 1980. Chromatographic Methods. Chapman and Hall

Web resources

<https://www.kobo.com/in/en/ebook/bioinstrumentation->

<https://www.worldcat.org/title/bioinstrumentation/oclc/74848857>

<https://www.amazon.in/Bioinstrumentation-M-H-Fulekar-Bhawana-Pandey-ebook/dp/b01jp3m9tw>

<https://www.britannica.com/science/chromatography>

PLANT DIVERSITY- I PRACTICAL
(ALGAE, FUNGI, LICHENS AND BRYOPHYTES)
(SUB. CODE: 26PBOE11)

SEMESTER - I	EC-1	HOURS -3	CREDITS – 2
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Morphological and anatomical studies on vegetative and reproductive organs of the following taxa.

Algae:

1. *Chaetomorpha*,
2. *Pithophora*,
3. *Coleochaete*,
4. *Ulva*,
5. *Halimeda*,
6. *Ectocarpus*,
7. *Padina*,
8. *Sargassum*
9. *Stoechospermum*
10. *Hypnea*
11. *Gracilaria*,
12. *Rivularia*,
13. *Anabaena*
14. *Scytonema*.

Fungi and Lichens:

1. *Saprolegnia*
2. *Phytophthora*
3. *Albugo*
4. *Penicillium*
5. *Aspergillus*
6. *Xylaria*
7. *Peziza*
8. *Agaricus*
9. *Usnea*.
10. *Ganoderma*

Bryophytes:

1. *Dumortiera*
2. *Riccia*
3. *Targionia*
4. *Polytrichum*

PLANT DIVERSITY- I PRACTICAL
(ALGAE, FUNGI, LICHENS AND BRYOPHYTES)
(SUB. CODE: 26PBOC12)

I. M.SC., BOTANY
SEMESTER: I

TIME: 3 HRS
MARKS: 50

1. Make suitable micro preparations of A, B & C. Stain and mount in glycerin. Draw labelled sketches and identify, giving reasons. Submit the slides for valuation 3×8=24
2. Identify any two microalgae from the given algal mixture (D & E) 2×3=06
3. Draw labelled sketches and write critical notes on F, G, H, I & J 5×4=20

ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS - PRACTICAL

(SUB CODE: 26PBOE12)

SEMESTER -I	EC-2	HOURS – 3	CREDITS -2
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ANATOMY

1. Study of the shoot apex of *Hydrilla*
2. Observation of Wood anatomy (T.S., T.L.S and R.L.S of different types of wood)
3. Sectioning and observation of nodal types.
4. Study of anomalous secondary growth of the following:
STEM- *Nyctanthus*, *Boerhavia*, *Mirabilis* (*Nyctaginaceae*), *Amaranthus Sp.* (*Amaranthaceae*) *Bignonia*, *Tecoma* (*Bignoniaceae*), *Piper betel* (*Piperaceae*) and *Aristolochia* (*Aristolochiaceae*), *Dracaena* (*Monocots*)
ROOT: *Acyranthus* (*Amaranthaceae*)
5. Observation of Stomatal types by epidermal peeling.
6. Maceration of wood and observation of the components of xylem.
7. Double staining technique to study the Stem Anomali.
8. Micrometry and measurement of cells and tissues.

EMBRYOLOGY

1. Observation of T.S. of anther.
2. Observation of ovule types.
3. Observation of mature embryo sacs.
4. Dissection and observation of embryos (globular and cordate embryos).
5. Study of pollen morphology
6. Study of *in vitro* pollen germination.
7. Observation of endosperm types.

MICROBIOLOGY, IMMUNOLOGY AND PLANT PATHOLOGY - PRACTICAL

(Sub Code: 26PBOE13)

SEMESTER – I	EC-3	HOURS – 3	CREDITS – 2
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MICROBIOLOGY

1. Sterilization of glassware
2. Preparation of media
 - i. Pour plate & streak plate technique Nutrient medium
 - ii. Muller - Hinton agar medium
 - iii. PDA medium
3. Motility in bacteria: Hanging drop experiment
4. Staining of bacteria by Gram's stain method
5. Microbial examination of different habitats (air, sewage, milk and Soil)
6. Tests to detect *E.Coli* contamination
7. Counting of microbes – Cell count method
8. To study the effect of different parameters on growth of *E.coli*: pH, temperature, sodium chloride concentration.
9. Crystal violet assay for estimation of biofilm formation.
10. Identification of bacteria using Biochemical tests

IMMUNOLOGY

1. Identification of various immune cells by morphology – Leishman staining, Giemsa staining
2. Differential counts
3. Total counts
4. Agglutination reactions

PLANT PATHOLOGY

1. Detailed study of symptoms and host parasite relationship of representative disease of plantation crops
2. Identification of pathogens from leaves (phyllosphere)
3. Collection and dry preservation of diseased specimens of important crops

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TAXONOMY OF ANGIOSPERMS AND ECONOMIC BOTANY

(Sub Code: 26PBOC21)

SEMESTER – II	CORE – 5	HOURS – 5	CREDITS – 4
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Course Outcomes:

Upon completion of the courses, the students will be able to

CO1	Recollect the basic concepts of morphology of leaves, flowers. Identify the types of compound leaves, inflorescences and fruits, describe their characteristic features (K1, K2 & K3).
CO2	Explain the principles of taxonomy. Summarize the taxonomic hierarchy. Define binomial nomenclature. Group activity – construct key preparation (K1, K2, K5 & K6).
CO3	Explain the various types of classification. Distinguish its advantages and disadvantages. Construction of floral formula and floral diagram (K1, K2, K3 & K4).
CO4	Illustrate and explain the characteristic features and list out the economic importance of the families. Field trip to local botanical garden and regional botanical garden (K1, K2, K3 & K4).
CO5	Illustrate and explain the characteristic features and list out the economic importance of the families (K1, K2, K3 & K5).
CO5	Illustrate and explain the characteristic features and list out the economic importance of the families (K1, K2, K3 & K5).
CO6	Evaluate the economic value of various plant products (K5 & K6)

Unit I-TAXONOMY AND SYSTEMATICS

(15 hours)

Principles of classification as proposed – Artificial – Linnaeus, Natural – Bentham and Hooker, Phylogenetic system - Hutchinson, Modern – Takhtajan and APG classification. Botanical gardens and herbaria of world, preparation and maintenance of Herbarium, Botanical survey of India – its organization and role.

Unit II-MODERN TRENDS IN TAXONOMY

(15 hours)

Modern trends in taxonomy, chemotaxonomy, numerical taxonomy and cladistics, biosystematics. ICN uninominal systems- genesis binomial nomenclature, importance and principle. Important articles, typification, principles of priority, effective and valid publication, author citation, recommendations and amendments of code.

Unit III-SYSTEMATIC ANALYSIS OF PLANTS-I

(15 hours)

Polypetalae – Nymphaeaceae, Sterculiaceae, Portulacaceae, Myrtaceae, Aizoaceae, Sapindaceae, Combretaceae. Gamopetalae – Sapotaceae, Oleaceae, Boraginaceae, Scrophulariaceae

Unit IV-SYSTEMATIC ANALYSIS OF PLANTS-II

(15 hours)

Gamopetalae - Bignoniaceae, Convolvulaceae, Acanthaceae, Verbenaceae. Monochlamydeae – Nyctaginaceae, Arecaceae, Casuarinaceae. Monocots – Orchidaceae, Liliaceae, Commelinaceae, Cyperaceae.

Unit V-ECONOMIC BOTANY

(15 hours)

General account on utilization of selected crop plants: Cereals (rice and wheat), Pulses (red gram and black gram), Drug yielding plants (*Withania somnifera* and *Coleus aromaticus*), Oil yielding plants (Groundnut, sunflower), Sugar yielding plants (sugarcane and sugar beet), Spices and condiments (cardamom, cinnamon), Commercial crops - fibre (jute), Timber (Teak and red sanders wood), Resins and gums (Asafoetida and gum arabic) – Essential oils (lemon grass and menthol), Beverages (tea, coffee), Plants used as avenue trees for shade, pollution control and aesthetics, Energy plantation - uses of *Casuarina*.

Text Books

1. Pandey, B.P. 2013. Taxonomy of Angiosperms, S. Chand Publishing, New Delhi.
2. Sharma, O.P. 2017. Plant Taxonomy. (II Edition). The McGraw-Hill Companies.
3. Singh, G. 2007. Plant Systematics Theory and Practices. Oxford and IBH Publishing Co.
4. Jain, S.K and Rao R.R. 1993. A Handbook of Field and Herbarium Methods. Today and Tomorrow Publ.
5. Pandurangan, A.G., Vrinda, K.B and Mathew Dan. 2013. Frontiers in Plant Taxonomy. JNTBGRI, Thiruvananthapuram, Kerala.
6. Vardhana, R. 2009. Economic Botany. 1st Ed. Sarup Book Publishers Pvt Ltd. New Delhi.
7. Subramaniam, N.S. 1997. Modern Plant Taxonomy. Vikas Publishing House, New Delhi.

Reference Books

1. Wallis, T.E. 1999. Text book of Pharmacognosy. CBS Publishers and Distributors, New Delhi.
2. Kumaresan, V and Annie Regland. 2004. Taxonomy of Angiosperms Systematic Botany, Economic Botany, Botany & Ethnobotany.
3. Anonymous, 2004. Cultivation of Selected Medicinal Plants. National Medicinal Plants Board, Govt. of India, New Delhi.
4. Vallabh. 2000. Practical Pharmacognosy, Kolkata. New Delhi.
5. Acharya Vipul Rao. 2000. Herbal Cure for Common Diseases. Diamond Books Pvt. Ltd.
6. Dey, A.C. 1998. Indian Medicinal Plants Used in Ayurvedic Preparations, Bishen Singh Mahendra Pal Singh.
7. Sathya, S., Jaiganesh, K.P and Sudha, T. 2019. Current Trends in Herbal Drug Technology. Pharmacy Council of India, New Delhi.
8. Mohamad Ali. 2009. Pharmacognosy and Phytochemistry. CBS Publications & Distribution, New Delhi, Volume.1.
9. Lewis, W.H and M.P.F. Elwin Lewis. 1976. Medical Botany. Plants Affecting Man's Health. A Wiley Inter Science Publication. John Wiley and Sons, New York.

Web Resources

1. <https://www.ipni.org/>
2. <http://www.theplantlist.org/>
3. <https://www.amazon.in/plant-taxonomy-Sharma/dp/0070141592>
4. <https://www.tropicos.org/home>
5. <http://apps.kew.org/herbcat/gotoHerbariumGrowthPage.do>
6. <https://www.absbooksindia.com/shop/science/botany/textbook-of-economic-botany>

**PLANT DIVERSITY-II
(PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY)
(SUB CODE: 26PBOC22)**

SEMESTER – II	CORE – 5	HOURS – 5	CREDITS – 4
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COURSE OUTCOMES (CO)

CO 1 Demonstrate a comprehensive understanding of the morphology, anatomy, and life cycles of Pteridophytes and Gymnosperms, including specialized phenomena like apogamy, apospory, and polyembryony.

CO2 Classify Pteridophytes and Gymnosperms using modern and classical systems (e.g., PPG/Schneider et al. 2016 and K.R. Sporne 1965) down to the family and order levels.

CO3 Critically examine the evolution of the stelar system and sori in Pteridophytes, and discuss the inter-relationships and origin of various Gymnosperm orders.

CO4: Explain the processes of fossilization and correlate the distribution of extinct plant groups across the geological time scale.

CO5: Appraise the medicinal, industrial, and ecological importance of these plant groups, focusing on wood values and their roles in diverse ecosystems.

UNIT: I PTERIDOPHYTES - Developmental studies not necessary (15 hours)

General Characters of Pteridophytes - morphology, anatomy, reproduction, Life Cycle, Apogamy, Apospory and polyembryony, Classification of Pteridophytes - Lycophytes and Ferns (PPG: Schneider *et al.* 2016); Distribution of pteridophytes in India with reference to endemics. Structural variation and evolutionary trends in stele, sori in Pteridophytes. Different spore germination patterns (Nayar and Kaur, 1971), Types of prothalli, Heterospory and Seed Habit. Medicinal and Ecological Importance of Pteridophytes.

(15 hours)

UNIT: II - LYCOPODIOPSIDA AND POLYPODIOPSIDA - Developmental studies not necessary

An overview of sporophytes' morphology, anatomy, sporangia, spores and gametophytes of living pteridophytes in Lycopodiopsida and Polypodiopsida - Equisetales, Ophioglossales, Marattiales, Hymenophyllales, Salviniaceae, Cyatheales, Polypodiales;

UNIT: III GYMNOSPERMS (15 hours)

General Characters and Classification (K. R. Sporne, 1965, up to family level); origin of Gymnosperms, ecology and distribution of Gymnosperms in India with reference to endemic species. Phylogeny and evolutionary relationships of Gymnosperms. Polyembryony with special reference to Gymnosperms. Economic importance of Gymnosperms.

UNIT: IV GYMNOSPERMS (15 hours)

An overview of morphology, anatomy, reproduction, life-cycle pattern of *Cycas*,

UNIT: V PALEOBOTANY

(15 hours)

Contribution of Birbal Sahni to Palaeobotany, Geological era and distribution of Pteridophytes and Gymnosperms. Fossil types, Fossilisation process, Radiocarbon dating; Fossil Pteridophytes and Gymnosperms from India. Economic importance of fossils. Study of organ genera: *Rhynia, Lepidocarpon, Calamites, Cordaites* and *Lyginopteris*.

Text Books

1. Vashishta, P.C., Sinha, A.K and Anil Kumar. 2016. Botany for Degree students. Gymnosperms. S. Chand and Company Ltd., New Delhi.
2. Singh, V., Pande, P.C and Jain, D. K. 2021. A Textbook of Botany. Rastogi Publications, Meerut.
3. Bhatnagar, S.P and Alok Moitra. 2020. Gymnosperms, New Age International (P) Ltd., Publishers, Bengaluru.
4. Sharma, O.P. 2017. Pteridophyta, McGraw-Hill Education, New York.
5. Vashishta, P.C., A.K. Sinha and Anil Kumar. 2018. Botany for Degree Students- Gymnosperms. S. Chand and Company Ltd., New Delhi.
6. Johri, R.M, Lata, S, Tyagi, K. 2005. A Textbook of Gymnosperms, Dominate Pub and Distributor, New Delhi.

REFERENCES

PTERIDOPHYTES:

1. **Smith, G. M. 1955 (Rep.1989).** Cryptogamic Botany Vol. II. Tata McGraw Hill, New Delhi.
2. **Foster & Gifford, 1959.** Comparative morphology of vascular plants. COH Freeman & Co.
3. **Bower, F. O. 1963 (Rep.).** The Ferns Vols. I, II & III. Today & Tomorrow's Printers & Publishers, New Delhi.
4. **Nayar, B. K. & Kaur, S. 1971.** Gametophytes of homosporous ferns. The Bot. Rev. 37: 295-396.
5. **Rashid, A. 1976.** An Introduction to Pteridophytes. Vikas Publishing House, New Delhi.
6. **Sporne, K. R. 1985.** The morphology of Pteridophytes. Hutchinson & Co. London.
7. **Manickam, V. S. & Irudayaraj, V. 1992.** Pteridophyte Flora of the Western Ghats, South India. B I Publications, Pvt. Ltd. New Delhi.
8. **Manickam, V. S. & Irudayaraj, V. 2003.** Pteridophyte Flora of Nilgiris, south India. Bishen Singh & Mahendra Pal Singh. Dehradun, India.
9. **Pullaiah, T. 2003.** Pteridophytes in Andhra Pradesh India. Daya Publishing House, India.
10. **Schneider et al., 2016.** A community-derived classification for extant lycophytes and ferns. The Pteridophyte Phylogeny Group. *J. Syst. & Evol.* 54: 563-603.

GYMNOSPERMS:

1. **Arnold, C. R. 1947 (Rep. 1979).** An Introduction to Palaeobotany. McGraw Hill Publishing Co. Ltd.
2. **Sporne, K. R. 1967.** The Morphology of Gymnosperms. Hutchinson & Co. London.
3. **Eames, A. J. 1972.** Morphology of Vascular Plants: Lower Groups. Tata McGraw Hill, New Delhi.

4. **Chamberlain, C. J. 1986.**Gymnosperms: Structure and Evolution. CBS, Publishers & Distributors, Delhi.
5. **Sharma, O. P. 1999 (3rd Edition).** Gymnosperms. Pragati Prakashan, Meerut, India.

PALEOBOTANY:

1. **Bower, F. O. 1935.** Primitive Plants. Macmillan
2. **Walton, 1951.** An Introduction to the Study of Fossil plants.
3. **Andrews, H. N. 1961.** Studies in Paleobotany, Wiley, N.Y.
4. **Surange, K. R. 1966.**India Fossil Pteridophytes. Botanical Monograph, No. 4, Council of Scientific & Industrial Research, New Delhi.
5. **Sewart, W. N. 1983.** Paleobotany and the Evolution of Plants. Cambridge Univ. Press.

ECOLOGY, PHYTOGEOGRAPHY AND CONSERVATION BIOLOGY
(SUB. CODE: 26PBOC23)

SEMESTER: II	CORE-7	HOURS: 5	CREDITS: 4
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COURSE OUTCOMES:

By the end of the course the student will be able to:

- Understand the importance of interaction of biotic and abiotic factors **(K1)**
- Learn the importance of ecology and ecosystems for the existence of the biosphere. **(K2)**
- Apply the methods of pollution control and biodiversity conservation. **(K3)**
- Analyse the reasons for distribution of plants and continental drift **(K4)**
- Measure the environmental pollution factors and apply the knowledge to control the pollution. **(K5).**
- Adopt the methods of *in-situ* and *ex-situ* conservation of the local environment **(K6)**

UNIT: I **(15 hours)**

History of ecology and relationship of ecology with other disciplines. The physical environment: atmosphere-composition, importance and zones in the atmosphere. Hydrosphere: properties of lotic and lentic waters. Zones found in lakes, streams and oceans. Cryosphere and its importance. Lithosphere: zones and their importance.

UNIT: II **(15 hours)**

Ecosystem: structure and function - homeostasis - ecosystem energetics. Laws of thermodynamics. Generalised energy flow model in an ecosystem. Primary production (methods of measurement, global pattern, controlling factors). Energy dynamics (trophic organisation, energy flow pathways, ecological efficiencies), litter fall and decomposition (mechanisms, substrate quality and climatic factors), global biogeochemical cycles of C, N₂, P and S.

UNIT: III **(15 hours)**

Population ecology: population attributes - density, natality, mortality, growth pattern and dispersal of populations - life tables and age structure - population regulation. Concept of carrying capacity. Meta population: concepts and dynamics. Community ecology-concept, ecological niche, ecotones and edge effects.

UNIT: IV **(15 hours)**

Environmental pollution: air, water, soil and radiation pollution - sources; quality parameters; effects on plants and ecosystems. Climate change: Greenhouse gases (CO₂, CH₄, N₂, O₃, CFCs; sources, trends and role); ozone layer and ozone hole; consequences of climate change (Global warming, sea level rise, UV radiation).

UNIT: V **(15 hours)**

Phytogeography: Principles of phytogeography, types of plant distribution, theories of plant distribution-continental drift, theory of land bridges. Endemism, age and area hypothesis.

Polytopy and polyphyletic centres of origin of crop plants and area hypothesis-Endemism- plant explorations, invasions and introductions, local plant diversity, and their socio-economic importance.

REFERENCES

1. **Alan Wellburn, 1988**, Air pollution and acid rain - the biological impact Longman Scientific and technical Singapore.
2. **Begon, M. J. L. Harper, C. R. Townsend, 1990**, Ecology Blackwell Scientific Publications Oxford
3. **Chhatwal, G. R. 1998**.Text Book of Biotechnology, Anmol Pub.
4. **Cunningham, W. P. &Saigo, B. W. 1999**. Environmental Science The McGraw Hill Company, New Delhi
5. **Harrison, R. Max. 1990**. Pollution causes effects and control, Royal society of Chemistry, Great Britain
6. **Heywood, V. H. and R. T. Watson. 1995**. Global biodiversity assessment, Cambridge University Press
7. **Khan, T. I. and Shishodia, Y. S. 1998**. Environment and metal pollution, ABD publishers Jaipur.
8. **Kumar, H. D. 1994**. General ecology, Vikas publishing, New Delhi
9. **Mason, C. F. 1981**. Biology of Freshwater, Longman, London
10. **Mishra, S. R. and D. N. Saxena. 1992**. Aquatic ecology, Efficient offset printers, New Delhi
11. **Odum, E. P. 1983**.Basic Ecology, CBS College Publishing.
12. **Odum, E. P. 1996**.Fundamentals of Ecology. Nataraj publishers, New Delhi.
13. **Sinha, R. K. and Dalbir Singh. 1997**. Global Biodiversity, INA Shree Publishers Jaipur.
14. **Thomas, M. Smith and Robert Leo Smith. 2007**. Elements of Ecology, Pearson Education
15. **Trivedi, P. R., Sharma, P. L. and Sudarshan, K. N. 1994**. Natural environment and Constitution of India, Efficient offset printers, New Delhi.
16. **Varshney, C. K. 1989**.Water pollution and management, S. P. Printers, Noida.

BIostatISTICS AND BIOinformatics
(SUB CODE: 26PBOC24)

SEMESTER – 2	CORE-8	HOURS - 6	CREDITS – 4
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Course outcomes:

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

CO1	Describe the aims, scope, applications and major biological databases used in bioinformatics (K1).
CO2	Explain the organization, retrieval and utilization of biological data from major bioinformatics resources such as NCBI, EMBL, DDBJ and PDB (K2).
CO3	Apply bioinformatics tools such as BLAST, FASTA and sequence alignment methods for similarity analysis and biological interpretation (K3).
CO4	Analyze biological datasets using statistical methods including measures of central tendency and dispersion (K4).
CO5	Examine sampling methods, probability concepts and normal distribution in biological data analysis (K4).
CO6	Evaluate research hypotheses using statistical testing procedures including p-value interpretation and Chi-square test (K5).

Unit: I

Introduction to Bioinformatics: definition, aims and scope and applications in modern biological research – Major areas of Bioinformatics including genomics and proteomics. – Biological databases – definition, importance and types (primary, secondary and specialized databases). Overview of major bioinformatics resources: NCBI, EMBL, DDBJ, PDB, PIR and SWISS-PROT. Specialized databases and principles of biological data organization. Methods of data retrieval, database searching and information mining.

Unit: II

Introduction to bioinformatics tools and software. Sequence similarity search tools – BLAST and FASTA. Sequence alignment tools (pairwise and multiple alignment – basic concepts). Molecular visualization tools and structure analysis. Introduction to molecular docking tools and homology modelling. Basics of computer-aided drug design and its applications in biotechnology and pharmaceutical research.

Unit: III

Introduction to biostatistics and its applications in biological sciences. Types of data – primary and secondary data. Methods of data collection and classification of data. Frequency distribution and frequency tables. Presentation of data through tabulation; elements of a statistical table. Graphical representation of data using graphs, charts, diagrams and pictorial representations. Measures of

central tendency – arithmetic mean, median and mode. Measures of dispersion – standard deviation and coefficient of variation.

Unit: IV

Concept and importance of sampling. Sampling methods and sample size determination. Advantages and applications of sampling and sample surveys. Principal steps involved in conducting a sample survey. Sampling theory – probability sampling and alternatives to probability sampling (non-probability sampling). Normal distribution and its applications in biological data analysis. Sampling bias and its effects. Mean square error and properties of estimates. Simple random sampling and methods of sample selection.

Unit: V

Introduction to hypothesis testing. Null and alternative hypotheses. Simple hypotheses and critical region. Level of significance. One-tailed and two-tailed tests. Types of errors (Type I and Type II) and statistical power. Concept of sample size determination. Interpretation of p-values and common misconceptions. Introduction to nonparametric tests. Test of goodness of fit and Chi-square test with biological applications.

Text Books

1. **Reddy, B. R., Sharma, K. L. A. P. and Pullaiah, T. (2012).** *Biostatistics*. Astral International Pvt. Ltd., New Delhi.
2. **Rajan, S. S. and Balaji, R. (2002).** *Introduction to Bioinformatics*. Himalaya Publishing House, Mumbai.
3. **Daniel, W. W. (2007).** *Biostatistics: A Foundation for Analysis in the Health Sciences*. Wiley India Pvt. Ltd.
4. **Mount, D. W. (2004).** *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor Laboratory Press.
5. **Lesk, A. M. (2014).** *Introduction to Bioinformatics*. Oxford University Press.
6. **Pevsner, J. (2015).** *Bioinformatics and Functional Genomics*. Wiley-Blackwell

Reference Books

1. **Balaji, K. P., Raghavaiah, V. S. and Jayaveera, K. N. (2012).** *Biostatistics*. I.K. International Publishing House Pvt. Ltd., New Delhi.
2. **Bergeron, B. (2003).** *Bioinformatics Computing*. Prentice Hall of India, New Delhi.
3. **Bozdogan, H. (2003).** *Statistical Data Mining and Knowledge Discovery*. CRC Press, Boca Raton.
4. **Shanmughavel, P. (2005).** *Principles of Bioinformatics*. Pointer Publishers, Jaipur.
5. **Zar, J. H. (2010).** *Biostatistical Analysis*. Pearson Education, New Delhi.
6. **Lesk, A. M. (2014).** *Introduction to Bioinformatics*. Oxford University Press, Oxford.
7. **Campbell, A. M. and Heyer, L. J. (2007).** *Discovering Genomics, Proteomics and Bioinformatics*. Pearson Education.

TAXONOMY OF ANGIOSPERMS & ECONOMIC BOTANY- PRACTICAL

(Sub Code: 26PBOE21)

SEMESTER – II	EC-4	HOURS – 3	CREDITS – 2
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Description of a species, based on virtual herbarium and live specimens of the families mentioned in the theory.

Study the products of plants mentioned in the syllabus of economic botany with special reference to the morphology, botanical name and family.

Solving nomenclature problems.

Field Visit: A Field visit to observe the different families in the field. Preparation of herbarium (20 sheets) and Digital documentation.

**PLANT DIVERSITY -II: PTERIDOPHYTES, GYMNOSPERMS AND
PALEOBOTANY PRACTICAL
(SUB CODE: 26PBOE22)**

SEMESTER - II	EC-5	HOURS -3	CREDITS -2
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PTERIDOPHYTES

1. Examine the different types of Stele
2. Visualize the different types of Sori
3. Describe the morphological features of *Marsilea*, *Lycopodiella*, *Isoetes*, *Selaginella*, *Equisetum*, *Ophioglossum*, *Angiopteris*, *Lygodium*, *Pteris*, *Adiantum*, *Pteridium*, *Trichomanes*, *Dicranopteris*, *Cyathea*, *Christella*, *Asplenium*, *Athyrium*, *Diplazium*, *Dryopteris*, *Blechnum*, *Lepisorus* - based on herbarium/ living specimens and prepare an identification key up to Genus level

GYMNOSPERMS

4. Illustrate the Wood anatomy (TLS / RLS) of *Pinus*, *Araucaria*, *Cupressus*, *Cedrus*, *Sequoia*, *Podocarpus*, *Gnetum*.
5. Identification of endemic Pteridophytes and Gymnosperms of India by Herbarium specimens or photographs – *Huperzia hilliana*, *Selaginella tenera*, *Osmunda hugeliana*, *Lindsaea malabarica*, *Cyathea nilgirinsis*, *Dryopsis scabrosa*, *Polystichum paleniensis*, *Bolbitis semicordata*, *Elaphoglossum beddomei*, *E. nilgiricum*, *Cycas beddomei*, *Gnetum ula*
6. Examine the Fossil slides of Pteridophytes and Gymnosperms and enumerate the morphological, anatomical and reproductive characters

PTERIDOPHYTES

External Morphology and Internal Anatomy of the Vegetative and Reproductive organs of the following living forms: *Selaginella*, *Equisetum*, *Angiopteris*, *Adiantum*, *Cyathea*, *Pteris*, *Marsilea* and *Azolla* (depending on availability of the specimen). Fossil slide observation: *Rhynia*, *Lepidocarpon*, *Calamites*.

GYMNOSPERMS

External Morphology and Internal Anatomy of the Vegetative and Reproductive organs of the following living forms: *Thuja*, *Cupressus*, *Araucaria*, *Podocarpus*, *Gnetum*, *Cycas* and *Pinus a*(depending on availability of the specimen). Fossil slides observation: *Cordaites* and *Lyginopteris*.

ECOLOGY AND PHYTOGEOGRAPHY – PRACTICAL
(SUB CODE: 26PBOS21)

SEMESTER -II	SEC-1	HOURS - 3	CREDITS - 2
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1. Study of vegetation using line transect, belt transect and quadrats.
2. To determine the minimum size of a quadrat using the Species Area Curve.
3. IVI using Quadrats
4. IVI using point frame
5. Stratification
6. Crown cover area
7. Similarity index of strands
8. Interspecies association and Chi-square test
9. Study of hydrophyte – Hydrilla, Nymphaea stems
10. Study of xerophyte – *Asparagus*, *Acacia*, *Casuarina*

WATER ANALYSIS:

1. Estimation of Productivity in *Hydrilla* plant in polluted and non-polluted waters.
2. Estimation of H₂S
3. Estimation of Na, K and Ca using a flame photometer
4. Estimation of PO₄
5. Measurement of noise using a sound level met

CELL BIOLOGY AND GENETICS
(SUB. CODE: 26PBOC31)

SEMESTER - III	CORE – 9	HOURS -5	CREDITS - 4
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COURSE OUTCOMES:

- Recite the importance of cells, organelles of the living world (K1)
- Understand the concepts of cell division and heredity (K2)
- Demonstrate the Mendelian principles (K3)
- Outline the fundamental concept of transferring traits from one generation to the next (K4)
- Justify the concepts of evolution in the origin of life (K5)
- Support the cytogenetic concept with different living systems (K6)

UNIT: I

(15 hours)

Cell Theory, Cell Structure, Cell Organelles and their function: Ultrastructure and function of biological membranes with special emphasis on plasma membrane and tonoplast, chloroplast, mitochondria, nucleus, Ribosome, microbodies, dictyosomes, lysosomes and endoplasmic reticulum. Cell Cycle - Biochemical and genetic mechanisms. Cell communication and Cell adhesion. Apoptosis - intrinsic and extrinsic pathways.

UNIT: II

(15 hours)

Cell division - mitosis, meiosis - cytokinesis and cell plate formation, role of cyclins and cyclin-dependent kinases, mechanism of programmed motor movements, regulation of cell cycle; Cell cycle significance. Structure and morphology of chromosomes. Biochemical composition and ultrastructure of chromosome and chromatin - heterochromatin and euchromatin. Banding; Karyotype analysis.

UNIT: III

(15 hours)

Genetic material: DNA, RNA, experimental evidence: Genomes of mitochondria and chloroplasts, semi-autonomy of the organelles. Endosymbiotic theory. Mendelian principles: Dominance, segregation, and independent assortment. Concept of gene: Allele, multiple alleles, pseudoallele, and complementation tests. Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters. Pedigree analysis.

UNIT: IV

(15 hours)

Gene mapping methods: Linkage maps, tetrad analysis- Ordered type (Neurospora) and unordered type (yeast), mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants. Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance. Mutation: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal versus somatic mutants, insertional mutagenesis. Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications.

UNIT: V**(15 hours)**

Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping, Recombination: Homologous and non-homologous recombination, including transposition. Cytogenetics of Polyploids and Aneuploids – Allopolyploidy and Autopolyploidy its phenotypic effects. Techniques involved in physical mapping of chromosomes *in situ* hybridization Fluorescence *in situ* hybridisation.

REFERENCES

1. **Alberts, Johanson, Lewis, Raff, Roberts and Walter. 2002.** The molecular Biology of the cell. 4th Edition, Garland Science Publishing.
2. **Lodish, H., Berk, A., Zipursky, S. L., Matsudaira, P., Baltimore, D. and Darnell, J. 2000.** Molecular Cell Biology, W. H. Freeman and Co., New York, USA.
3. **Brachet and Mirsky (ed.):** The Cell, Academic Press, Vols. 16.
4. **De Robertis, E. D. P. and De Robertis, E. M. F. 2001.** Cell and Molecular Biology, Lippincott Williams & Wilkins, Bombay.
5. **Wolfe, S. L. 1993.** Molecular and Cellular Biology,
6. Wordsworth Publ. Co., California, USA.
7. **Gupta, P. K. 2009.** Genetics, 4/e. Rastogi Publications, Meerut.
8. **Lewin, B. 2007.** Genes IX. Wiley Eastern Ltd., New Delhi.
9. **Snustad, D. P., Simmons, N. J. and Jenkins, J. B. 2003.** Principles of Genetics. John Wiley & Sons, New York.
10. **Strickberger, N. W. 1985.** Genetics 3rd Ed. Macmillan Co. New York.
11. **Hartl, D. L. and Jones, E. W. 1997.** Genetics: Principles and Analysis 4th Ed. Jones & Bartlett Publishers, Inc.
12. **Sharma, A.K. and Sharma, A. 1980.** Chromosome Techniques. Theory and Practice, Butterworth.
13. **Russel, P. J. 1998.** Genetics(5thed). The Benjamin Cummings Publishing Company Inc., USA.
14. **William S. Klug, Michael R. Cummings, Charlotte A. Spencer and Michael A. Palladino.** Concepts of Genetics (10th Edition) 10th Edition. Pearson publication.

BIOCHEMISTRY AND BIOPHYSICS

(SUB CODE:26PBOC32)

SEMESTER -III	CORE - 10	HOURS - 5	CREDITS -4
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Course outcomes (COs):

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

CO1: Explain the fundamental concepts of atomic structure, chemical bonds and biomolecules (K2)

CO2: Illustrate the structure, properties and biological significance of carbohydrates, amino acids, proteins, lipids, photosynthetic pigments, and vitamins in plant and animal systems (K2)

CO3: Analyse the metabolic pathways such as biosynthesis of palmitic acid and metabolism of phenylalanine and tyrosine, and relate structure-function relationships of proteins like haemoglobin and leghaemoglobin (K3)

CO4: Examine the principles of biophysics including laws of thermodynamics, redox potential, energy transduction, and photobiological processes to explain energy flow in biological systems (K4)

CO5: Interpret enzyme kinetics using the Michaelis-Menten equation and Lineweaver-Burk plots, and evaluate factors affecting enzyme action, inhibition, and applications of isozymes in diagnostics (K5)

CO6: Justify the role of coenzymes and buffers in biochemical reactions for research and applied contexts (K6)

UNIT: I

Biochemistry: Atomic structure: chemical bonds - ionic bond, covalent bond, coordinate covalent bond, hydrogen bond, hydrogen ion concentration (pH), buffers. Carbohydrates-classification, structure and properties of monosaccharides-glucose, fructose and disaccharides-sucrose, maltose, Lactose. Classification, structure and properties of polysaccharides-starch, glycogen, cellulose, hemicellulose.

UNIT II

Amino acids - classification, structure and properties - metabolism of phenylalanine and tyrosine. Proteins-classification, structure-primary, secondary, tertiary and quaternary - properties. Structure and function of haemoglobin and leghaemoglobin.

UNIT III

Lipids-classification, saturated and unsaturated fatty acids- Biosynthesis of palmitic acid, structure and characteristics of simple lipids (waxes and triglycerides) compound lipids (phospholipids and glycolipids), and derived lipids (steroids, carotenoids and terpenoids). Vitamins-structure, source and their role. - Chemistry of photosynthetic pigments (chlorophylls and flavonoids) and their biological significances.

UNIT IV

Biophysics: Laws of thermodynamics, Energy transduction in biological systems, redox potential-redox couples-ATP as a high-energy compound. Photobiology-dual nature of light, Energy states - singlet and triplet states- excitation and de-excitation and light emissions (Fluorescence, Phosphorescence and Bioluminescence).

UNIT V

Enzyme: Classification and nomenclature, concept of active site-mechanism of enzyme action, factors affecting enzyme action. Michaelis – Menten constant, MM equation, Lineweaver-Burk plot, Enzyme inhibition, coenzymes- mechanism of enzyme action, Isozymes-diagnostics, application, isolation and purification of enzymes.

References:

1. Albert L. Lehninger, 1975. Biochemistry, Kalyani Publishers, Ludhiana.
2. David L.Nelson & Michael M.Cox., 2000. Principles of biochemistry, Macmillan Worth Publishers, New York.
3. Eric E. Conn et al., 1987. Outline of Biochemistry, John Wiley & Sons Pvt. Ltd., Singapore
4. Lubert Stryer., 1995, Biochemistry, W.H.Freeman and Company, New York.
5. Pamela C. Champe & Richard A. Harwey., 1987 Biochemistry, Lippincott Williams & Wilkins, New York.
6. Philip W. Kuchel & Gregory B. Ralston 1988 Theory and problems of Biochemistry,
7. Schaum's outline series, McGraw-Hill Book Company, New Delhi.
8. Robert K. Murray et. al., 1998 Harper's Biochemistry, Prentice - Hall International, Inc. Singapore.
9. Salil Bose., 1981, Elementary Biophysics, Vijaya Printers, Madurai.
10. Trudy McKee & James R. McKee., 1996, Biochemistry, WM - C Brown Publishers, London.

PLANT BIOTECHNOLOGY

(SUB CODE: 26PBOC33)

SEMESTER -III	CORE-11	HOURS - 5	CREDITS -4
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Course Outcomes (CO):

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

CO1: Recall the principles and culture techniques of cells, callus, organs, pollen, anthers, embryos and protoplasts. Understand the basics of recombinant DNA technology. (K1)

CO2: Understand the techniques used in plant growth and regeneration under *in vitro conditions* and in rDNA technology. (K2)

CO3: Apply the role of plant tissue culture and rDNA techniques in the production of some secondary metabolites and planting stock in horticulture (K3)

CO4: Analyze the conditions that are suitable for direct and indirect plant regeneration and compare and contrast the recombinant organisms and natural organisms (K4)

CO5: Evaluate the self-skills obtained during the course through internal and external assessment systems. Create and develop skills for rDNA techniques and in producing hybrid varieties. (K5 & K6)

UNIT I: Basic Plant Tissue Culture

Totipotency and concepts of plant tissue culture – Laboratory organisation – Design of different laboratories and management - Aseptic techniques - Plant culture media – Inorganic nutrients – Macronutrients – Micronutrients - Carbon and energy sources – Organic supplements – Growth regulators – Solidifying agent – MS medium and B5 medium – Explant preparation - Methods of sterilization – Transfer and incubation of culture – Transplantation area.

UNIT II: Micropropagation

Micropropagation – Stages of Micropropagation, Shoot tip/Meristem culture for virus-free plants, Multiplication through callus culture – Multiplication and rooting - Hardening - Factors affecting micropropagation – Technical problems in micropropagation - Practical applications of micropropagation – Organogenesis and somatic embryogenesis; Somaclonal & gametoclonal variation – synthetic seed technology -

UNIT III: Cell and Protoplast cultures, Haploid production and Cryopreservation

Single cell and cell suspension culture – Applications - Production of haploids - Anther culture and pollen culture – Production and role of haploid plants in Plant breeding - Protoplast culture: Protoplast isolation, purification – regeneration – culturing. Protoplast fusion techniques – somatic hybridization and cybridization - Applications of protoplast culture and hybridization. Germplasm storage and conservation – Methods of *in vitro* conservation – Cryopreservation and steps involved in cryopreservation of plant materials

UNIT IV Secondary metabolite production (15 hours)

In vitro production of secondary metabolites – classification of secondary metabolites – techniques for producing cell lines for high yields of secondary metabolites – mass cultivation of plant cells – immobilised plant cell culture – Hairy root culture – Biotransformation. Application of tissue culture in forestry, horticulture, agriculture and pharmaceutical industry.

UNIT V Genetic engineering in plants (15 hours)

Agrobacterium-mediated plant transformation – Ti Plasmid – binary and co-integrate vectors – Genetic manipulation of plants for herbicide resistance, viral disease resistance and improvement of seed storage protein quality – golden rice – flavr-savr tomato.

Text Book:

1. Narayanaswamy, S. 1999. Plant cell and tissue culture. 8th edn. Tata McGraw Hill Publ. ISBN 0074602772.
2. Bhojwani, S.S and Razdan, M.K. 2004. Plant Tissue Culture, Read Elsevier India Pvt. Ltd. ISBN 818147 3256.
3. Trigiano, R.N and D.J. Gray (eds.). 2000. Plant tissue culture concepts and laboratory exercises. CRC Press. (Textbook). 2nd Edition.
4. Kyte, M and Kleyn, J. 1996. Plant from test tubes. Timber Press. Auge, R. et al., 1995. In vitro culture and its applications in horticulture. Science Publishers, Inc.
5. Auge, R. 1995. In vitro culture and its applications in horticulture. Science Publishers, Inc.
6. Gamborg, O.L. and G.C. Phillips (eds). 1995. Plant cell, tissue and organ culture. Springer Lab Manual.
7. Das, H.K. 2010. Textbook of Biotechnology (4th edition). Wiley India Pvt. Ltd. New Delhi
8. Verma, P.S and Agarwal V.K. 2009. Genetic Engineering. S.Chand & Co. Ltd. New Delhi
9. Kreuzer, H and A. Massey. 1996. Recombinant DNA and biotechnology. A guide for teachers. ASM Press.
10. Ramavat, K.G. 2006. Plant Biotechnology. S. Chand and Co. Ltd., New Delhi.
11. Chawla, H.S. 2009. Introduction to Biotechnology. 2nd edn. Oxford IBH, ISBN: 978-81-204-1732-8.
12. Halford, N. 2015. Plant Biotechnology: Current and Future Applications of Genetically Modified crops, John Wiley and Sons.
13. Thieman. 2014. Introduction to Biotechnology 3rd Edition. Pearson Education India.

Reference books:

1. Bhojwani, S. S and Dantu, P.K. 2013. Plant tissue culture: an introductory text (Vol. 318). New Delhi, India: Springer.
2. Vasil, I.K. and Thorpe, T.A. 1994. Plant Cell and Tissue Culture, Kluwer Academic Press, The Netherlands.
3. Loyola-Vargas, V.M. Ochoa-Alejo, N. 2016. Somatic embryogenesis: Fundamental aspects and applications, Springer International Publishing, Switzerland.
4. Elhiti, M., Stasolla, C and Wang, A. 2013. Molecular regulation of plant somatic embryogenesis. In Vitro Cellular & Developmental Biology-Plant, 49(6), 631-642

5. Collins, H.A. and Edwards, S. 1998. Plant Cell Culture, Bios Scientific Publishers, Oxford, UK.
6. Hall, R.D. (Ed.). 1999. Plant Tissue Culture: Techniques and Experiments, Academic Press, New York.
7. Kartha, K.K. 1985. Cryopreservation of plant cells and organs. CRC Press, Boca Raton, Florida.
8. Smith, J.K. 1996. Biotechnology – 3rd Ed. Cambridge Univ. Press, Cambridge.
9. Slater, A. Scott, N and Fowler, M. 2008. Plant Biotechnology: The Genetic Manipulation of Plants. Oxford University Press Inc.
10. Chawla, H.S. 2009. Introduction to Biotechnology, 2nd edn. Oxford IBH, ISBN:978-81-204-1732-8.
11. Halford, N. 2015. Plant Biotechnology: Current and Future Applications of Genetically Modified Crops, John Wiley and Sons.
12. Brown, T.A. 2001. Gene Cloning and DNA Analysis- An Introduction (4th edition). Blackwell Science. Oxford.

Web resources:

1. <https://nptel.ac.in/courses/102/103/102103016/>
2. <http://ugcmoocs.inflibnet.ac.in/ugcmoocs/spoc.php?coordinator=574>
3. <https://www.youtube.com/watch?v=bi755vQVNx8>
4. <https://www.elsevier.com/books/plant-tissue-culture/park/978-0-12-821120-5>
5. <https://onlinelibrary.wiley.com/doi/book/10.1002/9780470686522>
6. <https://www.amazon.in/Gene-Cloning-Manipulation-Christopher-Howe-ebook/dp/B000SK4YLI>
7. <https://www.futuremedicine.com/doi/book/10.2217/9781780842134>
8. https://www.researchgate.net/publication/51144570_Introduction_to_Gene_Therapy_A_Clinical_Aftermath
9. <https://link.springer.com/book/10.1007/978-88-470-1643-9>

PHYTOCHEMISTRY AND PHARMACOGNOY
(SUB CODE: 26PBOC34)

SEMESTER -III	CORE-12	HOURS - 6	CREDITS -4
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Course Outcomes:

Upon completion of the course, the students will be able to

CO1	Explain the history, scope, classification, and pharmacopoeial standards of pharmacognosy and indigenous systems of medicine (K2).
CO2	Describe secondary metabolites and their biosynthetic pathways and functions in plants (K2).
CO3	Apply extraction, chromatographic, and spectroscopic techniques for characterization of plant drugs (K3).
CO4	Analyze quality control methods and standardisation procedures of herbal drugs (K4).
CO5	Classify medicinal plants based on pharmacological activities and explain basic concepts of pharmacogenomics (K2).
CO6	Evaluate toxic plants and the applications of plant-based biopesticides, biocides, and biofungicides (K5).

Unit I

General Introduction – History and scope of Pharmacognosy. Indigenous System of Medicine- Overview. Various systems of classification of drugs. Pharmacological action of plant drugs. Significance of Pharmacopoeial standards.

Unit II

Secondary metabolites – Introduction (Terpenes, Phenolics & Nitrogen-containing compounds). Biosynthetic Pathways: Mevalonic Acid Pathway, Methylerythritol Phosphate Pathway and Shikimic Acid Pathway. Function of secondary metabolites in plants.

Unit III

Characterization of Therapeutic drugs: Extraction, separation, isolation (Chromatographic techniques) and characterization of secondary metabolites (Spectroscopic techniques). Quality control of plant drugs: Classical and modern approaches of drugs. Significance of Pharmacopoeial Standards.

Unit IV

Classification of plant drugs: Anti-cancer agents, Bitter tonics, Carminatives and Gastrointestinal regulators, Cardiotonics, CNS-Stimulants, Expectorant, Laxatives & Purgatives. Introduction of Pharmacogenomics.

Unit V

Hallucinogenic and allergenic plant types and effects. Poisonous plants and plant toxins: classification and toxic principles. Biopesticides: concept, types and application; Plant-based biocides and biofungicides.

Text Books

1. Dewick P. M., 2002. Medicinal Natural Products: A biosynthetic approach, John Wiley & Sons
2. Evans W.C. 2002, Trease and Evan's Pharmacognosy, W.B.Saunders.
3. Harborne, J. B., 1998. Phytochemical Methods, Chapman and Hall.
4. Vickery M. L. and B.Vickery, 1981. Secondary Plant Metabolism, The MacMillan Press Ltd.

Reference Books

1. Bruneton, J. 1999. Pharmacognosy, Phytochemistry, Medicinal Plants, Intercept Ltd.,Paris.
2. Evans W.C.2002, Trease and Evan's Pharmacognosy, W.B.Saunders.
3. Harborne, J.B.1998.Phytochemical Methods, Chapman and Hall.
4. Vickery M. L and B. Vickery, 1981. Secondary Plant Metabolism, The MacMillan Press Ltd.
5. Wagner H.,S. Bladtand E. M. Zgainski (Translated by A. Scott)1984, Plant Drug Analysis, Springer-Verlag.
6. Seigler, D.S.1998. Plant Secondary Metabolism. Springer Science + Business Media, LLC.
7. Herbert, R.B. 1981. The Biosynthesis of Secondary Metabolites. Chapman and Hall, London.

Web Resources

1. <https://pharmabookbank.files.wordpress.com/2019/03/14.2.pharmacognosy-by-biren-shahavinash-seth-1.pdf>
2. <https://www.pdfdrive.com/pharmacognosy-books.html>
3. <https://www.amazon.in/textbook-pharmacognosy-phytochemistry-kumar-jayaveera-ebook/dp/b06xksy76h>
4. <https://www.amazon.in/pharmacognosy-dr-c-k-kokate-ebook/dp/b07jhnnmwb>
5. <https://www.amazon.in/experimental-phytopharmacognosy-comprehensive-guide-khadabadi-ebook/dp/b07zfmyqk8>

CELL BIOLOGY AND GENETICS -PRACTICAL
(SUB. CODE: 26PBOE31)

SEMESTER - III	EC-6	HOURS -3	CREDITS - 2
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CELL BIOLOGY

1. Isolation of chloroplasts
2. Study of cell types – Guard cells, heterocysts, Sclereids, Storage cells
3. Use of fluorescent dye to visualize cell components
4. Smear preparations – *Allium cepa*/ *Zea mays* / *Tradescantia*
5. Determination of mitotic index
6. Preparation of Feulgen-stained chromosomes in root tip cells
7. Effect of colchicine on chromosome movements during mitosis
8. Karyotype analysis in plant species

GENETICS

9. Genetic problems on interaction of genes
10. Genetic problems on sex-linked inheritance
11. Multiple alleles and Blood group inheritance in human
12. Chromosome mapping based on three-point cross
13. Population genetics – Hardy Weinberg Law

BIOCHEMISTRY AND BIOPHYSICS -PRACTICAL
(SUB CODE: 26PBOE32)

SEMESTER -III	EC-7	HOURS - 3	CREDITS -2
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- Estimation of free amino acids and protein in plant sources.
- Estimation of total carbohydrates in plants.
- Estimation of lipids in plant extracts.
- Estimation of Iodine value in any two vegetable oils.
- Extraction and estimation of alkaloids.
- Estimation of cellulose.
- Estimation of enzyme activity and Km value - using Lineweaver-Burk plot.
- Effect of temperature and pH on enzyme activity.
- Estimation of cholesterol.
- Estimation of ascorbic acid.
- Estimation of Proline.
- Estimation of Phenols

PLANT BIOTECHNOLOGY- PRACTICAL
(SUB CODE: 26PBOS31)

SEMESTER -III	SEC-3	HOURS - 3	CREDITS -2
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1. Preparation of plant tissue culture media
2. Sterilization Methods
3. Seed Culture
4. Embryo culture
5. Spore Culture
6. Micropropagation
7. Callus induction
8. Organogenesis and Somatic embryogenesis
9. Haploid production
10. Single cell isolation
11. Protoplast isolation
12. Synthetic seed production
13. Plasmid DNA isolation
14. Restriction Digestion
15. Restriction mapping problems
16. Spotters

PLANT PHYSIOLOGY
(SUB CODE: 26PBOC 41)

SEMESTER: IV	CORE:13	HOURS:5	CREDITS:4
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COURSE OUTCOMES (CO)

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

CO1 : Relate understand properties and importance of water in biological system, nutrients and its translocation. (K1)

CO2 : Demonstrate the importance of light in plant growth and the harvest of energy. (K2)

CO3 : Explain the energy requirement and nitrogen metabolism. (K3)

CO4 : Compare the various growth regulators that influence plant growth. (K4)

CO5 : Discuss the senescence and plant response to environmental stress. (K5 & K6)

UNIT I: WATER RELATIONS

Physical and chemical properties of water –Components of water potential - Plasmolysis - water absorption by roots – Apoplast and Symplast concept - water transport through the xylem — Transpiration and evapotranspiration- stomatal structure and function – mechanism of stomatal opening and closing – mineral nutrition – essential nutrients – macro and micro nutrients – deficiencies and plant disorders – absorption of solutes – translocation of solutes – pathways and mechanisms. phloem loading and unloading - translocation of photosynthates – source- sink relationship – partitioning of assimilates and harvest index. SPAC.

UNIT II: PHOTOSYNTHESIS

The physical nature of light – the absorption and fate of light energy – absorption and action spectra- photoreceptors- Ultrastructure and biochemical compartmentation of Chloroplast; Photosynthetic Electron Transport and Photophosphorylation (cyclic and noncyclic): Photosystems and reaction centres - Light Harvesting complexes - Photosystem I & II and Oxidation of Water; Carbon metabolism: C3, C4 and CAM pathways and their distinguishing features - photorespiration and its significance.

UNIT III: RESPIRATION

An overview of plant respiration – Glycolysis – TCA cycle– Electron Transport – oxidative phosphorylation and ATP synthesis – Chemiosmotic Theory - Pentose Phosphate Pathway– Respiration and its significance in crop improvement. Cyanide resistant respiration; Nitrogen fixation (Biological - symbiotic and non-symbiotic), Physiology and Biochemistry of nitrogen fixation.

UNIT IV: GROWTH AND DEVELOPMENT

Phases of plant growth – growth types- Growth substances - Auxins, gibberellins, cytokinins, abscisic acid, ethylene, brassinosteroids - physiological effect and mechanism of action in agricultural and horticultural crops –Photoperiodism – Classification of plants and mechanism of flowering – Phytochrome and their action on flowering – Vernalization- Mechanism and its practical application, biological rhythms and movements. Seed dormancy and causes and Seed germination and their biochemical changes.

UNIT V: STRESS PHYSIOLOGY

Plant senescence –Types and Mechanism of senescence- Abscission: Morphological and biochemical changes – Significance. Fruit ripening- Biochemical, Physiological changes and control of fruit ripening. Plant response to environmental stress: Biotic and Abiotic stress – Water, temperature, light and salinity- Adaptive mechanism to various stresses (avoidance, escape, tolerance)–stress responsive proteins – anti-oxidative mechanism.

Text Book:

1. Gauch, H.G.1972. Inorganic Plant Nutrition. Hutchinson & Dowd. New York.
2. Govindji. 1982. Photosynthesis. AP. New York.
3. Jacob, W.P. 1979. Plant Hormones and Plant Development. Cambridge University Press. Cambridge
4. Khan, A.A. 1982. The Physiology and Biochemistry of Seed development, Dormancy and Germination. Elsevier. Amsterdam.
5. Salisbury, F. B.C.W. Ross.1991. Plant Physiology. Wassworth Pub. Co. Belmont.
6. Ting, I.P. 1982.Plant Physiology. Addison Wesley Pb. Philippines.
7. Sage, R and R.K. Monson (eds). 1999. The Biology of C4 Plants AP New York.
8. Postgate, J. 1987. Nitrogen Fixation. 2nd Edition Cassel, London.
9. Lincoln Taiz, Eduardo Zeiger, Ian Max Moller and Angus Murphy. 2015. Plant Physiology. 6th Ed., Sinauer Associates.
10. Stacey, G.R.H. Burris and Evans, H.J. 1992. Biological Nitrogen Fixation. Chapman and Hall, New York

Reference Books:

1. Bidwell, R.G.S. 1974. Plant Physiology, Macmillan Publishers, Boston.
2. Devlin, R.M. 1996. Plant Physiology, PWS Publishers, Boston.
3. Jain, V.K. 2017. Fundamentals of Plant Physiology. Chand & Company Ltd., New Delhi.

4. Gontia. 2016. A textbook of Plant Physiology. Satish Serial Publishing House, New Delhi.
5. Leopold, A.C, 1994. Plant Growth and Development, McGraw Hill, New York.
6. Lincoln Taiz et al., 2014. Plant Physiology and Development. Sinauer Associates Inc. Publishers, Sunderland, Massachusetts.
7. Moore, T.C. 1989. Biochemistry and Physiology of Plant Hormones (2nd Edition). Springer-Verlag, New York, USA.
8. Noggle, R.G and Fritz, G.J. 2010. Introductory Plant Physiology, PHI Learning Pvt Ltd, New Delhi.

MOLECULAR BIOLOGY AND GENETIC ENGINEERING
(SUB. CODE: 26PBOC42)

SEMESTER: IV	CORE: 14	HOURS:5	CREDITS:4
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COURSE OUTCOMES:

By the end of the course, the student will be able to:

CO 1: Acquire knowledge of modern scientific breakthroughs that influence society and the development of science in molecular level. **(K1)**

CO 2: Understand the importance of DNA and the cellular machinery in transmitting genetic information **(K2)**

CO 3: Apply the knowledge of how to identify the genetic information at the gene level. **(K3)**

CO 4: Analyze the genetic abnormalities and predict the remedy for that problem. **(K4)**

CO 5: Analyze the regulation of gene expression at the cellular level. **(K5)**

CO 6: Summarize the overall functions of genes in the human body and their importance. **(K6)**

UNIT: I

DNA and RNA structure: Primary, Secondary and supercoiling of DNA. Types of DNA & RNA, difference between DNA & RNA. RNA interference - replication: prokaryotic and eukaryotic DNA replication, mechanisms of DNA replication, Organization and functions of chloroplast and mitochondrial DNA-Chromatin Dynamics - C-Value Paradox - Transposons - types - significances, organization and functions of mitochondrial DNA.

UNIT: II

Transcription: Prokaryotic transcription, eukaryotic transcription, general and specific transcription factors, regulatory elements and mechanisms of transcription regulation, transcriptional and post-transcriptional gene silencing. Translation: Prokaryotic and eukaryotic translation machinery, mechanisms of initiation, elongation and termination, regulation of translation, co- and post-translational modifications of proteins.

UNIT: III

DNA damage and repair – Thymine dimers, Photoreactivation, excision repair. DNA sequencing: Principle - dideoxy chain termination, chemical methods, pyrosequencing and NGS. Strategies for genome sequencing; automated sequencing. Polymerase chain reaction: Principle and procedure; types, applications of PCR in basic and applied research. Blotting techniques: Concept of nucleic acid hybridization; Southern, Northern and Western blotting. Molecular markers: Types and characteristic features, Isozymes, RFLP, RAPD, AFLP, ISSR, MAS, QTLs, SSR and SNP techniques. DNA barcoding.

UNIT: IV

Gene cloning vectors: Plasmids, bacteriophages, phasmids, cosmids. Artificial chromosomes: BAC, PAC, YAC. Construction of genomic libraries and cDNA libraries. mRNA enrichment, reverse transcription. Library construction and screening. DNA primers, linkers, adaptors. Enzymes in genetic engineering.

UNIT: V

Identification of target gene - Gene transfer methods – physical, chemical and biological.
Selection of transformed organisms – Plant genetic engineering using Ti plasmid - GMO, GMC,
Selection of Transformed Organisms - Gene therapy - Bioethics - IPR and its applications, Human
Genome Project.

REFERENCES

1. **Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter. P. 2005.** Molecular biology of the cell, Macmillan Publishers Ltd. New York, USA.
2. **Benjamin Lewin. 2008.** Genes IX Jones and Bartlett Publishers
3. **Brown, T. A. 2001.** Genomes, J Wiley & Sons, USA
4. **Cooper, G. M. and Hausman, R. E. 2006.** The Cell A Molecular Approach, ASM Press and Sinauer Associates.
5. **Dabre, P. D. 1998.** Introduction to practical molecular biology, John Wiley and Sons Ltd. New York.
6. **Gilmartin, P. M. and Bowler, C. 2002.** Plant Molecular Biology (Volume 1 & Volume 2), Oxford University Press, UK.
7. **Harvey F. Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher (W.H.Freeman). 2008.** Molecular cell Biology.
8. **Karp, G. 2002.** Cell and Molecular Biology, J Wiley & Sons, USA.
9. **Lodish, H., Berk, A., Zipursky, S. L., Matsudaira, P., Baltimore, D. and Darnell, J. 2005.** Molecular Cell Biology, Jones and Bartlett Publ., USA.
10. **Primrose, S. B., Twyman, R. M., Old, R. W. 2001.** Principles of gene manipulation, Blackwell Publ UK
11. **Sambrook, J., Fritish E. F. and Maniatis, T. 2000.** Molecular cloning: A laboratory manual, Cold Spring Harbor Laboratory Press, New York.
12. **Tania, A., Baker, D., Watson, Stephen Bell. 2004.** Molecular Biology of Gene, Pearson Education.
13. **Twyman, R. M. and Wisden, W. 2000.** Advanced Molecular Biology, Springer Verlag, Germany.

ORGANIC FARMING
(SUB. CODE: 26 PBOC 43)

SEMESTER - IV

CORE-15

HOURS -4

CREDITS - 4

COURSE OUTCOMES:

By the end of the course, the students will be able to

- Acquire the knowledge of organic farming and its importance (K1)
- Understand the different techniques needed to practice organic farming (K2)
- Apply the learnt techniques practically at the local level (K3)
- Identify the nutrient deficiency symptoms and the remedies for various crop plants (K4).
- Manage soil fertility by adopting various methods (K5)
- Develop the necessary skills needed to market the organic produce (K6)

UNIT: I

Organic farming – introduction and history of organic farming – importance of organic farming -Organic farming and its relevance to Indian and global agriculture, prospects. Land management – land use, minimum tillage, use of cover crops.

UNIT: II

Water management – water use efficiency, preventing runoff water. Organic soil and crop management – mineralization of organic matter. Farming systems, crop rotation, multiple and relay cropping systems. Intercropping in relation to maintenance of soil productivity.

UNIT: III

Soil fertility and plant nutrition. Nutritional requirements of plants – compost and cover crops for organic farming – preparation and use of farmyard manure, compost, green manures, vermicompost, Panjakavium, biofertilizers and other organic concentrates – composition, availability and crop responses; recycling of organic wastes and residue management.

UNIT: IV

Nutrient deficiency symptoms and their remedy, nutrient deficiency diseases in crop plants. Control of weeds, diseases and insect pest management using biological agents, pheromones. Biopesticides.

UNIT: V

Socio-economic impact of organic farming; marketing of organic crops, marketing and export potential. Sorting, grading, labeling, inspection, certification, accreditation procedures; organic farming and national economy.

REFERENCES

1. **Nicolas Lampkin. 2003. Organic Farming.**
2. **Karl Schwnke.** Successful small-scale farming: An organic approach.
3. **Lokeretz, W. 2007.***Organic farming – an international history. CAB International.*
4. **Eric Lichtfouse. 2009.** Organic farming, pest control and remediation of soil pollutants. Springer.

PLANT PHYSIOLOGY – PRACTICAL
(SUB COE: 26PBOE41)

SEMESTER: IV	EC-8	HOURS:3	CREDITS:2
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1. Determination of water potential using gravimetric method.
2. Comparative spectroscopic analysis of photosynthetic pigments of Cryptogams and phanerogams
3. Isolation of chloroplast pigments using column chromatography
4. Estimation of photosynthetic pigments of different plant groups using Arnon's method
5. Effect of Substrate Concentration on Hill activity of isolated chloroplast by dye-reduction method
6. Effect of pH on Hill activity of isolated chloroplast by dye-reduction method
7. Effect of various lights on Hill activity of isolated chloroplast by dye-reduction method
8. Estimation of CAM by Titrimetry
9. Estimation of IAA of different plant groups
10. Estimation of amino acids of Stressed and Non-stressed plants

MOLECULAR BIOLOGY AND GENETIC ENGINEERING -PRACTICAL
(SUB. CODE: 26PBOS41)

SEMESTER: IV	SEC-4	HOURS:3	CREDITS:2
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1. Extraction and estimation of DNA from plant material and bacteria
2. Analysis of DNA by gel electrophoresis
3. Protein isolation from plant samples
4. Protein separation by polyacrylamide gel electrophoresis
5. Gene annotation
6. PCR amplification
7. Phylogenetic analysis of DNA profiles using NTSYS

PROJECT
(SUB. CODE: 26PBOC44)

SEMESTER: IV	PROJECT	HOURS:10	CREDITS:6
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As part of the curriculum, every M.Sc. Botany student is required to undertake a Project Work in any branch of Botany under the supervision of a faculty member. The project aims to develop research aptitude, practical skills, and scientific writing ability in students. Students are expected to conduct field/laboratory work, collect and analyse data, and submit a dissertation in the prescribed format, duly certified by the guide and Head of Department.

Marks: 100

Evaluation:

Internal Assessment: 50 Marks - Based on progress, regularity, data collection and presentation.

External Assessment: 50 Marks - Based on dissertation submission and viva-voce examination by an external examiner.

VALUE ADDED COURSES

FARM SCIENCES: GREEN WEALTH

Subject Code: 26PBOCC1

SEMESTER: I	CC- 1	Credits: 3	Hours: 2
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Course outcomes (CO):

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

- CO1 To identify the importance of agronomy and its scope. (K1)
- CO2 Demonstrate both the theoretical and practical knowledge in weed Management principles.(K2)
- CO3 Explain the methods of herbicide and fertilizer application. (K3)
- CO4 Compare and contrast the yield estimation and water management. (K4)
- CO5 Discuss and develop skills for effective conservation, harvesting and storage methods.(K5&K6)

Unit I

Agronomy and its scope, seeds and sowing, tillage and tillage tools, crop density and geometry, Crop nutrition, manures and fertilizers, nutrient use efficiency, water resources, soil-plant water relationship, crop water requirement, water use efficiency, irrigation scheduling criteria and methods, quality of irrigation water, waterlogging. Efficient utilization of water through soil and crop management practices. , Management of crops in rain-fed areas, Contingent crop planning for aberrant weather conditions, Concept, objective, principles and components of watershed management, factors affecting watershed management.

Unit II

Weeds- importance, classification, crop-weed competition, concepts of weed management principles and methods, herbicides- classification, selectivity and resistance, allelopathy. Growth and development of crops, factors affecting growth and development, plant ideotypes, crop rotation and its principles, adaptation and distribution of crops, crop management technologies in problematic areas, harvesting and threshing of crops.

Unit III

Identification of crops, seeds, fertilizers, pesticides and tillage implements, Effect of sowing depth on germination and seedling vigour, Identification of weeds in crops, Methods of herbicide and fertilizer application.

Unit IV

Study of yield-contributing characters and yield estimation, Seed germination and viability test, Numerical exercises on fertilizer requirement, plant population, herbicides and water requirement, Use of tillage implements-reversible plough, one-way plough, harrow, leveller, seed drill, Study of soil moisture measuring devices, Measurement of field capacity, particle density, bulk density and infiltration rate, Measurement of irrigation water.

Unit V

Harvesting, storage, physiological disorders of important vegetable crops like solanaceous fruit vegetables (brinjal, tomato & chilli), tuber crops (Potato), cucurbits (pumpkin, cucumber, watermelon & gourds), pod vegetables (pea & bean), cole crops (cabbage & cauliflower), bulb crops (onion, garlic), root crops (radish & carrot), common leafy vegetables, spices: turmeric and ginger, black pepper and cardamom.

Recommended Text:

1. Reddy, T.Y and G.H. Sankar Reddi. 2015. Principles of Agronomy. Kalyani Publishers.
2. Reddy, S.R. 2016. Principles of Agronomy. Kalyani Publishers.
3. Brady, N.C and Weil, R.R. 1996. The Nature and Properties of Soils - Weil, Prentice Hall Inc.
4. Craig, C. Sheaffer and Kristine, M. Moncada. 2012. Introduction to Agronomy-Food crops and Environment (Second Edition).
5. George Acquaah. 2004. Principles of Crop Production: Theory, Techniques, and Technology. Pearson education.

References books:

1. Yawalkar, K.S. Agarwal, J. P and S. Bokde. 1967. Manures and fertilizers – AgriHorticultural Publication House.
2. Russell, J.E. 2002. Soil Conditions and Plant Growth - Daya Books.
3. Hansen, V. E. Israelsen, O.W and G. E. Stringham. 1980. Irrigation Principles and Practices - , New York Wiley.
4. Reddy, S.R. 2017. Principles of Agronomy. [Kalyani Publishers](#)
5. Sathe, T.V. 2004. Vermiculture and Organic Farming. Daya Publishers.

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	3	2	1	2	2	1	2
CO2	3	3	2	2	3	3	2	3	3	2
CO3	2	2	3	3	1	2	1	3	2	1
CO4	3	3	3	3	3	2	3	3	2	3
CO5	3	3	2	2	3	2	2	3	3	3

S-Strong (3) M-Medium (2) L-Low(1)

HERBAL TECHNOLOGY

Subject Code: 26PBOCC2

SEMESTER: II	CC- 2	Credits: 3	Hours: 2
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Course outcomes (CO):

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

- CO1 Recollect the importance of herbal technology.(K1)
- CO2 Understand the classification of crude drugs from various botanical sources. (K2)
- CO3 Analyze on the application of secondary metabolites in modern medicine.(K3)
- CO4 Create new drug formulations using therapeutically valuable phytochemical compounds for the healthy life of society.(K4)
- CO5 Comprehend the current trade status and role of medicinal plants in socio economic growth.(K5)

Unit I

PHARMACOGNOSY

Pharmacognosy scope and importance - source - Crude Drugs – Scope and Importance, Classification (Taxonomical, Morphological Chemical, Pharmacological); Cultivation, Collection and processing of crude drugs. Cultivation and utilization of medicinal and aromatic plants in India.

Unit II

PLANT TISSUE CULTURE AS SOURCE OF MEDICINES

Plant tissue culture as source of medicines, Role of plant tissue culture in enhancing secondary metabolite production (*Withania somnifera*, *Rauwolfia serpentina*, *Catheranthus roseus*, *Andrographis paniculata* and *Dioscorea sp*) - Elicitation - Biotransformation, Hairy root culture. Factors affecting secondary metabolites production. Biogenesis of phytopharmaceuticals.

Unit III

PLANT PROPAGATION

ANALYSIS OF PHYTOCHEMICALS

Methods of Drug evaluation (Morphological, microscopic, physical and chemical). Phytochemical investigations – standardization and quality control of herbal drugs. Preliminary screening, Assay of Drugs - Biological evaluation/assays, Microbiological methods - Chemical Methods of Analysis, Detection of Adulterants: Chemical estimations, Spectrophotometry and fluorescence analysis. Drug adulteration - Types of adulterants.

Unit IV

GENERAL METHODS OF PHYTOCHEMICAL AND BIOLOGICAL SCREENING

Carbohydrates and derived products: Glycosides - extraction methods (*Digitalis*, *Dioscorea*); Tannins (Hydrolysable and Condensed types); Volatile oils - extraction methods (Clove, *Mentha*). Study of some herbal formulation techniques as drug cosmetics.

Unit V

TYPES OF PHYTOCHEMICALS

Alkaloids - extraction methods (*Taxus*, *Cinchona*); Flavonoids- extraction methods, Resins- extraction method: Application of phytochemicals in phytopharmaceuticals; Biocides, Biofungicides, Biopesticides. Women entrepreneurship development – marketing cultivated medicinal plants – National Medicinal Plants Board of India.

Recommended Texts:

1. Kokate, C.K., Purohit, A.P and S.B. Gokhale. 1996. Pharmacognosy. NiraliPrakashan, 4th Ed.
2. Roseline, A. 2011. Pharmacognosy. MJP publishers, Chennai.
3. Tilgner, Sharol Marie. 2018. Herbal ABC's: The Foundation of Herbal Medicine.
4. Natural Products in medicine: A Biosynthetic approach. 1997. Wiley.
Hornok, L. (ed.).
5. Chichister, U.K.J. 1999. Cultivation and Processing of Medicinal Plants, Wiley & Sons. Treaseand Evans.
6. Mukherjee, P.K. 2008. Quality control of herbal drugs. 3rd edition. Business Horizons Pharmaceutical Publishers, New Delhi, India.
7. Kirthikar and Basu. 2012. Indian Medicinal Plants. [University Bookstore](#), Delhi. India
8. Biswas, P.K. 2006. Encyclopedia of Medicinal plants (Vol. I-VII). Dominant Publishers, New Delhi.
9. Chaudhuri, A.B. 2007. Endangered Medicinal Plants. Daya Publishing House, New Delhi.
Tilgner, Sharol Marie. 2018. Herbal ABC's: The Foundation of Herbal Medicine.

Reference Books:

1. Wallis, T.E. 1999. Textbook of Pharmacognosy. CBS Publishers and Distributors, New Delhi.
2. Kumaresan, V and Annie Regland. 2004. Taxonomy of Angiosperms systematic Botany, Economic Botany, Botany & Ethnobotany.
3. Anonymous, 2004. Cultivation of Selected Medicinal Plants. National MedicinalPlants Board, Govt. of India, New Delhi.
4. Vallabh. 2000. Practical Pharmacognosy, Kolkata. New Delhi.
5. Acharya Vipul Rao. 2000. Herbal cure for common diseases. Diamond books, Pvt. Ltd.
6. Dey, A.C. 1998. Indian medicinal plants used in Ayurvedic preparations, Bishen Singh Mahendra Pal Singh.
7. Sathya, S., Jaiganesh, K.P and Sudha, T. 2019. Current Trends in Herbal Drug Technology. Pharmacy Council of India New Delhi.
8. Lewis, W.H and M.P.F. Elwin Lewis. 1976. Medical Botany. Plants affecting Man's Health. A Wiley Inter Science Publication. John Wiley and Sons, New York.

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	2	1	3
CO2	3	3	3	3	3	3	3	1	3	3
CO3	3	3	3	3	3	3	3	2	3	3
CO4	3	3	3	3	3	3	3	1	3	3
CO5	3	3	3	3	3	3	3	1	2	3

S-Strong (3) M-Medium (2) L-Low(1)

SECONDARY PLANT PRODUCTS AND FERMENTATION BIOTECHNOLOGY

Subject Code: 26PBOEC1

SEMESTER: III	EC-1	Credits: 3	Hours: 2
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Course outcomes (COs):

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

- CO1 Critically analyze the types of bioreactors and the fermentation process.(K1)
- CO2 Evaluate the role of microorganisms in industry.(K2)
- CO3 Analyze the types of bioreactors.(K3)
- CO4 Create to understand the significance of intrinsic and extrinsic factors on growth of microorganism.(K4)
- CO5 Evaluate the concept of downstream processing.(K5 &K6)

Unit I

SECONDARY METABOLITES:

A brief account of acetate malonate, acetate mevalonate and shikimic acid pathways. Categories of phytochemicals – Phenols, alkaloids, flavonoids, terpenoids, steroids, glycosides, carbohydrates, proteins, amino acids, lipids, pigments, vitamins and other related compounds.

Unit II

MICROBIAL GROWTH:

Factors affecting microbial growth; Stoichiometry: mass balances; Stoichiometry: energy balances; Growth kinetics; Measurement of growth.

Unit III

BIOREACTORS:

Introduction to bioreactors; Batch and Fed-batch bioreactors, Continuous bioreactors; Immobilized cells; Bioreactor operation; Sterilization; Aeration; Sensors; Instrumentation; Culture-specific design aspects: plant/mammalian cell culture reactors. Bioseparations: Biomass removal; Biomass disruption; Membrane-based techniques; Extraction; Adsorption and Chromatography Industrial Processes and Process economics: Description of industrial processes; Process flow sheeting; Process economics.

Unit IV

DOWNSTREAM PROCESSING:

Biomass removal and disruption; Centrifugation; sedimentation; Flocculation; Microfiltration; Sonication; Bead mills; Homogenizers; Chemical lysis; Enzymatic lysis; Membrane based purification: Ultrafiltration ; Reverse osmosis; Dialysis ; Diafiltration ; Pervaporation; Perstraction; Adsorption and chromatography: size, charge, shape, hydrophobic interactions, Biological affinity; Process configurations (packed bed, expanded bed, simulated moving beds); Precipitation (Ammonium Sulfate, solvent); Electrophoresis(capillary); Crystallization; Extraction (solvent, aqueous two phase, super critical), Drying; Case studies

Unit V

IMPORTANT PRODUCTS THROUGH FERMENTATION:

Organic acids citric acid acetic acid, enzymes – amylase, protease, lipase, antibiotics – penicillin, vitamins – B12, amino acids – glycine, glutamic acid, organic solvents – ethanol, butanol, acetone, alcoholic beverages – wine, beer, biomass – bakers yeast, biosurfactants, biopesticides, biopolymers.

Recommended Text:

1. Shuler, M. L and F. Kargi. 2002. *Bioprocess Engineering*, Prentice Hall Inc.
2. Doran, P.M. 1995. *Bioprocess Engineering Principles*, Elsevier.
3. Kaufman, P.B. L. J. Cseke, S. Warler, J. A. Duke, and H. L. Brielmann. 1999. *Natural Products from Plants*, CRC Press LLC.
4. Casia, J.R.L.E. 2009. *Industrial Microbiology*. New Age International (P) Ltd. Publisher, New Delhi.
5. Stanbury, P. F., Whitaker, A. and Hall, S.J. 1979. *Principles of Fermentation Technology*. Aditya Books (P) Ltd., New Delhi.
6. Potter, N. N. 2007. *Food Science*. CBS Publishers.

Reference books:

1. Rehm, H. J and G. Reed, *Biotechnology-A multi- Volume Comprehensive Treatise*, 2nd Ed, Vol 3, Wiley-VCH, 1993
2. Moo-Young, M. 2004. *Comprehensive Biotechnology*, Vol. 2, Pergamon Press,
3. Dicosmo, F and M. Missawa, 1996. *Plant Cell Culture Secondary Metabolism: Towards Industrial Application*. CRC LLC.
4. Frazier, W.C. and Weshoff, D.C. (2015). *Food Microbiology* (5th edition) McgrawHill.
5. Kumari, S. 2012. *Basics of Food Biochemistry and Microbiology*. Koros Press.
6. Whitaker. J.R. 2016. *Handbook of Food Enzymology*. CRC press
7. Shewfelt, R.L. 2013. *Introducing Food Science*. CRC Press.
8. Smith, J.S and Hui, Y.H. 2014. *Food Processing*. Wiley.
9. Varzakas, T and Tzia, C. 2016. *Handbook of Food Processing*. CRC Press.

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	3	2	1	2	2	2	1
CO2	3	3	2	2	3	3	2	3	3	3
CO3	2	2	3	3	1	2	1	3	1	2
CO4	3	3	3	3	3	2	3	3	3	2
CO5	3	3	2	3	2	3	3	3	2	3

BIOPESTICIDE TECHNOLOGY

Sub Code :(26PBOEC2)

SEMESTER: IV	EC-2	Credits: 3	Hours: 2
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Course outcomes (CO):

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

CO1: Understand the issues in use of chemical pesticides and their harmful effects on life. (K1 & K2)

CO2: Aware the significance of biopesticides and their beneficial role in controlling insect pests, diseases, nematodes and weeds. (K1 & K4)

CO3: Knowledge on identification of promising biopesticides and their mechanisms of action against insect pests, diseases, nematodes and weeds. (K2 & K6)

CO4: Learn the mass production and formulation technology of selected biopesticides. (K3 & K6)

CO5: Knowledge on product development for commercialization of biopesticides. (K5)

Unit I

INTRODUCTION

Introduction of biopesticides. Biological control, History and concept of biopesticides. Importance, scope and potential of biopesticide. Advantages for the use of biopesticides.

Unit II

TYPES OF BIOPESTICIDES

Classification of biopesticides, botanical pesticides and biorationals. Mass production technology of bio-pesticides. Major classes-Properties and uses of Bioinsecticides, biofungicides, biobactericides, bionematicides and bioherbicides. Importance of neem in organic agriculture.

Unit III

IMPORTANT BIOINSECTICIDES

Bacillus thuringiensis, NPV, entomopathogenic fungi (*Beauveria*, *Metarhizium*, *Verticillium*, *Paecilomyces*). Biofungicides: *Trichoderma*, *Gliocladium*, non-pathogenic *Fusarium*, *Pseudomonas* spp., *Bacillus* spp. Biobactericides: *Agrobacterium radiobacter*. Bionematicides: *Paecilomyces*, *Trichoderma*, Bioherbicides: *Phytophthora*, *Colletotrichum*.

Unit IV

STANDARDIZATION OF BIOPESTICIDES

Target pests and crops of important biopesticides and their mechanisms of action. Testing of quality parameters and standardization of biopesticides.

Unit V

FORMULATION

Mass multiplication and formulation technology of biopesticides. Prospects and problems in commercialization and efficiency of biopesticides. Commercial products of biopesticides

Recommended Texts:

1. Johri, J. 2020. Recent Advances in Biopesticides: Biotechnological Applications. New India Publishing Agency (NIPA), New Delhi.
2. Kaushik, N. 2004. Biopesticides for sustainable agriculture: prospects and constraints. TERIPress, New Delhi.
3. Sahayaraj, K. 2014. Basic and Applied Aspects of Biopesticides. Springer India, New Delhi.
4. Tebeest, D.O. 2020. Microbial Control of Weeds. CBS Publishers and Distributors, New Delhi.
5. Joshi, S.R. 2020. Biopesticides: A Biotechnological Approach. New Age International (P) Ltd. New Delhi.

Reference Books:

1. Ainsworth, G.C. 1971. A Dictionary of the Fungi. Commonwealth Mycological Institute, Kew, Surrey, England.
2. Carlile, M.J., Watkinson, S.C and Gooday, G.W. 2001. The Fungi. 2nd Edition. Academic Press, San Diego
3. Manoj Parihar, Anand Kumar. 2021. Biopesticides. Volume 2: Advances in Bio-inoculants. Elsevier.
4. [Bailey, A.](#), [Chandler, D.](#), [Grant, W. P.](#), [Greaves, J.](#), [Prince, G.](#), [Tatchell, M.](#) 2010. Biopesticides: pest management and regulation. Plumx.
5. Manoharachary, C., Singh, H.B., Varma, A. 2020. Trichoderma: Agricultural Applications and Beyond. Springer International Publishing, New York, USA.
6. Nollet, L.M.L and Rathore, H.S. 2019. Biopesticides Handbook. CRC Press, Florida, USA.
7. Anwer, M.A. 2021. Biopesticides and Bioagents: Novel Tools for Pest Management. Apple Academic Press, Florida, USA.
8. Awasthi, L.P. 2021. Biopesticides in Organic Farming: Recent Advances. CRC Press, Florida, USA.
9. Bailey, A., Chandler, D., Grant, W., Greaves, J., Prince, G., Tatchell, M., 2012. Biopesticides: Pest Management and Regulation. CABI, Surrey, UK.
10. Glare, T.R and Moran-Diez, M.E. 2016. Microbial-Based Biopesticides: Methods and Protocols. Humana Press, New Jersey, USA.
11. Gnanamanickam, S.S. 2019. Biological Control of Crop Diseases. CRC Press, Florida, USA.

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	3	3
CO2	3	2	2	2	3	2	3	1	3	3
CO3	3	3	3	3	1	2	S	2	3	2
CO4	3	2	2	2	3	3	2	1	2	1
CO5	3	3	3	3	2	2	2	3	2	3

S-Strong (3) M-Medium (2) L-Low(1)

SELF STUDY COURSES

ENTREPRENEURIAL OPPORTUNITIES IN BOTANY

Sub Code:(26PBOSS1)

SEMESTER: III	SS-1	Credits: 2	Hours: 4
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Course outcomes (CO)

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

- CO1** : Students can acquire knowledge about organic farming and their advantages (K1)
- CO2** : Analyze both the theoretical and practical knowledge in understanding various horticultural techniques. (K2)
- CO3** : To develop kitchen garden or terrace garden in their living area. (K3)
- CO4** : Evaluate the horticultural techniques to students can develop self employment and economical improvement. (K4)
- CO5** : Create and develop skills for mushroom cultivation. (K5 & K6)

UNIT I:

Organic manures and fertilisers. Composition of fertilizer, NPK content of various fertilisers. Common organic manures: bone meal, cow dung, poultry waste, oil cakes, organic mixtures and compost. Preparation of compost, aerobic and anaerobic – advantages. Vermicompost preparation, vermiwash. Panchakaviyam.

UNIT II:

Common garden tools. Methods of plant propagation by seeds. Vegetative propagation, cutting, grafting, budding and layering. Use of growth regulators for rooting.

UNIT III:

Gardening – types of garden, ornamental, indoor garden, kitchen garden, terrace garden, vegetable garden for marketing. Rockery and artificial ponds. Ornamental garden designing, garden components: flower beds, borders, hedges, edges, drives, paths, garden adornments.

UNIT IV:

Packaging of fruits, vegetables. Preservation techniques drying, heat treatment, low temperature storage and by chemicals. Preparation of wine, vinegar and dairy products.

UNIT V:

Significance of Mushrooms. Types of Mushrooms (button mushroom, oyster Mushroom). Spawn isolation and preparation. Cultivation. Value added products from mushroom – Pickles, Candies and dried Mushrooms.

Text Book:

1. Chmielewski, J.G and Krayesky, D. 2013. General Botany laboratory Manual. Author House, Bloomington, USA.
2. Russell, T. 2012. Nature Guide: Trees: The world in your hands (Nature Guides). Mukherjee D. Gardening in India, Oxford IBH publishing co, New Delhi.
3. Kumar, N. 1997. Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
4. Webster, J and Weber, R. 2007. Introduction to Fungi, 3rd Ed. Cambridge University Press, Cambridge.
5. Bendre, M. Ashok and Ashok Kumar, A. 2020. Text Book of Practical Botany (10th ed). Rastogi Publications, Meerut. 1
6. Singh, R and U.C. Singh 2020. Modern mushroom cultivation, 3d Edition Agrobios (India), Jodhpur.

Reference Books:

1. Adams, C.R. Banford, K.M. and Early, M.P. 1993. Principles of Horticulture.
2. Sathe, T.V. 2004. Vermiculture and Organic farming, Daya Publishers.
3. Peter, K.V. 2017. Basic Horticulture.
4. Hartman, H.T. and D.F. Kestler. 1976. Plant propagation principles and practice. Prentice Hall of India, New Delhi.
5. Jules Janick, 1982. Horticulture Science. Surjeet publications, New Delhi.
6. Ignacimuthu, S. 1998. Plant Biotechnology. Tata Mc Graw Hill Ltd., New Delhi.
7. Gupta. P.K., 1998. Elements of Biotechnology. Rastogi publications, Meerut.
8. Edmond Musser and Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
9. Janick Jules. 1979. Horticultural Science. (3rd Ed.), W.H. Freeman and Co., San Francisco, USA.

Web resources:

1. <https://www.kobo.com/in/en/ebook/composting-process-organic-manures-through-eco-friendly-waste-management-practices>
2. https://books.google.co.in/books/about/Plant_Propagation.html?id=K-gQh6OI7GcC&redir_esc=y
3. <https://www.ebooks.com/en-us/subjects/gardening/>
4. <https://www.amazon.in/Preservation-Techniques-Publishing-Technology-Nutrition-ebook/dp/B00RXCXB3Q>
5. <https://www.elsevier.com/books/food-preservation-techniques/zeuthen/978-1-85573-530-9>

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	3	2	1	2	2	3	2
CO2	3	3	2	2	3	3	2	3	2	3
CO3	2	2	3	3	1	2	1	3	3	1
CO4	3	3	3	3	3	2	3	3	3	3
CO5	3	3	2	3	2	3	3	3	3	2

S - Strong (3) M - Medium (2) L - Low (1)

FORESTRY AND WOOD TECHNOLOGY

Sub Code:(26PBOSS2)

SEMESTER: IV	SS-2	Credits: 2
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Course outcomes:

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

- CO1** : Knowledge on various aspects of Forest Botany (K1)
- CO2** : Understand the importance and of different forests. (K2)
- CO3** : Analyze the ecological significance of forests. (K3)
- CO4** : To understand the dynamics of the forest. (K4)
- CO5** : Understanding on various Indian forests laws and acts. (K5 & K6)

UNIT I:

Introduction and scope of Forest Botany - Merits of combining traditional Botany and Forestry practices. General introduction to forests, natural and manmade. Types of forests: tropical, temperate, evergreen, semi-evergreen, deciduous, monoculture, multipurpose, social and industrial. Forest and climate - Forest and Biodiversity - Forest and gene conservation - Forest and ecosystem - Forest and civilisation. Geographical history of forest vegetation - natural vs. artificial. Special emphasis on social forestry, Industrial forestry and Multi-purpose forestry. Preservation of natural forestry - Pollution control.

UNIT II:

Forest genetics, Forest physiology, forest ecology – strong interrelationships. Macro-dynamic ecosystem reserves, hydrological cycles, balance. Identification of timber plants based on vegetative features. Seedlings, leaves, bark, branching pattern, architectural models of trees. Major and minor forest products, use and misuse of forests by man, direct and indirect forest wealth, forest policies, forest protection through peoples committee.

UNIT III:

Silviculture: concept and scope of study, forest in general form, composition, classification of world forests and Indian forests. Classification based on its quality density, tolerance, crown; water cycles of forest. Photosynthetic processes in forest: nitrogen and mineral nutrition in forests.

UNIT IV:

Seed dynamics in forest: seed production, dissemination, germination, establishment and mortality, growth of trees in general terms – height, diameter, volume, growth of stands – gross increment, net increment, stand reaction to various types of cuttings.

UNIT V:

Measurement: definition, direct measurements, direct and indirect estimate, and prediction.

Measurement of diameter – rules and methods, measurement of height – different rules, methods, instruments, total height and merchantable length. Measurement of volume – common units, different methods and procedures of volume measurements. Measurement of age: direct estimate, averages, standard error, and sampling; general concept of indirect estimate based on one or more independent variables. Forestry for social and national development. Progress to be achieved in social forestry, industrial forestry and multiple forestry. Forest Laws- Indian Forest Act, 1927; Forest Conservation Act. Wildlife Protection Act, 1972.

Text Book:

1. Manikandan, K and S. Prabhu. 2013. Indian forestry, a breakthrough approach to forest service. Jain Bros.
2. Roger Sands. 2013. Forestry in a global context, CAB International.
3. Balakathiresan.S.1986. Essentials of Forest Management. Natraj Publishers, Dehradun.
4. Agarwala, V.P.1990.Forests in India, Environmental and Protection Frontiers. Oxford& IBH Publishing Co. New Delhi.
5. Chundawat, B.S. and Gautham, S.K. 1996. Textbook of Agroforestry. Oxford and IBH Publishers, New Delhi.
6. Singhi, G.B. 1987. Forest Ecology of India, Publisher: Rawat.
7. Ramprakash. 1986. Forest management. IBD Publishers, Dehra Dun.
8. Tiwari, K.M. 1983. Social forestry in India. Nataraj Publishers, Dehra Dun.
9. WWF. 2007. Timber identification manual. TRAFFIC, New Delhi.
10. Dhiman, A.K. 2003. Sacred plants and their medicinal uses. Daya publishing house, New Delhi.

Reference Books:

1. Donald L. Grebner. Jacek P. Siryand Pete Bettinger. 2012. Introduction to forestry and Natural resources Academic press
2. West, P.W. 2015. Tree and forest measurement, Springer international publishing Switzerland.
3. Kollmann, F.F.P and Cote, W.A. 1988. Wood Science and Technology. Vol. I & II Springer-Verlag, New York.
4. Agarwala, V.P.1990. Forests in India, Environmental and Protection Frontiers.OxfordIBHPublishingCo.,New Delhi.
5. Rao, K.R. and Juneja, K.B.S. 1992. Field identification of 50 important timbers of India. ICFRE Publi. Dehradun 123 p.
6. Avery, T.E. 1967. Forest Measurements. Mc Grand Hill Book Company, New York.
7. Manikandan K, Prabhu S. 2018. Indian Forestry A Breakthrough Approach To Forest Services, Jain Brothers.
8. Pathak, P.S, Ram Newaj. 2012. Agro forestry: Potentials and Opportunities. India Agrobios.
9. Powell, Baden B.H. 2004. Manual of Forest Law. New Delhi: Biotech.
10. Uthappa, A.R. 2015. Sangram Bhanudas Chavan, Competitive Forestry, New Vishal Publications, 1st ed.

11. Chaturvedi, A.N. and Khanna, L.S. 2015. Hand Book of Forestry (5th Edition).
12. Frederick Franklin Moon, 2018. The Book of Forestry. Repro Books.
13. Parthiban, K.T. 2018. Introduction to Forestry & Agroforestry.

Web resources:

1. http://www.wds.worldbank.org/external/default/WDServer/WDSP/IB/2006/10/19/000112742_20061019150049/Rendered/PDF/367890Loggerheads0Report.pdf.
2. <https://www.britannica.com/science/forestry>
3. <https://en.wikipedia.org/wiki/Forestry>.
4. <https://www.biologydiscussion.com/forest/essay-forest-importance.major-products-and-its-conservation/25119>
5. <https://academic.oop.com>
6. <https://www.sciencedirect.com/topics/agriculture-and-biological-science-forest-product>.

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	3	2	1	2	2	2	1
CO2	3	3	2	2	3	3	2	3	3	3
CO3	2	2	3	3	1	2	1	3	1	2
CO4	3	3	3	3	3	2	3	3	3	2
CO5	3	3	2	3	2	3	3	3	2	3

S - Strong (3)

M - Medium (2)

L – Low (1)