ST. XAVIER'S COLLEGE (AUTONOMOUS)
Palayamkottai - 627 002

(Recognized as "College with Potential for Excellence" by UGC)
(Accredited with "A^{++}" Grade with a CGPA of 3.66)

SYLLABUS
M.Sc. BOTANY

(w. e. f. 2023 - 24)

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 Post graduate programmes of study.

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

PO3: Problem Solving: Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's earning 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 addressing 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 sense of inquiry and capability

for asking relevant questions / problem arising / synthesizing / articulating / ability to recognize cause and effect relationships / define problems. Formulate hypothesis, 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-placed 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, 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 other's ideas, behaviors, beliefs and apply diverse frames of references to decisions and actions. To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill 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 tool 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 so as 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. BOTANY – Programme Pattern

(With effect from June 2023)

Sem	Part	Status	Subject Code	Title	Hours	Credits
I	A	Core	23PBOC11	Plant Diversity-I: Algae, Fungi, Lichens and Bryophytes	5	4
		Core	23PBOC12	Plant Diversity-II: Pteridophytes, Gymnosperms and Paleobotany	5	4
		Core	23PBOC13	Plant Diversity I & II - Practical	5(3+2)	3
		Core	23PBOC14	Microbiology, Immunology and Plant Pathology	5	4
		Core	23PBOC15	Microbiology, Immunology and Plant Pathology - Practical	2	1
		EC	23PBOE11	Research Methodology / Phtyopharmacognosy	4	2
	B	EC	23PBOE12	Conservation of Natural Resources and Policies / Horticulture	4	2
				Sub Total	**30**	**20**
II	A	Core	23PBOC21	Taxonomy of Angiosperms And Economic Botany	5	5
		Core	23PBOC22	Anatomy and Embryology of Angiosperms	5	5
		Core	23PBOC23	Taxonomy of Angiosperms and Economic Botany &Anatomy and Embryology of Angiosperms-Practical	5(3+2)	3
		Core	23PBOC24	Ecology, Phytogeography and Conservation Biology	5	4
		Core	23PBOC25	Ecology, Phytogeography and Conservation Biology – Practical	2	1
		EC	23PBOE21	Applied Bioinformatics/ Nanobiotechnology	4	2
		SEC -1	23PBOS21	Agriculture and Food Microbiology	4	2
				Sub Total	**30**	**22**
III		Core	23PBOC31	Cell and Molecular Biology	5	4
		Core	23PBOC32	Genetics, Plant Breeding and Biostatistics	5	4
		Core	23PBOC33	Cell and Molecular Biology & Genetics Plant Breeding and Biostatistics Practical	5 (3+2)	4
		Core	23PBOC34	Plant cell and Tissue Culture & Recombinant DNA Technology	5	4
		Core Industry module	23PBOC35	Industrial Botany	4	3
		EC	23PBOE31	Entrepreneurial opportunities in Botany	4	3
		SEC - 2	23PBOS31	Ethno botany, Naturopathy and Traditional Healthcare	2	2
		Internship	23PBOI31	Carried out at summer vacation at the		2

				end of I year		
				Sub Total	**30**	**26**
IV		Core	23PBOC41	Plant Physiology	5	4
		Core	23PBOC42	Biochemistry & Applied Biotechnology	5	4
		Core	23PBOC43	Plant Physiology and Biochemistry & Applied Biotechnology Practical	5 (3+2)	3
		EC	23PBOE41	Organic farming / Forestry and Wood Technology	4	2
		Project	23PBOC44	Project with viva voce	7	7
		SEC-3	23PBOS41	Botany for Advanced Research	4	2
		Extension Activity		STAND Carried out in the 1 year		1
				Sub Total	**30**	**23**
				GRAND TOTAL	**120**	**91**
				Additional Compulsory Courses		
I PG		Value Added	23PBOVA1	Farm Sciences- Green Wealth		3
			23PBOVA2	Herbal Technology		
II PG		Extra Credit Courses	23PBOEC1	Secondary Plant Products and Fermentation Biotechnology		3
			23PBOEC2	Biopesticide Technology		
				GRAND TOTAL	**120**	**97**

Abbreviation

C- Core**,** EC- Elective Course**,** SEC- Skill Enhancement Course**,** I- Internship

PLANT DIVERSITY – I
(ALGAE, FUNGI, LICHENS AND BRYOPHYTES)
Sub Code :23PBOC11

SEMESTER – I	CORE - 1	HOURS - 5	CREDITS –4

Course Outcomes:

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

CO1	**:**	Relate to the structural organizations of algae, fungi, lichens and Bryophytes (K1).
CO2	**:**	Demonstrate both the theoretical and practical knowledge in understanding the diversity of basic life forms and their importance (K2).
CO3	**:**	Explain life cycle patterns in algae, fungi, lichens and Bryophytes (K3).
CO4	**:**	Compare and contrast the mode of reproduction in diverse groups of basic plant forms (K4).
CO5	**:**	Discuss and develop skills for effective conservation and utilization of lower plant forms (K5 & K6).

Unit I –ALGAE **(15 Hours)**

General account of algology, Contributions of Indian Phycologist (M.O.P. Iyengar and V.Krishnamurthy), Classification of algae by F.E. Fritsch (1935). Algae of diverse habitats,Range of thallus organization, Reproduction (Vegetative, Asexual and Sexual) and life cycle patterns.Micro algal culture and Mariculture. Salient features of major classes: Cyanophyceae, Chlorophyceae, Phaeophyceae and Rhodophyceae.

Unit II –FUNGI **(15 Hours)**

General Characteristics, Occurrence and distribution. Mode of nutrition in Fungi. Contributions of Indian Mycologists (C.V.Subramanian), Classification of Fungi by Alexopoulos and Mims (1979) & Recent trends in the classification of Fungi - Phylogeny and inter-relationships of major groups of Fungi. General characters of major classes: Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina. Heterothallism in Fungi, Sexuality in Fungi, Para sexuality, Sex hormones in Fungi.

Unit III –LICHENS **(15 Hours)**

General Characters, Classification (Hale, 1969).Occurrence and inter-relationship of Phycobionts and Mycobionts, Thallus Structure and Reproduction in Ascolichens, Basiodiolichens and Deuterolichens.

Unit IV-BRYOPHYTES **(15 Hours)**

General characters and Classification of Bryophytes by Watson (1971).Distribution, Structural variations and evolution of gametophytes and sporophytes in Bryopsida, Anthoceropsida and Mosses.General characters of major groups - Marchantiales, Jungermaniales, Anthocerotales, Sphagnales, Funariales and Polytrichales. Reproduction - Vegetative and Sexual, Spore dispersal mechanisms in Bryophytes.

Unit V-ECONOMIC IMPORTANCE **(15 Hours)**

Algae - Economic importance in Food and feed - Single cell Protein, Industrial products (Agar-Agar, Carrageenan, Alginic acid, Iodine, Biofertilizers, Vitamins and Biofuel), Medicinal value. Fungi – Economic importance in food, industries and medicine. Lichen – Economic importance and as indicator pollution. Bryophytes – Ecological and Economic Importance – Industry, Horticulture and Medicine.

Text Books

1. Kumar, H.D.1999. Introductory Phycology. Affiliated East-West Press, Delhi.
2. Barsanti, L. and Guadtieri, P. 2014. Algae: Anatomy, Biochemistry and Biotechnology, 2nd Edition, CRC Press, ISBN: 1439867321.
3. Sharma, O.P. 2011. Fungi and Allied Microorganisms, McGraw Hill, ISBN:9780070700383, 0070700389
4. Kevin K. 2018. Fungi biology and Application, 3rd Edition, Wiley Blackwell.
5. Pandey, P.B. 2014. College Botany-1: Including Algae, Fungi, Lichens, Bacteria, Viruses, Plant Pathology, Industrial Microbiology and Bryophyta. Chand Publishing, New Delhi.

Reference Books

1. Sundaralingam, V. 1991. Marine algae. Bishen Singh and Mahendra Pal Singh Publishers, Dehradun.
2. Edwardlee,R. 2018. Phycology, 5th Ed., Cambridge UniversityPress, London.
3. Nash, T.H. 2008. Lichen Biology, Cambridge University press.
4. Johri, R.M., Lata, S. and Tyagi, K. 2012. A Textbook of Bryophyta. Dominant Publishers & Distributors Pvt., Ltd., New Delhi. ISBN: 9789384207335.
5. Alexopoulos, C.J. and Mims, M. 2007. Introductory Mycology. 4th Edition, Wiley Publishers, ISBN: 9780471522294

Web Resources

1. https://www.britannica.com/science/algae
2. https://en.wikipedia.org/wiki/Bryophyte
3. https://www.britannica.com/plant/bryophyte/Ecology-and-habits
4. https://www.livescience.com/53618-fungus.html.

Mapping with Programme Outcomes:

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

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

PLANT DIVERSITY – II
(PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY)
Sub Code: 23PBOC12

SEMESTER – I	CORE – 2	HOURS – 5	CREDITS – 4

Course Outcomes:
Upon completion of the courses, the students will be able to

CO1	**:**	Recall on classification, recent trends in phylogenetic relationship, general characters of Pteridophytes and Gymnosperms (K1 & K3).
CO2	**:**	Learn the morphological/anatomical organization, life history of major types of Pteridophytes and Gymnosperms (K3 & K4).
CO3	**:**	Comprehend the economic importance of Pteridophytes, Gymnosperms and fossils (K3 & K5).
CO4	**:**	Understanding the evolutionary relationship of Pteridophytes and Gymnosperms (K2).
CO5	**:**	Awareness on fossil types, fossilization and fossil records of Pteridophytes and Gymnosperms (K1 & K3).

Unit I - PTERIDOPHYTES (15 hrs)

General characteristics and Classification (Reimer, 1954), Structural variation and evolutionary trends in stele and sori in pteridophytes. Spore germination pattern, Life cycles, Gametophyte types and evolution, Apogamy and Apospory.Heterospory and Seed Habit, Economic and medicinal importance of Pteridophytes.

Unit II - PTERIDOPHYTES (15 hrs)

General characteristics of Sporophytes (Morphology, Anatomy, Sporangia and Spores) and gametophytes of living Pteridophytes in Lycopodiopsida and Polypodiopsida (*Selaginellales – Selaginella,* Equisetales – *Equisetum,* Ophioglossales – *Ophioglossum*, Marattiales - *Angiopteris,* Cyatheales – *Cyathea*, Polypodiopsida – *Adiantum*, *Pteris* and Salviniales –*Marsilea* and *Azolla.* Distribution of Pteridophytes in India with reference to endemics.

Unit III – GYMNOSPERMS (15 hrs)

General characters - A general account of distribution of Gymnosperms in India.Morphology, Anatomy, Reproduction, Phylogeny and Classification (K.R.Sporne, 1965).Economic importance of Gymnosperms.

Unit IV – GYMNOSPERMS (15 hrs)

Structure (Exomorphic and Endomorphic), anatomy, reproduction and life histories of the following genera:*Cupressus, Araucaria, Podocarpus, Gnetum*

Unit V – PALEOBOTANY (15 hrs)

Contribution of BirbalSahni to Paleobotany.Geological Time Scale; Radiocarbon dating; Gondwana flora of India.Fossilization and fossil types. Economic importance of Fossils – fossil fuels and industrial raw materials and uses. 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.CandJain,D.K. 2021. AText Book of Botany.Rastogi Publications, Meerut.
3. Bhatnagar, S.P and AlokMoitra. 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 AnilKumar. 2018. Botany for Degree Students-Gymnosperms. S. Chand and Company Ltd., New Delhi.
6. Johri, R.M, Lata, S, Tyagi, K. 2005. A Text Book of Gymnosperms, Dominate Pub and Distributer, New Delhi.

Reference Books

1. Parihar, N.S. 2019. An Introduction to EmbryophytaPteridophytes. 5th Edition, Surjeet Publication, Delhi.
2. Pandey, S.N and Trivedi, P.S. 2015. A Text Book of Botany Vol. II- 12th Edition, Vikas Publishing.
3. Rashid, A. 2013. An Introduction to Pteridophyta – Diversity, Development and differentiation (2nd Edition), Vikas Publications.
4. Arnold A.C.2005.An Introduction to Paleobotany. Agrobios (India).Jodhpur.
5. Sporne, K.R. 2017. The Morphology of Pteridophytes (The structure of Ferns and Allied Plants), Andesite Press.
6. Sporne, K.R. 1967. The Morphology of Gymnosperms. Hutchinson & Co., London.
7. Taylor, E, Taylor, T, Krings, M. 2008. Paleobotany: The Biology and Evolution of Fossil Plants, 2nd Edition, AcademicPress.

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	3	3	3	3	3	3	3	3	3
CO3	2	3	3	3	3	1	3	3	3	3
CO4	3	3	2	3	3	3	3	2	3	2
CO5	3	2	2	2	2	2	2	1	2	1

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

PLANT DIVERSITY I & II PRACTICAL

Sub Code: 23PBOC13

SEMESTER – I	CORE – 3	HOURS – 5	CREDITS – 3

Course Outcomes:

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

CO1	**:**	Recall and applying the basic keys to distinguish at species level identification of important algae and fungi through its structural organizations (K1 & K4).
CO2	**:**	Demonstrate practical skills in Thallophytes, Pteridophytes and Gymnosperms (K2).
CO3	**:**	Describe the structure of Algae, Fungi, Lichens, Bryophytes, Pteridophytes and Gymnosperms (K3).
CO4	**:**	Determine the importance of structural diversity in the evolution of plant forms (K5).
CO5	**:**	Formulate techniques to isolate and culture of alga and fungi as well as to understand the diversity of plant forms (K5 & K6).

ALGAE

External morphology and internal anatomy of the vegetative and reproductive structures of the following living forms: *Rivularia, Anabena,Scytonema, Coleochaete, Chaetomorpha, Ulva, Halimeda, Padina, Sargassum, Stochoespermum, Ectocarpus* and *Gracilaria, Amphiroa, Hypnea*(depending on availability of the specimen).

To record the local algal flora–Study of their morphology and structure. Identification of algae to species level (at least one).

FUNGI

Study of morphological and reproductive structures of the following living forms: *Saprolegnia, Agaricus, Xylaria, Peziza, Aspergillus, Penicillium, Phytophthora, Polyporus* (depending on availability of the specimen).

LICHENS

Study of Morphological and Reproductive structures of the genera *Usnea.*

BRYOPHYTES

External morphology and internal Anatomy of the Vegetative and Reproductive organs of thefollowinglivingforms: *Riccia, Dumeriera, Targionia, Polytrichum*(depending onavailability of thespecimen).

PTERIDOPHYTES

External Morphology and Internal Anatomy of the Vegetative and Reproductive organs of thefollowinglivingforms: *Selaginella, Equisetum, Angiopteris, Adiantum, Cyathea, Ophioglossum, Pteris*, *Marsilea* and *Azolla* (depending on availability of the specimen). *Fossil slides 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* and *Ephedra* (depending on availability of the specimen).Fossil slides observation*: Cordaites* and *Lyginopteris.*

Text Books

1. Kumar,H.D.1999. Introductory Phycology. Affiliated East-West Press, Delhi.
2. Das,S and Saha, R.2020.Microbiology Practical Manual.CBS Publishers and Distributors(P) Ltd., New Delhi,India.
3. Sharma,O.P.2012. Pteridophyta,Tata McGraw-Hills Ltd, NewDelhi.
4. Sharma O.P and S, Dixit.2002.Gymnosperms.PragatiPrakashan.
5. Johri, R.M, Lata, S, Tyagi, K. 2005. A Text Book of Gymnosperms, Dominate Pub and Distributer, New Delhi.

Reference Books

1. Chmielewski, J.G and Krayesky, D. 2013. GeneralBotany Laboratory Manual. AuthorHouse, Bloomington, USA.
2. Webster, J and Weber, R.2007. Introduction to Fungi, 3rd Ed. Cambridge University Press, Cambridge.
3. Sharma,O.P.2017. Bryophyta, Mac MillanIndia Ltd, New Delhi.
4. Ashok, M. Bendre and Kumar. 2010. A Text Book of Practical Botany, Algae, Fungi, Lichen, Bryophyta, Pteridophyta, Gymnosperms and Palaeobotany. Revised Edition. Published by Rakesh Kumar Rastogi Publication.
5. Gangulee, H.C and A.K. Kar. 2013. College Botany. Vth Edition. S. Chand.

Web Resources

1. https://www.frontiersin.org/articles/10.3389/fmicb.2017.00923/full
2. https://microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175e.pdf
3. http://www.cuteri.eu/microbiologia/manuale_microbiologia_pratica.pdf
4. https://www.amazon.in/Manual-Practical-Bryophyta-Suresh-Kumar/dp/B0072GNFX4
5. https://www.amazon.in/Practical-Manual-Pteridophyta-Rajan-Sundara/dp/8126106883

Mapping with Programme Outcomes:

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

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

MICROBIOLOGY, IMMUNOLOGY AND PLANT PATHOLOGY

Sub Code : 23PBOC14

SEMESTER – I	CORE – 4	HOURS – 5	CREDITS – 4

Course Outcomes:

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

CO1	**:**	Recognize the general characteristics of microbes, plant defense and immune cells (K1).
CO2	**:**	Explain about the stages in disease development and various defense mechanisms in plants and humans (K2).
CO3	**:**	Elucidate concepts of microbial interactions with plant and humans (K3).
CO4	**:**	Analyze the importance of harmful and beneficial microbes and 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 characteristic of Virus, 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 characteristic 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 - FOOD 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). Microorganisms in organic matter decomposition. Environmental Microbiology: Microbiology of water and air. Water borne diseases - diphtheria, chicken pox. Air borne diseases - Swine flu and Measles. Microbial degradation of chemical pesticides and hydrocarbon

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 ofplant 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. Defence mechanism of host – structural and biochemical defences. Important diseases of crop plants in India - Sheath blight of rice, Late blight of potato, Little leaf of Brinjal and Red rust of tea.

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 Immuno biology. 9th Edition. Garland Publisher.

Reference Books

1. Agrios, A.G. 2007. Plant Pathology, Elsevier. ISBN: 9780120445653.
2. Jeffery, C., PommerVille. 2014. AlcamosFundalmedals 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.

Mapping with Programme Outcomes:

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

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

LAB COURSE – II MICROBIOLOGY, IMMUNOLOGY AND PLANT PATHOLOGY PRACTICAL

Sub Code: 23PBOC15

SEMESTER – I	CORE - 5	HOURS – 2	CREDITS – 1

Course Outcomes:

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

CO1 : Recall the basic techniques of microbiology (K1).
CO2 : Understand the morphology and biological structure of microbes (K2).
CO3 : Analyze the importance of microbes in our lives and the ecosystem (K3).
CO4 : Compare the various facets of the life of a microorganism (K4).
CO5 : Apply the importance of microbes in the life of human beings and plants (K5).

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

Text Books

1. Das, S and Saha, R.2020. Microbiology Practical Manual.CBS Publishers and Distributors(P) Ltd., New Delhi, India.
2. Dubey R.C. 2004. A Text Book of Biotechnology, Aspects of Microbiology, British Sun Publication.
3. Subha Rao, N.S.2000. Soil Microbiology, Oxford & IBH Publishers, New Delhi.

4. Sharma, P.D. 2005. Environmental Microbiology, Narosa Publishing House Pvt. Ltd., New Delhi.

Reference Books

1. Pelzer, M.J., Chan, E.C.S and Krieg, N.R. 1983. Microbiology, Tata MaGraw Hill Publishing House, New Delhi.
2. Pandey, P.B. 2014. College Botany- 1: Including Algae, Fungi, Lichens, Bacteria, Viruses, Plant Pathology, Industrial Microbiology and Bryophyta. Chand Publishing, New Delhi.
3. Raina Maier M. Iran Pepper L., Charles P. Gerba, 2000, Environmental Microbiology, Academic press, U.K.
4. Alexander, N. Glazer and Hiroshi Nikaido. Microbial Biotechnology WH Freeman and company New York
5. Duby, R. C. and Maheswari, D. K. 2000. A Text book of Microbiology, S Chand & Co Ltd, Delhi.
6. Larry McKane, Judy KanelII.Ed. 1996. Microbiology - Essentials and Applications McGraw Hill Inc. Newyork.

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.

Mapping with Programme Outcomes:

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

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

RESEARCH METHODOLOGY

Sub Code : 23PBOE11

SEMESTER – I	EC – 1	HOURS – 4	CREDITS – 2

Course Outcomes:

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

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

Unit I **(12 hrs)**

Research techniques: meaning and objectives, methods and approaches in research. Literature collection and citation: bibliography bibliometrics (scientometrics): definition-laws - citations and bibliography - biblioscape - 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 **(12 hrs)**

Microscopy: components of microscope, Principles of microscopy – stereo, phase contrast and fluorescence, electron microscopy (TEM and SEM) principle, 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 **(12 hrs)**

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; pHmetry: Principles, electrodes, measurement of pH, buffers and its uses.

Unit IV **(12 hrs)**

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 **(12 hrs)**

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. SreeRamulu, 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

1. https://www.kobo.com/in/en/ebook/bioinstrumentation-1
2. https://www.worldcat.org/title/bioinstrumentation/oclc/74848857
3. https://www.amazon.in/Bioinstrumentation-M-H-Fulekar-Bhawana-Pandey-ebook/dp/b01jp3m9tw
4. https://www.britannica.com/science/chromatography

Mapping with Programme Outcomes:

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

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

PHYTOPHARMACOGNOSY

Sub Code: 23PBOE11

SEMESTER – I	EC – 1	HOURS – 4	CREDITS – 2

Course Outcomes:

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

CO1	**:**	Review on the traditional knowledge and classification of plant derived drugs (K1).
CO2	**:**	Knowledge on biosynthetic pathway of different classes of plant metabolites (K2).
CO3	**:**	Knowledge on modern instrumentation on characterization of plant metabolites (K3 & K6).
CO4	**:**	Discuss various aspects of pharmacological action of herbal drugs (K4 & K5).
CO5	**:**	Understanding medical and non-medical potential of plant derived in various sectors (K6).

Unit I **(12 hrs)**

General Introduction – History and scope of Pharmacognosy including indigenous system of medicine.Various systems of classification of drugs.Pharmacological action of plant drugs. Significance of Pharmacopoeial standards.

Unit II **(12 hrs)**

Morphological and Microscopical Biosynthetic pathway of secondary metabolites: Acetate pathway (fatty acids and polyketides), Mevalonate and eoxy-xylulosephosphate path way(terpenoidsandsteroids),Shikimate pathway (phenols, amino acids etc.).

Unit III **(12 hrs)**

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 **(12 hrs)**

Pharmacological action of Plant Drugs: Anti-cancer, Bitter tonic, Carminatives and G.I. regulators, Cardiotonics, CNS-Stimulant, Expectorant, Laxatives, Purgatives. Outline of pharmacogenomics functions.

Unit V **(12 hrs)**

Hallucinogenic, allergenic and other toxic plants, poisonous plants - biopesticides - biocides– bio fungicides.

Text Books

1. DewickP.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. EvansW.C.2002, Trease and Evan's Pharmacognosy, W.B. Saunders.
3. Harborne, J.B.1998.Phytochemical Methods, Chapman and Hall.
4. Vickery M. Land B.Vickery,1981.Secondary Plant Metabolism, The MacMillan Press Ltd.
5. Wagner H.S. Bladt and E.M. Zgainski (Translated by A. Scott) 1984, Plant Drug Analysis, Springer- Verlag.

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

Mapping with Programme Outcomes:

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

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

CONSERVATION OF NATURAL RESOURCES AND POLICIES

Sub Code : 23PBOE12

SEMESTER – I	EC – 2	HOURS – 4	CREDITS – 2

Course Outcomes:

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

CO1	**:**	Understand the concept of different natural resources and their utilization (K1).
CO2	**:**	Critically analyze the sustainable utilization of land, water, forest and energy resources (K2 & K6).
CO3	**:**	Evaluate the management strategies of different natural resources (K3).
CO4	**:**	Reflect upon the different national and international efforts in resource management and their conservation (K4).
CO5	**:**	State the various environmental policy passed to conserve the natural resources (K5).

Unit I - NATURAL RESOURCES (12 hrs)

Definition – Importance – Classification – Human physiological socio-economic and cultural development – Human Population Explosion – Natural Resource Degradation – Concept of conservation – Value system – Equitable resource use for sustainable life system.

Unit II - FOREST RESOURCES (12 hrs)

Forest cover in India and the World – Importance – Desertification – Forest Wealth – Afforestation – Vanasamrakshna Samithi– Agroforestry – Social Forestry – Joint Forest Management Strategy for Forest Conservation. **Wild Life:** Resources – Importance – Benefits – Wild life Extinction – Causes for Extinction – List of Endanger species in India and in the World – Ecological approach in wild life management – Eco Tourism – Wild Life projects in India – Sanctuaries and National Parks in India – Man and Bio sphere Programme.

Unit III - LAND AND SOIL RESOURCES (12 hrs)

Soil, Complexity of soil nature, regional deposits, Land use and capability classification systems, Land use Planning models and their limitations. Impacts of natural and man-made activities on land characteristics and land use planning– Soil Erosion – Loss of Soil Nutrients – Restoration of Soil Fertility – Soil Conservation Methods and Strategies in India. Wet Land Conservation and Management – Ecological Importance of wet lands in India – Conservation Strategy and ecological Importance. Water Resources: Rivers and Lakes in India – Water Conservation and ground water level increase - Watershed Programme.

Unit IV - MINERAL RESOURCES (12 hrs)

Use and exploitation – Environmental effects of extracting and using mineral resources – Restoration of mining lands – Expansion of supplies by substitution and conservation. Food Resources: World Food Problems – Changes caused by agriculture – overgrazing effects of modern agriculture – Fertilizer-Pesticide problems – Water Logging – Salinity – Sustainable agriculture, life stock breeding and farming.

Unit V - ENVIRONMENTAL POLICY IN INDIA (12 hrs)

Need for policies- Public Policy – Economic policies – Relationship between economic development and environment – Implementing Environmental Public Policy Strategies in

pollution control – Constitutional provisions in India regarding environment – Public Awareness and Participation in Environmental Management – National Land Use Policy 1988 – Industrial Policy 1991.

Text Books

1. Trivedi R.K.1994. Environment and Natural Resources Conservation.
2. Murthy J.V.S.1994. Watershed Management in India.
3. Raymond, F Dasmann. 1984. Environmental Conservation, John Wiley.
4. Nalini, K.S. 1993. Environmental Resources and Management, Anmol Publishers, New Delhi.
5. Shyam Divan and Armin Rosencranz. 2001. Environmental Law and Policy in India, Oxford University Press.

Reference Books

1. Haue, R and Freed V.H. 1975. Environmental Dynamics of Pesticides, Menum Press, London
2. Singh, B. 1992. Social Forestry for Rural Development, Anmol Publishers, New Delhi.
3. Shafi. R. 1992. Forest Ecosystem of the World.
4. Stacy Keach. 2016. Natural Resources Management. Syrawood Publishing House.
5. Rathor B.S. 2013. Management of Natural Resource for Sustainable Development. Daya Publishing House, New Delhi.

Web Resources

1. https://www.amazon.in/conservation-natural-resources-gifford-pinchot-ebook/dp/b07hx76tvn
2. https://books.google.co.in/books/about/Natural_Resource_Conservation_and_Enviro.html?id=T2SRuhxpUW8C&redir_esc=y
3. https://www.kobo.com/ww/en/ebook/natural-resources-conservation-law
4. https://www.scribd.com/book/552185119/Natural-Resources-Conservation-and-Advances-for-Sustainability.
5. https://www.scribd.com/document/354699536/Conservation-of-Natural-Resources.

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	2	3	2	3	2	3
CO2	3	3	3	3	2	2	1	3	1	3
CO3	3	3	3	2	2	2	1	3	1	3
CO4	3	3	3	2	2	2	1	3	1	3
CO5	3	3	3	2	2	2	1	3	1	3

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

HORTICULTURE

Sub Code: 23PBOE12

SEMESTER – I	EC – 2	HOURS – 4	CREDITS – 2

Course Outcomes:

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

CO1	**:**	Identify and categorize various horticultural plants and conditions that affect their growth and productivity (K1).
CO2	**:**	Explain the various structures and growth processes of horticultural plants (K2).
CO3	**:**	Demonstrate the propagation, growth, and maintenance of plants in horticulture system (K3).
CO4	**:**	Correlate the soil characteristics and fertility to good plant growth (K4).
CO5	**:**	Utilize the role of plant tissue culture in the production of quality planting stock in horticulture (K5).
CO6	**:**	Apply horticultural skills and knowledge to explore career opportunities in horticulture industry (K6).

Unit I - INTRODUCTION TO HORTICULTURE (12 hrs)

Definition; Brief History, Divisions of Horticulture, Classification of horticultural plants, Structure of Horticultural Plants –Cell and Tissue systems, Anatomy of stem root and leaf, Morphological structures, Plant growth processes-A brief account of Photosynthesis, Respiration, Transpiration and Translocation, Stages of plant growth.

Unit II - FACTORS AFFECTING PLANT GROWTH (12 hrs)

Plant Growth Environment: Abiotic factors, Soil –Profile structure, Primary and Secondary nutrients and their functions, Organic matter, Fertilizers –organic, Inorganic and Potting Media, Bio inoculants, Methods of fertilizer application, Directing Plant growth-Training - Pruning and thinning.

Unit III - PLANT PROPAGATION (12 hrs)

Plant propagation: Seeds –Advantages, Viability, Mechanism of Dormancy and Dormancy Breaking: Methods of Direct and Indirect Seedling Production in Nurseries and Transplantation; Propagation through specialized underground structures – Corm, Tuber, Sucker, Bulb, Bulbil, Rhizome; Vegetative Propagation –Cutting, Layering, Grafting and Budding.

Unit IV - MICROPROPAGATION TECHNIQUES (12 hrs)

Stages, multiplication by shoot tip, Nodal culture and Callus culture-Application and Limitations, Somatic embryogenesis, Synthetic seeds –Preparation and Potential uses of artificial seeds, Embryo Rescue, Soil-less Production of Horticultural crops –Hydroponics, sand culture, gravel culture.

Unit V - AESTHETICS OF HORTICULTURE (12 hrs)

Design: Elements and Principles of Design, Flower Arrangement, Terrarium Culture, Bonsai, Growing Plants Indoors, Turf Production, Landscaping-Principles, Types of Parks, Xeriscaping. Postharvest handling of Horticultural Products –Harvesting, Storage, Processing, Elements of Marketing.Robotics in Horticulture.

Text Books

1. Acquaah, G. 2011.Horticulture: Principles and Practices. (4th ed), Pearson Education, London, UK.
2. Janik, J. 1972. Horticultural Science. W.H. Freeman & Company, San Francisco.
3. Kumar, N. 1994. Introduction to Horticulture, Rajalakshmi Publication, India.
4. Manibhushan Rao, K. 2005. Text Book of Horticulture. (2nd ed), Macmillan India Ltd., New Delhi.
5. Schilletter, J. C. and Richey, H. W. 2005. Text Book of general Horticulture. 2nd ed. Biotech Books, Delhi.
6. Sharma, R.R. 2016. Propagation of Horticultural Crops. Kalyani Publishers, New Delhi.
7. SubbaRao, N.S. 1997. Bio fertilizers in Agriculture and Forestry. India Book House Limited, Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.

Reference Books

1. Acquaah, G. 2002. Horticulture Principles and Practices. 2nd ed. Pearson Education (Singapore) Pvt. Ltd.
2. Ashman, M.A. and Puri, G. 2002. Essential Soil Science-A Clear and Concise Introduction to Soil Science. Blackwell Scientific Publishers, London.
3. Denisen, E.L. 1979. Principles of Horticulture. MacMillan Publishing co, Inc. New York.
4. Dirr, M. and Heuser, C.W. 2009. The Reference Manual of Woody Plant Propagation: From Seed to Tissue Culture. Timber Press, Oregon, USA.
5. Thomson, L.M. and Troen, F.R. 1975. Soils and Soil Fertility Tata, McGraw Hill Publication Co. Ltd. New Delhi.
6. Tolanus, S. 2006. Soil Fertility, Fertilizer and Integrated Nutrient management. CBS Publication, Delhi, India.

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	2	1	3	3	3	3	3	3	3	2
CO3	3	1	3	3	3	3	3	2	3	3
CO4	3	3	3	1	1	2	2	3	1	3
CO5	3	3	3	3	3	3	2	3	3	2

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

TAXONOMY OF ANGIOSPERMS AND ECONOMIC BOTANY

Sub Code: 23PBOC21

SEMESTER – II	CORE – 6	HOURS – 5	CREDITS – 5

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).

Unit I - TAXONOMY AND SYSTEMATICS (15 hrs)

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 hrs)

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 hrs)

Polypetalae – Nympheaceae, Sterculiaceae, Portulaceae, Rhamnaceae, Vitaceae, Sapindaceae, Combretaceae. Gamopetalae – Sapotaceae, Oleaceae, Boraginaceae, Scrophulariaceae

Unit IV - SYSTEMATIC ANALYSIS OF PLANTS-II (15 hrs)

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

Unit V - ECONOMIC BOTANY (15 hrs)

i. General account on utilization of selected crop plants:
ii. Cereals (rice and wheat)
iii. Pulses (red gram and black gram),
iv. Drug yielding plants (*With aniasomnifera* and *Coleus aromaticus)*

v. Oil yielding plants (Groundnut, sunflower).
vi. Sugar yielding plants (sugarcane and sugar beet),
vii. Spices and condiments (cardamom, cinnamon).
viii. Commercial crops - fibre (jute),
ix. Timber (Teak and red sanders wood),
Resins and gums (Asafoetida and gum arabic) –
x. Essential oils (lemon grass and menthol),
xi. Beverages (tea, coffee),
xii. Plants used as avenue trees for shade, pollution control and aesthetics
xiii. 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. AcharyaVipulRao. 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

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	3	2	3	3	2	2	1	2	2
CO3	3	3	2	3	1	3	2	3	3	1
CO4	3	2	3	3	2	3	3	1	3	3
CO5	3	3	2	2	1	2	1	3	2	1

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

ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS

Sub Code: 23PBOC22

SEMESTER – II	CORE – 7	HOURS – 5	CREDITS – 5

Course Outcomes:

Upon completion of the courses, 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).

Unit I - CELL WALL (15 hrs)

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 organization – multiplicative and additive divisions. Xylem: Primary and secondary xylem – tracheary elements and vessels – vesselless 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: Ultra structure and ontogeny of sieve tube elements and companion cell. Evolution of tracheary elements.

Unit II – PERIDERM (15 hrs)

Structure, organization and activity of phellogen. Polyderm and Rhytiderm – 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; Kranz anatomy and its significance. Microtechnique: Principle of killing and fixation, dehydration and rehydration of botanical specimens. Stains: Principle of double staining (fast-green and light green) of free hand sections; Protocol for serial sectioning of paraffin wax impregnated specimens; Mounting and mounting media.

Unit III - MICROSPORANGIUM AND MALE GAMETOPHYTE (15 hrs)

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 hrs)

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

Unit V – POLYEMBRYONY (15 hrs)

Endosperm: Development of endosperm, types, physiological efficiency of endosperm haustoria and functions; Ruminate 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 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. Text Book of Plant Anatomy. Arjun Publishing House, New Delhi.
4. Pandey.S.N and Ajanta Chandha. 2006. Plant Anatomy and Embryology. Vikas Publishinf House Pvt. Ltd, New Delhi.
5. Narayanaswamy, S. 1994. Plant Cell and Tissue Culture. Tata McGraw Hill Ltd. New Delhi.

Reference Books

1. Krishnamurthy, K.V. 1988. Methods in Plant Histochemistry. S. Viswanathan & Co., Madras.
2. Swamy, B.G.L and Krishnamurthy. K.V 1990. From Flower to Fruits, Tata – McGraw Hill Publishing Co Ltd, New Delhi.
3. Pullaiah, T., Lakshiminarayana, K and HanumanthaRao, B. 2006. Text Book of Embryology of Angiosperms. Regency Publications, New Delhi.
4. 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.
5. Cutler, D. F., Botha, T and Stevenson, D.W. 2008. Plant Anatomy: An Applied Approach. Blackwell Publishing, Malden, USA.
6. Eames, A.J and Mac Daniels, 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

Mapping with Programme Outcomes:

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

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

TAXONOMY OF ANGIOSPERMS & ECONOMIC BOTANY AND ANATOMY & EMBRYOLOGY OF ANGIOSPERMS - PRACTICAL

Sub Code: 23PBOC23

SEMESTER – II	CORE – 8	HOURS – 5	CREDITS – 3

Course Outcomes:

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

CO1	**:**	To gain recent advances in plant morphological and floral characteristics (K1).
CO2	**:**	Understand about different floral characteristics and artificial key preparation which employed for plant identification and conservation (K2).
CO3	**:**	Recall the information including basic and advanced in relation with plant anatomy and embryology (K4 & K5).
CO4	**:**	Apply their idea on sectioning and dissection of plants to demonstrate various stages of plant development (K3).
CO5	**:**	Know about different nomenclature problems (K3).

TAXONOMY AND ECONOMIC BOTANY OF ANGIOSPERMS

Preparation of Artificial keys.

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 TRIP

A field trip at least 3-4 days to a floristically rich area to study plants in nature and field report submission of not less than 20 herbarium sheets representing the families studied.

ANATOMY

1. Study of shoot apex of *Hydrilla*
2. Observation of cambial types.
3. Sectioning and observation of nodal types.
4. Study of anomalous secondary growth of the following:
   STEM- *Nyctanthus, Boerhavia, Aristolochia, Bignonia, Piper* petal and *Mirabilis.*
   ROOT: *Acyranthus*
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.

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.

Text Books

1. Subramaniam, N.S. 1996. Laboratory Manual of Plant Taxonomy. Vikas Publishing House Pvt. Ltd., New Delhi.
2. Gokhale, S.B., Kokate, C.K. and Gokhale, A. 2016. Pharmacognosy of Traditional Drugs. Nirali Prakashan, st Edition. ISBN: 9351642062.
3. Joshi, S.G. 2018. Medicinal Plants. Oxford & IBH Publishing C., Pvt., Ltd., New Delhi. ISBN: 9788120414143.
4. Cutler, D.F., Botha, C.E.J., Stevenson, D.W., and William, D. 2008. Plant Anatomy: An Applied Approach (No. QK641 C87). Oxford: Blackwell, UK.
5. Sundara, R. S. 2000. Practical Manual of Plant Anatomy and Embryology. Anmol Publ. PVT LTD, New Delhi.
6. Panshin, A.J and C. de Zeeuw.1980.Textbook of Wood Technology. Structure, Identification and Uses of the Commercial Woods of the United States and Canada. Fourth Edition. New York: McGraw-Hill Book Company.
7. Sharma, H.P. 2009. Plant Embryology: Classical and Experimental, Bombay Popular Prakashan.

Reference Books

1. Aler Gingauz.2001. Medicinal Chemistry. Oxford University Press &Wiley Publications.
2. MannJ.Davidson,R.SandJ.B.Hobbs,D.V.Banthorpe,J.B.Harborne.1994.*Natural Products*.Longman Scientific and Technical Essex.
3. Gopalan,C.,B.V.RamasastriandS.C.Balasubramanian.1985.NutritiveValue of Indian Foods. National Institute of Nutrition, Hyderabad.
4. Harborne. J.B. 1998. Phyto chemical Methods. A Guide to Modern Techniques of Plant Analysis, Chapman and Hall publication, London.

Web Resources

1. https://www.kobo.com/gr/en/ebook/phytochemistry-2
2. https://www.amazon.in/textbook-pharmacognosy-phytochemistry-kumar-jayaveera-ebook/dp/b06xksy76h
3. https://www.amazon.in/computational-phytochemistry-satyajit-dey-sarker-ebook/dp/b07cv96nzj

Mapping with Programme Outcomes:

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

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

ECOLOGY, PHYTOGEOGRAPHY AND CONSERVATION BIOLOGY

Sub Code: 23PBOC24

SEMESTER – II	CORE – 9	HOURS – 5	CREDITS – 4

Course Outcomes:

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

CO1	**:**	Understand the scope and importance of population ecology, plant communities and ecosystem ecology (K1 & K2).
CO2	**:**	Understand the applied aspect of environmental botany (K1 & K4).
CO3	**:**	Students will spot the sources of pollution and seek remedies to mitigate and rectify them (K2 & K6)
CO4	**:**	Identify different plant communities, categorize plant biomes and identify threatened, endangered plant species and create awareness program in protection of biodiversity (K3 & K6).
CO5	**:**	Analyze insight into the vegetation types, species interaction and their importance and the factors influencing the environmental conditions (K5).

Unit I **(15 hrs)**

Introduction to ecology, Principles and scope of ecology. Structure and functions of Ecosystems: Abiotic and Biotic components of ecosystems, Nutrient Cycling in Ecosystems – water, carbon, nitrogen and phosphorus. Ecosystem types and diversity in India and around the world. Threats to ecosystems due to human activities: acid rain, ozone hole, global warming and climate change, IPCC.

Unit II **(15 hrs)**

Ecosystems – Components of an ecosystem – ecosystem structure and function**.** Flow of Energy in Ecosystems. Food chain and food web, energy flow, Productivity in ecosystems –primary and secondary productivity –GPP & BPP. Ecological Energetics.

Diversity of plant life; growth forms, life forms. Basic concepts of population ecology– population dynamics – Regulation of population. Basic concepts of community– characteristics, composition, structure, origin and development – community dynamics– Succession.

Unit III **(15 hrs)**

Energy resources; renewable and non-renewable sources of energy. Soilformation, types of soils, soil profile – soil horizon – soil erosion and conservation,Water resources– water availability, water conservation and management.Waste management – Solidande-waste, recycling of wastes. Ecorestoration / remediation - ecological foot prints - carbon foot print - ecolabeling - environmental impact assessment.

Unit IV **(15 hrs)**

Phytogeographical Zones - Vegetation types of India and Tamil Nadu, Distribution: Continuous, Discontinuous and Endemism. Theories of discontinuous distribution: Continentaldrift,Age and areahypothesis. Classification of forests of India by Champion and Seth (1968). Introduction to Geographical Information System (GIS) and remote sensing – Applications of GIS and Remote Sensing in Environmental Conservation.

Unit V **(15 hrs)**

Definition, types of biodiversity – values of biodiversity – Hot spots – Threats to biodiversity: habitat loss. Poaching of wild life – Invasion of exotic species, man and wild

life conflicts - endangered and endemic plant species of India, Red list, categories of IUCN, Biotechnology assisted plant conservation – *insitu* and *exsitu* methods.

Text Books

1. Sharma, P.D. 2017. Ecology and Environment- Rastogi Publication, Meerut.
2. Pushpa Dahiya and Manisha Ahlawat. 2013. Environmental Science- A New Approach, Narosa Pub. House, New Delhi.pp.2.1-2.60.
3. Eugene Odum, 2017. Fundamentals of Ecology 5th Ed. Cengage, Bengaluru.
4. Sharma P.D. 2019. Plant Ecology and Phytogeography, Rastogi Publications, Meerut.
5. Neeraj Nachiketa. 2018 Environmental & Ecology A Dynamic Approach. 2nd Edition GKP Access Publishing.
6. Chandra, A.M and Ghosh, S.K. 2010. Remote Sensing and Geographical Information System, Narosa Publishing House Pvt. Ltd. New Delhi.

Reference Books

1. Keddy, P.A. 2017. Plant Ecology: Origins, Processes, Consequences. 2nd Ed. Cambridge
2. University Press. ISBN. 978-1107114234.
3. Krishnamurthy, K.V. 2004. An Advanced Text Book of Biodiversity- Principles and
4. Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi.
5. Nithyananda, K.V. 2019. Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
6. Kormondy, E.J. 2017. Concepts of Ecology. Prentice Hall, U.S.A. 4th edition.
7. Gillson, L. 2015. Biodiversity Conservation and Environmental Change, Oxford University Press, Oxford.

Web Resources

1. https://www.intechopen.com/chapters/56171
2. https://plato.stanford.edu/entries/biodiversity/
3. https://sciencing.com/four-types-biodiversity-8714.html.
4. https://www.iaea.org/topics/plant-biodiversity-and-genetic-resources
5. http://www.bsienvis.nic.in/Database/Status_of_Plant_Diversity_in_India_17566.aspx
6. https://www.youtube.com/watch?v=qtTLiQoYTyQ
7. https://www.youtube.com/watch?v=208B6BtX0Ps
8. https://www.youtube.com/watch?v=6p1TpVJYTds

Mapping with Programme Outcomes:

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

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

ECOLOGY, PHYTOGEOGRAPHY & CONSERVATION BIOLOGY PRACTICAL

Sub Code: 23PBOC25

SEMESTER – II	CORE – 10	HOURS – 2	CREDIT – 1

Course Outcomes:

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

CO1	**:**	Understand the importance of interaction of biotic and abiotic factors (K1 & K2)
CO2	**:**	Understand the applied aspect of environmental botany (K1 & K4)
CO3	**:**	Students will spot the sources of pollution and seek remedies to rectify them (K2 & K6)
CO4	**:**	Identify the environmental pollution factors and apply the knowledge to control the pollution (K3 & K6).
CO5	**:**	Know about different vegetation sampling methods (K5)

ECOLOGY,

1. Determination of the quantitative characters of a plant community by random quadrat method (abundance, density, dominance, species diversity, frequency) in grazing land, forests.
2. Estimation of above ground and below ground biomass in a grazing land employing minimum size of quadrat.
3. Stratification study
4. Crown cover area
5. To determine soil moisture, porosity and water holding capacity of soil collected from varying depth at different locations.
6. Determination of pH of soil and water by universal indicator (or) pH meter.
7. Determination of dissolved oxygen.
8. Estimation of carbonate.
9. Estimation of bicarbonate.
10. Estimation of productivity in *Hydrilla* plant
11. Estimation of H_2S, PO_4
12. Estimation of Na, K and Ca using flame photometer
13. Microbial analysis of polluted waters.

PHYTOGEOGRAPHY, CONSERVATION BIOLOGY &INTELLECTUAL PROPERTY RIGHTS

1. Mapping of world vegetation
2. Mapping of Indian vegetation.

Text Books

1. Sharma, P.D. 2017. Ecology and Environment- Rastogi Publication, Meerut.
2. Pushpa Dahiya and Manisha Ahlawat. 2013. Environmental Science- A New Approach, Narosa Pub. House, New Delhi.pp.2.1-2.60.
3. Eugene Odum, 2017. Fundamentals of Ecology 5th Ed. Cengage, Bengaluru.
4. Sharma P.D. 2019. Plant Ecology and Phytogeography, Rastogi Publications, Meerut.
5. Neeraj Nachiketa. 2018 Environmental & Ecology A Dynamic approach. 2nd Edition GKP Access Publishing.
6. Chandra, A.M and Ghosh, S.K. 2010. Remote Sensing and Geographical Information System, Narosa Publishing House Pvt. Ltd. New Delhi

Reference Books

1. Keddy, P.A. 2017. Plant Ecology: Origins, Processes, Consequences. 2nd Ed. Cambridge University Press. ISBN. 978-1107114234.
2. Krishnamurthy, K.V. 2004. An Advanced Text Book of Biodiversity- Principles and
3. Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi.
4. Kormondy, E.J. 2017. Concepts of Ecology. Prentice Hall, U.S.A. 4th edition.
5. Gillson, L. 2015. Biodiversity Conservation and Environmental Change, Oxford University Press, Oxford.

Web Resources

1. https://www.intechopen.com/chapters/56171
2. https://plato.stanford.edu/entries/biodiversity/
3. https://sciencing.com/four-types-biodiversity-8714.html.
4. https://www.iaea.org/topics/plant-biodiversity-and-genetic-resources
5. http://www.bsienvis.nic.in/Database/Status_of_Plant_Diversity_in_India_17566.aspx

Mapping with Programme Outcomes:

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

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

APPLIED BIOINFORMATICS
Sub Code: 23PBOE21

SEMESTER – II	EC – 3	HOURS – 4	CREDITS – 2

Course Outcomes:

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

CO1	**:**	Familiarize with the tools of DNA sequence analysis (K1 & K2).
CO2	**:**	Use and explain the application of bioinformatics (K2 & K3).
CO3	**:**	Master the aspects of protein-protein interaction, BLAST and PSI-BLAST (K3 & K4).
CO4	**:**	Describe the features of local and multiple alignments (K3 & K4).
CO5	**:**	Interpret the characteristics of phylogenetic methods and bioinformatics applications (K4 & K5).

Unit I - Bioinformatics and Internet **(12 hrs)**

Internet Basics –File Transfer Protocol –The World Wide Web-Internet Resources– Databases–types-Applications - NCBI Data Model – SEQ-Ids– Bio sequences – Bio sequence sets–Sequence annotation–Sequence description.

Unit II - Genbank Sequence Database **(12 hrs)**

Introduction- Primary and Secondary Databases - Format Vs Content- Genbank Flatfile-Submitting DNA Sequences to the Databases - DNA/RNA-Population, Phylogenetic, and Mutation Studies - Protein-Only Submissions - Consequences of DNA Model – EST/STS/GSS/HTG/SNP and Genome Centers -Contact points for submission of sequence data to DBJ/EMBL/Gen bank.

Unit III - Structure Databases **(12 hrs)**

Introduction to Structures- Protein Data Bank (PDB) – Molecular Modeling; Database at NCBI Structure File Formats - Visualizing Structural Information –Database Structure Viewers –Advanced Structure Modeling –Structure Similarity Searching.

Unit IV - Sequence Alignment and Database Searching **(12 hrs)**

Introduction-Evolutionary Basis of Sequence Alignment – Modular Nature of Proteins –Optimal Alignment Methods – Substitution Scores and Gap Penalties – Database Similarity Searching-FASTA–BLAST (BlastP, BlastN,etc.,) – Position Specific Scoring Matrices, Spliced Alignments.

Unit V - Predictive Methods **(12 hrs)**

Using Protein Sequences Protein Identity Based on Composition – Physical Properties Based on Sequence - Motifs and Patterns - Secondary Structure and Folding Classes – Specialized Structures or Features - Tertiary Structure.

Text Books

1. Baxevanis,A.D.&Ouellette,B.F.2001.Bioinformatics:APracticalGuidetotheAnalysisofGenesand Proteins. NewYork: Wiley-Interscience.
2. Bourne,P.E.,&Gu,J.2009. Structural Bio informatics. Hoboken, NJ:Wiley-Liss.
3. Lesk,A.M.2002. Introduction to Bioinformatics. Oxford: Oxford University Press.
4. Mount,D.W.2001.Bioinformatics: Sequence and Genome Analysis.Cold Spring Harbor,

NY:Cold Spring Harbor Laboratory Press.
5. Pevsner,J.2015.Bio informatics and Functional Genomics. Hoboken, NJ:Wiley-Blackwell.

Reference Books

1. Campbell,A.M and Heyer,L.J.2003.Discovering Genomics, Proteomics, and Bioinformatics. SanFrancisco: Benjamin Cummings.
2. Green, M. Rand Sambrook,J.2012.Molecular Cloning: ALaboratory Manual.Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. Liebler,D.C.2002.Introduction to Proteomics:Tools for the New Biology.Totowa, NJ: Humana Press.
4. Old, R.W.,Primrose,S.B.,andTwyman,R.M.2001.Principles of Gene Manipulation: An Introduction to Genetic Engineering. Oxford: Blackwell Scientific Publications.
5. Primrose,S.B.,Twyman,R.M.,Primrose,S.B.,andPrimrose,S.B.2006. Principles of Gene Manipulation and Genomics. Malden, MA: Black well Publication.

Web Resources

1. Bioinformatics:Algorithms &ApplicationsbyProf.M.MichaelGromihaIIT-Madras. https://nptel.ac.in/courses/102/106/102106065/#.
2. Christopher Burge, David Gifford, and Ernest Fraenkel. *7.91*.J Foundations of Computational and Systems Biology. Spring 2014.Massachusetts Institute of Technology: MITOpenCourseWare,https://link.springer.com/book/10.1007/978-3-540-72800-9.
3. https://www.amazon.in/Applied-Bioinformatics -Paul-Maria-Selzer-ebook /dp/B001AUOYY2.
4. https://books.google.co.in/books/about/Applied_Bioinformatics.html?id=PXZZDwAAQBAJ&redir_esc=y

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	2	3	3	3	3	2	2	3	2	2
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	1	3	3
CO5	3	2	2	2	3	3	3	3	3	3

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

NANOBIOTECHNOLOGY

Sub Code: 23PBOE21

SEMESTER – II	EC – 3	HOURS – 4	CREDITS – 2

Course Outcomes:

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

CO1	**:**	Recall the essential features of biology and nanotechnology that are converging to create the new area of bio-nanotechnology (K1).
CO2	**:**	Formulate procedures for the synthesis of nanoparticles which are of medical importance which could be used to treat specific diseases (K2).
CO3	**:**	Characterize the various types of nano particle synthesis and advocate and promote the use of nano materials and nano composites (K3).
CO4	**:**	Analyze and apply the nanoparticles in plant diversity (K4).
CO5	**:**	Construct various types of nanomaterial for application and evaluate the impact on environment (K5 & K6).

Unit I -Basic concepts in Nanobiology **(12 hrs)**

History of Nanotechnology, Difference between Nanoscience and Nanotechnology, Green nanotechnology, Bottom up and top down approaches.

Unit II-Diversity in Nanosystems **(12 hrs)**

Carbon based nanostructures - fullerences, nanotubes, nanoshells, buckyballs – biomolecules and nanoparticles, nanosensors, nanomaterials - Classification based on dimensionality quantum dots, wells and wires – metal based nano materials (gold, silver and oxides) – Nanocomposites- Nanopolymers – Nanoglasses–Nano ceramics.

Unit III-Methods of Nano biotechnology **(12 hrs)**

Optical tools – Nanoforce and imaging – Surface methods – Mass spectrometry – Electrical Characterization and Dynamics of Transport – Microfludics: Concepts and applications to the Life Sciences.

Unit IV-Nanobiotechnology **(12 hrs)**

Nanodevices and nanomachines based on biological nanostructures - Protein and DNA nanoarrays, tissue engineering, and luminescent quantum dots for biological labeling.

Unit V-Applications of Nanobiotechnology **(12 hrs)**

Real Time PCR – Biosensors : From the glucose electrode to the Biochip – DNA Microarrays – Protein Microarrays – Cell Biochips – Lab on a chip – Polyelectrolyte multilayers – Biointegrating materials – Pharmaceutical applications of nanoparticles carriers.

Text Books

1. Dupas, C, Houdy, P., Lahmani, M. 2007. Nanoscience: ―Nanotechnologies and Nanophysics‖, Springer-Verlag Berlin Heidelberg.
2. Sharon, M and Sharon, M. 2012. Bio-Nanotechnology- Concepts and Applications, CRC Press.
3. Atkinson, W.I. 2011. Nanotechnology. Jaico Book House, New Delhi.
4. Nalwa, H.S. 2005. Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology. American Scientific Publ.

5. Lindsay, S.M. 2011. Introduction to Nanoscience, Oxford universal Press, First Edition.
6. Jain K.K. 2006. Nanobiotechnology molecular diagnostics: Current techniques and application (Horizon Bioscience).Taylor & Francis 1st edition.
7. Pradeep, T. 2012. Textbook of Nanoscience and Nanotechnology, McGraw Hill Education(India)Private Limited.
8. XiuMeiWang, Murugan Ramalingam,Xiangdong Kong and Lingyun Zhao.2017. Nanobiomaterials: Classification, Fabrication and Biomedical Applications, Wiley-VCHVerlagGmbH & Co. KGaA.

Reference Books

1. Claudio Nicolini. 2009. Nanotechnology Nanosciences, Pon Stanford Pub.Pvt.Ltd,
2. Robert, A and Ferias, Jr. 1999. Nanomedicine, Volume I: Basic Capabilities, Landes Bioscience.
3. Barbara Panessa-Warren. 2006 Understanding Cell-Nanoparticle Interactions making Nanoparticles more Biocompatible. Brookhaven National Laboratory.
4. European Commission, SCENIHR. 2006. Potential risks associated with engineered and adventitious products of nanotechnologies, European Union.
5. Gysell Mortimer, 2011. The interaction of synthetic nanoparticles with biological systems PhD Thesis, School of Biomedical Sciences, Univ..of Queensland.
6. Murty, B.S., Shankar, P., Raj, B., Rath, B.B., Murday, J. 2013. Textbook of Nanoscience and Nanotechnology. Spirnger Publication.

Web Resources

1. https://onlinelibrary.wiley.com/doi/book/10.1002/3527602453
2. https://www.elsevier.com/books/nanobiotechnology/ghosh/978-0-12-822878-4
3. https://www.routledge.com/Nanobiotechnology-Concepts-and-Applications-in-Health-Agriculture-and/Tomar-Jyoti-Kaushik/p/book/9781774635179
4. https://www.nanowerk.com/nanotechnology/periodicals/ebook_a.php
5. https://phys.org/news/2014-10-endless-possibilities-bio-nanotechnology.html
6. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC419715/

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	3	3	3	3	3	2	1	2	3
CO3	3	3	3	2	3	3	3	2	2	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

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

AGRICULTURE AND FOOD MICROBIOLOGY

Sub Code: 23PBOS21

SEMESTER – II	SEC – 1	HOURS – 4	CREDITS – 2

Course Outcomes:

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

CO1	**:**	Recognize the general characteristics of microbes and factors affecting its growth (K1).
CO2	**:**	Explain the significance of microbes in increasing soil fertility (K2).
CO3	**:**	Elucidate concepts of microbial interactions with plant and food (K3).
CO4	**:**	Analyze the impact of harmful microbes in agriculture and food industry (K4).
CO5	**:**	Determine and appreciate the role of microbes in food preservation and as bio-control (K5 & K6).

Unit I - Role of Microorganisms in Agriculture (12 hrs)

Role of symbiotic and free-living bacteria and cyanobacteria in agriculture, Mycorrhiza, Plant Growth Promoting Microorganims (PGPM) and Phosphate Solubilizing Microorganims (PSM).

Unit II - Biocontrol and Biofertilization (12 hrs)

Biocontrol of plant pathogens, pests and weeds, Restoration of waste and degraded lands,Biofertilizers: Types, technology for their production and application, Vermi-compost.

Unit III - Soil Microbiology (12 hrs)

Soil as a habitat for microorganisms; soil enzymes, soil water and microbial activity, Soil fertility and management of agricultural soils; Microbiology of composting; Reclamation of barren lands using microbial technology; Microbiology of plant surfaces-Rhizoplane, phylloplane and rhizosphere microbes and their interaction with plants.

Unit IV - Food Microbiology (12 hrs)

Intrinsic and extrinsic factors influencing growth of microorganisms in food, Microbes as source of food: Mushrooms, single cell protein.

Unit V - Food Microbiology (12 hrs)

Microbial spoilage of food and food products: Cereals, vegetables, prickles, fish and dairy products. Food poisoning and food intoxication. Food preservation processes. Microbes and fermented foods: Butter, cheese and bakery products.

Text Books

1. Pelczar M.J., Chan E.C.S. and Krieg N.R. 2003. Microbiology. 5th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi.
2. SubbaRao, N. S. 2000. Soil Microbiology. 4th Edition, Oxford and IBH publishing Co. Pvt. Ltd., Calcutta, New Delhi, India.
3. Rangaswami, G. and Bagyaraj, D.J. 2006. Agricultural Microbiology. 2nd Unit 2nd Edition, PHI Learning, New Delhi, India.
4. Prescott, L.M.,Harley J.P., KleinD. A. 2005.Microbiology, McGrawHill,India. 6thEdition.
5. Goldman, E.and Green,L.H.2015.Practical Hand book of Microbiology(3rd Ed.).CRC Press.

Reference Books

1. Adams, M.R. and Moss M. O. 2008. Food Microbiology, 3rd Edition, Royal Society of Chemistry, Cambridge, U.K.
2. Sylvia D.M. 2004. Principles and Applications of Soil Microbiology, 2nd Edition, Prentice Hall, USA.
3. Frazier, W.C. 1995. Food Microbiology, 4th Edition, Tata McGraw Hill Education, Noida, India.
4. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. 2001. Industrial Microbiology: An Introduction. 1st Edition, Blackwell Science, London, UK.
5. Das, S. and Saha, R.2020.Microbiology Practical Manual.CBS Publishers and Distributors (P) Ltd., New Delhi, India.

Web Resources

1. https://www.kopykitab.com/Agriculture-and-Food-Microbiology-In-Hindi-by-Dr-Q-J-Shammi
2. https://agrimoon.com/agricultural-microbiology-icar-ecourse-pdf-book/
3. https://play.google.com/store/books/details/Applied_Microbiology_Agriculture_Environmental_Foo?id=DgVLDwAAQBAJ&hl=en_US&gl=US
4. https://www.scientificpubonline.com/websitebooks/ebooks/agriculture/microbiology
5. https://www.amazon.in/Food-Microbiology-Martin-R-Adams-ebook/dp/B01D6B7V6A

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)

CELL AND MOLECULAR BIOLOGY

Sub Code: 23PBOC31

SEMESTER-III	Core- 11	Hours: 5	Credits: 4

Course Outcomes:

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

CO1: Recall a plant cell structure and explain its function. (K1)

CO2: Illustrate and explain the structure of various cell organelles. (K2)

CO3: Explain the structure and functional significance of nucleic acid. (K3)

CO4: Compare and contrast the DNA replication (prokaryotes and eukaryotes),enzymes involved in replication, DNA repair. (K4)

CO5: Discuss and develop skills for DNA/gene manipulating and the (K5 & K6)

UNIT I **(15 hrs)**

The dynamic cells, Concept of prokaryote and Eukaryote. Structural organization of plant cell, specialized plant cell types. Cell wall- Structure and functions, Plasma membrane; structure, models and functions, site for ATPase, ion carriers channels and pumps, receptors. Plasmodesmata and its role in movement of molecule.

UNIT II **(15 hrs)**

Chloroplast-structure and function, genome organization, gene expression, RNA editing, Mitochondria; structure, genome organization, biogenesis. Plant Vacuole - Tonoplast membrane, ATPases transporters as a storage organelle.Structure and function of other cell organelles- Golgi apparatus, lysosomes, endoplasmic reticulum and microbodies.

UNIT III **(15 hrs)**

Nucleus: Structure and function, nuclear pore, Nucleosome organization, euchromatin and heterochromatin. Ribosome- Structure and functional significance. RNA types, DNA Structure. Cell cycle and Apoptosis; Control mechanisms, role of cyclin dependent kinases. Retinoblastoma and E2F proteins, cytokinesis and cell plate formation, mechanisms of programmed cell death.

UNIT IV **(15 hrs)**

DNA replication (prokaryotes and eukaryotes), enzymes involved in replication, DNA damage and repair (Thymine dimer, photoreactivation, excision repair). DNA sequencing. Transcription, enzymes involved in transcription, post transcription changes, reverse transcription, Translation. overlapping genes.

UNIT V **(15 hrs)**

DNA/gene manipulating enzymes: endonuclease, ligase, polymerase, phosphatase, transcriptase, transferase, topoisomerase. Gene cloning: cloning vectors, molecular cloning and DNA libraries. Molecular genetic elements, insertion elements, transposons.Recombinant DNA. Direct and indirect gene transfer. Detection of recombinant molecule, production of gene products from cloned genes.cDNA library.

Text Book:

1. Roy, S.C and Kumar, K.D.C. 1977. Cell Biology, New Central Book Agency, Calcutta.

2. Karp, G. 2010.Cell and Molecular Biology: Concepts and Experiments.6th edition. John Wiley& Sons.
3. Aminul, I. 2011. Text Book of Cell Biology. Books and Allied (P) Ltd, Kolkata, India.
4. Geoffrey M.Cooper.2019.TheCell:AMolecularApproach, OxfordUniversityPress.
5. Turner, P.C., Mclenann,A.G., Bates, A.D. and White, M.R.H. 2001. Instant notes on molecular biology.

Reference Books:

1. Alberts B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J. D. 1989. Molecular biology of the Cell (2nd edition). Garland Pub. Inc., New York.
2. Karp, G. 1999. Cells and Molecular Biology: Concepts & Experiments. John Wiley and Sons, Inc., USA.
3. Lodish S, Baltimore B , Berk, C and Lawrence K, 1995 , Molecular Cell Biology , 3rd edn, Scientific American Books, N.Y
4. De Robertis and De Robertis, 1988, Cell and Molecular Biology, 8th edn, Info-Med, Hongkong.
5. Lewin, B. 2000. GENE VII. Oxford University Press, New York, USA 7. Cooper G M and Hausman R E,2007 , The Cell: Molecular Approach 4th Edn, SinauerAssociates,USA.

Web resources:

1. https://www.pdfdrive.com/cell-biology-books.html
2. http://www.bio-nica.info/Biblioteca/Bolsover2004CellBiology.pdf
3. https://www.e-booksdirectory.com/listing.php?category=549

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	3	2	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)**

GENETICS, PLANT BREEDING AND BIOSTATISTICS

Sub Code: 23PBOC32

SEMESTER-III	Core - 12	Hours: 5	Credits: 4

Course outcomes (CO):

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

CO1 : Understand the Mendal's Law of inheritance and gene interactions. (K1)

CO2 : Analyze the various factors determining the heredity from one generation to another. (K2)

CO3 : Explain Gene mapping methods**:** Linkage maps. (K3)

CO4 : Compare and contrast the genetic basis of breeding self and cross – pollinated crops. (K4)

CO5 : Discuss and develop skills for statistical analysis of biological problems. (K5 &K6)

UNIT I: (15 hrs)

Mendal's Law of inheritance. Gene interactions and modified dihybrid ratios. Quantitative inheritance.Sex determination in plants and theories of sex determination. Sex linked characters. Structure of Gene, Operon, inducible operon, Operator site, Promoter, Polycistronic mRNA, Regulator, regulator constitutive, Regulator super repressor, repressor, super repressor, inducer. Gene function and regulation in prokaryotes with reference to Lac operon and trp operon - Producer gene, structural gene and integrator gene. Gene Regulation eukaryotes –Britten and Davidson model, *Arabidopsis*- gene regulation in flowering.QTL mapping, Gene mapping methods**:** Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids. Extra chromosomal inheritance, maternal inheritance.

UNIT II: (15 hrs)

Recombination:Homologous and non-homologous recombination, site-specific recombination. Holiday model of recombination.Transposable genetic elements: Ac element, transposase, transposon, simple transposon, composite transposon, Is element. Transposons in *Zeamays*.Transposable elements in prokaryotes.UV induced mutation and its repair mechanism. Mismatch DNA repair mechanism. Mutation types- frame shift mutation, addition, deletion, substitution, transition and transversion.

UNIT III: PLANT BREEDING: (15 hrs)

Objectives of plant breeding, characteristics improved by plant breeding, Genetic basis of breeding self and cross – pollinated crops. Pure line theory, pure line selection and mass selection, clonal selection methods.Hybridization, Genetics and physiological basis of heterosis.

UNIT IV: BIOSTATISTICS: (15 hrs)

Measures of central tendency (Mean, Median, Mode) and dispersal (Mean deviation, Standard deviation, Standard errors), regression and correlation; Chi Square test; basic introduction to Multivariate statistics, etc.

UNIT V: BIOSTATISTICS: (15 hrs)

Student t-test; Analysis of variance ANOVA (One way) - significances. Probability distributions (Binomial, Poisson andNormal); sampling distribution; difference between parametric and non-parametric statistics; confidence interval; errors; levels of significance. Uses of MS Excel in biostatistics.

Text Book:

1. Benjamin, A. Pierce. 2012. Genetics- A conceptual Approach. W.H. Freeman and Company, New York, England.
2. Stansfield, W.D. 1969. Theory and problems of Genetics. McGraw-Hill
3. Sinnott, E.W.Dunn, L.E and Dobzhansky, T. 1973. Principles of Genetics. McGraw-Hill.New York.
4. Chaudhari, H.K.1984. Elementary Principles of Plant Breeding. Oxford & IBH Publishing Company.
5. Brown, T.A. 1992. Genetics a Molecular Approach, 2nd Ed. Chapman and Hall.
6. Chahal, G.S and Gosal, S.S. 2018. Principles and Procedures of Plant Breeding Biotechnological and Conventional Approaches, Narosa Publishing House, New Delhi.
7. Singh, B.D. 2013. Plant Breeding: Principles and Methods, Kalyani Publishers, New Delhi
8. Singh, P. 2017. Fundamentals of Plant Breeding, Kalyani Publishers.
9. Chaudhary, R.C. 2017. Introductory principles of plant breeding, Oxford IBH Publishers, New Delhi.
10. Gupta, P.K. 2009. Genetics. Rastogi publications, Meerut, New Delhi.
11. Gupta, S.C. 2013. Fundamentals of statistics, Himalaya Publishers, Mumbai.
12. Kothari, C.R and Garg, G. 2014. Research methodology –Method and techniques. New Age International (P) Ltd. New Delhi.
13. Gurumani, N. 2005. Biostatistics, 2nd edn. MJP publications, India.

Reference Books:

1. Watson, J.D. et al. 2003. Molecular Biology of the Gene. Fourth Edition. TheBenjamin Cummings Pub. Co.
2. Lewin, B. 2003. Genes VIII. Oxford University Press.
3. Friefelder,D. 2005. Molecular Biology. Second Edition. Narosa Pub. House.
4. Sobtir.C. and Gobe. 1991. Eukaryotic chromosomes. Narosa Publishing house.
5. Smith-Keary, P. 1991. Molecular Genetics. Macmillan Pub. Co. Ltd.London.
6. Acquaah, G.2007. Principles of Plant Genetics and Breeding. BlackwellPublishing.
7. William.S., Klug and Michael, R. Cummings, 2003. Concepts of Genetics.Seventh edition. Pearson Education (Singapore)Pvt.Ltd.
8. Simmonds, N.W. 1979. Principles of Crop improvement. Longman, London.
9. Lewin, B. 2000. Genes VII, Oxford University Press, USA.
10. Strickberger, M.W. 2005. Genetics (III Ed). Prentice Hall, New Delhi, India.
11. Allard, R.W. 2010. Principles of Plant Breeding. 2 nd ed. John Wiley and Sons, Inc. New Jersey, US.

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	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	3	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)

CELL AND MOLECULAR BIOLOGY & GENETICS, PLANT BREEDING AND BIOSTATISTICS - PRACTICAL

Sub Code : 23PBOC33

SEMESTER: III	Core- 13	Credits: 4	Hours: 5

Course outcomes (CO):

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

CO1: Recall or remember the various aspects of cell biology, genetics, molecular biology, plant breeding and tissue culture. (K1)

CO2: Understand various concepts of cell biology, genetics, plant breeding and tissue culture. (K2)

CO3: Apply the theory knowledge gained into practical mode in order to acquire applied knowledge by day-to-day hands-on experiences. (K3)

CO4: Analyze or interpret the results achieved in practical session in the context of existing theory and knowledge. (K4)

CO5: Evaluate the theory and practical skills gained during the course. (K5 &K6)

EXPERIMENTS:

UNIT I: CELL AND MOLECULAR BIOLOGY

1. Identification of different stages of mitosis from suitable plant material. (Onion root tips).
2. Isolation of cell organelles: Chloroplast, Nucleus, acetocarmine staining (Nucleus) and microscopic observation (Chloroplast)
3. Study of mitotic index from suitable plant material.
4. Histo chemical Localization of Metabolites
5. To study plant vacuole in cells of onion leaf peel.
6. To study the structure and organization of plant cell in various tissues of various plants (incl. leaf, stem and roots).

UNIT II: GENETICS

1. Problem solving on dihybrid phenotypic, genotypic and test cross ratios.
2. Incomplete dominance in plants.
3. Interactions of factors and modified dihybrid ratios.
4. Multiple alleles in plants, blood group inheritance in human.
5. Sex linked inheritance in plants.

UNIT III: GENETICS

1. Calculate gene and genotypic frequency by Hardy- Weinberg equation.

UNIT IV: PLANT BREEDING

1. Techniques in plant hybridization.

UNIT V: BIOSTATISITCS

1. Collection of data– census method; population size– sampling methods– random sampling lottery method,
2. Presentation of the data– Bar diagrams, Graphs, Pie chartusing software.

3. Measures of central tendency - Mean, Median and Mode using software.
4. Problems - correlation, regression, using software
5. ANOVA (one way, two way)- solving statistical problems using software MS EXCEL.

Text Book:

1. George M Malacinski. 2015. Freifelders Essentials of Molecular Biology (4th ed.). Jones & Bartlett.
2. Gupta P.K. 2017. Cell and Molecular Biology (5th ed.), Rastogi Publications, Meerut.
3. Gupta, P.K. 2018. Cytogenetics, Rastogi Publications, Meerut.
4. Kumar, H.D. 2007. Molecular Biology and Biotechnology, Vikas Publishing House, New Delhi.
5. Bharadwaj, D.N. 2012. Breeding of field crops (pp. 1-23). Agrobios (India).
6. Singh, R.J. 2016. Plant Cytogenetics. CRC press, US.

Reference Books:

1. Gardener, J, Simmons, H.J and Snustad, D.P. 2006. Principle of Genetics, John Wiley & Sons, New York.
2. De Robertis E.D.P. and De Robertis E.M.P. 2017. Cell and Molecular Biology (8thed.) (South Asian Edition), Lea and Febiger, Philadelphia, USA.
3. Jackson, S.A., Kianian, S.F., Hossain, K.G., and Walling, J. G. 2012. Practical laboratory exercises for plant molecular cytogenetics. In Plant Cytogenetics (pp. 323-333). Springer, New York, NY.
4. Glick, B.R and J.E. Thompson. 1993. Methods in Plant Molecular Biology and Biotechnology. CRC Press, Boca Raton, Florida.
5. Glover, D.M and B.D. Hames (Eds). 1995. DNA cloning 1: A Practical Approach; Core Techniques, 2nd edition PAS, IRL press at Oxford University Press, Oxford.
6. Gunning, B.E.S and M. W. Steer. 1996. Plant Cell Biology: Structure and function. Jones and Bartlett Publishers, Boston, Massachusetts.
7. Hackett, P.B. and J.A. Fuchs, J.W. Messing. 1988. An Introduction to Recombinant DNA Techniques: Basic Experiments in Gene Manipulation. The Benjamin/ Cummings Publishing Co., Inc Menlo Park, California. 8. Hall, RD. (Ed).1999. Plant Cell Culture Protocols. Humana Press, New Jersey.
8. Harris, N and K.J. Oparka. 1994. Plant cell Biology: A Practical Approach. IRL Press, At Oxford University Press, Oxford, UK.

Web sources:

1. https://www.madrasshoppe.com/cell-biology-practical-manual-dr-renu-gupta-9788193651223-200674.html
2. https://www.bjcancer.org/Sites_OldFiles/_Library/UserFiles/pdf/Cell_Biology_Laboratory_Manual.pdf
3. https://www.kopykitab.com/Genetics-With-Practicals-by-Prof-S-S-Patole-Dr-V-R-Borane-Dr-R-K-Petare
4. https://www.kopykitab.com/Practical-Plant-Breeding-by-Gupta-S-k
5. https://www.kopykitab.com/Cell-And-Molecular-Biology-A-Lab-Manual-by-K-V-Chaitanya
   https://www.amazon.in/Plant-Tissue-Culture-Theory-Practicals/dp/9386347350

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)**

PLANT CELL & TISSUE CULTURE, RECOMBINANT DNA TECHNOLOGY

Sub Code :23PBOC34

SEMESTER: III	Core - 14	Hours: 5	Credits: 4

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 plant tissue culture and rDNA techniques in the production 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 recombined organism and natural organisms (K4)

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

UNIT I: Basic Plant Tissue Culture **(15 hrs)**

Totipotency and concepts of plant tissue culture – Laboratory organization – 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 **(15 hrs)**

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: **(15 hrs)**

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 *invitro* conservation – Cryopreservation and steps involved in cryopreservation of plant materials

UNIT IV **(15 hrs)**

Recombinant DNA technology tools: Restriction enzymes, Ligases, Phosphatases, T4 Polynucleotide kinase, DNAPolI and Klenow fragment.Cloning vectors:General Features of Plasmids, Bacterio phages (lambda&M-13),Cosmids & Phagemidsas cloning vectors.

UNIT V **(15 hrs)**

Gene Transfer in Plants using *Agrobacterium tumefaciens*, Salient features of Ti plasmid, Concept of Binary vectors & Co-integrate vectors, Vector less Gene Transfer (Gene Gun, electroporation, Polyethyleneglycol, Silicon Carbide fibre), Golden Rice, Bt Cotton. GMOs, GMCs, Gene therapy, IPR.

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. Cyropreservation 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

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	3
CO2	3	3	2	2	3	3	2	3	2	2
CO3	2	2	3	3	1	2	1	3	3	3
CO4	3	3	3	3	3	2	3	3	3	3
CO5	3	3	2	3	2	3	3	3	2	3

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

INDUSTRIAL BOTANY

Sub Code :23PBOC35

SEMESTER: III	Core Industry Module	Hours: 4	Credits: 3

Course outcomes (CO):

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

CO1 : Understand the basics of algae in industrial applications. (K1)

CO2 : Demonstrate and to recollect the uses in fungi in industries. (K2)

CO3 : Explain bacterial role in industries. (K3)

CO4 : Compare and contrast the use of plants in industries. (K4)

CO5 : Discuss and develop skills for working in industries specializing in biomolecules. (K5 & K6)

UNIT I: Algae in Industries **(12 hrs)**

Fertilizer industry-Seaweeds, pharmaceutical industry – antibiotics, agar, carageenin, alginin, diatomate earth, mineral industry, fodder industry

UNIT II: **Fungi in Industries** (12 **hrs)**

Beneficial use of yeast, Fermentation of alcohol, preparations of enzyme, organic acid preparation, cheese production, protein manufacture, vitamins, fats.

UNIT III: Plant Products **(12 hrs)**

Fibres and Fibre-Yielding Plants, wood and cork, tannins and dyes, rubber, fatty oils and Vegetable fats, sugars and starches, pulp and paper, gums and resins.

UNIT IV: Bacteria in Industry **(12 hrs)**

Food industry, dairy products, bioleaching, biogas production**,** bioremediation.

UNIT V: Recombinant Plants **(12 hrs)**

Tissue culture: Micropropagation, somatic seeds, cell culture.

Text Book:

1. Trivedi, P.C. 2001. Algal Biotechnology. Point publisher, Jaipur.India.
2. Dinabandhu, S and Kaushik. B.D. 2012. Algal Biotechnology and Environment. I.K. International, New Delhi.
3. Poonam Singh and Ashok Pandey. 2009. Biotechnology for agro-Industrial residues utilization. Springer.
4. Dilip K. Arora. 2003. Handbook of Fungal Biotechnology. CRC Press book.
5. Vardhana, R. 2009. Economic Botany. 1st ed. Sarup Book Publishers Pvt Ltd. New Delhi.
6. Dubey R.C. 2004. A text book of Biotechnology aspects of microbiology, British Sun Publication.

Reference books:

1. Becker. E.W. 1994. Micro algae Biotechnology and Microbiology.Cambridge University press.
2. Borowitzka, M.A. and borowizka, L.J. 1996. Microalgal Biotechnology. Cambridge University Press, Cambridge,
3. Sahoo, D. 2000. Farming the ocean: seaweed cultivation and utilization. Aravali International, New Delhi.
4. Mahendra Rai. 2009. Advances in Fungal Biotechnology. I.K. International Publishing House, New Delhi.
5. Street,H.E.1978. EssayinPlant Taxonomy,Academic Press, London,UK.
6. Alexander N. Glazer and Hiroshi Nikaido. 1994. Microbial Biotechnology.
7. Pandey, B.P. 2005. College Botany I: Including Algae, Fungi, Lichens, Bacteria, Viruses, Plant Pathology, Industrial Microbiology and Bryophyta. S Chand & Company.

Web resources:

1. https://www.elsevier.com/books/algal-biotechnology/ahmad/978-0-323-90476-6
2. https://www.amazon.in/Fungi-Biotechnology-Prakash-ebook/dp/B07PBF2R3D
3. https://www.amazon.in/Plant-Based-Natural-Products-Derivatives-Applications-ebook/dp/B07438N1CJ
4. https://link.springer.com/book/10.1007/978-981-16-5214-1
5. https://link.springer.com/book/10.1385/0896031616

Mapping with Programme Outcomes:

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

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

ENTREPRENEURIAL OPPORTUNITIES IN BOTANY

Sub Code: 23PBOE31

SEMESTER: III	EC - 4	Hours: 4	Credits: 3

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: (12 hrs)

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

UNIT II: (12 hrs)

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

UNIT III: (12 hrs)

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: (12 hrs)

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

UNIT V: (12 hrs)

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 andKrayesky,D. 2013.GeneralBotany laboratory Manual.AuthorHouse, 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,JandWeber,R.2007.IntroductiontoFungi,3rdEd.CambridgeUniversityPress, Cambridge.
5. Bendre,M. Ashok and AshokKumar,A.2020.TextBookofPracticalBotany 1 (10th ed). Rastogi Publications, Meerut.
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)**

ETHNOBOTANY, NATUROPATHY AND TRADITIONAL HEALTHCARE

Sub Code :23PBOS31

SEMESTER: III	SEC- 2	Hours: 2	Credits: 2

Course Outcomes (CO):

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

CO1 : Recall or remember concept of ethnobotany. (K1)

CO2 : Understand the life style and traditional practices of plants by Indian tribals. (K2 & K6)

CO3 : Highlight the role of Non-Timber Forest products for livelihood of tribal people of India (K3)

CO4 : Assess the methods to transform ethnobotanical knowledge into value added products. (K4)

CO5 : Build idea to make digitization of ethnobotanical knowledge. (K5)

UNIT I: Ethnobotany (6 hrs)

Concept, important landmarks in the development, scope, sub disciplines of ethno botany. Interdisciplinary approaches. Knowledge of following sociological and anthropological terms: culture, values and norms, institutions, culture diffusion and ethnocentrism. History of ethnobotany: A brief history of ethno botanical studies in the world and in India.

UNIT II: Plants used by Tribes of India (6 hrs)

Plants used by tribes of Tamil Nadu. Distribution of tribes in India. Basic knowledge of following tribes of Tamil Nadu: Irula, Kani, Paliyar, Baduga, Kurumba, Toda and Malayali.

UNIT III: Sources of Ethnobotanical Data (6 hrs)

Primary - archeological sources and inventories, Secondary - travelogues, folklore and literary sources, herbaria, medicinal texts and official records. Methods in ethnobotanical research.Prior Informed Consent, PRA techniques, interviews and questionnaire methods, choice of resource persons.Folk taxonomy – plants associated with culture and socio-religious activities. Non – timber forest products (NTFP) and livelihood – Sustainable harvest and value addition.

UNIT IV: Naturopathic medicine (6 hrs)

Role of plants in naturopathy- Importance and relevance of medicinal drugs in India.Indian Systems of Medicine (Ayurveda, Siddha, Homeopathy, Unani, Tibetan, and Naturopathy). Disease diagnosis, treatment, and cure using natural therapies including dietetics, botanical medicine, homeopathy, detoxification, and chelation, clinical nutrition, hydrotherapy, naturopathic manipulation.

UNIT V: Bioprospecting and Value Addition (6 hrs)

Bioprospecting of drug molecules derived from Indian traditional plants; Methods for bioprospecting of natural resources; From folk Taxonomy to species confirmation - evidences

based on phylogenetic and metabolomic analyses; Ethno botanical databases and Traditional knowledge Digital Library (TKDL).

Text Book:

1. Subramaniam, S.V and V.R. Madhavan (Eds,). 1983. Heritage of the Tamil Siddha Medicine. International Institute of Tamil Studies. Madras.
2. Jain, A. and Jain, S.K. 2016. Indian Ethno botany - Bibliography of 21st Century Scientific Publishers (India).
3. Gokhale, S.B., Kokate, C.K and Gokhale, A. 2016. Pharmacognosy of Traditional Drugs. 1st ed. NiraliPrakashan, Pune.
4. Gringauz. 2012. Introduction to Medicinal Chemistry: How Drugs Act & Why? Wiley India Pvt Ltd. Noida.
5. Joshi, S.G. 2018. Medicinal Plants. Oxford & IBH Publishing C., Pvt., Ltd., New Delhi.

Reference Books:

1. CSIR. 1940-1976. Wealth of India. A Dictionary of Raw Materials and Industrial Products - Raw Materials. Vol.1-11. CSIR Publication & Information Directorate. New Delhi.
2. Gokhale, S.B., Kokate, C.K and Gokhale, A. 2016. Pharmacognosy of Traditional Drugs. 1st ed. NiraliPrakashan, Pune.
3. Laird, S.A. 2002. Biodiversity and Traditional knowledge equitable partnerships in Practice. Earthscan Publications Ltd., London.
4. Ministry of Environment and Forests. 1994. Ethno biology in India. A Status Report. All India Coordinated Research Project on Ethno biology. Ministry of Environment and Forests. New Delhi.
5. Kumar, N. 2018. A Textbook of Pharmacognosy. Aitbs Publishers, India.
6. Premendra Singh. 2013. Medicinal Plants: Conservation, Cultivation and Utilization. Daya Publishing House, New Delhi.
7. Albuquerque, U.P., Ramos, M.A., Júnior, W.S.F., and De Medeiros, P.M. 2017. Ethnobotany.

Web resources:

1. file:///C:/Users/HP/Downloads/8-Vol.-5-Is-3-March-2014-IJPSR-1178-A-Paper-81.pdf 2
2. http://www.plantsjournal.com/archives/2017/vol5issue3/PartB/5-3-8-217.pdf 3
3. https://shodhganga.inflibnet.ac.in/bitstream/10603/116454/7/07_chapter%201.pdf 4
4. https://www.cell.com/action/showPdf?pii=S1360-1385%2817%2930001-8 5
5. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3465383/pdf/pnas.201202242.pdf 6
6. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4151377/pdf/1746-4269-10-48.pdf 7 Jain, S. K. 1994. http://www.worldcat.org/identities/lccn-n85-4353/
7. http://www.frlht.org/

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	3	3	3	3	3	2	3	3	3
CO3	3	3	3	2	3	3	3	3	3	3
CO4	3	3	3	3	2	3	3	3	2	3
CO5	3	3	3	3	3	3	3	3	3	3

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

INTERNSHIP
Sub Code :23PBOI31

Semester-III	Internship	**Credits: 2**

- All PG students will undergo internship during the summer holidays of the first year after completing II semester.
- Two credits will be given for internship.
- Minimum Days: 30
- Minimum working time per day: 3 Hrs. & Maximum working Time: 5 Hrs.
- The places of internship can be government offices, Panchayats, MP, MLA offices, private institutions, companies, production units etc.
- The HoD of the departments will give a letter of introduction to each student.
- The students will identify the company / institution for internship.
- The students will be divided equally based on the number of professors available in the departments. Each professor will serve as a guide to the assigned students.
- The students will finalize the institutions / companies for the internship in consultation with the guides.
- The students shall maintain a work diary which will be countersigned by the managers / authorities of the company in which the students do the internship on daily basis.
- The work diary, Work completion certificate obtained from the company and a comprehensive report on the learning outcomes will be submitted to the guides at the end of the internship.
- Viva will be conducted based on the experience of the internship in the month of August. The guide will be the internal examiner and another faculty from the same department will serve as the external examiner.

PLANT PHYSIOLOGY
Sub Code: 23PBOC41

SEMESTER: IV	Core- 15	Hours: 5	Credits: 4

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)

CO1 : Demonstrate the importance of light in plant growth and the harvest of energy. (K2)

CO1 : Explain the energy requirement and nitrogen metabolism. (K3)

CO1 : Compare the various growth regulators that influence plant growth. (K4)

CO1 : Discuss the senescence and plant response to environmental stress. (K5 & K6)

UNIT I: (15 hrs)

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.

UNIT II: (15 hrs)

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: (15 hrs)

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: (15 hrs)

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: (15 hrs)

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. Cambrigde
4. Khan, A.A. 1982. The Physiology and Biochemistry of Seed development, Dormancy and Germination. Elesiver. 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 Publisher, Boston.
2. Devlin, R.M. 1996. Plant Physiology, PWS publisher, 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. Sinauver Associates Inc. Publishers, Sunderland, Massachusetts.
7. Moore, T.C. 1989. Biochemistry and Physiology of Plant Hormones (2nd Edition). SpringerVerlag, New York, USA.
8. Noggle, R.G and Fritz, G.J. 2010. Introductory Plant Physiology, PHI Learning Pvt Ltd, New Delhi.
9. Park S. Nobel. 2005. Physicochemical and Environmental Plant Physiology. Elsevier Academic Press, New York.

10. Panda, S.K, 2005. Advances in Stress Physiology of Plants. Scientific Publishers India, Jodhpur.

Web resources:

1. https://www.sciencedirect.com/topics/agriculture-and0biological-sciences/plant-physiology.
2. https://learn.careers 360.com/biology/plant-physiology-chapter/
3. https://www.biologydiscussion.com/plants/plant-physiology/top-6-processes-of- plant- physiology/24154.
4. https://apan.net/meetings/apan45/files/17/17-01-01-01.pdf
5. https://basicbiology.net/plants/physiology

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)**

BIOCHEMISTRY & APPLIED BIOTECHNOLOGY

Sub Code: 23PBOC42

SEMESTER: IV	Core - 16	Hours: 5	Credits: 4

Course outcomes (CO):

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

CO1 : Knowledge on the fundamentals and significance of Plant Biochemistry. (K1)

CO2 : Understanding on the structure and properties of plant biomolecules. (K2)

CO3 : Explain the role of enzymes in plants. (K3)

CO4 : Compare and contrast the methods of transgenic plants production and natural plants. (K4)

CO5 : Discuss and develop skills for effective utilization of microbial/plant enzymes and their role in biological cells. (K5 & K6)

UNIT I: (15 hrs)

Atomic structure: chemical bonds - ionic bond, covalent bond, coordinate covalent bond, hydrogen bond, hydrogen ion concentration (pH), buffers. Thermodynamics principle, First Law of Thermodynamics a) energy (b) Enthalpy (ii) second law of thermodynamics (a) Spontaneity and disorder (b) entropy (c) free energy, redox potential, dissociation and association constant, activation energy, binding energy. Photobiology – Phosphorescence, Fluorescence &Bioluminescence and bioenergetics.

UNIT II: (15 hrs)

Biomolecules: Classification of carbohydrates; Structure and properties of monosaccharides, Disaccharides, Oligosaccharides, Polysaccharides – Glycoproteins. Protein and Amino acids: Structure, Classification and properties; Peptides - Structure: Primary, secondary, Ramachandran plot, tertiary and quaternary structures. Classification of Lipids: Structure and properties of fatty acids, phospholipids, glycolipids, lipoproteins, cholesterol - structure and functions.

UNIT III: (15 hrs)

Enzymes- Classification and nomenclature chemical nature of enzymes – factors affecting enzyme action – Michaelis – Menton constant, MM equation, Lineweaver Burk plot, Enzyme inhibition, co enzymes- mechanism of enzyme action, isoenzymes. Secondary Metabolites: Structure, classification and properties of steroids, terpenoids, flavonoids Anthocyanins and alkaloids

UNIT IV: (15 hrs)

Transgenic plants - pest resistance, herbicidal resistance, Disease resistant, abiotic and biotic stress tolerant, in improving crop yield, food quality- Golden rice, Edible vaccines, Virus and Bacteria based transient gene expression systems. Virus induced gene complementation, Virus induced gene silencing. Cytoplasmic male sterility and fertility restoration, terminator Seed technology, antisense technology for Delayed fruit ripening, Plants as factories for useful products and pharmaceuticals.

UNIT V: **(15 hrs)**

Screening of Bio transformants - Fermentation techniques- Types. Industrial Production of enzymes-amylase, and their applications. Immobilization for enzymes production. Antibiotic Penicillin production. Amino acid - Glutamic acid production. Production of ethanol. Bioreactors for culturing. Super bug and its role in biodegradation. Bioremediation - *In situ* and *Ex situ*.

Text Book:

1. Satyanarayana, U and chakrapani, U. 2005. Biochemistry, Books and Allied (P) Ltd. Calcutta.
2. A.L. Lehninger, D.L.Nelson & M.M.Cox. 1993. Principles of Biochemistry. Worth Publishers, New York.
3. Stryer, L. 1994. Biochemistry. Freeman & Co, New York.
4. Zubay, G. 1988. Biochemistry. 1988 Macmillan Publishing Co, New York.
5. Harold, F.M. 1986. The vital force: A study of Bioenergetics. Freeman & Co, New York.
6. Jain, J.L. 2005. Fundamentals of Biochemistry. S. Chand & Co. New Delhi.
7. Lehninger, A.L. 1982. Principles of biochemistry, CBS Publication. Halford, N. 2015. Plant Biotechnology: Current and Future Applications of Genetically Modified crops,John Wiley and Sons.
8. Kumar, Pradeep. 2018. Advances in Microbial Biotechnology: Current Trends and Future Prospects. 10.1201/9781351248914.

Reference Books

1. Bonner, J. and Warner, W.H. 1961. Plant Biochemistry. Academic Press. Inv. New York.
2. Gupta, S.N. 2016. Biochemistry Rastogi Publications, Meerut.
3. Satyanarayana, U. and Chakkrapani, U. 2013. Biochemistry. Elsevier India Pvt Ltd & Books Allied Pvt.Ltd, New Delhi.
4. Nelson, D.L. and Cox, M.M. 2017. Lehninger's Principles of Biochemistry, Prentice Hall, International N.J, 7th Edition.
5. Heldt, H-W. 2005. Plant Biochemistry, 3rd Edition. Elsevier Academic Press.
6. Buchanan, B.B., Grissem, W. and Jones, R.L. 2000. Biochemistry and molecular biology of plants. 5th Edition. Wiley-Blackwell.
7. Jain, J.L., Jain, S. and Jain, N. 2016. Fundamentals of Biochemistry. Chand Publishing, New Delhi.
8. Chawla, H.S. 2009. Introduction to Biotechnology, 2nd edn. Oxford IBH, ISBN:978-81-204-1732-8.
9. Halford, N. 2015. Plant Biotechnology: Current and Future Applications of Genetically Modified Crops, John Wiley and Sons.

Web sources:

1. http://priede.bf.lu.lv/grozs/AuguFiziologijas/Augu_biokimija/Plant%20Biochemistry 204.pdf
2. http://www.brainkart.com/subject/Plant-Biochemistry_257/
3. https://swayam.gov.in/nd2_cec20_bt12/preview
4. https://www.biorxiv.org/content/10.1101/660639v2

5. https://www.scribd.com/document/378882955/
6. https://nptel.ac.in/courses/102/107/102107075/
7. https://plantae.org/plant-physiology-top-articles-of-2020-based-on- altmetric-scores/
8. https://.britannica.com/technology/biotechnolog/
9. https://manavrachna.edu.in/blog/scope-of-biotechnology/

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	1
CO2	3	3	2	2	3	3	2	3	2	3
CO3	3	2	3	3	1	2	1	3	3	1
CO4	3	3	3	3	3	2	3	1	3	3
CO5	3	3	2	3	2	3	3	1	3	2

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

PLANT PHYSIOLOGY & BIOCHEMISTRY AND APPLIED BIOTECHNOLOGY - PRACTICAL

Sub Code: 23PBOC43

SEMESTER: IV	Core- 17	Hours: 5	Credits: 4

Course outcomes (CO):

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

CO1 : Perform quantitative tests for all major macro molecules and file a report of Chemical profile of a plant cell. (K1)

CO2 : Analyze the structure and properties of various enzymes. (K2)

CO3 : Understand the fundamentals of water and its relation to plants. (K1&K3)

CO4 : Understand the role of pigment in photosynthetic mechanism and related events of plants. (K4)

CO5 : Evaluate the theory and practical skills gained during the course and create idea to seek for suitable job in relevant industries. (K5 & K6)

UNIT I: PLANT PHYSIOLOGY

1. Determination of osmotic potential by plasmolytic method.
2. Determination of water potential using gravimetric method.
3. Determination of water potential using dye method (Chardakov's method).
4. Effect of Monochromatic light on apparent photosynthesis.

UNIT II: PLANT PHYSIOLOGY

1. Effect of temperature on protoplasmic membrane.
2. Separation of chloroplast pigments using paper chromatographic technique.
3. Estimation of chlorophyll content using Arnon's method.
4. Experiment to study the rate of Hill activity of isolated chloroplast by dye-reduction.

UNIT III: BIOCHEMISTRY

1. Estimation of IAA.
2. Effect of auxin on root initiation.
3. Experiments to show the heribicidal action of Auxin (2-4,D).
4. Effect of synthetic Cytokinin on the destruction of chlorophyll.

UNIT IV: BIOCHEMISTRY

1. Estimation of total carbohydrates.
2. Estimation of proteins.
3. Estimation of Proline content.
4. Estimation of ascorbic acid
5. Estimation of phenols.
6. Determination of Relative Water Content.

Text Book:

1. Plummer, D. 1988.An introduction to Practical Biochemistry, Tata McGraw–Hill

Publishing Company Ltd., New Delhi.
2 Palanivelu, P. 2004.Laboratory Manual for analytical biochemistry and separation techniques, School of Biotechnology, Madurai Kamaraj University, Madurai.
3. Jayaraman.J.1981.Laboratory Manual in Biochemistry. Whiley Eastern Limited,New Delhi.
4. Bendre, A. M. and Ashok Kumar, 2009. A textbook of practical Botany. Vol. I & II. Rastogi Publication. Meerut. 9th Edition.
5. ManjuBala,Sunita Gupta, Gupta NK. 2012. Practicals in Plant Physiology and Biochemistry. Scientific Publisher.
6. Joy, P.P., Surya, S and Aswathy, C. 2015. Laboratory Manual of Biochemistry, Agricultural University, Pineapple Research Station, Ernakulam, Kerala.
1. Poonam Sharma – Natu, Vijay Paul and P.S. Deshmukh. 2021. Laboratory manual Experimental Plant Physiology. Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi.
2. George M Malacinski. 2015. Freifelders Essentials of Molecular Biology (4th ed.) Jones & Bartlett.
3. Gupta P.K. 2017. Cell and Molecular Biology (5th ed.), Rastogi Publications, Meerut.
4. Kumar, H.D. 2007. Molecular Biology and Biotechnology, Vikas Publishing House, New
Delhi.
5. Shivakumar, S. 2002. Molecular analysis: Laboratory Manual. University press, Palkalainagar, Madurai, India.

Reference books:

1. Bala, M., Gupta, S., Gupta, N.K and Sangha, M.K. 2013. Practicals in plant physiology and biochemistry. Scientific Publishers (India).
2. Wilson, Kand J. Walker (Eds). 1994. Principles and Techniques of Practical Biochemistry (4th Edition) Cambridge University Press, Cambridge.
3. Bendre, A. Mand Ashok Kumar. 2009. A textbook of practical Botany. Vol. I & II. Rastogi Publication. Meerut. 9th Edition.
4. Manju Bala, Sunita Gupta, Gupta, N. K. 2012. Practicals in Plant Physiology and Biochemistry. Scientific Publisher.
5. Wilson, K and J. Walker. 2005. Principles and Techniques of Practical Biochemistry, 5th Edition. Cambridge University press, New York.
6. Rodney Boyer. 2000. Modern Experimental Biochemistry, 3rd Edition. Published by Addison Wesley Longman. Singapore.
7. Glick, B.R and J.E. Thompson. 1993. Methods in Plant Molecular Biology and Biotechnology. CRC Press, Boca Raton, Florida.
8. Glover, D.M and B.D. Hames (Eds). 1995. DNA cloning 1: A Practical Approach; Core Techniques, 2nd edition PAS, IRL press at Oxford University Press, Oxford.
9. Hackett, P.B. and J.A. Fuchs, J.W. Messing. 1988. An Introduction to Recombinant DNA Techniques: Basic Experiments in Gene Manipulation. The Benjamin/ Cummings Publishing Co., Inc Menlo Park, California. 8. Hall, RD. (Ed).1999. Plant Cell Culture Protocols. Humana Press, New Jersey.

Web resources:

1. file:///C:/Users/User/Downloads/2021%20Botany%20Syllabus%20after%20BoS%20formatted1%20(1).pdf
2. https://kau.in/document/laboratory-manual-biochemistry
3. https://www.amazon.in/Practical-Manual-on-Plant-Biochemistry/dp/6200539790
4. https://www.amazon.in/Laboratory-Manual-Physiology-Mukesh-Amaregouda/dp/6133993502
5. https://www.kopykitab.com/A-Laboratory-Manual-of-Plant-Physiology-Biochemistry-and-Ecology-by-Akhtar-Inam

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	3
CO2	3	3	2	2	3	3	2	3	2	3
CO3	3	2	3	3	1	2	1	3	1	3
CO4	3	3	3	3	3	2	3	3	3	3
CO5	3	3	2	3	2	3	3	3	3	3

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

ORGANIC FARMING

Sub Code:23PBOE41

SEMESTER: IV	EC - 5	Hours: 4	Credits: 2

Course outcomes (CO):

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

CO1 : Knowledge on various aspects of organic farming. (K1)

CO2 : Understand the relevance of organic farming, its advantages. (K2)

CO3 : Explain the short comings against conventional high input agriculture. (K3)

CO4 : Compare the packaging methods of harvest. (K4)

CO5 : Discuss and develop skills for post harvest management. (K5 &K6)

UNIT I: Agronomy (12 hrs)

Organic farming- concept, characteristics, significance, organic ecosystem, scope of organic farming in India - Principles and types of organic farming. Choice of crops & varieties in organic farming - Initiative by Govt/NGOs/Other organizations for promotion of organic farming Operational structure of NPOP (National Programme for Organic Production) - Concept of dryland agronomy Organic nutrient resources & their fortification, restriction to nutrient use in organic farming - Organic production methods for cereals, vegetables and fruit crops

UNIT II: Soil Science (12 hrs)

Organic farming for sustainable agriculture; Manures- compost, methods of composting - Green manuring, vermicompost and biofertilizer. Harmful effect of non-judicious chemical fertilization - Organic farming practices for improving soil health. Quality parameters of organic manures and specifications - Soil fertility in organic farming systems. -Manure preparation methodology - Soil improvement

UNIT III: Fundamental of organic Farm Management (12 hrs)

Land management in organic farming - Water management in organic farming.Organic insect disease management - Organic pest disease management. Preventive and cultural methods for insects and pest control - Identification of different fungal and bacterial biocontrol agents Indigenous technical knowledge for insects-pest, disease - Weed and nutrient management in organic farming

UNIT IV: Post Harvest Management (12 hrs)

Processing, labelling of organic produce - Storage and transport of organic produce.

UNIT V: Organic Quality Control Standards (12 hrs)

Certification- types, process & procedure and agencies. Quality aspect and grading - Packaging and handling. Economic considerations and viability of organic products - Export of organic product and marketing.

Text Book:

1. NIIR Board. 2012. The complete Technology Book on Biofertilizer and organic farming. 2nd Edition. NIIR Project Consultancy Services.
2. Sathe, T.V. 2004. Vermiculture and Organic Farming. Daya publishers.
3. Subba Rao N.S. 2017. Bio fertilizers in Agriculture and Forestry. Fourth Edition. Medtech.
4. Vayas, S.C, Vayas, S. and Modi, H.A. 1998. Bio-fertilizers and organic Farming Akta Prakashan, Nadiad.
5. Singh, S M. 2018. Organic Manure: Sources Preparation and Usage in Farming Lands, Siya Publishing House.

Reference books:

1. Reddy, S.R. 2019. Fundamentals of Agronomy Kalyani Publications, Uttar Pradesh
2. Tolanur, S. 2018. Fundamentals of Soil Science IIndEdition , CBS Publishers , New Delhi
3. Reddy, S.R. 2017. Principles of Organic Farming Kalyani Publishers , New Delhi
4. Dongarjal, R.P and Zade, S.B. 2019. Insect Ecology and Integrated Pest Management Akinik Publications, New Delhi.
5. Ahmad Mehraban. 2013. The Basis of Organic Fertilizers, LAP LAMBERT Academic Publishing.

Web resources:

1. https://www.amazon.in/Healthy-earth-organic-Hari-prasad-ebook/dp/B08L5KFKDV
2. https://www.kobo.com/in/en/ebook/organic-farming-for-sustainable-agriculture
3. https://www.elsevier.com/books/organic-farming/chandran/978-0-12-813272-2
4. https://link.springer.com/book/10.1007/978-3-030-04657-6
5. https://www.afrimash.com/product-category/livestock-section/book/organic-farming-ebooks/

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	1	1	2	1	3	2	1
CO4	3	3	3	3	3	2	3	3	2	3
CO5	3	3	2	3	2	3	3	2	3	1

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

FORESTRY AND WOOD TECHNOLOGY
Sub Code: 23PBOE41

SEMESTER: IV	EC - 5	Hours: 4	Credits: 2

Course outcomes (CO):

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: (12 hrs)

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 civilization. Geographical history of the forest vegetation - natural vs. artificial. Special emphasizes on social forestry, Industrial forestry and Multi-purpose forestry. Preservation of natural forestry - Pollution control.

UNIT II: (12 hrs)

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: (12 hrs)

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: (12 hrs)

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 varies types of cuttings.

UNIT V: (12 hrs)

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. Wild Life 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. Text book of Agro forestry. Oxford and IBH publisher, New Delhi.
6. Singhi, G.B. 1987. Forest Ecology of India, Publisher: Rawat.
7. Ramprakash. 1986. Forest management. IBD Publishers, Debra 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. Oxford IBH Publishing Co., 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://wwwwds.worldbank.org/external/default/WDServer/WDSP/IB/2006/10/19/00011 2742_2006 1019150049/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)**

PROJECT WITH VIVA VOCE
Sub Code: 23PBOC44

SEMESTER: IV	Project	Hours: 7	Credits: 7

Course outcomes (CO):

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

CO1 : For students in those pertinent core areas, the project is preparing them to become professionals after graduation. (K1)

CO2 : Compile data and familiarize yourself with techniques for planning and carrying out tests. (K2)

CO3 : Collect data and educate yourself on how to evaluate the analyzed results of your scientific studies. (K3 & K5)

CO4 : In-the-moment industrial exposure helps them become more knowledgeable and skilled in the latest technology. (K4)

CO5 : Improving communication skills and coming up with creative ideas are crucial components of training that help someone become an entrepreneur. (K5 & K6)

UNIT I:

1. Each student will be allotted a Project Guide from the faculty of the department concerned by lot method.
2. The topic of the dissertation shall be assigned to the candidate before the beginning of third semester.
3. After the completion of the project work, the student has to submit four copies of dissertation with report carrying his/ her project report for evaluation by examiners. After evaluation, one copy is to be retained in the College Library.
4. Project work will be evaluated and Viva Voce will be conducted by both the external and the internal (Project Guide) examiners for the maximum of 100 marks in total on the scale of the maximum of 50 marks for the internal and the external each.

UNIT II:

All the candidates of M.Sc (Botany) are required to undergo a major project and submit the following:

1. Dissertation/Thesis based on the work done by the student.

UNIT III: Suggested areas of work:

Algae, fungi, microbiology, biocontrol agents, plant tissue culture, plant physiology, phytochemistry, biochemistry, anatomy, plant taxonomy, Ethnobotany, ecology, sustainable agriculture, herbal formulations, cytogenetics, molecular biology, biotechnology, bioinformatics, nanotechnology and applied botany etc.

UNIT IV: Methodology:

Each project should contain the following details:

1. Brief introduction on the topic
2. Review of Literature
3. Materials and Methods

4. Results and Discussion – evidences in the form of figures, tables and photographs.

5. Summary

6. Bibliography

Text Book:

1. Wilson, KandJ. Walker (Eds). 1994. Principles and Techniques of Practical Biochemistry (4th Edition) Cambridge University Press, Cambridge.
2. Bendre, A. M and Ashok Kumar. 2009. A text book of practical Botany. Vol. I & II. Rastogi Publication. Meerut. 9th Edition.
3. Manju Bala, Sunita Gupta, Gupta, N. K. 2012. Practicals in Plant Physiology and Biochemistry. Scientific Publisher.
4. Wilson, Kand J. Walker. 2005. Principles and Techniques of Practical Biochemistry, 5th Edition. Cambridge University press, New York.
5. RodneyBoyer.2000. Modern Experimental Biochemistry, 3rd Edition. Published by Addison Wesley Longman. Singapore.

Reference Books:

1. Dawson, C. 2002. Practical research methods. UBS Publishers, New Delhi.
2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. 1995. Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.
3. Ruzin, S.E. 1999. Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A.
4. Wilson and Goulding. 1987. Principles of biochemical techniques, Oxford University Press.
5. Mukherji, S. and Ghosh, A.K. 2005. Plant Physiology. First Central Edition, New Central Book Agency (P) Ltd., Kolkata.

Web resources:

1. https://handbook.monash.edu › units › BIO3011
2. https://www.amazon.in/Practical-Manual-on-Plant-Biochemistry/dp/6200539790
3. https://www.amazon.in/Laboratory-Manual-Physiology-Mukesh-Amaregouda/dp/6133993502
4. https://www.kopykitab.com/A-Laboratory-Manual-of-Plant-Physiology-Biochemistry-and-Ecology-by-Akhtar-Inam
5. https://kau.in/document/laboratory-manual-biochemistry

Mapping with Programme Outcomes:

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

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

BOTANY FOR ADVANCED RESEARCH

Sub Code: 23PBOS41

SEMESTER: IV	SEC - 3	HOURS: 4	CREDITS: 2

Course outcomes (CO):

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

CO1 : Understand of the basic principles of systematics, including identification, nomenclature, classification, and the inference of evolutionary patterns from data (K1, K2 & K5)

CO2 : Learn the structures, functions and roles of apical *vs* lateral meristems in monocot and dicot plant growth. (K1, K3 & K5)

CO3 : Understand the organization of nuclear genome (K3 & K5)

CO4 : Understand the various steps involved in the basic functioning of plant growth and the nutritive value of food. (K2, K3 & K5)

CO5 : Gain awareness about the various processes involved in the energy production in plants and metabolic pathways. (K1, K5 & K6)

UNIT I: Molecular Genetics (12 hrs)

Genomics: Structural genomics, Genetic and physical mapping (RFLP), microsatellite maps, cyotogenetic maps, physical maps, positional cloning, chromosome walks and jumps, Genome sequencing, genome databases, human genome sequencing project. Functional genomics. transcriptome, proteome and meta bolome, Microarrays and gene-chips. Comparative genomics. Functional and evolutionary relationships prokaryotes, organelles and eukaryotes, orthologues and paralogues. Metabolomics: Identification and quantification of cellular metabolites in biological samples. Pharma cogenomics and drug designing.

UNIT II: Advanced Trends in Systematics (12 hrs)

Molecular trends in Biosystematics

a. Molecules and genomes in plant systematics, techniques used in molecular taxonomy, molecular systematics in crop evolution

b. Serology in relation to plant taxonomy- Methods, role of serology in taxonomy.

c. Cladistics and Phenetics (iv) Molecular trends in Reproductive Biology: (i) Apomixis – Types, cytogenetic basis and induction of apomixes, applications.

Chemotaxonomy, Biochemistry and genetics of incompatibility, methods to overcome incompatibility, pollen viability tests, molecular basis of incompatibility

Sterility – Male sterility, CMS, GMS, CGMS, temperature sensitive and photosensitive male sterility, transgenic male sterility, female sterility and zygotic sterility.

UNIT III: Plant Physiology (12 hrs)

Modern concepts Photosynthesis – Environmental and agricultural relevance; Respiration – Biochemical control of respiration. Plant growth and development Patterns of growth and differentiation; Gene expression and mutations regulating meristem function, embryogenesis, seedling, root, leaf and flower development. Homeotic genes, ABCD model

in Arabidopsis flower, hormonal control of plant tissue development, effect of auxins on root and root formation, gibberellin promoted growth of plants, ethylene and triple response mutants, brassinosteroids and photomorpho genesis.

UNIT IV: Plant Physiology (12 hrs)

Enzymes: General account: Importance and properties of enzymes in biological sciences, the classification and nomenclature of enzymes with examples, Mechanism of enzyme action role of enzyme in chemical action, various factors affecting the enzyme activity. Molecular genetics in plant physiology, Environmental plant physiology, Stress physiology.

UNIT V: Economic Botany (12 hrs)

Economic importance of Cereals, Tuber Crops, Fibre yielding plants, Plantation Crops, Sugar yielding plants, Narcotics, Vegetables, Oil yielding plants, Pulses and Beverages.

Text Book:

1. Sharma, O.P. 2017. Plant Taxonomy. (II Edition).The McGraw Hill Companies.
2. Maheshwari, P. 1963. Recent Advances in Embryology of Angiosperms. Intl. Soc. Plant Morphologists, New Delhi.
3. Sharma, P.C. 2017. Text Book of Plant Anatomy. Arjun Publishing House, New Delhi.
4. Jain, V.K. 2017. Plant Physiology, S.Chand& Company Ltd. New Delhi.
5. Lincoln, T, Eduardo, Z, Ian Max, M, and Angus, M. 2018. Fundamentals of Plant Physiology. Sinauer Associates Inc., US.
6. Becker, W.M., Kleinsmith L.J. & Hardin J. 2005. The World of the Cell (6th edition). Benjamin/Cummings Pub. Co. New York.
7. Brooker, R. J. 1999. Genetics Analysis and Principles. Addison Wesley Longman Inc., New York.
8. Bruce, A. et. al. 2002. Molecular Biology of the Cell. Garland Publishing. New York.

Reference books:

1. Mabberley, J.D. 2014. Mebberley's Plant-Book: A portable dictionary of plants, their classification and uses, 3rd ed. Cambridge University Press, Cambridge, U.K. 1021pp.
2. Pandey.B.P. 1999. Economic Botany. S. Chand Limited, New Delhi.
3. Bhojwani, S.S. and Soh, W.Y. 2013. Current trends in the embryology of angiosperms. Springer Science & Business Media, Germany.
4. Cutler, D. F., Botha, T and Stevenson, D.W. 2008. Plant Anatomy: An Applied Approach. Blackwell Publishing, Malden, USA.
5. Steward, F.C. 2012. Plant Physiology Academic Press, US.
6. Hopkins, W.G and Huner, N.P. 2009. Introduction to Plant Physiology (4th ed.). John Wiley & Sons. U.S.A.
7. Noggle G.R and G.J. Fritz. 2002. Introductory Plant Physiology. Prentice Hall of India, New Delhi.
8. Anthony J . F. G .2000. An Introduction to Genetic Analysis. W. H. Freeman &Co. New York.

9. Hartl, .D.L & Jones E. W. 2000. Genetic analysis of Genes and Genomes Jones and Bartlett Pub, Boston.
10. Klug .S.W. & Cummings, M.R. 2003. Concepts of Genetics . Pearson Education Pvt. Ltd., Singapore. Kreezer et al . 2001. Recombinant DNA and Biotechnology. American Society for Cell Biology, New York.
11. Lodish Harvey. 1999. Molecular Cell Biology. W.H. Freeman &Co. New York.
12. Russell, P.J. 2005. Genetics: A Molecular Approach (2nd edition). Pearson/Benjamin Cumming, San Francisco.
13. Snustad, D. P. & Simmons M.J. 2003.Principles of Genetics. John Hailey & Sons Inc. U.S.A.

Web resources:

1. http:// www.ornl.gov.
2. http:// ash. gene. ncl. ac .nk..
3. http://tor. cshl. org. http:www. gdb. org.
4. http: //www. neg r. org.
5. http: // www. genetics. wustl. edu.
6. http: // genome. imb-jena. dc.

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	2
CO2	3	3	2	2	3	3	2	3	2	3
CO3	2	2	3	3	1	2	1	3	1	3
CO4	3	3	3	3	2	2	3	2	3	1
CO5	3	3	2	3	2	1	3	3	2	3

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

FARM SCIENCES: GREEN WEALTH

Subject Code: 23PBOVA1

SEMESTER: I	CC- 1	Hours: 2	Credits: 4

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 tilt, 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, water logging. 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 vigor, 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, leveler, 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 Plants 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: 23PBOVA2

SEMESTER: II	VA- 2	Hours: 2	Credits: 4

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 AND 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 phytopharmacueticals; Biocides, Biofungicides, Biopesticides. Women entrepreneurship development – marketing cultivated medicinal plants – National Medicinal Plants Board of India.

Recommended Text:

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. 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 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: 23PBOEC1

SEMESTER: III	ECC- 1	Hours: 2	Credits: 4

Course outcomes (CO):

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 solvenst – 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

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

BIOPESTICIDE TECHNOLOGY
Sub Code : 23PBOEC2

SEMESTER: IV	ECC- 2	Hours: 2	Credits: 4

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 onlife.(K1& K2)

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

CO3: Knowledge on identification of promising bio pesticides 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 biorationales.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: *Agro bacterium 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 efficiacy of biopesticides. Commercial products of biopesticides

Recommended Text:

1. Johri,J.2020.Recent Advances in Biopesticides: Biotechnological Applications. New India Publishing Agency (NIPA), NewDelhi.
2. Kaushik,N.2004. Biopesticides for sustainable agriculture: prospects and constraints. TERI Press, 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)