ST. MARY'S COLLEGE (Autonomous)

(Re-accredited with 'A^{+}' Grade by NAAC)

Thoothukudi-628001, Tamil Nadu

(Affiliated to Manonmaniam Sundaranar University)

M.Sc. Botany

School of Biological Sciences

Outcome Based Curriculum

(W.e.f.2023)

Preamble

The Department of Botany offers an enriched learning environment in Plant Sciences. The Botany programme provides basic training in Plant Biology, Ecology, Physiology, Marine Botany, Mycology. Plant Diseases and Biotechnology. The Department has excellent laboratory and research facilities to augment research in the fields of botany. Besides, students develop transferable skills, critical and lateral thinking, analytic and interpretive skills and communicating skills. It has great scope for higher education in diverse branches of botany. The programme opens avenues for multiple job opportunities as Soil and Plant Scientist, Biophysicist, Biochemist, Biological Technician, Environmental Scientist, Mycologist, Plant Breeders, Horticulturist and Entrepreneur in plant products and herbal medicine.

Vision : Developing academically, professionally and ethically empowered human resources

Mission : To provide an academic ambience that strengthens critical thinking, scientific inquiry and problem solving in the frontier areas of plant biology

Programme Outcome:

PO No.	After completion of the Postgraduate programme the students of St. Mary's College will be able to
PO 1	acquire expertise knowledge in their respective disciplines and become professionals.
PO 2	develop critical/logical thinking skills, managerial skills and become locally, nationally and globally competent and be a lifelong learner
PO 3	pursue research / higher learning programme and apply their experiment and research skills to analyse and solve complex problems.
PO 4	compete in the job market by applying the knowledge acquired in Arts, Science, Economics, Commerce and Management studies
PO 5	be an empowered and economically independent woman with efficient leadership qualities and develop the themselves as a holistic person

Programme Specific Outcome:

PSO No.	Students of M. Sc Botany will be able to	PO Matched
PSO-1	show proficiency in understanding cryptogams and phanerogams, as well as expertise in regulating biochemical processes, comprehending molecular mechanisms, analyzing palynological and embryological processes, exploring plant pathology and applying biostatistics.	**PO1**
PSO-2	develop advanced skills in laboratory techniques, identification of plants, microbial and molecular techniques, medicinal plants, handling of instruments, advanced software for biology, plant pathology, IPR, remote sensing and ethnobotany.	**PO2**
PSO-3	make use of critical thinking to formulate and independently carry out projects, design experiments both in the field and laboratory and execute them utilizing all requisite abilities.	**PO2, PO4**
PSO-4	employ an interdisciplinary approach by blending diverse areas of botany with other scientific disciplines for the purpose of conducting research.	**PO3, PO4, PO5**
PSO-5	apply the acquired knowledge to suggest remedies for diverse aspects of human and environmental well-being.	**PO3,PO5**

ST. MARY'S COLLEGE (AUTONOMOUS), THOOTHUKUDI
DEPARTMENT OF BOTANY
PG COURSE STRUCTURE (w.e.f. 2023)
SEMESTER I

Components	**Course Code**	**Course Title**	**Hours / Week**	**Credits**	**Max. Marks**		
					CIA	**ESE**	**Total**
Core **I**	23PBOC11	Plant Diversity I - Algae, Fungi, Lichens and Bryophytes	7	5	25	75	100
Core **II**	23PBOC12	Plant Diversity II - Pteridophytes, Gymnosperms and Paleobotany	7	5	25	75	100
Core Practical **I**	23PBOCR1	Laboratory Course - I: Covering Core Papers - I and II	6	4	40	60	100
Discipline Specific Elective **I**	**23PBOE11** 23PBOE12	**Microbiology, immunology and plant pathology** OR Phytopharmacognosy	5	3	25	75	100
Discipline Specific Elective **II**	**23PBOE13** 23PBOE14	**Ethnobotany, Naturopathy and Traditional Healthcare** OR Herbal Technology	5	3	25	75	100
MOOC (Compulsory)				+2			
Total			**30**	**20+2**			

SEMESTER II

Components	Course Code	Course Title	Hours / Week	Credits	Max. Marks		
					CIA	ESE	Total
Core **III**	23PBOC21	Taxonomy of Angiosperms and Economic Botany	5	5	25	75	100
Core **IV**	23PBOC22	Plant Anatomy, Embryology and Morphogenesis	5	5	25	75	100
Core Practical **II**	23PBOCR2	Taxonomy of Angiosperms, Plant Anatomy and Embryology Practical	4	2	40	60	100
Discipline Specific Elective **III**	**23PBOE21** 23PBOE22	**Ecology, Phytogeography, Conservation Biology and Intellectual Property Rights** OR Phytochemistry	4	3	25	75	100
Discipline Specific Elective **IV**	**23PBOE23** 23PBOE24	**Research Methodology and Bioinstrumentation** OR Nanobiotechnology	4	3	25	75	100
Discipline Specific Elective Practical **I**	23PBOER1	Ecology, Phytogeography, Research Methodology and Bioinstrumentation Practical	4	2	40	60	100
Skill Enhancement Course **I** (Discipline Specific)	23PBOSE1	Agriculture and Biopesticide Technology	4	2	25	75	100
Total			**30**	**22**			

SEMESTER – III

Components	Course Code	Course Title	Hours / Week	Credits	Max. Marks		
					CIA	ESE	Total
Core **V**	23PBOC31	Biochemistry	6	5	25	75	100
Core **VI**	23PBOC32	Genetics, Plant Breeding and Biostatistics	5	5	25	75	100
Core **VII**	23PBOC33	Plant Biotechnology	5	5	25	75	100
Core Practical **III**	23PBOCR3	Biochemistry Practical	2	1	40	60	100
Core Practical **IV**	23PBOCR4	Genetics, Plant Breeding, Biostatistics and Plant Biotechnology Practical	4	2	40	60	100
Discipline Specific Elective **V**	**23PBOE31** 23PBOE32	**Entrepreneurial Botany** OR Global Climate Change	4	3	25	75	100
Skill Enhancement Course **II** (Discipline Specific)	23PBOSE2	Horticulture Techniques	4	3	25	75	100
Internship / Self- Study (Optional) **I**	23PBOI31 23PBOSS1	---------- Renewable Energy Resources		+ 2		50	50
Total			**30**	**24 + 2**			

SEMESTER – IV

Components	Course Code	Course Title	Hours / Week	Credits	Max. Marks		
					CIA	ESE	Total
Core **VIII**	23PBOC41	Plant Functions	5	5	25	75	100
Core **IX**	23PBOC42	Molecular Biology and Bioinformatics	5	5	25	75	100
Core **X**	23PBOC43	Marine Biology	4	4	25	75	100
Core Practical **V**	23PBOCR5	Plant Functions Practical	2	1	40	60	100
Core Practical **VI**	23PBOCR6	Molecular Biology, Bioinformatics and Marine Biology Practical	4	2	40	60	100
Discipline Specific Elective **VI**	23PBOE41 23PBOE42	**Floriculture** OR Forestry	4	3	25	75	100
Core **XI** (Project)	23PBOP41	Project and Viva Voce	6	4	40	60	100
Total			**30**	**24**			

Note:

1. It is mandatory for all I PG students to complete a MOOC course in the Swayam NPTEL Portal. Two credits will be awarded to the students who successfully pass the MOOC course in the Portal. Students who fail to pass in their first and second attempts via the Swayam NPTEL Portal will be eligible to take a supplementary exam given by the college for which one credit will be given.
2. Internship can be completed during the second semester vacation.

Semester	Hours	Credits	Extra Credits
I	30	20	--
II	30	22	2
III	30	24	2
IV	30	24	--
Total	120	90	4

Master of Science (Botany)

Courses	Number of Courses	No. of Hours	Credits	Extra Credits
Core Theory	10	54	49	--
Core Practical	6	22	12	--
Discipline Specific Elective	6	26	18	--
Discipline Specific Elective Practical	1	4	2	
Group Project	1	6	4	--
Skill Enhancement Course	2	8	5	--
MOOC (Compulsory)	1	--	-	2
Internship/Self Study Paper (Optional)	1	--	-	2
Total		**120**	**90**	**4**

SEMESTER I			
CORE I - PLANT DIVERSITY I - ALGAE, FUNGI, LICHENS AND BRYOPHYTES			
Course Code: 23PBOC11	**Hrs/ Week: 7**	**Hrs/ Semester: 105**	**Credits: 5**

OBJECTIVES

1. To learn about the classification, distinguishing traits, geographic distribution, and reproductive cycle of algae, fungi, lichens, and bryophytes.
2. To gain knowledge about the ecological and economic importance of algae, fungi, lichens and bryophytes.
3. To spark interest in the evolutionary roots of plant development.
4. To study the biodiversity by describing and explaining the morphology and reproductive processes of algae, fungi, bryophytes and microorganisms.
5. To expose the beneficial and harmful view point.

COURSE OUTCOMES

CO. No.	Upon completion of this course, students will be able to	PO
CO1	recall the structural organizations, ecological and economic importance of algae, fungi, lichens and bryophytes	K1
CO2	discuss both the theoretical and practical knowledge in understanding the diversity of basic life forms and their economic importance.	K2
CO3	relate life cycle patterns in algae, fungi, lichens and bryophytes and present the knowledge of their chemical components into develop industrial products.	K3
CO4	compare and contrast the mode of reproduction in diverse groups of basic plant forms and their economic importance.	K4
CO5	conclude and develop skills for effective utilization of lower plant forms.	K5

SEMESTER I			
CORE I - PLANT DIVERSITY I - ALGAE, FUNGI, LICHENS AND BRYOPHYTES			
Course Code: 23PBOC11	**Hrs/ Week: 7**	**Hrs/ Semester: 105**	**Credits: 5**

UNIT I General account of algology, Contributions of Indian Phycologist (T.V. Desikachary, V. Krishnamurthy, V.S. Sundaralingam, and M.O.P. Iyengar), Classification of algae by F.E. Fritsch (1935-45) and Silva (1982). Salient features of major classes: Cyanophyceae, Chlorophyceae, Xanthophyceae, Chrysophyceae, Cryptophyceae, Dinophyceae, Chloromonadineae, Euglenophyceae, Charophyceae, Bacillariophyceae, Phaeophyceae and Rhodophyceae. Range of thallus organization, algae of diverse habitats, reproduction (vegetative, asexual and sexual) and life cycles. Phylogeny and inter-relationships of algae, origin and evolution of sex in algae. Structure, reproduction and life histories of the following genera: *Oscillatoria, Scytonema, Ulva, Codium, Diatoms, Padina* and *Hypnea.*

UNIT II 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) and Recent trends in the classification of fungi - Phylogeny and inter-relationships of major groups of fungi. General characters of major classes: Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotinaand Deuteromycotina. Heterothallism in fungi, sexuality in fungi, Para sexuality, sex hormones in fungi. Structure, reproduction and life histories of the following genera: *Plasmodiophora, Phytophthora, Rhizopus, Xylaria, Polyporus* and *Colletotrichum.*

UNIT III Introduction and Classification (Hale, 1969). Occurrence and inter-relationship of phycobionts and mycobionts, structure and reproduction in Ascolichens, Basiodiolichens and Deuterolichens.

UNIT IV General characters and Classification of Bryophytes by Rothmaler (1951). 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, spore germination patterns in bryophytes. Structure, reproduction and life histories of the following genera: *Targionia, Lunularia, Porella* and *Polytrichum.*

UNIT V Algae - Economic importance in Food and feed - Single cell protein, Industrial products (Agar-Agar, Carrageenan, Alginic acid, Iodine, biofertilizers, Vitamins and biofuel), Medicinal value and Diatomaceous earth. Fungi – Economic importance in food, industries and medicine. Culturing and cultivation of mushrooms *Pleurotus.* Lichen –economic importance and as indicator pollution. Bryophytes – Ecological and economic importance – industry, horticulture and medicine.

Recommended texts

1. Kumar, H.D.1999. Introductory Phycology. Affiliated East-WestPress, 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, Mc Graw 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.
6. Singh, Pandey and Jain. 2020. A text book of Botany, 5th Edition, Rastogi Publication, Meerut.
7. Sharma, O.P. 2014. Bryophyta, Mcgraw Hill, ISBN: 9781259062872, 1259062872

Reference Books

1. Sundaralingam, V. 1991. Marine algae. Bishen Singh and Mahendra Pal Singh Publishers, Dehradun.
2. Edwardlee,R. 2018. Phycology, 5th Ed., Cambridge University Press, 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 and 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.
5. http://www.uobabylon.edu.iq/eprints/paper_11_20160_754.pdf
6. https://www.youtube.com/watch?v=vcYPI6y-Udo
7. https://www.youtube.com/watch?v=XQ_ZY57MY64
8. http://www-plb.ucdavis.edu/courses/bis/1c/text/Chapter22nf.pdf

MAPPING WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	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
Avg	2.8	2.8	2.4	2.8	2.2	2.2	2.2	2.8	2.2	2.8

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

SEMESTER I			
CORE II- PLANT DIVERSITY II - PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY			
Course Code: 23PBOC12	**Hrs/ Week: 7**	**Hrs/ Semester: 105**	**Credits: 5**

OBJECTIVES

1. To investigate the classification, distinctive traits, distribution and reproduction and life history of the various classes and major types of Pteridophytes and Gymnosperms.
2. To identify and characterize diversity of lower vascular plants in order to comprehend the dynamics of diversity to realize the importance of diversity.
3. To research the classification, phylogeny and economic importance of Pteridophytes and Gymnosperms.
4. To study and understand the phylogeny and Paleontology of Pteridophytes and Gymnosperms.
5. To learn about the concept of fossils and process of fossilization; distinctive characteristics of fossil records of Pteridophytes and Gymnosperms.

COURSE OUTCOMES

CO. No.	Upon completion of this course, students will be able to	PO
CO-1	recall on classification, recent trends in phylogenetic relationship, general characters and economic importance of pteridophytes and gymnosperms	**K1**
CO-2	learn the morphological/ anatomical organization, life history of major types of pteridophytes and gymnosperms.	**K2**
CO-3	apply knowledge of pteridophytes and gymnosperms to identify and classify different genera and fossilization and types of fossils to interpret their significance in understanding evolution	**K3**
CO-4	analyze the life cycles of different pteridophytes and gymnosperms for similarities and difference, the evolutionary relationship of pteridophytes and gymnosperms, the economic importance of fossils, particularly in terms of fossil fuels and industrial raw materials	**K2**
CO-5	evaluate the impact of environmental changes on the life cycles of pteridophytes and gymnosperms, the contributions of different genera in paleobotany to our understanding of evolution	**K5**

SEMESTER I			
CORE II- PLANT DIVERSITY II - PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY			
Course Code: 23PBOC12	**Hrs/ Week: 7**	**Hrs/ Semester: 105**	**Credits: 5**

UNIT I Pteridophytes: General characteristics and classification (Reimer, 1954). Range of structure, reproduction and evolution of the gametophytes, Gametophyte types – sex organs. Apogamy and Apospory. Life cycles. Stellar evolution. Heterospory and seed habit, Telome theory, morphogenesis, Economic importance of Pteridophytes.

UNIT II Pteridophytes: Structure, anatomy, reproduction and life histories of the following genera: *Isoetes, Equisetum, Angiopteris, Osmunda, Pteris* and *Azolla.*

UNIT III Gymnosperms: General characters - A general account of distribution of Gymnosperms. Morphology, anatomy, reproduction, phylogeny and classification (K.R.Sporne, 1965). Economic importance of Gymnosperms.

UNIT IV Gymnosperms: Structure (Exomorphic and endomorphic), anatomy, reproduction and life histories of the following genera: *Thuja, Cupressus, Araucaria, Podocarpus, Gnetum*and *Ephedra*.

UNIT V Paleobotany**:** Geological Scale; Radiocarbon dating; Contribution of Birbal Sahni to Paleobotany.Gondwana flora of India. Study of fossils in understanding evolution. 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.*

Recommended Text

1. Vashishta, P.C. Sinha, A.K and Anil Kumar. 2016. Botany for Degree students. Gymnosperms. S. Chand and Company Ltd., New Delhi.
2. Singh, V., Pande, P.C and Jain,D.K. 2021. A Text Book of Botany. Rastogi Publications, Meerut.

3. Bhatnagar, S.P and Alok Moitra. 2020. Gymnosperms, New Age International (P) Ltd., Publishers, Bengaluru.
4. Sharma, O.P. 2017. Pteridophyta, McGraw Hill Education, New York.
5. Vashishta.P.C., A.K. Sinha and AnilKumar. 2018. Botany for Degree students-Gymnosperms.S. Chand and Company Ltd., NewDelhi.
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 Embryophyta Pteridophytes. 5th Edition, Surjeet Publication, Delhi.
2. Pandey, S.N and Trivedi, P.S. 2015. A Text Book of Botany Vol. II- 12th edition (Paperback), Vikas Publishing.
3. Rashid, A. 2013. An introduction to Pteridophyta – Diversity, Development and differentiation (2nd edition), Vikas Publications.
4. ArnoldA.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) (Paper back), Andesite Press.
6. Sporne, K.R. 1967. The Morphology of Gymnosperms. Hutchinson and Co., London.
7. Taylor, E, Taylor, T, Krings, M. 2008. Paleobotany: The Biology and Evolution of Fossil Plants, 2nd Edition, AcademicPress.

Web resources

1. https://www.toppr.com/guides/biology/plant-kingdom/pteridophytes/
2. http://www.bsienvis.nic.in/Database/Pteridophytes-in-India_23432.aspx
3. https://books.google.co.in/books?hl=en&lr=&id=Pn7CAAAQBAJ&oi=fnd&pg=PA1&dq=Introduction+to+Gymnosperms&ots=sfYSzCL02&sig=ysX1KRvetV0bAza4Sq6RWau4XU8&redir_esc=y#v=onepage&q=Introduction%20to%20Gymnosperms&f=false
4. https://books.google.co.in/books/about/Botany_for_Degree_Gymnosperm_Multicolor.html?id=HTdFYFNxnWQC&redir_esc=y
5. https://books.google.co.in/books/about/Gymnosperms.html?id=4dvyNcknI8wC
6. https://arboretum.harvard.edu/wp-content/uploads/2013-70-4-beyond-pine-cones-an-introduction-to-gymnosperms.pdf
7. https://www.palaeontologyonline.com/
8. https://books.google.co.in/books/about/Paleobotany.html?id=HzYUAQAAIAAJ
9. https://trove.nla.gov.au/work/11471742?q&versionId=46695996

MAPPING WITH PROGRAMME OUTCOMES

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	1	1	3	3	2	2	2
CO2	3	2	2	1	1	3	3	2	2	2
CO3	2	2	2	1	1	3	3	2	2	2
CO4	3	2	2	1	1	3	3	2	2	2
CO5	3	2	2	1	1	3	2	1	2	1
Avg	2.8	2	2	1	1	3	2.8	1.8	2	1.8

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

SEMESTER I			
CORE PRACTICAL I- LABORATORY COURSE- I: COVERING CORE PAPERS - I AND II			
Course Code: 23PBOCR1	**Hrs/ Week: 6**	**Hrs/ Semester: 90**	**Credits: 4**

OBJECTIVES

1. To learn how to employ the use of instruments, technologies and methodologies related to thallophytes and non-flowering plant groups.
2. To enhance information on the identification of each taxonomical group by developing the skill-based detection of the morphology and microstructure of algae, and fungi.
3. To comprehend the fundamental concepts and methods used to identify Bryophytes, Pteridophytes and Gymnosperms through morphological changes and evolution, anatomy and reproduction.
4. To develop the technical abilities in staining, sectioning, sterilizing, and characterizing the thallophytes, and other varieties of non-flowering plants.
5. To compare the structural diversity of fossil and extant plant species.

COURSE OUTCOMES

CO. No.	Upon completion of this course the student will be able to	PO
CO1	recall and applying the basic keys to distinguish at species level identification of important algae, fungi, lichens, bryophytes, pteridophytes and gymnosperms through its structural organizations.	**K1**
CO2	explain the structure of algae, fungi, lichens, Bryophytes, Pteridophytes and Gymnosperms.	**K2**
CO3	demonstrate practical skills in thallophytes, Pteridophytes and Gymnosperms	**K3**
CO4	analyse the importance of structural diversity in the evolution of plant forms.	**K4**
CO5	evaluate the techniques to isolate and culture of alga and fungi as well as to understand the diversity of plant forms.	**K5**

SEMESTER I			
CORE PRACTICAL I- LABORATORY COURSE- I: COVERING CORE PAPERS - I AND II			
Course Code: 23PBOCR1	**Hrs/ Week: 6**	**Hrs/ Semester: 90**	**Credits: 4**

UNIT I **Algae:** Study of algae in the field and laboratory of the genera included in theory. External morphology and internal anatomy of the vegetative and reproductive structures of the following living forms: *Oscillatoria, Scytonema, Ulva, Codium, Diatoms, Padina* and *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). Preparation of culture media and culture of green algae and blue green algae in the laboratory (Demonstration).

UNIT II **Fungi:** Study of morphological and reproductive structures of the following living forms: *Plasmodiophora, Phytophthora, Rhizopus, Xylaria, Polyporus* and *Colletotrichum* (depending on availability of the specimen).

Isolation and identification of fungi from soil, air, and Baiting method. Preparation of culture media. Cultivation of mushroom in the laboratory (Demonstration).

Lichens: Study of Morphological and reproductive structures of the genera *Parmelia.*

UNIT III **Bryophytes:** External morphology and internal anatomy of the vegetative and reproductive organs of the following living forms: *Targionia, Lunularia, Porella* and *Polytrichum* (depending on availability of the specimen).

UNIT IV **Pteridophytes:** External morphology and internal anatomy of the vegetative and reproductive organs of the following living forms: *Isoetes, Equisetum, Angiopteris, Osmunda, Pteris* and *Azolla* (depending on availability of the specimen).

Fossil slides observation: *Rhynia, Lepidocarpon, Calamites.*

UNIT V **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.*

Recommended Text

1. Kumar, H. D. 1999. Introductory Phycology. Affiliated East-West Press, Delhi.
2. Das, SandSaha, 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. Pragati Prakashan.
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. General Botany laboratory Manual. Author House, Bloomington, USA.
2. Webster, J and Weber, R. 2007. Introduction to Fungi, 3rdEd. Cambridge University Press, Cambridge.
3. Sharma, O. P. 2017. Bryophyta, MacMillan India Ltd, NewDelhi.
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
6. https://www.google.co.in/books/edition/Gymnosperms/3YrT5E3Erm8C?hl=en&gbpv=1&dq=gymnosperms&printsec=frontcover
7. https://www.amazon.in/Paleobotany-Biology-Evolution-Fossil-Plants/dp/0123739721

MAPPING WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	1	1	3	3	2	1	1
CO2	3	1	1	2	1	3	2	2	1	2
CO3	3	3	2	2	1	3	3	3	2	2
CO4	3	2	2	1	2	3	2	2	2	3
CO5	3	3	3	3	2	3	3	3	3	2
Avg	3	2.4	2	1.8	1.4	3	2.6	2.4	1.8	2

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

SEMESTER I			
DISCIPLINE SPECIFIC ELECTIVE I - MICROBIOLOGY, IMMUNOLOGY AND PLANT PATHOLOGY			
Course Code: 23PBOE11	**Hrs/ Week: 5**	**Hrs/ Semester: 75**	**Credits: 3**

OBJECTIVES

1. To provide comprehensive knowledge about microbes and its effect on man and environment.
2. To provide comparative analysis of major groups of microbes.
3. To study the principles of immune system, immunizing agents like antibodies and vaccines and gene therapy methods.
4. To enhance the knowledge and skills needed for self-employment using the microbial derived products.
5. To appreciate the role of immune system in conferring disease resistance.

COURSE OUTCOMES

CO. No.	Upon completion of this course the student will be able to	PO
CO-1	recognize the general characteristics of microbes, plant pathogens and immune cells.	**K1**
CO-2	explain the microbial processes of replication, survival, stages in disease development and various defense mechanism in plants.	**K2**
CO-3	identify the harmful and beneficial microbes in plants, water, soil, milk and food.	**K3**
CO-4	analyze the interaction of microbes with plants and antigen antibody interaction.	**K4**
CO-5	recommend diagnostic techniques to detection of plant pathogens, microbes and antigens.	**K5**

SEMESTER I			
DISCIPLINE SPECIFIC ELECTIVE I - MICROBIOLOGY, IMMUNOLOGY AND PLANT PATHOLOGY			
Course Code: 23PBOE11	**Hrs/ Week: 5**	**Hrs/ Semester: 75**	**Credits: 3**

UNIT I Bacteria: Types of microorganisms. General characteristic of bacteria – Outline classification of Bergey's manual of 9th edition. 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 II Viruses: General characters, Classification, Structure, Multiplication. Overview of Phycoviruses and Mycoviruses. Viruses of Eukaryotes – Animal and Plant viruses. Cultivation of viruses – in embryonated egg and in plants. Control of viral infections. Bacteriophages- classification, replication of DNA and RNA phages -Lytic and Lysogenic cycle. Viroids and prions. Mycoplasma: Structure and classification.

UNIT III Food Microbiology: Beneficial role of microbes – yoghurt, Olives, Cheese, Bread, Wine, Tempeh, Miso and Fermented green tea. Spoilage of fruits, vegetables, meats, poultry, eggs, bakery products, dairy products and canned foods. Microbial toxins - Exotoxin, Endotoxin and Mycotoxin. Action of Enterotoxin, Cytotoxin and 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) and with higher plants (rhizosphere and 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: Introduction; Immune System; Types of Immunity - Innate and Acquired Immune Cells - Hematopoiesis, B and T lymphocytes - Maturation, NK cells. Introduction to inflammation, Adaptive immune system, Innate Immune system. Antigen: Definition, Properties and types. Antibody – Structure, types and function. Generation of antibody diversity. Antigen - Antibody interactions: definition, types- Precipitation, Agglutination, Complement fixation. Immune Response – Humoral and Cell Mediated. Vaccines – history, types and recombinant vaccines. Immunodiagnosis –Blood Grouping, Widal test, Enzyme-Linked Immunosorbent Assay (ELISA), Immunoelectrophoresis and Immunodiffusion.

UNIT V Plant pathology: History and significance of plant pathology. Classification of plant diseases, Symptomology (important symptoms of plant pathogens). Principles of plant infection –Inoculum, inoculum potential, Pathogenicity. Disease triangle. Host parasite interrelationship and interaction. Causal agents of plant diseases - biotic causes (fungi, bacteria virus, mycoplasma, nematodes, parasitic algae, angiospermic parasites - Abiotic causes (Physiological, deficiency of nutrients and 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).

Recommended Text

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

Reference books

1. Agrios, A.G. 2007. Plant Pathology, Elsevier. ISBN: 9780120445653.
2. Jeffery, C., 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 Mc Graw 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	2	2	2
CO3	3	3	3	3	3	3	3	3	2	3
CO4	3	3	3	3	3	3	3	3	2	1
CO5	3	3	3	3	3	3	3	2	3	3
Avg	3	3	2.8	2.8	3	3	2.8	2.4	2.4	2.2

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

SEMESTER I			
DISCIPLINE SPECIFIC ELECTIVE I - PHYTOPHARMACOGNOSY			
Course Code: 23PBOE12	**Hrs/ Week: 5**	**Hrs/ Semester: 75**	**Credits: 3**

OBJECTIVES

1. To learn the traditional knowledge on plant derived drugs and their conventional classification.
2. To elucidate the biosynthetic pathway of major classes of secondary metabolites.
3. To study the general pharmacological mode of action of crude drugs of few medicinal plants.
4. To elucidate the isolation and characterization of plant derived drugs using modern biotechniques.
5. Knowledge on pharmacological action of drugs.
6. To learn the traditional knowledge on plant derived drugs and their conventional classification.

COURSE OUTCOMES

CO. No.	Upon completion of this course the student will be able to	PO
CO1	recall the traditional knowledge and classification of plant derived drugs.	**K1**
CO2	explain on biosynthetic pathway of different classes of plant metabolites.	**K2**
CO3	present the knowledge on modern instrumentation on characterization of plant metabolites.	**K3**
CO4	analyze various aspects of pharmacological action of herbal drugs.	**K4**
CO5	evaluate the medical and non-medical potential of plant derived in various sectors.	**K5**

SEMESTER I			
DISCIPLINE SPECIFIC ELECTIVE I - PHYTOPHARMACOGNOSY			
Course Code: 23PBOE12	**Hrs/ Week: 5**	**Hrs/ Semester: 75**	**Credits: 3**

UNIT I 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 Morphological and microscopical biosynthetic pathway of secondary metabolites: Acetate pathway (fatty acids and polyketides), mevalonate and deoxyxylulose phosphate pathway (terpenoids and steroids), shikimate pathway (phenols, amino acids etc.).

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

UNIT IV Pharmacological action of Plant Drugs: Anti-cancer, Bitter tonic, Carminatives and G.I.regulators, Cardiotonics, CNS-Stimulatant, Expectorant, Laxatives, Puragatives. Outline ofpharmacogenomicsfunctions.

UNIT V Hallucinogenic, allergenic and other toxic plants, poisonous plants - biopesticides -biocides– biofungicides.

Recommended Text

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

Reference books

1. Bruneton, J. 1999. Pharmacognosy, Phytochemistry, Medicinal Plants, Intercept Ltd., Paris.
2. Evans W.C. 2002, Trease and Evan's Pharmacognosy, W.B.Saunders.
3. Harborne, J. B. 1998. Phytochemical Methods, Chapman and Hall.
4. Vickery M. L and B.Vickery, 1981. Secondary Plant Metabolism, The MacMillan Press Ltd.
5. Wagner H., S. 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
Avg	3	2.2	2.6	3	3	2.8	2.4	1.6	2.6	1.6

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

SEMESTER I			
DISCIPLINE SPECIFIC ELECTIVE II - ETHNOBOTANY, NATUROPATHY AND TRADITIONAL HEALTHCARE			
Course Code: 23PBOE13	**Hrs/ Week: 5**	**Hrs/ Semester: 75**	**Credits: 3**

OBJECTIVES

1. Understand the concept of ethnobotany and the life style and traditional practices of plants by Indian tribals.
2. Emphasize the importance of non-timber forest products for Indian tribal people livelihoods.
3. Evaluate the various research techniques to gather tribal knowledge of ethnobotany.
4. Use strategies to turn ethno botanical knowledge into goods with value additions.
5. To save and document ethno botanicals in order to use plant resources sustainably.

COURSE OUTCOMES

CO. No.	Upon completion of this course the student will be able to	PO
CO-1	recall the concept and their importance of ethnobotany and naturopathy.	**K1**
CO-2	understand the life style and traditional practices of plants by Indian tribals.	**K2 & K6**
CO-3	implement the role plants and their products for their livelihood of tribal people of India	**K3**
CO-4	assess the methods to transform ethnobotanical knowledge into value added products.	**K4**
CO-5	build idea to make digitization of ethnobotanical knowledge.	**K5**

SEMESTER I			
DISCIPLINE SPECIFIC ELECTIVE II - ETHNOBOTANY, NATUROPATHY AND TRADITIONAL HEALTHCARE			
Course Code: 23PBOE13	**Hrs/ Week: 5**	**Hrs/ Semester: 75**	**Credits: 3**

UNIT I Ethnobotany: 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 tribals of India: Distribution of tribes in India. Basic knowledge of following tribes of Tamil Nadu: Irulas, Kanis, Paliyars Badagas, Kurumbres, Thodas and Malayalis. Plants used by tribals of Tamil Nadu.

UNIT III Sources of ethnobotanical data: 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: Role of plants in naturopathy- Importance and relevance of medicinal drugs in India. Indian Systems of Medicine (Ayurveda, Siddha, Allopathy, Homeopathy, Unani, Tibetan, Yoga and Naturopathy). Disease diagnosis, treatment, and cure using natural therapies including dietetics, botanical medicine, homeopathy, fasting, exercise, lifestyle counseling, detoxification, and chelation, clinical nutrition, hydrotherapy, naturopathic manipulation, spiritual healing, environmental assessment,

Traditional health care: Health practices, approaches, knowledge and beliefs incorporating plant, animal and mineral based medicines, spiritual therapies, manual techniques and exercises, applied singularly or in combination to treat, diagnose and prevent illnesses or maintain well-being.

UNIT V Bioprospecting and value addition: 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).

Recommended Text

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 and Why? Wiley India Pvt Ltd. Noida.
5. Joshi, S.G. 2018. Medicinal Plants. Oxford and 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 and 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-Issue-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%2930001-85
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
Avg	3	3	3	2.8	2.8	3	2.8	3	2.8	3

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

Semester I			
DISCIPLINE SPECIFIC ELECTIVE II - HERBAL TECHNOLOGY			
Course Code: 23PBOE14	**Hrs/ Week: 5**	**Hrs/ Semester: 75**	**Credits: 3**

OBJECTIVES

1. To understand various plants-based drugs used in ayurvedha, unani, homeopathy, siddha etc.
2. To apply the knowledge to cultivate medical plants.
3. To know the pharmacological importance of medicinal plants.
4. To enlist phytochemicals and secondary metabolites of market and commercial value.
5. To design and develop their own business prepositions such as the in the making of herbal insecticides.

COURSE OUTCOMES

CO. No.	Upon completion of this course the student will be able to	PO
CO-1	recall the importance of herbal technology	K1
CO-2	understand the classification of crude drugs from various botanical sources.	K2
CO-3	apply new drug formulations using therapeutically valuable phytochemical compounds for the healthy life of society	K3
CO-4	analyze on the application of secondary metabolites in modern medicine	K4
CO-5	critique the current trade status and role of medicinal plants in socio economic growth.	K5

SEMESTER I			
DISCIPLINE SPECIFIC ELECTIVE II - HERBAL TECHNOLOGY			
Course Code: 23PBOE14	**Hrs/ Week: 5**	**Hrs/ Semester: 75**	**Credits: 3**

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

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

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

UNIT V Types of phytochemicals - Alkaloids - extraction methods (*Taxus, Cinchona*); Flavonoids- extraction methods, Resins- extraction method: Application of phytochemicals in 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 and 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.
10. Tilgner, SharolMarie. 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 and 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.

Web resources

1. https://www.kopykitab.com/Herbal-Science
2. https://kadampa.org/books/free-ebook-download-howtotyl?gclid=CjwKCAiA6vXwBRBKEiwAYE7iS5t8yenurClUCTdV9olKo9TbyAh4fsoFqPYWGs5qBTbytD22z7lo0BoCYnUQAvD_BwE
3. https://www.barnesandnoble.com/b/free-ebooks/nook-books/alternative-medicine-natural-healing/herbal-medicine/_/N-ry0Z8qaZ11iu
4. http://cms.herbalgram.org/heg/volume8/07July/HerbalEBooks.html?t=1310004932&ts=

1579066352&signature=1dd0d5aef818b19bcdcd6c063a78e404
5. https://www.dattanibookagency.com/books-herbs-science.html
6. https://www.springer.com/gp/book/9783540791157

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
Avg	3	3	3	3	3	3	3	1.4	2.4	3

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

SEMESTER II			
Core III - TAXONOMY OF ANGIOSPERMS AND ECONOMIC BOTANY			
Course Code: 23PBOC21	**Hrs/Week : 5**	**Hrs/ Semester: 75**	**Credits: 5**

OBJECTIVES

1. To be familiar with the basic concepts and principles of plant systematics.
2. To develop a suitable method for correct characterization and identification of plants.
3. To understand the importance of taxonomic relationships in research of plant systematics.
4. To provide information on various classification systems
5. To know about the economic importance of plants.

COURSE OUTCOMES

Co. No.	On completion of this course the students will be able to:	PO
CO1	revise the taxonomic hierarchy, botanical nomenclature, major system and tools of classification, characteristics and economic significance of families	**K1**
CO2	discuss the various taxonomic evidences, classification and current trends in biosystematics. Compare the vegetative, floral characters of the different families	**K2**
CO3	Compile the relative merits and demerits of major systems of classifications, rules of ICBN, tools of taxonomy and economic importance of the different families.	**K3**
CO4	analyze and illustrate the floral characters of different families and outline the principles of botanical nomenclature, major systems of classifications and the taxonomic evidences	**K4**
CO5	examine and identify the locally available plants prescribed in the syllabus and construct taxonomic key (group activity)	**K5, K6**

SEMESTER II			
Core III - TAXONOMY OF ANGIOSPERMS AND ECONOMIC BOTANY			
Course Code: 23PBOC21	**Hrs/Week : 5**	**Hrs/ Semester: 75**	**Credits: 5**

UNIT I **Introduction**: Definition, objectives and brief history of plant taxonomy. **Botanical Nomenclature**: need for scientific name, type method, author citation, and typification and effective publication, rejection of names and principle of priority. Principles, rules and recommendations of ICBN. **Phylocode**: principles and salient features. **Taxonomical Hierarchy:** Taxonomic groups, categories and ranks, species concept, infraspecific ranks, genus and family.

UNIT II **Classifications:** Relative merits and demerits of major systems of classifications: Linnaeus (1753), Bentham and Hooker's (1862-1883) and Angiosperm Phylogeny Group (IV) (2016). **Current Trends in Biosystematics**: **Phenetics**: principles of taximetrics, Operational Taxonomic Units (OTUs). **Cladistics**: phylogenetic terms, concepts and phylogenetic diagrams. **Numerical taxonomy**: construction of taxonomic groups, applications, merits and demerits.

UNIT III **Tools of Taxonomy**: Floras, manuals, monographs, websites. Roles of herbarium and important botanical gardens (New York Botanical Garden, USA and Royal Botanical Garden, Kew) of the World. **Dichotomous keys**: guidelines for constructing dichotomous keys (indented and bracketed key). **Digital herbaria:** e- flora. **Taxonomic evidences:** anatomy, cytology, embryology and chemosystematics based on the phytochemicals (phenols, alkaloids, flavonoids and terpenoids). Molecular systematics (DNA bar coding).

UNIT IV **Vegetative, floral characters and economic importance of the following families:**

Polypetalae: Brassicaeae, Malvaceae, Tiliaceae, Meliaceae, Rhamnaceae, Sapindaceae, Papilionaceae Mimosaceae, Combretaceae, Myrtaceae, Passifloraceae

Gamopetalae: Rubiaceae, Sapotaceae, Solanaceae, Boraginaceae.

UNIT V **Vegetative, floral characters and economic importance of the following families:**

Gamopetalae: Scrophulariaceae, Bignoniaceae, Verbenaceae.

Monochlamydeae: Nyctaginaceae, Casuarinaceae. **Monocots**: Musaceae, Zingiberaceae, Cannaceae, Commelinaceae, Cyperaceae.

Recommended Text

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. New Yark
3. Singh, G. 2007. Plant systematics theory and practices. Oxford and IBH Publishing Co. Shahpur, Delhi.
4. Jain, S.K and Rao R.R. 1993. A handbook of field and herbarium methods. Today and Tomorrow Publcation, Delhi
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.
8. Vashista P.C. Taxonomy of Angiosperms. New Delhi: Vikas Publications, 1985.

Reference Books

1. Singh V. and Jain.1997. Taxonomy of Angiosperms, Rastogi publications, New York.
2. Rendle. 1979. The classification of flowering plants vol. II and I. Vikas Publishing House Pvt. Ltd., Shaibabad, UP.
3. Wallis, T.E. 1999. Text book of Pharmacognosy. CBS Publishers and Distributors, New Delhi.
4. Kumaresan, V and Annie Regland. 2004. Taxonomy of Angiosperms systematic Botany, Economic Botany and Ethnobotany. Saras Publication, Nagercoil, Tamil Nadu.
5. Vallabh. 2000. Practical Pharmacognosy, Kolkata. New Delhi.
6. Pandey B.P. 1999. Economic Botany. New Delhi: S.Chand and Company Ltd.,New Delhi.

Web resources

1. https://www.ipni.org/
2. http://www.theplantlist.org/
3. https://www.amazon.in/PLANT-TAXONOMY-Sharma/dp/0070141592
5. https://www.tropicos.org/home
6. http://apps.kew.org/herbcat/gotoHerbariumGrowthPage.do
7. 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	2	2	1	1	1	3	1	1	3
CO2	3	2	2	1	1	1	3	1	1	2
CO3	3	3	2	1	1	1	3	1	2	3
CO4	3	1	2	1	2	1	3	1	1	2
CO5	3	2	3	1	2	1	3	2	2	2
Avg	3	2	2.2	1	1.4	1	3	1.2	1.4	2.4

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

SEMESTER II			
Core IV- PLANT ANATOMY, EMBRYOLOGY AND MORPHOGENESIS			
Course Code: 23PBOC22	**Hrs/Week:5**	**Hrs/Semester:75**	**Credits: 5**

OBJECTIVES

1. To acquire knowledge on the anatomical structure and reproductive phase of angiosperms.
2. Learn the importance of plant anatomy in plant production systems.
3. Classify meristems and identify their structures, functions and roles in monocot and dicot plants growth and secondary growth of woody plants.
4. Understand the mechanism underling the shift from vegetative to reproductive phase.
5. Trace the development of male and female gametophyte.
6. Understand the recent advances in palynology.

COURSE OUTCOMES

CO. No.	On completion of this course the students will be able to:	PO
CO1	remember the types of tissues, the process of secondary growth, the development stages of the gametophyte, the basic concepts and processes involved in fertilization and the definition of morphogenesis and its relationship to morphology	**K1**
CO2	understand the general account of leaf anatomy, the role and significance of cambium in the secondary growth, significance of embryology in the context of plant development, the significance and role of fertilization in plant reproduction and the concept of polarity and its importance in morphogenesis.	**K2**
CO3	apply knowledge of primary structure to differentiate between dicot and monocot plants, to analyze nodal anatomy and seed anatomy, to identify the types of ovules based on their structure, to explain the differences between various types of endosperms and to identify and describe the role of morphogenetic factors in specific developmental contexts.	**K3**
CO4	analyze the theories of root and shoot apices and their implications on plant development, the factors influencing anomalous secondary growth, the factors influencing microsporogenesis and megasporogenesis, the mechanisms involved in overcoming sexual incompatibility and the molecular mechanisms at the cellular level that contribute to morphogenesis	**K4**
CO5	evaluate the importance of secretary tissues in external and internal plant structures, the significance of seed anatomy and different types of embryo sac in the context of plant reproduction, the advantages and disadvantages of polyembryony in practical applications and the importance of polarity in guiding plant development.	**K5**

SEMESTER II			
Core IV-PLANT ANATOMY, EMBRYOLOGY AND MORPHOGENESIS			
Course Code: 23PBOC22	**Hrs/Week: 5**	**Hrs/Semester: 75**	**Credits: 5**

UNIT I Meristematic tissues: Definition, characteristics, classification of meristems, theories of root and shoot apices. Permanent tissues: simple tissues (parenchyma, collenchyma and sclerenchyma), complex tissues (xylem and phloem). Secretary tissues (external and internal).Primary structure: General account of dicot and monocot stem, primary anomalous structure in stem. General account of root anatomy, development of lateral roots and adventitious roots, root – stem transition. Ontogeny of leaves, General account of leaf anatomy.

UNIT II Secondary growth in dicot stem: activity of cambium (formation of cambial ring and secondary vascular tissues, structure of wood), activity of cork cambium (formation of periderm, bark, lenticels).Secondary growth dicot root. Anomalous secondary growth in dicot stem, root and monocot stem. Nodal anatomy. Seed anatomy.

UNIT III Introduction to embryology. Structure of microsporangium, microsporogenesis. Structure of pollen grain. Development of male gametophyte. Structure of megasporangium, types of ovules, megasporogenesis, development of female gametophyte. Types of embryo sac (monosporic, bisporic, tetrasporic), nutrition of embryo sac.

UNIT IV Fertilization. Sexual incompatibility (pollen-stigma incompatibility), methods to overcome incompatibility. Endosperms: Types (nuclear endosperm, cellular endosperm, helobial endosperm), haustoria, physiology and functions of endosperm. Structure and development of dicot and monocot embryo. Polyembryony: Causes of polyembryony, classification of polyembryony, practical application of polyembryony. Apomixis.

UNIT V Morphogenesis: Definition, morphogenesis and its relation to morphology, Turing's diffusion reaction theory, Morphogenetic factors - growth regulators, genetic and environment, polarity. Molecular basis of

morphogenesis, Cellular level morphogenesis, Asymmetric divisions and their significance, Morphogenesis at tissue level - Differentiation, dedifferentiation and redifferentiation of vascular tissue *in vitro* and *in vivo* and in wounds. Plant galls and their importance in morphogenesis.

Recommended Text

1. Bhojwani, S.S. Bhatnagar, S.Pand 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 Publishing House Pvt.Ltd, New Delhi.

Reference Books

1. Krishnamurthy, K.V.1988. Methods in Plant Histochemistry .S.Viswanathan and 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 Hanumantha Rao, B. 2006.Textbook of Embryology of Angiosperms. Regency Publications, New Delhi.
4. Bierhorst, D.W. 1971. Morphology of Vascular Plants. Macmillan publishers,NewYork.
5. Crang, R., Lyons-Sobaski, S and Wise, R. 2018. Plant Anatomy:A Concept-Based Approach to the Structure of Seed Plants. Springer International Publishing.
6. Cutler, D.F., Botha, T. and Stevenson, D.W. 2008. Plant Anatomy:An Applied Approach. Black well Publishing , Malden, USA.
7. Eames, A.J and Mac Daniels,L.H.2013.Introduction to Plant Anatomy,3rd Edition. McGraw-HillInc., 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
6. http://greenlab.cirad.fr/GLUVED/html/P1_Prelim/Bota/Bota_typo_014.html
7. https://www.askiitians.com/

MAPPING WITH PROGRAMME OUTCOMES:

Cos	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	3	1	1	3	3	3	2	1
CO2	3	1	3	1	1	3	3	3	2	1
CO3	3	1	3	1	1	3	3	2	2	1
CO4	3	1	3	1	1	3	3	2	2	1
CO5	3	1	3	1	1	3	3	3	2	1
Avg	3	1	3	1	1	3	3	2.6	2	1

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

SEMESTER II			
CORE PRACTICALII -TAXONOMY OF ANGIOSPERMS, ECONOMIC BOTANY, PLANT ANATOMY AND EMBRYOLOGY PRACTICAL			
Course Code:23PBOCR2	**Hrs/Week : 4**	**Hrs/Semester: 60**	**Credits: 2**

OBJECTIVES

1. Understand and develop skill sets in plant morphological, floral characteristics and artificial key preparation.
2. To develop skill on plant identification
3. To acquire knowledge on the anatomical structure and reproductive phase of angiosperms.
4. Expedite skilled workers to carry out research in frontier areas of plant science.
5. Classify meristems and identify their structures, functions and roles in monocot and dicot plants growth and secondary growth of woody plants
6. Learn the importance of plant anatomy in plant production systems.

COURSE OUTCOMES

CO. No	On completion of this course the students will be able to:	PO
CO1	recall the botanical names, families, and morphological features of plants mentioned in the syllabus, the anatomical features of plants, the types of stomata observed through epidermal peeling, structures observed in the transverse section (T.S.) of an anther and the types of ovules observed in permanent slides	**K1**
CO2	understand the principles and criteria for creating effective artificial keys for plant identification, the principles behind maceration of wood and micrometry of xylem elements and the various stages of embryo development through dissection	**K2**
CO3	apply knowledge to correlate plant products with their morphological features, botanical names, and families and recognize and classify nodal types, trichome types, different ovule types	**K3**
CO4	analyze the characteristics of species using virtual herbarium and live specimens for accurate identification, the processes and factors influencing secondary growth and the stages and factors influencing pollen grain germination	**K4**
CO5	create artificial keys for a variety of plant species, considering differentiating characteristics, accurate species descriptions based on virtual herbarium and live specimens and evaluate the ecological importance of trichomes in different plant species, the effectiveness of the hanging drop technique in studying pollen grain germination.	**K5 & K6**

SEMESTER II			
CORE PRACTICALII -TAXONOMY OF ANGIOSPERMS, ECONOMIC BOTANY, PLANT ANATOMY AND EMBRYOLOGY PRACTICAL			
Course Code:23PBOCR2	**Hrs/Week : 4**	**Hrs/Semester: 60**	**Credits: 2**

TAXONOMY AND ECONOMIC BOTANY OF ANGIOSPERMS

1. Preparation of artificial keys.
2. Description of a species, based on live specimens of the families mentioned in the theory.
3. Study the products of plants mentioned in the syllabus with special reference to the morphology, botanical name and family.
4. Solving nomenclature problems.
5. Identify the locally available plants.

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. Study of trichomes.
3. Sectioning and observation of nodal types.
4. Study of anatomy of dicot and monocot leaves.
5. Study of secondary growth of root and stem
6. Study of anomalous secondary growth of root and stem.
7. Observation of stomatal types by epidermal peeling.
8. Maceration of wood and micrometry of xylem elements.
9. Submission of permanent slide using double staining technique.

EMBRYOLOGY

1. Observation of T.S. of anther.
2. Germination of pollen grains (hanging drop technique)
3. Observation of ovule types (Permanent slides).

4. Observation of mature embryo sacs (Permanent slides).
5. Dissection and observation of different stages of embryos.
6. Observation of endosperm types (Permanent slides).

Recommended Text

1. Gample J.S. Flora of the Presidency of Madras–VolI and II, Reprint. Authority of Secretary of state for Indian Council, 1956.
2. Subramaniam, N.S. 1996. Laboratory Manual of Plant Taxonomy.Vikas Publishing House Pvt.Ltd., New Delhi.
3. Cutler, D.F., Botha, C.E.J., Stevenson, D.W. and William, D. 2008. Plant anatomy:an applied approach (No.QK641C87).Oxford:Blackwell,UK.

Reference books

1. Katherine Esau. 2006. Anatomy of Seed Plants.2nd edition, John Wiley and Sons.
2. Mathew K.M. The flora of Tamil Nadu, Carnatic. Volume I to III. Tiruchirapalli:Rapinet herbarium,St.Joseph'sCollege,1981 to1984.
3. Ashok Bendre and Ashok Kumar. Text Book of Practical Botany II. Meerut:Rastogi Publications,2008.

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
4. https://studyfrnd.com/pharmacognosy-and-phytochemistry-book/
5. https://www.worldcat.org/title/textbook-of-pharmacognosy-and-phytochemistry/oclc/802053616
6. https://www.worldcat.org/title/phytochemistry/oclc/621430002

MAPPING WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	1	1	3	3	2	1	1
CO2	3	2	2	2	2	3	3	2	2	1
CO3	3	2	1	2	2	3	3	2	1	1
CO4	3	2	3	2	1	3	3	2	2	1
CO5	3	2	2	2	1	3	3	1	2	1
Avg	3	2	2	1.8	1.4	3	3	1.8	1.6	1

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

SEMESTER II			
DISCIPLINE SPECIFIC ELECTIVE III - ECOLOGY, PHYTOGEOGRAPHY, CONSERVATION BIOLOGY AND INTELLECTUAL PROPERTY RIGHTS			
Course Code: 23PBOE21	**Hrs/ Week: 4**	**Hrs/ Semester: 60**	**Credits: 3**

OBJECTIVES

1. To analyze and comprehend the fundamental ideas of plant ecology as a scientific study of environment.
2. To study the plant communities and ecosystem.
3. To ensure a better understanding of phytogeographical regions with reference to geographical information system.
4. To study biodiversity management and conservation
5. To enhance the knowledge of the students about intellectual property rights.

COURSE OUTCOMES

CO. No	On completion of this course the students will be able to:	PO
CO1	describe the scope and importance of population ecology, plant communities and ecosystem ecology	**K1**
CO2	explain the vegetation types of biodiversity and the principles of remote sensing.	**K2**
CO3	identify the different ecosystem, threatened, endangered plant species, intellectual property rights.	**K3**
CO4	evaluate the causes of environmental deterioration.	**K4**
CO5	recommend methods to conserve and manage the natural resources and protect the biodiversity.	**K5**

SEMESTER II			
DISCIPLINE SPECIFIC ELECTIVE III - ECOLOGY, PHYTOGEOGRAPHY, CONSERVATION BIOLOGY AND INTELLECTUAL PROPERTY RIGHTS			
Course Code: 23PBOE21	**Hrs/ Week: 4**	**Hrs/ Semester: 60**	**Credits: 3**

UNIT I ECOLOGICAL PRINCIPLES:

Introduction, History, scope, concepts of ecology. Population ecology: Basic concepts, population characteristics, population dynamics: plant population dynamics, factors influencing population density. Basic concepts of community: characteristics, composition, structure, origin and development. Characters used to describe community structure (analytical and synthetic characters), methods of community studies.

UNIT II ECOSYSTEM ECOLOGY AND RESOURCE ECOLOGY

Introduction: kinds, structure of ecosystem: abiotic components, biotic components and ecological pyramids, food chain, food web. Structure of typical ecosystem: pond and forest. Laws of thermodynamics. Productivity: primary productivity (Gross Primary Productivity (GPP) and Net Primary Production (NPP), secondary productivity.

Resource Ecology: Energy resources: renewable (solar and ocean) and non-renewable (coal and natural gas).

Environment Deterioration: Global warming, Greenhouse effect, ozone depletion, acid rain, Climate change. Waste management and recycling: Solid and e-waste. Eco restoration/remediation, ecolabeling, environmental auditing.

UNIT III PHYTOGEOGRAPHY

Phytogeographical Zones: Vegetation types of India and Tamil Nadu, Distribution: Continuous, Discontinuous and Endemism. Theories of discontinuous distribution: Continental drift, Age and area hypothesis. Geographical Information System (GIS): Principles of Remote Sensing and its applications.

UNIT IV BIODIVERSITY AND CONSERVATION ECOLOGY

Definition, types of biodiversity, values of biodiversity. Hot spots: Threats to Indian biodiversity. Concepts of threatened species: Characteristic of endangered species. International Union for Conservation of Nature (IUCN): endangered and endemic plant species of India (any 20). Biotechnology assisted plant conservation: *in situ* and *ex situ* methods.

UNIT V INTELLECTUAL PROPERTY RIGHTS:

Intellectual Property Rights: Introduction, Kinds of Intellectual Property Rights: Patents, Trademarks, Copyrights, Trade Secrets, need for intellectual property right, advantages and disadvantages of IPR. International Regime Relating to IPR: Trade Related Aspects of Intellectual Property Rights (TRIPS), World Intellectual Property Organization (WIPO), World Trade Organization (WTO), General Agreement on Tariff and Trade (GATTS). IPRs and ownership of Traditional Knowledge. Geographical Indication: introduction, types. Patent filing procedure for ordinary application.

Recommended texts

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.
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 and Ecology A Dynamic approach. 2nd Edition GKP Access Publishing, New Delhi.
6. Chandra, A.M and Ghosh, S.K. 2010. Remote sensing and Geographical Information System, Narosa Publishing House Pvt. Ltd. New Delhi.
7. Krishnamurthy. K.V. 2006. An advanced textbook on Biodiversity Principles and Practice. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
8. Prabu, P.C; Udayasoorian. C and Balasubramanian. G. 2009. An Introduction to Ecology and Environmental Science. Avinash Paperbacks, Delhi.
9. Rana. S.V.S. 2009. Essential of Ecology and Environmental Science. PHI Learning Private Limited, 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 Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi.
3. Ahuja, V.K. 2017. Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.
4. Nithyananda, K.V. 2019. Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
5. Venkataraman M. 2015. An introduction to Intellectual property rights. Create space Independent Pub.North Charleston, USA.
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	2	3	2	1	1	2	1	2	3
CO2	3	2	3	1	2	1	3	2	2	3
CO3	3	2	3	2	2	2	3	2	1	2
CO4	3	3	3	2	1	1	1	2	2	3
CO5	3	3	3	2	1	1	2	1	2	3
Avg	3	2.4	3	1.8	1.4	1.2	2.2	1.6	1.8	2.8

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

SEMESTER II			
DISCIPLINE SPECIFIC ELECTIVE III- PHYTOCHEMISTRY			
Course Code: 23PBOE22	**Hrs/ Week: 4**	**Hrs/ Semester: 60**	**Credits: 3**

OBJECTIVES

1. To comprehend the various classes of phytochemicals present in the plant kingdom.
2. To understand the biosynthetic processes through which diverse phytochemicals are synthesized and to study their structural and functional characteristics.
3. To learn about the isolation of different phytochemicals using the state-of-the art techniques.
4. To learn about the application of different phytochemicals to cure diseases in human and animals.
5. To understand the information of the traditional system of medicine

COURSE OUTCOMES

CO. No.	Upon completion of this course students will be able to:	PO
CO1	recall the role of plants in the survival of humans and other organisms	**K1**
CO2	explain the contribution of primitive people in the exploration of plant knowledge to alleviate common disease and enzymatic processes involved in the production of specific phytochemical compounds.	**K2**
CO3	demonstrate knowledge of traditional systems of medicine and various method of extraction, characterization and isolation of plants secondary metabolites.	**K3**
CO4	Investigate the principles of herbalism and ethnobotany to address health issues and promote sustainable practices.	**K4**
CO5	Recommend solutions for concepts related to the application of phytochemicals, herbalism, and the ethnobotanical field.	**K5**

SEMESTER II			
DISCIPLINE SPECIFIC ELECTIVE III- PHYTOCHEMISTRY			
Course Code: 23PBOE22	**Hrs/ Week: 4**	**Hrs/ Semester: 60**	**Credits: 3**

UNIT I SECONDARY METABOLITES AND CLASSIFICATION

Phytochemistry: Definition, history, principles. Secondary metabolites: definition, classification, occurrence and distribution in plants, functions, chemical constituents. Alkaloids, terpenoids, flavonoids, steroids, and coumarins.

UNIT II ISOLATION AND QUANTIFICATION OF PHYTOCHEMICALS

Techniques for isolation of medicinally important biomolecules: solvent extraction, chemical separations, steam distillation, soxhlet extraction. Purification, concentration, determination and quantification of compounds (TLC, Column, HPLC). Characterization of phytochemicals: spectroscopic methods.

UNIT III BIOSYNTHETIC PATHWAYS AND APPLICATION OF PHYTOCHEMICALS

Biosynthetic pathways of secondary compounds: Shikimic pathway; Mevalonic Acid Pathway; Pathways for commercially important phytochemicals: Taxol and *Vinca* alkaloids. Applications of phytochemicals in medicine, pharmaceuticals, food, flavor and cosmetic industries.

UNIT IV HERBALISM AND ETHNOBOTANY

Herbs and healing: Historical perspectives: local, national and global level; Herbal cultures: origin and development of human civilizations; Ethnobotany and Ethno medicine; Development of European, South and Central American, African, Indian, Chinese, and South East Asian Herbal Cultures.

UNIT V TRADITIONAL SYSTEM OF MEDICINE

Classical health traditions: Systems of medicine: origin and development of biomedicine; Indian Systems of Medicine (Ayurveda, Siddha, Unani,

Tibetan, Yoga and Naturopathy) Ayurveda: Histoirical perspective, *Athuravritta* (disease management and treatment which involves eight specialties including Internal medicine and surgery); Fundamental principles of Ayurveda: Panchabhootha theory, Thridosha theory, Saptadhatu theory and *Mala* theory; Ayurvedic Pharmacology Ayurvedic Pharmacopoeia;*Vrikshayurveda.*.

Recommended texts

1. Kokate, C.K., Purohit, A.P and Gokhale, S.B. 2010. Pharmacognosy. Vol. I & II. NiraliPrakashan, Pune.
2. Mohamed Ali. 2012. Textbook of Pharmacognosy. CBS Publishers and Distributors Pvt. Ltd., New Delhi.
3. Gokhale, S.B., Kokate, C.K. and Gokhale, A. 2016. Pharmacognosy of Traditional Drugs. NiraliPrakashan, 1st Edition. ISBN: 9351642062. 2.
4. Joshi, S.G. 2018. Medicinal Plants. Oxford and IBH Publishing C., Pvt., Ltd., New Delhi.
5. Kumar, N. 2018. A Textbook of Pharmacognosy. Aitbs Publishers, India

Reference Books

1. Shah, B.N. 2005. Textbook of Pharmacognosy and phytochemistry. Cbs Publishers and Distributors, New Delhi.
2. Harshal A and Pawar. 2018. Practical book of pharmacognosy and phytochemistry-Everest Publishing house.
3. Varsha Tiwari and Shamim Ahmad. 2018. A practical book of pharmacognosy and phytochemistry. Niraliprakashan advancement of knowledge.
4. Braithwaite,A and F.J.Smith. 1996. Chromatographic Methods (5thEdition) Blackie Academic and Professional London.
5. Wilson,K and J.Walker(Eds). 1994. Principles and Techniques of Practical Biochemistry (4th Edition) Cambridge University Press, Cambridge.
6. Harborne. J.B. 1998. Phytochemical 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
4. https://studyfrnd.com/pharmacognosy-and-phytochemistry-book/
5. https://www.worldcat.org/title/textbook-of-pharmacognosy-and-phytochemistry/oclc/802053616
6. https://www.worldcat.org/title/phytochemistry/oclc/621430002

MAPPING WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	1	2	3	3	2	3	3
CO2	3	3	2	3	3	3	2	3	3	3
CO3	3	3	3	3	2	3	3	3	3	2
CO4	2	2	2	3	3	2	1	2	2	3
CO5	3	3	2	3	2	3	2	2	3	3
Avg	2.8	2.6	2.2	2.6	2.4	2.8	2.2	2.4	2.8	2.8

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

SEMESTER II			
DISCIPLINE SPECIFIC ELECTIVE IV - RESEARCH METHODOLOGY AND BIOINSTRUMENTATION			
Course Code: 23PBOE23	**Hrs/Week : 4**	**Hrs/ Semester: 60**	**Credits:3**

OBJECTIVES

1. To equip students to write and present their research report by their own inquiries in a scientific manner.
2. To provide an overview on modern equipment that they would help students gain confidence to instantly commence research careers and/or start entrepreneurial ventures.
3. To develop the knowledge on plagiarism and research ethics.
4. To make students understand the basic principles behind the preparation of buffers
5. To make the students operate various biological instruments in the laboratory

COURSE OUTCOMES

CO. No.	On completion of this course, the students will be able to:	PO
CO1	realize the need of research, literature writing, research ethics and usage of various instruments used in research	**K1**
CO2	compare the methods of documentation, types of citation methods, reference tools and instruments and use the appropriate one.	**K2**
CO3	compile the steps involved in research, writing project proposal, funding agencies and principles of various bioinstruments.	**K3**
CO4	outline the use of literature survey in documentation, indexing services, plagiarism tools and methodology of bioinstruments	**K4**
CO5	analyse the search engines, writing different form of papers for funding agencies and separation techniques used.	**K5**

SEMESTER II			
DISCIPLINE SPECIFIC ELECTIVE IV - RESEARCH METHODOLOGY AND BIOINSTRUMETATION			
Course Code:23PBOE23	**Hrs/Week : 4**	**Hrs/ Semester: 60**	**Credits:3**

UNIT I **Fundamentals of research:** Meaning and objective of research, types of research (basic, applied and patent oriented), research process and steps involved in research process. **Methods of literature survey**: Use of library, books, journals, e-journals, thesis, chemical abstracts and patent database. **Documentation:** importance of documentation, documentation techniques. Use of computer programs/packages (online resources such as-scientific search engines and online servers) in literature survey and documentation.

UNIT II **Technical writing and reporting of research: Types of research report**: Dissertation and thesis, research paper, review article, short communication, conference presentation, meeting report etc. Structure and organization of research reports: Title, abstract, key words, introduction, methodology, results, discussion, conclusion, acknowledgement, references, footnotes, tables and illustrations. Reference citing style: APA, MLA, Chicago, Turabian and IEEE, use of reference managing softwares (such as Zotero). Impact factor, rating, indexing of journal.

UNIT III **Research ethics:** Definition, responsibility and accountability of the researchers, ethical consideration during animal experimentation including CPCSEA guidelines, **Plagiarism**: Concept, significance and use of plagiarism detection softwares (Turnitin, Urkund, Copycatch, Gplag and Plagiarismdetect). **Funding agencies and research grants:** Introduction to various research funding agencies such as-DST, DBT, UGC, CSIR and ICMR along with their functions in India. Writing a research project and procurement of research grant.

UNIT IV **Bioinstrumentation: Buffers:** Preparation of buffers, standard buffers, molar and normal solutions. **Microscopy:** Simple, compound, phase contrast, electron microscope (TEM, SEM). Basic principles, methodology and applications of pH meter, colorimeter, UV-visible spectrophotometer, Flame photometer.

UNIT V **Separation techniques:** Centriguge (Bench top centrifuge, microcentrifuge, refrigerated centrifuge, ultracentrifuge), **Chromatography:** Paper, Thin Layer Chromatography (TLC), Gas chromatography with mass spectrum (GC/MS) and HPLC. **Electrophoresis:** Agarose gel electrophoresis and Polyacrylamide gel electrophoresis (PAGE).

Recommended Text:

1. Mishra, S.B and S. Alok. 2017. Handbook of Research Methodology A Compendium for Scholars and Researchers. Educreation Publishing, Dwarka, New Delhi.
2. Gurumani N. Scientific thesis writing and paper presentation. Chennai: MJP Publishers, 2010.
3. Gurumani, N. 2019. Research Methodology: For Biological Sciences, MJP. Publishers, Chennai.
4. Veerakumari, L. 2017. Bioinstrumentation. MJP Publisher, India. p578.

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 and Researchers, Ebooks2go Inc.
3. Narayana, P.S.D. Varalakshmi, T. Pullaiah. 2016. Research Methodology in Plant Science, Scientific Publishers, Jaipur, Rajasthan.

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://en.wikipdia.org/wiki/bioinstrumentation
5. https://www.britannica.com/science/chromatography
6. https://en.wikipedia.org/wiki/electrophoresis

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
Avg	3	1.6	1.8	2.6	3	3	2.8	1.4	3	2.8

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

SEMESTER II			
DISCIPLINE SPECIFIC ELECTIVE IV- NANOBIOTECHNOLOGY			
Course Code: 23PBOE24	**Hrs/Week : 4**	**Hrs/ Semester: 60**	**Credits: 3**

OBJECTIVES

1. To introduce the learners to the basic concepts in the emerging frontiers of nanotechnology.
2. To give perspective to researchers and students who are interested in nanoscale physical and biological systems and their applications in medicine.
3. To introduce the concepts in nanomaterials and their use with biocomponents to synthesize and interact with larger systems.
4. To impart knowledge on the most recent molecular diagnostic and therapeutic tools used to treat various diseases.
5. Incorporate sustainability in to account when you develop nanotechnology responsibly.

COURSE OUTCOMES

CO. No.	On completion of this course, the students will be able to:	PO
CO1	recall the basic concepts of nanobiology, nanobiotechnology, diversity of nanosystems, their characterization and applications	**K1**
CO2	explain the structure, physical and chemical properties, production and uses of various type of nanosystem	**K2**
CO3	Demonstrate and characterize the various types of nano particle syntheised using different techniques and their applications	**K3**
CO4	analyze and know the application of nanodevices and nanomachines made by based on biological nanostructures	**K4**
CO5	construct various types of nanomaterials and evaluating their potential applications in pharmaceuticals	**K5**

SEMESTER II			
DISCIPLINE SPECIFIC ELECTIVE IV- NANOBIOTECHNOLOGY			
Course Code: 23PBOE24	**Hrs/Week : 4**	**Hrs/ Semester: 60**	**Credits: 3**

UNIT I **Basic Concepts in Nanobiology**

History of Nanotechnology, Difference between Nanoscience and Nanotechnology, Green nanotechnology, Bottom up and top down approaches. Key issues in the fabrication of bionanomaterials.

UNIT II **Diversity in Nanosystems**

Carbon based nanostructures: fullerences, nanotubes, nanoshells, buckyballs, 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 **Characterization Techniques**

Structural characterization: X-ray diffraction (XRD) technique, particle size determination. Microscopy: Optical microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy. Spectroscopic Techniques: UV visible spectroscopy, Infrared Spectroscopy and Fourier Transform Infrared Spectroscopy

UNIT IV **Nanobiotechnology**

Nanodevices and nanomachines based on biological nanostructures: Protein and DNA nanoarrays, tissue engineering, and luminescent quantum dots for biological labeling. Nanobiotechnology for the management of crops and food production: nanofertilizers, nanopesticides, nanoinsecticides, nanofungicides, nanoherbicides and nanosensors for crop protection.

UNIT V **Applications of Nanobiotechnology**

Diagnostic applications: biosensors, biomarkers. Therapeutic applications: drug delivery, antimicrobial therapy, tissue regeneration. Cell Biochips: lab-on-a-chip (LOC), Polyelectrolyte multilayers.

Recommended Text

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 and Francis 1st edition.
7. Pradeep, T. 2012. Textbook of Nanoscience and Nanotechnology, McGraw Hill Education (India)Private Limited.
8. Xiu Mei Wang, Murugan Ramalingam, Xiangdong Kong and Lingyun Zhao. 2017. Nanobiomaterials: Classification, Fabrication and Biomedical Applications, Wiley-VCH Verlag GmbH and 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.
7. Prashant Kesharwani. 2019. Nanotechnology-Based Targeted Drug Delivery Systems for Lung Cancer. Academic Press. An imprint of Elsevier.

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/

7. https://phys.org/news/2014-10-endless-possibilities-bio-nanotechnology.html
8. http://www.particle-works.com/applications/controlled-drug-release/Applications

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
Avg	3	3	3	2.8	3	3	2.8	2.4	2.6	3

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

SEMESTER II			
DISCIPLINE SPECIFIC ELECTIVE PRACTICAL I - ECOLOGY, PHYTOGEOGRAPHY, RESEARCH METHODOLOGY AND BIOINSTRUMENTATION PRACTICAL			
Course Code:23PBOER1	**Hrs/Week: 4**	**Hrs/ Semester: 60**	**Credits: 2**

OBJECTIVES

1. To expedite skilled workers to carry out research in frontier areas of plant science.
2. To know about different vegetation sampling methods.
3. To familiarize in collection of literature and method of citation
4. To know the basic tools in research and to facilitate the students to undergo basic and application-oriented research
5. To make them able to use various web resources for biological research

COURSE OUTCOMES

CO. No.	On completion of this course, the students will be able to	PO
CO1	recall about different plant communities, vegetation in India and basic principles of chromatography	**K1**
CO2	explain about different vegetation sampling methods, mapping of world and Indian vegetation and usage of reference tools	**K2**
CO3	compile the procedure for finding physical and chemical properties of soil, remote sensing and separation of dna and protein	**K3**
CO4	analyse the estimation of carbonate, bicarbonate, interpretation of satellite images and pka values	**K4**
CO5	critically analyse the writing of project proposal, remote sensor usage	**K5 & K6**

SEMESTER II			
DISCIPLINE SPECIFIC ELECTIVE PRACTICAL I - ECOLOGY, PHYTOGEOGRAPHY, RESEARCH METHODOLOGY AND BIOINSTRUMENTATION PRACTICAL			
Course Code:23PBOER1	**Hrs/Week: 4**	**Hrs/ Semester:60**	**Credits: 2**

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. To determine soil moisture, porosity and water holding capacity of soil collected from varying depth at different locations.
3. Determination of pH of soil and water by universal indicator (or) pH meter.
4. Determination of dissolved oxygen.
5. Estimation of carbonate.
6. Estimation of bicarbonate.

PHYTOGEOGRAPHY, CONSERVATION BIOLOGY AND INTELLECTUAL PROPERTY RIGHTS

1. Mapping of world vegetation
2. Mapping of Indian vegetation.
3. Remote sensing – Analyzing and interpretation of Satellite photographs-Vegetation/ weather.
4. Visit to remote sensing laboratory (at Anna University, Regional eteorological Centre at Numgambakkam).

RESEARCH METHODOLOGY AND BIOINSTRUMENTATION

1. Determination of pKa value of HCl
2. Separation of amino acids by TLC
3. Separation of DNA by AGE
4. Separation of protein by PAGE
5. Preparation of bibliography using Zotero
6. Estimation of Na and K using flame photometer

7. Calculation of citation index.
8. Writing project proposal to any one funding agency

Recommended Text

1. Sharma P.D. 2019. Plant ecology and phytogeography, Rastogi Publications, Meerut.
2. Neeraj Nachiketa. 2018 Environmental and Ecology A Dynamic approach. 2nd Edition GKP Access Publishing
3. Veerakumari, L. 2017. Bioinstrumentation. MJP Publisher, India. p578.
4. Gurumani, N. 2019. Research Methodology: For Biological Sciences, MP. Publishers.
5. Pomurugan P and Gangathara Prabhu B.2012. Biotechniques. Chennai: MJP publishers.

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 Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi
3. Jayaraman, J. 2000. Laboratory manual of Biochemistry, Wiley Eastern Limited, New Delhi 110 002.
4. Narayana, P.S.D. Varalakshmi, T. Pullaiah. 2016. Research Methodology in Plant Science, Scientific Publishers, Jaipur, Rajasthan.

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. https://en.wikipdia.org/wiki/bioinstrumentation
6. https://www.britannica.com/science/chromatography

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
Avg	3	2.8	2.6	3	3	2.8	2.6	1.6	2.8	2.8

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

SEMESTER II			
SKILL ENHANCEMENT COURSE I- AGRICULTURE AND BIOPESTICIDE TECHNOLOGY			
Course Code: 23PBOSE1	**Hrs/ Week: 4**	**Hrs/ Semester: 60**	**Credits: 2**

OBJECTIVES

1. To provide comprehensive knowledge about agriculture in Indian economy and crop adaptation.
2. To understand about the microorganisms used in agriculture.
3. To know the value, limitations and constraints of biopesticides.
4. To gain knowledge about several biopesticides
5. To inculcate skill in management of plant diseases.

COURSE OUTCOMES

CO. No.	On completion of this course, the students will be able to	PO
CO1	understand the scope and importance of agriculture, biofertilizers and biopesticdes.	**K1**
CO2	discuss the general characteristics of agricultural zones, biofertlilzers and biopesticides used in agriculture and their production.	**K2**
CO3	relate the various factors affecting crop production, mass cultivation of biofertilizers.	**K3**
CO4	analyze the climatic conditions in agriculture, biofertilizer in cultivation of crops, beneficial role of biopesticides in controlling insect pests.	**K4**
CO5	evaluate the various types of biofertilizer in plant growth and biopesticide in control of pests.	**K5**

SEMESTER II			
SKILL ENHANCEMENT COURSE I- AGRICULTURE AND BIOPESTICIDE TECHNOLOGY			
Course Code: 23PBOSE1	**Hrs/ Week: 4**	**Hrs/ Semester: 60**	**Credits: 2**

UNIT I **Introduction to Agriculture**: Definition, scope of agriculture in India, importance of agriculture in Indian economy, branches of agriculture. Development of scientific agriculture. History of agricultural development in the world and India. Agro-climatic zones of India and Tamil Nadu – Agro ecological zones of India. Crops and major soils - Classification – Economic and agricultural importance in India and Tamil Nadu. Factors affecting crop production – climatic – edaphic – bioticphysiographic and socio economic factors.

UNIT II **Biofertilizers:** Introduction, types (nitrogen, phosphorus, compost, seaweed and organic), benefits of using biofertilizer. **Mass cultivation of Biofertilizers:** *Azospirllium, Azotobacter*, *Azolla,* production of mycorrhiza – *Rhizobium,* phosphate solubilizing bacteria (PSB).

UNIT III **Biopesticides:** Introduction, history, current status and global scenario of bio-pesticides, advantages, limitations and constraints of using bio-pesticides, remedies for bio-pesticide production, usage and marketing, regulatory framework, main statues and legal requirements for bio-pesticides.

UNIT IV **Pest control using biopesticides:** Pests of rice and their biocontrol (thrips, brown plant hopper, yellow stem borer and leaf folder). Pests of maize and their biocontrol (stem fly and stem borer). Pests of sugarcane and their biocontrol (white flies, sugarcane holy aphid, termites and grass hopper). Pests of peanut and their biocontrol (red hairy caterpillar, gram pod borer and pod bug).

UNIT V **Lecture cum Lab for the following topics** - Hybrid Seed Production, Tissue Culture - Micropropagation, Biocontrol agents - *Trichoderma* and *Pseudomonas*, Biofertilizer and Soil testing (Submission of individual report).

Text Books

1. Suri. S. 2019. Biofertilizers and biopesticides. A.P.H. Publishing Corporation. New Delhi
2. Chandrasekaran, B, Annadurai, K and Somaundaram, E. 2010. Text book of agronomy. New Age International (P) Ltd. Publishers. New Delhi.
3. Jeeva, S. 2010. Microbiology. SCITECH Publications Pvt. Ltd. Chennai.
4. Rao, V.S. 1983. Principles of weed science. Oxford and IBH, New Delhi.
5. Sankaran, S. V.T.Subbiah Mudaliar. 1997. Principles of Agronomy, The Bangalore Printing and Publication Company Pvt. Ltd., Bangalore.
6. Yeilamanda Reddy and G.H. Sankara Reddi,1998. Principles of Agronomy, Kalyani Publishers, Ludhiana.
7. Johri, J. 2020. Recent Advances in Biopesticides: Biotechnological Applications. New India Publishing Agency (NIPA), New Delhi.
8. Kaushik, N. 2004. Biopesticides for sustainable agriculture: prospects and constraints. TERIPress, New Delhi.
9. Sahayaraj, K. 2014. Basic and Applied Aspects of Biopesticides. Springer India, New Delhi.
10. Tebeest, D.O. 2020. Microbial Control of Weeds. CBS Publishers and Distributors, New Delhi.
11. Joshi, S.R. 2020. Biopesticides: A Biotechnological Approach. New Age International (P) ltd. New Delhi.

Reference Books

1. Manoj Parihar, Anand Kumar. 2021. Biopesticides. Volume 2: Advances in Bio- inoculants. Elsevier.
2. Bailey, A., Chandler, D., Grant, W. P., Greaves, J., Prince, G., Tatchell, M. 2010. Biopesticides: pest management and regulation. Plumx.
3. Manoharachary, C., Singh, H.B., Varma,A. 2020. *Trichoderma*: Agricultural Applications and Beyond. Springer International Publishing, New York, USA.
4. Nollet, L.M.L and Rathore, H.S. 2019. Biopesticides Handbook. CRC Press, Florida, USA.
5. Bailey, A., Chandler, D., Grant, W., Greaves, J., Prince, G., Tatchell, M., 2012. Biopesticides: Pest Management and Regulation. CABI, Surrey, UK.
6. Glare, T.R and Moran-Diez, M.E. 2016. Microbial-Based Biopesticides: Methods and Protocols. Humana Press, New Jersey, USA.
7. Gnanamanickam, S.S. 2019. Biological Control of Crop Diseases. CRC Press, Florida,USA.

Web resources

1. https://www.manage.gov.in/nf/pptspdfs/Biofertilizers%20and%20Biopesticides-Balaraju.pdf
2. https://www.shobhituniversity.ac.in/pdf/econtent/Potential-of-Biofertilizers-in-Indian-Agriculture-Prof-Amar-P-Garg.pdf
3. https://egyankosh.ac.in/bitstream/123456789/8903/1/Unit-3.pdf

MAPPING WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	1	2	2	3	3
CO2	3	2	2	3	3	2	3	1	3	3
CO3	3	3	3	3	3	2	3	2	3	2
CO4	3	2	2	2	3	2	2	3	2	1
CO5	3	3	3	3	2	2	3	3	2	3
Avg	3	2.6	2.6	2.8	2.8	1.8	2.6	2.2	2.6	2.4

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

SEMESTER III			
CORE V – BIOCHEMISTRY			
Course Code: 23PBOC31	**Hrs / Week: 6**	**Hrs / Semester: 90**	**Credits: 5**

COURSE OBJECTIVE

To understand the significance of organic reactions, chemical bonding, strong and weak interactions in various biomolecules with reference to biological systems.

COURSE OUTCOMES

CO. No.	Upon completion of this course, students will be able to	PO
CO1	recall the classification, structure and properties of biomolecules andlight.	K1
CO2	relate the structure, properties and significance of biomolecules with enzymes, vitamins and bioenergetics.	K2
CO3	demonstrate the concept of enzymes, energy and the network of metabolic pathways involving biomolecules.	K3
CO4	analyze the mechanism of enzyme action, enzyme kinetics and discriminate the biomolecules from hormones and vitamins	K4
CO5	evaluate the interdependence of biomolecules and bioenergetics in plants'metabolism	K5

SEMESTER III			
CORE V – BIOCHEMISTRY			
Course Code: 23PBOC31	**Hrs / Week: 6**	**Hrs / Semester: 90**	**Credits: 5**

UNIT I **Carbohydrates** - Classification, Structure of monosaccharides (glucose and fructose), Properties of monosaccharides, Structure and properties of disaccharides (trehalose, sucrose, maltose and cellobiose), polysaccharides (starch and cellulose). **Amino acids: C**lassification of amino acids (based on structure, side chains, metabolism, nutritional requirements). Properties of amino acids, General reactions of amino acids, Derivatives of amino acids.

UNIT II **Proteins:** Primary, secondary, tertiary, quaternary and domain structure of protein, Forces stabilizing protein structure, Ramachandran plot, DNA-protein and protein-protein interactions, protein folding, protein misfolding, protein sequencing. **Lipids:** Classification of lipids, Saturated, unsaturated and trans fatty acids, Structure and properties of simple lipids (triglyceride and wax), Compound lipids (phospholipids and glycolipids) and Derived lipids (steroids - cholesterol, terpines, carotenes).

UNIT III **Metabolism:** Biosynthesis and breakdown of sucrose, starch and cellulose, Synthesis of fatty acids, Amino acid pathway, Shikimic acid pathway, Mevalonate pathway, Major classes of secondary metabolites (alkaloids, phenolics, terpenoids), Applications of plant secondary metabolites.

UNIT IV **Chemistry of Enzymes:** Nomenclature and Classification of enzymes**,** General properties of enzymes**,** Concept of active site, Activation energy, Mechanism of enzyme action: Michaelis Menton equation and Km value, Enzyme modifiers: activators, inhibitors, Allosteric enzymes: Isozymes – diagnostic applications, Factors influencing enzyme activity. **Vitamins:** Biochemical functions of vitamin A, B_{12}, C, D.

UNIT V **Thermodynamics:** Dual nature of light, Electromagnetic spectrum, Phosphorescence, Fluorescence and Bioluminescence. Laws of thermodynamics, Concept of enthalpy, entropy and free energy. Redox couple, Redox potential, Coupled reactions, Oxidative phosphorylation, High energy compound - ATP.

Books for Reference

1. Bhutani, S. P. (2009). *Chemistry for daily life* . New Delhi: Ane Books Pvt. Ltd.
2. Conn, E. E., and Stumpf, P. K. (1987). *Outline of biochemist*ry. New York: John Wileyand Sons, Inc.
3. Cox, M. M., and Nelson, D. L. (2008). *Principles of biochemistry*. (5th ed.). India: Replika Press Pvt. Ltd.
4. David, R. (2004). *Biochemistry.* New Delhi: Panima Publications.
5. Ferrier, D. R. (2014). *Biochemistry* (6th ed.). New Delhi: Wolters Kluwer (India) Pvt.Ltd.
6. Gupta, S. N. (2011). *Biochemistry*. Meerut, India: Rastogi Publications.
7. Lehninger, A. L. (1987). *Principles of biochemistry*. Delhi: CBS publishers andDistributors.
8. Nagini, S. (2007). *Textbook of biochemistry* (2nd ed.). Chennai, India: Scitech Publications Pvt. Ltd.
9. Bose, S. (1982). *Elements of biophysics*. Madurai: Jothi Books.
10. Sathyanarayana, U., and Chakrapani, U. (2006). *Biochemistry* (3rd ed.). Kolkata: Arunabha Sen, Books and Allied (P) Ltd.

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	3	3	3	3	3	3	3	3
CO3	3	3	3	2	2	3	3	3	2	3
CO4	3	3	2	3	3	2	3	3	3	3
CO5	3	3	3	3	3	3	2	2	3	2
Avg	3	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8

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

SEMESTER III			
CORE VI - GENETICS, PLANT BREEDING AND BIOSTATISTICS			
Course Code: 23PBOC32	**Hrs / Week: 5**	**Hrs / Semester: 75**	**Credits: 5**

COURSE OBJECTIVE

To understand laws of inheritance, recombination of genes, plant breeding and solve the problem statistically.

COURSE OUTCOMES:

CO. No.	Upon completion of this course, students will be able to	PO
CO1	recall the laws of inheritance, recombination of genes, breeding techniques, statistical data analysis.	K1
CO2	discuss the importance of recombination of genes, linkages, hybridization techniques.	K2
CO3	explain the mechanism of recombination, gene mapping methods, extra chromosomal inheritance, pure line theory, pure line selection, methods of mass selection and clonal selection.	K3
CO4	analyze the mechanism of homologous and non-homologous recombination, transposition, gene mapping.	K4
CO5	recommend methods for recombination, gene mapping and breeding	K5

SEMESTER III			
CORE VI - GENETICS, PLANT BREEDING AND BIOSTATISTICS			
Course Code: 23PBOC32	**Hrs / Week: 5**	**Hrs / Semester: 75**	**Credits: 5**

UNIT I **Gene interaction:** Mendal's Law of inheritance. Gene interactions and modified dihybrid ratio: dominant epistasis (12:3:1), recessive epistasis (9:3:4), duplicate dominant gene (15:1), duplicate recessive gene (9:7). Linkage and crossing over: complete and incomplete linkages in *Drosophila*, cytological demonstrations of crossing over: Creighton and Mc.Clinlock's experiment on corn, Messlson and Weigie's experiment on lambda phage. Two point crossing over and mitotic crossing over.

UNIT II **Recombination:** Mechanism of homologous recombination: Precocity theory, Belling's hypothesis. Non-homologous recombination: White house model, Holliday model. Transposable genetic elements: Insertion sequences (Is element), Transposon – Dotted (Dt) element, Activator dissociation (Ac – Ds) element in *Zea mays*, retroelements. Mechanism of transposition, uses of transposons.

UNIT III **Gene mapping:** Two point test cross, three point test cross, tetrad analysis, plant pedigree analysis, cytogenetic maps, extra chromosomal inheritance, maternal inheritance, cytoplasmic male sterility in plants, chloroplast inheritance and mitochondrial inheritance.

UNIT IV **Plant breeding:** Objectives of plant breeding, Breeding methods for self and cross – pollinated crops, pure line theory, pure line selection, mass selection, clonal selection, hybrid breeding and genetics basis of heterosis, breeding for resistance to disease and pest.

UNIT V **Biostatistics:** Quantifying variability: calculating Mean, variance and standard deviation. Chi-square test: goodness of fit, independence and homogenecity. Student's t-test: estimation of population mean, matched pair data analysis and comparison of means of two groups. Probability distributions (Binomial)

Books for Reference:

1. Brown, T. A. (1992). *Genetics: A Molecular Approach* (2nd ed.). New York: Chapman and Hall.
2. Chaudhari, H. K. (1984). *Elementary Principles of Plant Breeding*. Delhi: Oxford and IBH Publishing Company.
3. Gupta, P. K. (2009). *Genetics*. New Delhi: Rastogi Publications, Meerut.
4. Gupta, S. C. (2014). *Fundamentals of Statistics*. Mumbai: Himalaya Publishers.
5. Gurumani, N. (2005). *Biostatistics* (2nd ed.). Mumbai: MJP Publications.
6. Kothari, C. R., and Garg, G. (2014). *Research Methodology – Method and Techniques*. New Delhi: New Age International P. Ltd.
7. Paul, A. (2011). *Textbook of Genetics – From Genes to Genome*. Kolkatta: Books and Allied P. Ltd.
8. Pierce, B. A. (2012). *Genetics: A Conceptual Approach*. New York: W.H. Freeman and Company.
9. Strickberger, M. W. (2022). *Genetics.* Uttar Pradesh: Pearson India Education Service P. Ltd.
10. Singh, B. D. (2013). *Plant Breeding: Principles and Methods*. New Delhi: Kalyani Publishers.
11. Sinnott, E. W., Dunn, L. E., and Dobzhansky, T. (1973). *Principles of Genetics*. New York: McGraw-Hill.
12. Stansfield, W. D. (1969). *Theory and Problems of Genetics*. New York: McGraw-Hill.

MAPPING WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	3	3	3	3	3	3	2
CO2	3	3	3	3	3	3	3	3	2	3
CO3	3	3	3	3	3	3	2	3	3	3
CO4	3	3	3	3	3	2	3	3	3	3
CO5	3	3	3	3	2	3	3	3	3	3
Avg	3	3	2.8	3	2.8	2.8	2.8	3	2.8	2.8

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

SEMESTER III			
CORE VII–PLANT BIOTECHNOLOGY			
Course Code: 23PBOC33	**Hrs / Week: 5**	**Hrs / Semester: 75**	**Credits: 5**

COURSE OBJECTIVE

To learn the plant genome organization and expression and the applied aspects of bio technology, gene insertion and production of recombined new plants.

COURSE OUTCOMES

CO. No.	Upon completion of this course, students will be able to	PO
CO1	recall the basic plant genome organization, expression and various methods of genetic manipulations in plants and its application	K1
CO2	discuss the genome organization, gene transfer mechanism and plant tissue culture techniques in crop plants for the benefit of humans	K2
CO3	demonstrate the *Agrobacterium* mediated gene transfer for the crop improvement and plant tissue culture techniques	K3
CO4	outline the principles underlying the structure of the plant genome, their expression, and the use of biotechnology to agricultural enhancement.	K4
CO5	recommend the genetic manipulation techniques for the production of plant-based products and improved crops	K5

SEMESTER III			
CORE VII–PLANT BIOTECHNOLOGY			
Course Code: 23PBOC33	**Hrs / Week: 5**	**Hrs / Semester: 75**	**Credits: 5**

UNIT I: Introduction and scope of plant Biotechnology. Structure, evolution, expression and gene regulations of chloroplast genome, mitochondrial genome and nuclear genome

UNIT II: The biology of *Agrobacterium*, Ti Plasmid, t-DNA transfer and integration, transformation in plant with an example of *Arabidopsis thaliana*, advantages and disadvantages of *Agrobacterium* mediated gene transfer method. Selection of recombinant plants: reporter genes, nopaline synthase gene

UNIT III: *Bacillus thuringiensis* (Bt) approach in pest resistance, use of Bt as a biopesticide, Bt- based genetic modification of plants, development of pest resistant crops. **Plant tissue culture:** plasticity and totipotency of plant cells, organogenesis, embryogenesis. Physical, chemical and environmental factors that affect the tissue culture. Culture types: callus culture, embryo culture, nodal culture. Synthetic seeds. Culture of plant cells for the extraction of secondary metabolites**.**

UNIT IV: Transgenic plants as bioreactors: carbohydrates, lipids, protein quality, vitamin and mineral, biodegradable plastics. Transgenic plant of improved quality: extended self-life, flower color and shape, male sterility, terminator seed. Plant derived compounds as drugs, current demand of alternative fuels from plants. Types of herbicides, transgenic approach for improving tolerance to herbicide, plant-based detoxification.

UNIT V: **Biotechnology in pollution control:** environmental monitoring, environmental impact assessment method. Biological tools used to detect pollutant level: biosensors, DNA probes. **Biological degradation of xenobiotics**: degradation of pesticides, hydrocarbons, polychlorinated biphenyl compounds. Bioleaching: heaps or dumps method, advantages of bioleaching. Microbial enhancement of oil recovery (MEOR).

Books for Reference

1. Abdin, M. Z., Kiran, U., Kamaluddin, M., and Ali, A. (Eds.). (2017). *Plant Biotechnology: Principles and Applications,* Springer publishers.
2. Chawla, H.S. (2010). *Introduction to Biotechnology*, 2nd edn. Oxford IBH. 2009. Company.
3. Das H. K. (2017). *Text Book of Biotechnology*. Wiley; Fifth edition.
4. Dubey R. C. (2005). *Textbook of Biotechnology*. New Delhi: S. Chand and Co.
5. Dubey, R. C. (2014). *Advanced Biotechnology. 5th edn*. S. Chand Publication.
6. George, E. F., and Sherrington, P. D. (1984). *Plant propagation by tissue culture*. London: Exegetic Ltd.
7. Glick, B. R., Pasternak, J. J., and Patten, C. L. (2010). *Molecular Biotechnology: principles and applications of recombinant DNA*. Washington: ASM Press. 4th edition.
8. Gupta, P. K. (2000). *Elements of Biotechnology*. Meerut: Rastogi publication.
9. Kalyan Kumar De. (2004). *An Introduction to Plant Tissue Culture*. Calcutta: New Central Book Agency.
10. Kumar, H. D. (1993). *Molecular biology and Biotechnology.* New Delhi: Vikas publishers.
11. Sathyanarayana, U. (2006). *Biotechnology*. Kolkatha: Books and Allied (P). Ltd.

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	2	3	2	2	2	3
CO3	3	3	3	3	3	3	3	3	3	2
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3
Avg	3	2.8	2.8	2.8	2.8	3	2.8	2.8	2.8	2.8

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

SEMESTER III			
CORE PRACTICAL III – BIOCHEMISTRY PRACTICAL			
Course Code: 23PBOCR3	**Hrs / Week: 2**	**Hrs / Semester: 30**	**Credit: 1**

COURSE OBJECTIVE

To develop skills to prepare standard chemical solutions and use of handling of glasswares, minor equipment for conducting experiments

COURSE OUTCOMES

CO. No.	Upon completion of this course, students will be able to	PO
CO1	recall the qualitative analysis of biomolecules.	K1
CO2	estimate the amount of biomolecules present in the plant samples	K2
CO3	analyse the activity of amylase and nitrate reductase	K3
CO4	examine the usage of separation techniques for isolating biomolecules	K4
CO5	evaluate the preparation of buffers	K5

SEMESTER III			
CORE PRACTICAL III – BIOCHEMISTRY PRACTICAL			
Course Code: 23PBOCR3	**Hrs / Week: 2**	**Hrs / Semester: 30**	**Credit: 1**

PRACTICALS

1. Preparation of solutions, pH and buffers.
2. Qualitative analysis of biomolecules.
3. Estimation of reducing and non-reducing sugar by Nelson – Somogyi method
4. Estimation of starch by anthrone method / phenol – sulphuric method using colorimeter.
5. Identification of amino acids by paper chromatography.
6. Determination of pKa value of amino acid using pH meter.
7. Estimation of soluble proteins in germinating and non-germinating seeds by Lowry /Bradford's method using colorimeter.
8. Identification of lipids by TLC
9. Determination of saponification value of oil or fat by titration.
10. Effect of pH, temperature and substrate concentration on enzyme action.
11. Determination of alpha amylase activity from germinating seeds.
12. Determination of *Km* value of enzyme nitrate reductase.

- Submission of record.

Reference

1. Jayaraman, J. (2008). *Laboratory Manual in Biochemistry*. New Delhi: New Age International (P) Limited Publishers.
2. Sadasivam, S., and Manickam, A. (2002). *Biochemical Methods*. (2nd ed.). Coimbatore: Tamil Nadu Agricultural University and New Delhi: New Age International (P) Limited Publishers.

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	2	3	3	3	3	3	3
CO3	3	2	3	3	2	3	2	3	2	3
CO4	3	3	3	3	3	2	3	2	3	3
CO5	3	3	2	3	3	3	3	3	3	3
Avg	3	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	3

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

SEMESTER III			
CORE PRACTICAL IV - GENETICS, PLANT BREEDING, BIOSTATISTICS AND PLANT BIOTECHNOLOGY PRACTICAL			
Course Code: 23PBOCR4	**Hrs / Week: 4**	**Hrs / Semester: 60**	**Credits: 2**

COURSE OBJECTIVE

To provide a working knowledge of laboratory techniques used in genetics, plant breeding and biotechnology

COURSE OUTCOMES

CO. No.	Upon completion of this course the student will be able to	PO
CO1	recall the fundamental steps in biotechnology, plant breeding technology genetics and biostatistics	**K1**
CO2	discuss the dihybrid ratio and its modification, crossing over, linkages, breeding and tissue culture techniques	**K2**
CO3	demonstrate how to providentially handle the tools in plant breeding and plant biotechnology	**K3**
CO4	examine practical obstacles to the development of recombinant plants and plant breeding	**K4**
CO5	recommend methods for plant biotechnology, breeding plants and statistical analysis	**K5**

SEMESTER III			
CORE PRACTICAL IV - GENETICS, PLANT BREEDING, BIOSTATISTICS AND PLANT BIOTECHNOLOGY PRACTICAL			
Course Code: 23PBOCR4	**Hrs / Week: 4**	**Hrs / Semester: 60**	**Credits: 2**

GENETICS, PLANT BREEDING AND BIOSTATISTICS

1. Study the various types of gene interaction and modification of typical dihybrid ratio
2. Determination of linkage and crossing over through two point test cross and three point test cross.
3. Quantifying variability by measuring mean, variance and standard deviation.
4. Study the Chi - square test for goodness of fit, test of homogenity
5. Study of male sterility.
6. Calculation of probabilities for a binomial distribution.
7. Study the emasculation and pollination techniques in any three plants.

PLANT BIOTECHNOLOGY

1. Extraction of total RNA from plant tissues
2. Isolation and recombinant preparation of Ti Plasmid
3. Transformation of plasmid into *E. coli*
4. Protoplast isolation - electrofusion and regeneration
5. Preparation of plant tissue culture media
6. Direct organogenesis in plants
7. Callus induction
8. Somatic embryogenesis
9. Gus assay

Reference

1. Paul, A. (2011). *Text book of Genetics- from genes to genome.* Books and Allied P. limited, Kolkatta.
2. Neil Stewert Jr. (2008). *Plant Biotechnology and Genetics.* Jhon Wiley and Sons. Inc., New jersy.
3. Palanisamy, S., and Manoharan, M. (1994). *Statistical methods for biologists II Edition*.Palani Paramount Publishers, Chennai.
4. Sharma, J.K. (1984). *Principles and Practices of Plant Breeding*. Tata McGraw –Hill publishing company limited, New Delhi.
5. Slater, A., Scott, N.W., and Fowler, M.R. (2008). *Plant Biotechnology- the Genetic manipulation of Plants.* Oxford University Press.

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	3	2	3	2	2	2	2
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	2	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3
Avg	3	2.8	2.8	2.8	2.8	3	2.8	2.8	2.8	2.8

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

SEMESTER III			
DISCIPLINE SPECIFIC ELECTIVE V – ENTREPRENEURIAL BOTANY			
Course Code: 23PBOE31	**Hrs. / Week: 4**	**Hrs. / Semester: 60**	**Credits: 3**

COURSE OBJECTIVES

To understand the available natural resources and explore the greatest opportunity and to expose students to various business opportunities emerging from the plant resources.

COURSE OUTCOMES

CO. No.	Upon completion of this course, students will be able to	PO
CO1	recall the methods, characters, packaging techniques and importance of commercial applications	K1
CO2	explain the cultivation methods and identify commercial wood and understand the marketing concept.	K2
CO3	apply the knowledge gained in creating and maintaining business in the suggested avenues	K3
CO4	analyze the use of fresh and dry flowers for and the advantages and challenges associated with Small Scale Industries	K4
CO5	rate the concepts and entrepreneurship principles	K5

SEMESTER III			
DISCIPLINE SPECIFIC ELECTIVE V – ENTREPRENEURIAL BOTANY			
Course Code: 23PBOE31	**Hrs. / Week: 4**	**Hrs. / Semester: 60**	**Credits: 3**

UNIT I **Preservation of Fruits and Vegetables:** Methods: Dehydration, canning, salting, pickling and freezing. Fruits and Vegetables Products: tutti frutti, health drink, mango pulp, pickle, jam, jelly, amla candy and raisin. Factors influencing the growth of microorganisms in food. Sources of contamination of fruits. Types of spoilage.

UNIT II **Value added plant based products:** Coconut, Banana, Palm, Drumstick, Tomato, Amla and Ginger. Packing techniques and materials: low, trans wrap, deep drawing, doy, sachet, top seal, vacuum.

UNIT III **Commercial Wood products**: Natural durability of wood. Wood preservation: Nonpressure processes, Pressure process, Chemical processing of wood. Commercial wood species and identification, Types and importance wood: plywood, Fuel wood, paper making woods, matchstick wood.

UNIT IV **Entrepreneurial start-up:** entrepreneurial traits-definition and concept-types and characterization, values-motivation, barriers and innovations-basics of organizational behavior- risk assessment and solutions-various form of business organization (sole proprietorship, partnership, corporations, Limited Liability Company), mission, vision and strategy formulation. Communication-power of talk, personal selling, risk taking, resilience and negotiation.

UNIT V **Marketing and trade**: Steps and registration for starting a small scale industry. Role of SIDBI. Advantages and problems of SSI. Government Schemes for SSI: NABARD, NCDC, MSME, NSIC. Marketing and entrepreneurship: different types of marketing, identification of types of consumers and their needs, building consumer relationship. Strategies of import and export business development.

Books for Reference:

1. Cruses W.V. and Fellows P.J. (2000). *Commercial fruits and vegetable processing*. United States: CRC press.
2. Desai V. (2015). *Entrepreneurship development*. First edition, Mumbai: Himalaya publication house.
3. Khanna S.S. (2016). *Entrepreneurial development*. New Delhi: S. Chand Company Ltd.
4. Lal G., Siddhapa G.S. and Tandon G.L. (2009). *Preservation of fruits and vegetables*. New Delhi: Indian council of Agricultural Research (ICAR).
5. Manohar D. (1989) *Entrepreneurship of small scale industries*, New Delhi: Deep and deep publication.
6. Narayanaswami R.V. and Rao K.N. (1976) *Outlines of Botany*, Chennai: Esvee Press.
7. Pearson and Brown. (1984). *Commercial Timbers of India*. New Delhi: Government of India Publication.
8. Ranganna S. (2001). *Hand book of analysis and quality control of fruits and vegetable products*, Second edition. New Delhi: Tata mc graw hill.
9. Taneja S. and Gupta S.L. (2015). *Entrepreneurship development*, New Delhi:New venture creation, Galgeha Publication Company.

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	2	3	3	3	3	3	3
CO3	3	2	3	3	2	3	2	3	2	3
CO4	3	3	3	3	3	2	3	3	3	3
CO5	3	3	2	3	3	3	3	3	3	3
Avg	3	2.8	2.8	2.8	2.8	2.8	2.8	3	2.8	3

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

SEMESTER III			
DISCIPLINE SPECIFIC ELECTIVE V - GLOBAL CLIMATE CHANGE			
Course Code: 23PBOE32	**Hrs / Week: 4**	**Hrs / Semester: 60**	**Credits: 3**

COURSE OBJECTIVE

To create awareness about global climate change and mitigation measures.

COURSE OUTCOMES

CO. No.	Upon completion of this course, students will be able to	PO
CO1	recall the anthropogenic pressure on the environment, atmosphericlayers, impacts of biodiversity, greenhouse gases and its effect	K1
CO2	explain about the carbon footprint, international efforts on climate change, atmospheric deposition, acid rain and the physical basis of natural green gas house effect on man and materials.	K2
CO3	construct the factors responsible for climate change, mitigation of ozone layer, carbon sequestration and human influenced driver of ourclimate system and its applications.	K3
CO4	analyze the causes and effects of depletion of the Kyoto mechanism, impact of forestry, agriculture, present and past scenario of atmospheric.	K4
CO5	conclude the new strategies to mitigate effects of globalenvironmental change.	K5

SEMESTER III			
DISCIPLINE SPECIFIC ELECTIVE V - GLOBAL CLIMATE CHANGE			
Course Code: 23PBOE32	**Hrs / Week: 4**	**Hrs / Semester: 60**	**Credits: 3**

UNIT I **Introduction to Climate change:** Atmosphere and climate, natural causes of climate change, physical basis of climate change and anthropogenic causes of climate change. **Water Conservation:** Energy sources to reduce climate change.

UNIT II **Climate change and Global water crisis:** Linkage among climate change energy and water, Risks of managing water and energy climate change, businessrisks of water and climate change.

UNIT III **Climate change risks in the context of scientific uncertainty:** Myths about climate change, Underestimating climate change, Potential trap doors and Probability Climate change severity.

UNIT IV **Policy Guide on Planning and Climate change:** Global warming, carbon credits, Kyoto mechanism. Factors responsible for climate change, Climate change in relation to the changes in patterns of temperature, precipitation and sea level rise. **Impacts of climate change:** Agriculture, Forestry and Ecosystem.

UNIT V **Energy issues and climate change:** Global warming and Greenhouse effect, greenhouse gases (GHGS) and their sources, quantifying CO_2 and methane emission from rice (paddy), Ocean ecosystem, Mountain and Hill ecosystems, Human health, melting of ice and sea level rise, Change of temperature in the environment. Acid rain and its effects on plants, animals, microbes and ecosystems.

Book for reference

1. Adger, N. Brown, K., and Conway, D. (2012). *Global Environmental Change: Understanding the Human Dimensions.* The National Academic Press.
2. Eugene Odum. (2017). *Fundamentals of Ecology 5th Ed*. Cengage, Bengaluru.

3. Rao, KK. (2011). *Environment and Climate Change.* Manglam Publications.
4. Sandeep Kumar. (2009). *Biodiversity Environment and Sustainable Management.* A.K Publications.
5. Sharma, P.D. (2019). *Plant ecology and phytogeography*, Rastogi Publications, Meerut.

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	3	3	3	2	3
CO3	2	2	3	2	2	3	3	3	3	2
CO4	3	3	3	3	3	2	3	3	3	3
CO5	3	3	3	3	3	3	2	2	3	3
Avg	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8

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

SEMESTER III			
SKILL ENHANCEMENT COURSE II - HORTICULTURE TECHNIQUES			
Course Code: 23PBOSE2	**Hrs / Week: 4**	**Hrs / Semester: 60**	**Credits: 3**

COURSE OBJECTIVE

To learn the basic concept of horticulture and build up the skill in plant growing and maintenance

COURSE OUTCOMES

CO. No.	Upon completion of this course, students will be able to	PO
CO1	recall the steps involved in different propagation techniques, pomology and olericulture	K1
CO2	explain the special features and principles behind the different divisions of horticulture	K2
CO3	apply the knowledge and techniques of horticulture in addressing various societal needs	K3
CO4	compare and contrast different divisions of horticulture to understand their respective roles	K4
CO5	evaluate the different propagation techniques based on specific plant characteristics and develop skills in different gardening techniques.	K5 & K6

SEMESTER III			
SKILL ENHANCEMENTCOURSE II - HORTICULTURE TECHNIQUES			
Course Code: 23PBOSE2	**Hrs / Week: 4**	**Hrs / Semester: 60**	**Credits: 3**

UNIT I **Introduction to horticulture:** definition, special features of horticulture, divisions of horticulture, importance of horticulture. **Plant growing structure:** Hot beds, cold frames, green houses. Nutrition of horticulture plants, irrigation of horticulture plants.

UNIT II **Sexual Propagation:** seed germination, seed testing and sowing. **Vegetative propagation:** Cutting (stem, leaf and root cutting), Layering (simple, compound and air layering), Grafting (approach, tongue, side, saddle, cleft, whip, veneer and epicotyl grafting), Budding (T budding, chip, ring, flute, flap and patch budding). Propagation by specialized plant parts.

UNIT III **Pomology:** Definition, establishment of orchard: location and site, preliminary operation, planning of an orchard, laying out of the orchard, planting distance, season, planting method and transplantation. Training, pruning, cropping, harvesting, handling. Storage and preservation of fruits and vegetables.

UNIT IV **Olericulture:** Definition, principles and cultivation of tomato, brinjal, chilly, lady's finger, cluster beans, dolichos bean, onion, cucumber, bitter guard. Kitchen gardening

UNIT V **Course work:** Establishment and maintenance of lawn, rockery, water garden, terrarium, hanging basket and bonsai.

Books for Reference:

1. Chauhan, R. K. (2011). *Encyclopedia of General Gardening for Common People*. New Delhi: Dominant Publishers and Distributors.
2. De, L. C. (2012). *Handbook of Gardening*. Jaipur: Aavishkar Publishers, Distributors.
3. Hartmann, and Kester. (1989). *Plant Propagation*. New Delhi: Prentice-Hall of India Pvt. Ltd.

4. Kumar, N. (2010). *Introduction to Horticulture* (7th ed.). New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.
5. Sheela, V. L. (2011). *Horticulture*. Chennai: MJP Publishers.

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	3	2	2	2	3
CO3	2	3	3	3	2	3	3	3	3	3
CO4	3	3	3	2	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3
Avg	2.8	3	2.8	2.8	2.8	3	2.8	2.8	2.8	3

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

SEMESTER III	
SELF-STUDY I - RENEWABLE ENERGY RESOURCES	
Course Code: 23PBOSS1	**Credits: +2**

COURSE OBJECTIVE

The course is designed to enrich students' understanding of the diverse renewable energy resources present in the country, delving into their potential, the spectrum of energy technologies in promoting sustainable development.

COURSE OUTCOMES

CO. No.	Upon completion of this course, students will be able to	PO
CO1	discuss the need of energy conversion and various methods of energy storage.	K2
CO2	demonstrate the fundamental concepts and working principles of renewable energy systems and devices	K3
CO3	examine the field applications of renewable energy sources	K4
CO4	evaluate renewable energy sources as an alternate form of energy and to know how it can be tapped.	K5
CO5	create awareness among the students about the array of energy resources and highlight their significance for promoting sustainable energy practices.	K6

SEMESTER III	
SELF-STUDY I - RENEWABLE ENERGY RESOURCES	
Course Code: 23PBOSS1	**Credits: +2**

UNIT I **Fundamentals of Energy:** Introduction to energy, Classification of energy sources, Energy chain, Common forms of energy, Advantages and disadvantages of conventional and non-conventional energy sources, Environmental aspects of energy, Energy for sustainable development, Energy scenario in India.

UNIT II **Solar Energy:** Introduction**,** Types, advantages, disadvantages and applications of **s**olar radiation**,** Solar water heating**,** Solar cooking**,** Solar greenhouse, Solar distillation, Solar pond.

UNIT III **Wind Energy:** Introduction**,** Basic principles of wind energy conservation, Wind energy conversion, Advantages and disadvantages of wind power, Wind energy storage, Application of wind energy, Environmental aspects of wind energy.

UNIT IV **Bio Energy:** Biomass resources**,** Biomass resource conversion technologies, Urban waste to energy conversion, Biomass gasification, Biomass liquification, Biogas production from waste biomass, Biodiesel production, Biomass energy scenario in India.

UNIT V **Ocean and Geothermal Energy:** Introduction to ocean energy, Principle of ocean thermal energy conversion (OTEC), Methods of electricity conversion system, Ocean tidal energy, Advantages, disadvantages and applications of OTEC, Geothermal energy source, Advantages, disadvantages and applications of geothermal energy, Environmental problems related to geothermal energy.

Books for Reference

1. Illayaraja, K., and Siddharth, S. (2000). *Renewable Energy Resources*. Mahesh Karthick Publications. Palani.
2. Twidell, J., and Weir, J. (2006). *Renewable Energy Resources* (2nd ed.). Taylor and Francis Group. London and New York.
3. Khan, B. H. (2009). *Non-conventional Energy Resources* (2nd ed.). Tata McGraw Hill Publication. Noida.
4. Kothari, D. P., Singal, K. C., and Ranjan, R. (2008). *Renewable Energy Sources and Emerging Technologies*. Prentice-Hall of India Private Limited. New Delhi.
5. Rai, G. D. (1999). *Non-conventional Energy Resources*. Khanna Publishers. New Delhi.
6. Rajput, R. K. (2012). *Non-conventional Energy sources and Utilization*. S. Chand and Company Ltd. New Delhi.

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	2	3	3	3	3	2	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	2	2	2	3	3	3	3	3
CO5	3	3	3	3	3	3	2	3	3	3
Avg	2.8	2.8	2.8	2.8	2.8	3	2.6	3	3	3

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

SEMESTER – IV			
CORE VIII - PLANT FUNCTIONS			
Course Code: 23PBOC41	**Hrs / week: 5**	**Hrs / Semester: 7**5	**Credits: 5**

COURSE OBJECTIVE

To explore and understand the fundamental physiological processes and mechanism underlying the growth, development and response of plants to their environment.

COURSE OUTCOMES

CO. No.	Upon completion of this course, students will be able to	PO
CO1	describe the fundamental physiological processes in plants.	K1
CO2	explain the physiological processes occurring in different plant tissues to comprehend the intricate mechanisms behind the physiological adaptations that plants to overcome environmental challenges.	K2
CO3	apply critical thinking skills to analyze complex physiological processes in plants.	K3
CO4	analyze the physiological processes involved in plant growth, development, and metabolism.	K4
CO5	evaluate how plants respond and adapt to environmental factors, including light, temperature, air and water availability.	K5

SEMESTER - IV			
CORE VIII - PLANT FUNCTIONS			
Course Code: 23PBOC41	**Hrs / Week: 5**	**Hrs / Semester: 75**	**Credits: 5**

UNIT I **Water relations of plants:** Components of water potentials and their relation, absorption of water, mechanism of ascent of sap. Translocation: mechanism of translocation of solutes, source sink relationship, phloem loading and unloading. Transpiration: Stomatal movement, antitranspirants, guttation. Inorganic nutrient ion uptake: Passive and active uptake and transport. Role of mineral nutrients, deficiency and toxicity symptoms. Hydroponics and its significance.

UNIT II **Photosynthesis:** General concepts: thylakoid membrane, pigment system, absorption and action spectrum, quantum requirement and quantum yield, Red drop and Emerson enhancement effect. Photochemical reaction: Cyclic and non-cyclic (Z-scheme) electron transport and photophosphorylation, regulation of photosynthetic machinery. Carbon reaction: C_3 and C_4 cycles, CAM, C_2 oxidative photosynthetic carbon cycle (photorespiration).

UNIT III **Respiration:** Respiratory substrates, glycolysis, Krebs cycle, phosphate pentose pathway (PPP), electron transport system and terminal oxidation, difference between substrate and oxidative phosphorylation, alternative oxidase mechanism in plants (cyanide resistance respiration in plants), Assimilation of mineral nutrients in plants: Nitrogen, Sulphur and Phosphorus.

UNIT IV **Growth hormone:** History, biosynthesis, molecular mechanism of action and physiological role of auxin, gibberellin, cytokinin, abscisic acid ethylene, morphactins and brassinosteroids. Photomorphogenesis: Phytochrome mediated photo responses, Physiology of flowering: Photoperiodism, Vernalization. Biological clock: occurrence of circadian rhythm in plants with examples.

UNITV **Stress physiology:** Morphological, anatomical, metabolical and physiological adaptive mechanism of abiotic stress: salinity, drought, freezing, temperature and heavy metal. Biotic stress: Role of secondary metabolites in plants defense mechanism against pathogens, insect and herbivores, hypersensitive response (HR), Secondary acquired resistance (SAR). Secondary messenger in plants - cAMP, Ca-calmodulin.

Books for Reference

1. Beevers, L. (1976). *Nitrogen metabolism in plants.* London: William clowes and sons Ltd.
2. Bidwell, R.G.S. (1979). *Plant physiology*. New York: Macmillan publishing company.
3. Devlin, R.M. (1974). *Plant Physiology*. New Delhi: Narosa publishing House.
4. Jain, V.K. (2004). *Fundamentals of Plant Physiology*. New Delhi: Chand and Co. Ltd.
5. Noggle, G.R., and Fritz, G.J. (2002). *Introductory plant physiology.* New Delhi Prentice Hall.
6. Salisbury, F.B., and Ross, C.W. (2007). *Plant Physiology*. Thomson Wordsworth.
7. Taiz, L., and Zeiger, E. (1998). *Plant Physiology*. United States of America: Sinauer Associates, Publishers Massachusetts.

MAPPING WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2	3	3	2	3	3
CO2	3	3	3	2	2	2	3	3	2	3
CO3	3	3	3	3	2	3	3	3	3	2
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	2	3	2	3	3	3	3	3
Avg	3	3	2.8	2.8	2.2	2.8	3	2.8	2.8	2.8

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

SEMESTER IV			
CORE IX - MOLECULAR BIOLOGY AND BIOINFORMATICS			
Course Code: 23PBOC42	**Hrs / Week: 5**	**Hrs / Semester: 75**	**Credits: 5**

COURSE OBJECTIVE

To understand the basic concepts and principles of molecular biology and bioinformatics.

COURSE OUTCOMES

CO. No.	Upon completion of this course, students will be able to	PO
CO1	recall the structure of nucleic acids, genetic code, gene concepts,scope and objectives of bioinformatics.	K1
CO2	discuss the types of DNA, methods of replication, cellular machinery for translation, biological databases and sequence alignment	K2
CO3	demonstrate DNA, RNA as genetic material, mechanism of transcription and translation and sequence analysis.	K3
CO4	analyse the enzymes used in replication, gene regulation and uses ofsequence similarity searching tools	K4
CO5	evaluate post transcriptional, post translational changes, sequencealignment scores, construction and visualization of phylogenetic tree	K5

SEMESTER IV			
CORE IX - MOLECULAR BIOLOGY AND BIOINFORMATICS			
Course Code: 23PBOC42	**Hrs / Week: 5**	**Hrs / Semester: 75**	**Credits: 5**

UNIT I **Nucleic acids:** Central dogma of molecular biology, History of nucleic acids. **DNA:** Components of DNA, Chargaff's rule, Watson and Crick model of DNA, Different forms of DNA (A, B, C, Z forms), Experiments to prove DNA as genetic material (Griffith's experiment, Avery, MacLeod, McCarty experiment, Hershey and Chase experiment). **RNA:** Structure, types of RNA, experiment to prove RNA as genetic material. DNA repair mechanism**.**

UNIT II **DNA Replication:** Types (Conservative, semi conservative and dispersive model), Meselson and Stahl experiment to prove semi conservative replication model, Enzymes used in replication, Mechanism of replication. **Transcription**: Enzymes involved in transcription, Mechanism of transcription (initiation, elongation and termination), Post transcriptional changes, Reverse transcription. **Genetic Code**: Characteristics, Wobblehypothesis.

UNIT III **Translation:** Cellular machinery required for protein synthesis, Mechanism of protein synthesis (initiation, elongation and termination). Post translation modification. **Gene regulation**: Operon concept, components of an operon, *lac* operon, *trp* operon.

UNIT IV **Bioinformatics:** Scope and application. **Biological databases:** Primary, secondary and composite database. **Nucleic acid databases**: NCBI, EMBL, DDBJ. **Protein Database**: PDB, SWISS PROT. **Sequence similarity searching tools**: BLAST and FASTA.

UNIT V **Methods of Sequence Analysis**: **Pairwise sequence alignment**: E-Value, P- Value, scoring matrix, PAM, BLOSUM and Gap Penalty. **Multiple Sequence Alignments**: Clustal W, Hidden Markov models. **Prediction of protein structure**: RASMOL. **Phylogenetic Analysis Tools**: GROWTREE, PAUP, PHYLIP and MEGA. Construction and visualization of Phylogenetic tree, Application of Phylogenetic Analysis.

Books for Reference

1. Clark, D. (2010). *Molecular Biology*. Academic Press Publication. United States.
2. Freifelder, D. (2008). *Essentials of Molecular Biology*. Narosa Publishing House.New Delhi.
3. Cooper, G. M. (2019). *The Cell: A Molecular Approach*. Oxford University Press.Chennai.
4. Dhingra, G. K. (2021). *Cell, Molecular Biology and Biotechnology*. Uttarakhand Open University, Haldwani, Nainital.
5. Gupta, P. K. (2018). *Molecular Biology*. Rastogi Publications. Meerut, Uttar Pradesh.
6. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments (6^{th} ed.).John Wiley and Sons.
7. Turner, P. C., Mclenann, A. G., Bates, A. D., and White, M. R. H. (2001). *Instant Noteson Molecular Biology*.
8. Rastogi, V. B. (2010). *Fundamentals of Molecular Biology*. Ane Books India. NewDelhi.
9. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., and Losick, R. (2014). *Molecular Biology of the Gene* (7^{th} ed.). Pearson Press. London.

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	2	2	3	3	3	3
CO3	3	2	3	3	3	3	3	3	3	2
CO4	3	3	3	2	3	3	3	3	3	3
CO5	2	3	3	3	3	3	2	2	2	3
Avg	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8

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

SEMESTER IV			
CORE X - MARINE BIOLOGY			
Course Code: 23PBOC43	**Hrs / Week: 4**	**Hrs / Semester: 60**	**Credits: 4**

COURSE OBJECTIVE

To understand different types of marine habitats, its adaptations and their socio - economic and environmental significance.

COURSE OUTCOMES

CO. No.	Upon completion of this course, the students will be able to	PO
CO1	recall the classification of marine environment and to identify role of marine plants and their adaptation to its hostile environment.	**K1**
CO2	distinguish between different types of marine plants.	**K2**
CO3	demonstrate practical skills in collection, processing and preservation of marine plants.	**K3**
CO4	analyze the pollution issues, their sources and the influences humans have with the dynamic marine environment.	**K4**
CO5	evaluate the uses of marine resources and realize the role of phytoplankton and bacteria in the economy of the ocean.	**K5**

SEMESTER IV			
CORE X - MARINE BIOLOGY			
Course Code: 23PBOC43	**Hrs / Week: 4**	**Hrs / Semester: 60**	**Credits: 4**

UNIT I Classification of marine environment (pelagic and benthic). Sea shore: sandy, muddy, rocky shore and estuaries. Physical and chemical properties of sea water. Habitat, importance, classification, sampling and preservation of marine and estuarine phytoplankton:

UNIT II **Marine Bacteria:** distribution of bacteria in sea and their role in the biological and chemical cycles in the sea (nitrogen, phosphorus, carbon and sulphur cycles). **Marine viruses** – genetic diversity, life cycle and effect of viruses on host diversity and environmental chemistry.

UNIT III **Mangroves:** geographical distribution, habit, adaptations, plant and animal's ecosystem, values of forest, sacred groves, causes of degradation and destruction, growing methods and conservation of ecosystem. **Coral reefs** – ecology, types, distribution in India, species interaction, biological diversity, economic importance, threats and conservation.

UNIT IV **Seaweeds** - Commercial cultivation of seaweeds. **Sea grasses** - distribution, inhabitants of sea grass beds, structure, reproduction and ecological functions. **Salt marsh**es – distribution, erosion control and storm surge protection, plant species and threats

UNIT V **Marine pollution** – solid waste dumping, sewage effluents, toxicants, plastic trash, eutrophication and hypoxia, oil spills and their impact on coral bleaching. Policies to protect the marine environment.

Books for References

1. Acharya, M. (2011). *Marine biology*. New Delhi: International Scientific Publishing Academy.
2. Dubey, S. K. (2005). *Marine Biology.* New Delhi: Dominant Publishers and Distributors.
3. Kathiresan, K., and Rajendran, N. (2005). *Mangrove forests*. Environmental Information System (ENVIS), Parangaipettai, Tamil Nadu.

4. Khanna, D. R. (2010). *Marine microbial ecology.* New Delhi: Discovery Publishing Pvt. Ltd.
5. Mitra, A., Banerjee, K., and Gangopadhyay, A. (2004). *Introduction to marine Plankton.* New Delhi: Daya Publishing.
6. Rajakumar, R. (2005). *Coral reefs*. Environmental Information System (ENVIS), Parangaipettai, Tamil Nadu.
7. Seshappa, G. (1991). *Indian marine biology*. Delhi: Daya Publishing House.
8. Sverdrup, K. A., and Kudela, R. M. (2017). *Investigating Oceanography*. New York: McGraw-Hill Education.
9. Sverdrup, K. A., Johnson, M. W., and Fleming, R. H. (1961). *The Oceans: Their physics, chemistry and general biology*. Tokyo, Japan: Modern Asia Edition.
10. Tait, R. V. (1978). *Elements of Ecology*. London: Butterworths.

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	2	2	2	3	3	3	3
CO3	2	3	3	3	3	3	3	3	2	2
CO4	3	3	3	3	3	3	2	3	3	3
CO5	3	2	3	3	3	3	3	3	3	3
Avg	2.8	2.8	2.8	2.8	2.8	2.8	2.8	3	2.8	2.8

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

SEMESTER - IV			
CORE PRACTICAL V - PLANT FUNCTIONS PRACTICAL			
Course Code: 23PBOCR5	**Hrs / Week: 2**	**Hrs / Semester: 30**	**Credit: 1**

COURSE OBJECTIVE

To provide hands-on experience for students in exploring and understanding the physiological processes and mechanisms underlying plant growth, development, and responses to environmental stimuli.

COURSE OUTCOMES

CO. No.	Upon completion of this course, students will be able to	PO
CO1	recall the fundamentals of water and its relation to plants.	K1
CO2	explain the role of pigment in photosynthetic mechanism and related events of plants.	K2
CO3	demonstrate the importance of light in stomatal transpiration, plant growth and harvest of energy	K3
CO4	investigate how the physical process and chemical connection determine plant's function and to layout practical skills in conducting a physiological experiments.	K4
CO5	evaluate the practical skills gained during the course and create idea to seek for suitable job in relevant industries	K5

SEMESTER - IV			
CORE PRACTICAL V - PLANT FUNCTIONS PRACTICAL			
Course Code: 23PBOCR5	**Hrs / Week: 2**	**Hrs / Semester: 30**	**Credit: 1**

EXPERIMENTS

1. Determination of water potential by falling drops method
2. Study of membrane permeability using different solvents and temperature
3. Estimation of the relation between absorption of water and transpiration using Vosuque's photometer
4. Study the effect of anti-transpirants on transpiration by single leaf method.
5. Determination of stomatal frequency and index
6. Determination of chlorophyll content at different stage of leaves (young, mature and senescence)
7. Determination of chlorophyll content under different light conditions.
8. Estimation of cell free photosynthesis (Hill activity)
9. Estimation of nitrate reductase activity under different light condition (Light/Shade)
10. Study of nutrient ion uptake using potato cells as a model.
11. Comparison of respiratory quotients of different seeds by respiroscopes.
12. Determination of peroxidase activity
13. Effect of water and salinity stresses on proline contents of leaves.

DEMONSTRATION

1. Demonstration of ascent of sap
2. Demonstration of suction power of transpiration
3. Demonstration of liberation of CO_2 during aerobic respiration by using retorts
4. Demonstration of geotropism by clinostat.

5. Compare the rate of transpiration from the lower and upper surface of the surface of leaf by bell jar method
6. Demonstration of Hydroponics.

Reference

1. Bala, M., Gupta, S., Gupta, N.K., and Sangha, M.K. (2013). *Practicals in plant physiology and biochemistry.* India, Scientific Publishers.
2. Bentre and Kumar. (2018). *A text Book of Practical Botany.* Rastogi Publications.
3. Francis, H., Witham David, F., Blaydes and Robert, N. (1970) *Experiments in Plant Physiology.* New Delhi :Vanmostr and Rain hold Company.

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	2
CO3	3	3	3	2	2	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	2	3	3	3	3
Avg	3	3	3	2.8	2.8	2.8	3	3	3	2.8

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

SEMESTER IV			
CORE PRACTICAL VI - MOLECULAR BIOLOGY, BIOINFORMATICS AND MARINE BIOLOGY PRACTICAL			
Course Code: 23PBOCR6	**Hrs / Week: 4**	**Hrs / Semester: 60**	**Credits: 2**

COURSE OBJECTIVES

1. To develop proficiency in fundamental molecular biology laboratory techniques, including DNA extraction, gel electrophoresis, and DNA quantification and to analyze and interpret biological data using computational approaches.
2. To learn quantitative methods for assessing marine biodiversity, including speciesrichness, abundance, and diversity indices.

COURSE OUTCOMES

CO. No.	Upon completion of this course, students will be able to	PO
CO1	recall the basics of molecular biology, bioinformatics and plantspresent in marine environment	K1
CO2	discuss the isolation methods of DNA, its quantification and marineplants	K2
CO3	apply theory knowledge to solve molecular biology and bioinformatic problems	K3
CO4	analyze and interpret the quantitative analysis of data obtained invarious experiments.	K4
CO5	evaluate essential molecular biology laboratory techniques, bioinformatics tools, and fieldwork skills in marine biology	K5

SEMESTER IV			
CORE PRACTICAL VI - MOLECULAR BIOLOGY, BIOINFORMATICS AND MARINE BIOLOGY PRACTICAL			
Course Code: 23PBOCR6	**Hrs / Week: 4**	**Hrs / Semester: 60**	**Credits: 2**

MOLECULAR BIOLOGY AND BIOINFORMATICS

1. Isolation of plant genomic DNA by CTAB method.
2. Estimation of DNA using diphenylamine method using spectrophotometer.
3. Determination of Tm value of DNA using spectrophotometer.
4. Simple molecular biology problems related to mutation, transcription and translation.
5. Retrieval of a protein/nucleotide sequence from NCBI and GenBank database.
6. Determination of similarity between sequences using BLAST and FASTA
7. Prediction of secondary structure of protein using Raptor X.
8. Prediction of tertiary structure of protein using RASMOL.
9. Demonstration of amplification of DNA using PCR, molecular weight predictionusing gel images.

MARINE BIOLOGY

1. Determination of acidity, alkalinity and salinity from different water samples.
2. Collection and identification of phytoplanktons.
3. Determination of total hardness from water samples.
4. Estimation of nitrate and phosphate from water samples.
5. Morphological and anatomical studies of salt marshes – *Sesuvium* and *Suaeda*
6. Morphological and anatomical studies of *Avicennia* and *Rhizophora*.
7. Isolation and identification of marine bacteria from sea water.

8. Extraction of agar – agar from *Gracilaria*.
9. A survey of seaweeds from Hare island
    - Submission of record.
    - Field trip for 1 or 2 days to be arranged.

Reference

1. Cappuccino, J. G., and Sherman, N. (1996). *Microbiology – A Practical Manual*. NewYork: Benjamin Cummings.
2. Lakshmanan, M., Kunthala Jeyaraman, Jeyaraman, and Gnanam. (1971). *Laboratory Experiments in Microbiology and Molecular Biology*. Higginbothams Pvt. Ltd.
3. Maff, K. (1987). *ICES Techniques in Marine Environmental Sciences*. Denmark:International Council for the Exploration of the Sea.
4. Santos, G. A. (Consultant). (Year not provided). *A Manual for the Processing of Agar from Gracilaria.* Honolulu, Hawaii: Seaweed Processing Consultant.
5. Stansfield, W. D., Colome, J. S., and Cano, R. J. (2019). *Theory and Problems: Molecular and Cell Biology*. Schaum's Outline Series (First edition). McGraw-Hill.
6. Strickland, J. D. H., and Parsons, J. D. H. (1972). *A Practical Handbook of Sea wateranalysis*. (Bulletin 167). Canada: Fisheries Research Board of Canada.

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	2	2	2	2	2	2	2
CO3	2	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	2	3	3	3	3	3	3	3	3
Avg	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8

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

SEMESTER IV			
DISCIPLINE SPECIFIC ELECTIVE VI - FLORICULTURE			
Course Code: 23PBOE41	**Hrs / Week: 4**	**Hrs / Semester: 60**	**Credits: 3**

COURSE OBJECTIVE

To learn the techniques for growing and marketing flowers and foliage plants.

COURSE OUTCOMES

CO. No.	Upon completion of this course, students will be able to	PO
CO1	recall the fundamentals of growing and marketing flowers and foliage plants	K1
CO2	discuss the role of growth regulators and nursery management in the floriculture and marketing of cut flowers	K2
CO3	demonstrate the various techniques in used in floriculture and in value addition.	K3
CO4	analyze the management strategies for the production of economically important cut flowers and their value addition.	K4
CO5	conclude and develop skills forthe production of disease-free ornamental plants and their value addition products.	K5

SEMESTER IV			
DISCIPLINE SPECIFIC ELECTIVE VI - FLORICULTURE			
Course Code: 23PBOE41	**Hrs / Week: 4**	**Hrs / Semester: 60**	**Credits: 3**

UNIT I Introduction, history of gardening, scope and importance of commercial floriculture in India. Indian floriculture industry: an overview. Strategies for marketing of floriculture products, quarantine laws.

UNIT II Role of plant growth regulators in floriculture. Media and soil mixtures for growing plants. Ornamental plants: flowering annuals, herbaceous perennials, divine vines, shade and ornamental trees, ornamental bulbous and foliage plants, cacti and succulents. Cultivation of plants in pots. Diseases and pests of floriculture plants.

UNIT III Nursery management and routine garden operations: propagation methods of cut flowers (*Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolous, Tuberose, Marigold, Rose, Lilium, Orchids*), soil sterilization, seed sowing, pricking, planting and transplanting, shading, stopping or pinching, defoliation, wintering, mulching and foliar nutrition. Landscaping places of public importance: landscaping highways and educational institutions. Managing plant environment: green house, green house covering material, environmental controls, mist chambers.

UNIT IV Commercial floriculture: factors affecting flower production, production and packaging of cut flowers. Flower arrangements: methods to prolong vase life. Cultivation of important cut flowers (*Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolous, Tuberose, Marigold, Rose, Lilium, Orchids*), harvesting techniques.

UNIT V Cutting, grading, packaging and marketing of cut flower crops (Aster, Carnation, Chrysanthemum, Gladiolus, Narcissus, Orchids and Antirrhinum) for national and international markets. **Course work:** Value addition in floriculture.

***Visit to commercial cut flower units.**

***Project submission on regionally important cut flowers**

Books for Reference

1. Armitage, A. M., and Laushman, J. M. (2003). *Specialty Cut Flowers, The Production of Annuals, Perennials, Bulbs, and Woody Plants for Fresh and Dried Cut Flowers, Second Edition*. Timber Press, Portland.
2. Arora, J. S. (2007). *Introductory ornamental Horticulture*. Kalyani Publishers.
3. Bhattacharjee, S. K. (2006). *Advances in ornamental Horticulture*. Pointer Publishers.
4. Bhattacharjee, S. K. (2005). *Post Harvest Technology of flowers and ornamental plants*. Pointer Publishers.
5. Bhattacharjee, S. K. (2010). *Advanced Commercial Floriculture*. Aaviskar Publishers.
6. Bose, T. K., Malti, R. G., Dhua, R. S., and Das, P. (1999). *Floriculture and Landscaping*. Naya Prokash.
7. Bose, T. K. and Yadav, L. P. (1989). *Commercial Flowers*. Naya prokash.
8. Prasad, S., and Kumar, U. (2003). Commercial Floriculture. Agrobios.
9. Randhawa, G. S. and Mukhopadhyay, A. (1986). *Floriculture in India*. Allied Publ.
10. Reddy, S., Janakiram, B., Balaji, T., Kulkarni, S., and Mishra, R. L. (2007). *High-tech Floriculture*. Indian Society of Ornamental Horticulture, New Delhi.
11. Sadhu, M. K. (1989). *Plant Propagation*. New Age International Publishers.

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	3	3	3	2	2
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	2	2	3	3
CO5	3	3	3	3	2	3	3	3	3	3
Avg	3	2.8	2.8	2.8	2.8	3	2.8	2.8	2.8	2.8

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

SEMESTER IV			
DISCIPLINE SPECIFIC ELECTIVE VI - FORESTRY			
Course Code: 23PBOE42	**Hrs / Week: 4**	**Hrs / Semester: 60**	**Credits: 3**

COURSE OBJECTIVE

To provide knowledge about forest ecosystem concept, regeneration of tree species, tree measurements, forest inventory and yield concepts and forest policy and laws.

COURSE OUTCOMES

CO. No.	Upon completion of this course, students will be able to	PO
CO1	recall the general characteristics and concept of forestry.	**K1**
CO2	explain the types of forests and their management.	**K2**
CO3	compile the ecophysiology of tree growth and measurement of tree parameters.	**K3**
CO4	analyze the applications of forest management and forest protection.	**K4**
CO5	critique the various factors that affect tree growth and laws framed to protect trees.	**K5**

SEMESTER IV			
DISCIPLINE SPECIFIC ELECTIVE VI - FORESTRY			
Course Code: 23PBOE42	**Hrs / Week: 4**	**Hrs / Semester: 60**	**Credits: 3**

UNIT I **Tree growth and forest:** Branches of forestry, Classification of forests, Direct and indirect benefits of forests, Impact of climatic factors on forest, Site quality, Bioclimate and microclimate of forests, Natural and artificial regeneration of forests.

UNIT II **Sustainable forest management:** Introduction, Concept, Components, Criteria, Indicators, Challenges, Constraints to sustainable forest management, Forest certification.

UNIT III **Timber measurements and inventory of timber:** Concept and scope of forest mensuration, Measurements of tree diameter, height, basal area and stem/ log volume. Stem form, Timber inventory, Point sampling.

UNIT IV **Timber and non-timber forest products:** Introduction: Lumber/ timber, Composite wood/ engineered wood: Veneers and other composite woods, other multiple uses of wood, Non-wood forest products.

UNIT V **Forest Policy and Legislations:** What is Policy, Forest policy 1894, 1952 and 1988. Indian forest act (1927), Wildlife act (1972), Forest act (1980), Forest rights act (2006), International Tropical Timber Agreement (ITTA).

Books for reference

1. Antony Joseph Raj, and Lal, S.B. (2013). *Forestry Principles and Applications*. India: Scientific Publishers.
2. Chaturvedi, A.N., and Khanna, L.S. (1994). *Forest Mensuration*. International Book Distributor.
3. Chaturvedi, A.N. (2011). *Forest Policy and Law*. Khanna Bandhu.
4. Dwivedi, A.P. (1992). *Agroforestry: Principles and Practices*. Oxford and IBH.
5. Dwivedi, A.P. (1993). *A Text Book of Silviculture*. Dehradun: International Book Distributors.
6. Indian Forest Acts, (1975). Allahabad Law Agency.
7. Negi, S.S. (1985) *Forest Law*. Natraj Publications.

8. Ram Parkash, (1983). *Forest Surveying*. R.P.S. Gahlot for International Book Distributors.
9. Sharpe, G.W., Hendee, C.W., and Sharpe, W.E. (1986). *Introduction to Forestry*. McGraw-Hill.
10. Simmons, C.E. (1980). *A Manual of Forest Mensuration*. Dehradun: Bishen Singh Mahender Pal Singh.

MAPPING WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	3	3	3	3	3	3	3
CO 2	3	3	3	3	3	3	2	3	3	3
CO 3	3	3	3	2	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3
Avg	3	3	2.8	2.8	3	3	2.8	3	3	3

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