PG & RESEARCH DEPARTMENT OF BOTANY

M. Sc., BOTANY SYLLABUS

(TANSCHE)

(FROM THE ACADEMIC YEAR 2023-2024)

H.H. THE RAJAH'S COLLEGE (AUTONOMOUS)

PUDUKKOTTAI – 622 001

M.Sc. BOTANY PROGRAMME – Course Structure under CBCS Pattern

(For the candidates admitted from the academic year 2023 onwards)

S. No.	Sem	Course Code	Paper	Hrs/ Week	Credit	Exam Hrs.	MARKS		
							Internal	External	Total
Semester - I									
1	I	23PBT1	Core Course I - Plant Diversity – I (Alage, Fungi, Lichens and Bryophytes)	7	5	3	25	75	100
2		23PBT2	Core Course II – Plant Diversity – II (Pteridophytes, Gymnosperms and Paleobotany)	7	5	3	25	75	100
3		23PBT3P	Core Course III – Laboratory Course covering Diversity I & II)	4	4	4	40	60	100
4		23PBT E1A	Elective Course I - Microbiology, Immunology and Plant Pathology	6	3	3	25	75	100
		23PBT E1B	Elective Course I - Mushroom Cultivation						
5		23PBTE2A	Elective Course II – Herbal Technology	6	3	3	25	75	100
		23PBTE2B	Elective Course II – Horticulture						
Semester - II									
6	II	23PBT4	Core Course IV –Plant Taxonomy of Angiosperms and Economic Botany	6	5	3	25	75	100
7		23PBT5	Core Course V –Plant Anatomy and Embryology of Angiosperms	6	5	3	25	75	100
8		23PBT6P	Core Course VI –Laboratory Course covering Papers IV and V	4	4	4	40	60	100
9		23PBTE3A	Elective Course III – Phytochemistry	5	3	3	25	75	100
		23PBTE3B	Elective Course III – Research Methodology, Computer Applications and Bioinformatics						
10		23PBTE4A	Elective Course IV - Biostatistics	5	3	3	25	75	100
		233PBTE4B	Elective Course IV – Intellectual Property Rights (IPR)						
11		23PBTSE1	Skill Enhancement Course – I - Agriculture and Food Microbiology	4	2	3	25	75	100
Semester – III									
12	III	23PBT7	Core Course VII – Cell and Molecular Biology	6	5	3	25	75	100
13		23PBT8	Core Course VIII – Genetics, Plant Breeding and Biostatistics	6	5	3	25	75	100
14		23PBT9	Core Course IX –Ecology, Phytogeography and Conservation Biology and Intellectual Property Rights	5	5	3	25	75	100
15		23PBT10P	Core Course X –Laboratory Course covering Papers VII, VIII and IX	4	4	4	40	60	100
16		23PBTE5A	Elective Course V – Applied Plant Cell and Tissue Culture	5	3	3	25	75	100
		23PBTE5B	Elective Course V – Entrepreneurial Oppertunities in Botany						
17		23PBTSE2	Skill Enhancement Course II – Online Objective Paper	4	2	3	25	75	100
		23PIT	Intenship for Industrial Activity (30 Hours)		2	3			
Semester – IV									
18	IV	23PBT11	Core Course XI – Plant Physiolog and Biochemistry	6	5	3	25	75	100
19		23PBT12P	Core Course XII –Laboratory Course covering Papers XI	4	4	4	40	60	100
20		23PBT13PW	Core Course –Project with Viva Voce	12	7	3	25	75	100
21		23PBTE6A	Elective Course VI – Organic Farming	4	3	3	25	75	100
		23PBTE6B	Elective Course VI – Gene Cloning and Gene Therapy						
22		23PBTSE3	Skill Enhancement Course III – Nursery and Gardening	4	2	3	25	75	100
		23PEA	Extention Activity		1	3			
Total				120	91				2400

Content

1. Introduction: PO & PSO

Programme Outcome, Programme Specific Outcome and Course Outcome

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

TANSCHE REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK FOR POSTGRADUATE EDUCATION	
Programme	**M.Sc. BOTANY**
Programme Code	**PBT**
Duration	**PG - 2 years**
Programme Outcomes (Pos)	**PO1: Problem Solving Skill** Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context. **PO2: Decision Making Skill** Foster analytical and critical thinking abilities for data-based

	decision-making. **PO3: Ethical Value** Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities. **PO4: Communication Skill** Ability to develop communication, managerial and interpersonal skills. **PO5: Individual and Team Leadership Skill** Capability to lead themselves and the team to achieve organizational goals. **PO6: Employability Skill** Inculcate contemporary business practices to enhance employability skills in the competitive environment. **PO7: Entrepreneurial Skill** Equip with skills and competencies to become an entrepreneur. **PO8: Contribution to Society** Succeed in career endeavors and contribute significantly to society. **PO 9 Multicultural competence** Possess knowledge of the values and beliefs of multiple cultures and a global perspective. **PO 10: Moral and ethical awareness/reasoning** Ability to embrace moral/ethical values in conducting one's life.
Programme Specific Outcomes (PSOs)	**PSO1 – Placement** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions.

	PSO 2 - Entrepreneur To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations. **PSO3 – Research and Development** Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development. **PSO4 – Contribution to Business World** To produce employable, ethical and innovative professionals to sustain in the dynamic business world. **PSO 5 – Contribution to the Society** To contribute to the development of the society by collaborating with stakeholders for mutual benefit.

M.Sc. BOTANY CURRICULUM

SEMESTER – I

CORE I - PLANT DIVERSITY – I: ALGAE, FUNGI, LICHENS AND BRYOPHYTES

Title of the Course		**PLANT DIVERSITY – I: ALGAE, FUNGI, LICHENS AND BRYOPHYTES**					
Paper Number		**CORE I**					
Category	Core	**Year**	I	**Credits**	5	**Course Code**	**23PBT1**
		Semester	I				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
				--	7		
Pre-requisite		Students should be familiar with the basics of algae, fungi, lichens and Bryophytes.					
Learning 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 viewpoint.					

UNIT	CONTENTS
I	**ALGAE:** General account of algology, Contributions of Indian Phycologist (T.V.Desikachary, V.Krishnamurthy and V.S. Sundaralingam), Classification of algae by F.E. Fritsch (1935-45) & 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, Dictyota* and *Gelidium.*

II	**FUNGI:** General Characteristics, occurrence and distribution. Mode of nutrition in fungi. Contributions of Indian Mycologists (C.V.Subramanian), Classification of Fungi by Alexopoulos and Mims (1979) & Recent trends in the classification of fungi - Phylogeny and inter-relationships of major groups of fungi. General characters of major classes: Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina. Heterothallism in fungi, sexuality in fungi, Para sexuality, sex hormones in fungi. Structure, reproduction and life histories of the following genera: *Plasmodiophora, Phytophthora, Rhizopus, Taphrina, Polyporus* and *Colletotrichum.*
III	**LICHENS:** Introduction and Classification (Hale, 1969). Occurrence and inter-relationship of phycobionts and mycobionts, structure and reproduction in Ascolichens, Basiodiolichens and Deuterolichens.
IV	**BRYOPHYTES:** General characters and Classification of Bryophytes by Watson (1971). Distribution, Structural variations and evolution of gametophytes and sporophytes in Bryopsida, Anthoceropsida and Mosses. General characters of major groups - Marchantiales, Jungermaniales, Anthocerotales, Sphagnales, Funariales and Polytrichales. Reproduction - Vegetative and sexual, spore dispersal mechanisms in bryophytes, spore germination patterns in bryophytes. Structure, reproduction and life histories of the following genera: *Targionia, Lunularia, Porella* and *Polytrichum.*
V	**ECONOMIC IMPORTANCE:** 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.

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Relate to the structural organizations of algae, fungi, lichens and Bryophytes.	K1
CO2	Demonstrate both the theoretical and practical knowledge in understanding the diversity of basic life forms and their importance.	K2
CO3	Explain life cycle patterns in algae, fungi, lichens and Bryophytes.	K3
CO4	Compare and contrast the mode of reproduction in diverse groups of basic plant forms.	K4

CO5	Discuss and develop skills for effective conservation and utilization of lower plant forms.	K5 & K6
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)	
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill	

Recommended texts:

1. Kumar, H.D.1999. Introductory Phycology. Affiliated East-West Press, Delhi.
2. Barsanti, L. and Guadtieri, P. 2014. Algae: Anatomy, Biochemistry and Biotechnology, 2nd Edition, CRC Press, ISBN: 1439867321.
3. Sharma, O.P. 2011. Fungi and Allied Microorganisms, 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, 5thEd., Cambridge UniversityPress, London.
3. Nash, T.H. 2008. Lichen Biology, Cambridge University press.
4. Johri, R.M., Lata, S. and Tyagi, K. 2012. A Textbook of Bryophyta. Dominant Publishers & Distributors Pvt., Ltd., New Delhi. ISBN: 9789384207335.
5. Alexopoulos, C.J. and Mims, M. 2007. Introductory Mycology. 4th Edition, Wiley Publishers, ISBN: 9780471522294

Web resources:

1. https://www.britannica.com/science/algae
2. https://en.wikipedia.org/wiki/Bryophyte
3. https://www.britannica.com/plant/bryophyte/Ecology-and-habits
4. https://www.livescience.com/53618-fungus.html.
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	S	3	2	3	2	1	2	2	2	2
CO 2	3	3	2	2	3	3	2	3	2	3
CO 3	2	2	3	3	1	2	1	3	1	3
CO 4	3	3	3	3	3	2	3	3	3	3
CO 5	3	3	2	3	2	3	3	3	3	3

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

CORE II - PLANT DIVERSITY – II (PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY)

Title of the Course		**PLANT DIVERSITY – II (PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY)**					
Paper Number		**CORE II**					
Category	Core	**Year**	I	**Credits**	4	**Course Code**	**23PBT2**
		Semester	I				

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	3	2	--	5

Pre-requisite	Students should know about the fundaments of Pteridophytes, Gymnosperms and fossil records.
Learning 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.

UNIT	**CONTENTS**
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.
II	**PTERIDOPHYTES:** Structure, anatomy, reproduction and life histories of the following genera: *Isoetes, Equisetum Angiopteris, Osmunda, Pteris* and *Azolla.*
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.
IV	**GYMNOSPERMS:** Structure (Exomorphic and endomorphic), anatomy, reproduction and life histories of the following genera: *Thuja,Cupressus, Araucaria, Podocarpus, Gnetum* and *Ephedra*.
	PALEOBOTANY: Geological Scale; Radiocarbon dating; Contribution of Birbal Sahni to Paleobotany.

V	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.*

Course Outcomes:	**On completion of this course the student will be able to**	**Programme Outcomes**
CO1	Recall on classification, recent trends in phylogenetic relationship, general characters of Pteridophytes and Gymnosperms.	K1 & K3
CO2	Learn the morphological/anatomical organization, life history of major types of Pteridophytes and Gymnosperms.	K3 & K4
CO3	Comprehend the economic importance of Pteridophytes, Gymnosperms, and fossils.	K3 & K5
CO4	Understanding the evolutionary relationship of Pteridophytes and Gymnosperms.	K2
CO5	Awareness on fossil types, fossilization and fossil records of Pteridophytes and Gymnosperms.	K1 & K3

K1 - Remember; **K2 -** Understand; **K3 -** Apply; **K4 -** Analyze; **K5 -** Evaluate; **K6** – Create.

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

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 Anil Kumar. 2018. Botany for Degree students - Gymnosperms. S. Chand and Company Ltd., New Delhi.
6. Johri, R.M, Lata, S, Tyagi, K. 2005. A 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- 12 th edition (Paper back), Vikas Publishing.

3. Rashid, A. 2013. An introduction to Pteridophyta – Diversity, Development and differentiation (2nd edition), Vikas Publications.
4. Arnold A.C. 2005. An Introduction to Paleobotany. Agrobios (India). Jodhpur.
5. Sporne, K.R. 2017. The morphology of Pteridophytes (The structure of Ferns and Allied Plants) (Paper back), Andesite Press.
6. Sporne, K.R. 1967. The Morphology of Gymnosperms. Hutchinson & Co., London.
7. Taylor, E, Taylor, T, Krings, M. 2008. Paleobotany: The Biology and Evolution of Fossil Plants, 2nd Edition, Academic Press.

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
   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	3	3	3	3	3	3	3	3	3
CO 2	3	3	3	3	3	3	3	3	3	3
CO 3	2	3	3	3	3	1	3	3	3	3
CO 4	3	3	2	3	3	3	3	2	3	2
CO 5	3	2	2	2	2	2	2	1	2	1

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

CORE III - CORE-III LABORATORY COURSE-I COVERING THEORY PAPERS I AND II

Title of the Course		**CORE-III LABORATORY COURSE-I COVERING THEORY PAPERS I AND II**					
Paper Number		**CORE III**					
Category	Core	**Year**	I	**Credits**	4	**Course Code**	**23PBT3P**
		Semester	I				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		3	2	--	5		
Pre-requisite		Students should be familiar with the fundamentals of algae, fungi, lichens, Bryophytes, Pteridophytes, Gymnospersms, Paleobotany and microbes in addition to essential laboratory techniques.					
Learning 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. thallophytes, and other varieties of non-flowering plants.					
		5.To compare the structural diversity of fossil and extant plant species.					

UNIT	EXPERIMENTS
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*, *Dictyota*and *Gelidium*(depending onavailability 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).
	FUNGI Study of morphological and reproductive structures of the following living

II	forms: *Plasmodiophora, Phytophthora, Rhizopus, Taphrina, 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.*
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).
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.*
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.*

Course outcomes: **CO**	**On completion of this course the student will be able to**	**Programme outcomes**
CO1	Recall and applying the basic keys to distinguish at species level identification of important algae and fungi through its structural organizations.	K1 & K4
CO2	Demonstrate practical skills in thallophytes, Pteridophytes and Gymnosperms.	K2
CO3	Describe the structure of algae, fungi, lichens, Bryophytes, Pteridophytes and Gymnosperms.	K3
CO4	Determine the importance of structural diversity in the evolution of plant forms.	K5
CO5	Formulate techniques to isolate and culture of alga and fungi as well as to understand the diversity of plant forms.	K5 & K6

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

1. Kumar, H.D. 1999. Introductory Phycology. Affiliated East-West Press, Delhi.
2. Das, S and Saha, R. 2020. Microbiology Practical Manual. CBS Publishers and Distributors (P) Ltd., New Delhi, India.
3. Sharma, O.P. 2012. Pteridophyta, Tata McGraw-Hills Ltd, New Delhi.
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, 3rd Ed. Cambridge University Press, Cambridge.
3. Sharma, O.P. 2017. Bryophyta, MacMillan India Ltd, New Delhi.
4. Ashok, M. Bendre and Kumar. 2010. A text book of Practical Botany, Algae, Fungi, Lichen, Bryophyta, Pteridophyta, Gymnosperms and Palaeobotany. Revised edition. Published by Rakesh Kumar Rastogi publication.
5. Gangulee, H.C and A.K. Kar. 2013. College Botany. Vth Edition. S. Chand.

Web resources:

1. https://www.frontiersin.org/articles/10.3389/fmicb.2017.00923/full
2. https://microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175e.pdf
3. http://www.cuteri.eu/microbiologia/manuale_microbiologia_pratica.pdf

4. https://www.amazon.in/Manual-Practical-Bryophyta-Suresh-Kumar/dp/B0072GNFX4
5. https://www.amazon.in/Practical-Manual-Pteridophyta-Rajan-Sundara/dp/8126106883
6. https://www.google.co.in/books/edition/Gymnosperms/3YrT5E3Erm8C?hl=en&gbpv=1&dq=gy mnosperms&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	2	3	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	3	1	3	1	3
CO3	3	3	3	3	3	3	2	3	2	3
CO4	3	3	2	1	2	2	1	2	1	3
CO5	3	3	3	3	3	3	3	2	3	2

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

ELECTIVE I - MICROBIOLOGY, IMMUNOLOGY AND PLANT PATHOLOGY

Title of the Course	**MICROBIOLOGY, IMMUNOLOGY AND PLANT PATHOLOGY**						
Paper Number	ELECTIVE I						
Category	ELECTIVE	**Year**	I	**Credits**	3	**Course Code**	**23PBTE1A**
		Semester	I				

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	3	2	--	5

Pre-requisite	1.The goal of the course is to provide students with basic understanding of microbiology, immunology, plant pathology and the etiology of specific plant diseases.
Learning Objectives	2.To provide comprehensive knowledge about microbes and its effect on man and environment.
	3.To provide comparative analysis of major groups of microbes.
	4.To study the principles of immune system, immunizing agents like antibodies and vaccines and gene therapy methods.
	5.To enhance the knowledge and skills needed for self-employment using the microbial derived products.
	6.To appreciate the role of immune system in conferring disease resistance.

UNIT	**CONTENTS**
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.
II	**VIRUSES:** General characters, Classification, Structure, Multiplication. Overview of Phycoviruses and Mycoviruses. Viruses of Eukaryotes – Animal & 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.

III	**FOOD MICROBIOLOGY:** Beneficial role of microbes – yoghurt, Olives, Cheese, Bread, Wine, Tempeh, Miso & Fermented green tea. Spoilage of fruits, vegetables, meats, poultry, eggs, bakery products, dairy products and canned foods. Microbial toxins - Exotoxin, Endotoxin & Mycotoxin. Action of Enterotoxin, Cytotoxin& Neurotoxin. Food Preservation – temperature, drying, radiation and chemicals. Soil Microbiology: Importance of Microbial flora of soil and factors affecting the microbial community in soil. Interaction among soil microbes (positive and negative interactions) & with higher plants (rhizosphere &phyllosphere). Microorganisms in organic matter decomposition. Environmental Microbiology: Microbiology of water and air. Water borne diseases - diphtheria, chicken pox. Air borne diseases - Swine flu and Measles. Microbial degradation of chemical pesticides and hydrocarbon.
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.
V	**PLANT PATHOLOGY:** History and significance of plant pathology. Classification of plant diseases, Symptomology (important symptoms ofplant pathogens). Principles of plant infection –Inoculum, inoculum potential, Pathogenicity. Disease triangle. Host parasite interrelationship and interaction. Causal agents of plant diseases - biotic causes (fungi, bacteria virus, mycoplasma, nematodes, parasitic algae, angiospermic parasites - Abiotic causes (Physiological, deficiency of nutrients & minerals and pollution).Mechanism of penetration- Disease development of pathogen (colonization) and dissemination of pathogens. Role of enzymes and toxins in disease development. Defence mechanism of host – structural and biochemical defences. Important diseases of crop plants in India - Sheath blight of rice, Late blight of potato, Little leaf of Brinjal and Red rust of tea. Principles of disease management – Cultural practices, physical, chemical and biological methods, disease controlled by immunization. Biocontrol - merits and demerits; Plant quarantine and legislation. Integrated Pest Management system. Diagnostic technique to detect pest/pathogen infection - Immunofluorescence (IF).

Course outcomes: **CO**	**On completion of this course the student will be able to**	**Programme outcomes**

CO1	Recognize the general characteristics of microbes, plant defense and immune cells.	K1
CO2	Explain about the stages in disease development and various defense mechanisms in plants and humans.	K2
CO3	Elucidate concepts of microbial interactions with plant and humans.	K3
CO4	Analyze the importance of harmful and beneficial microbes and immune system	K4
CO5	Determine and interpret the detection of pathogens and appreciate their adaptive strategies.	K5 & K6
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)	
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill	

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. Alcamos Fundalmedals of Microbiology. 10th Edition. Johnsand Bartlett Learning.
3. Pelczar, M. J. 2007. Microbiology. 35th Edition, Tata-McGraw Hill Publications, New York, ISBN: 0074623260.
4. Ravi Chandra, N.G. 2013. Fundamentals of Plant Pathology, Phi Learning, ISBN:812034703X.
5. Willie, J. and Sherwood, L. 2016. Prescott's Microbiology McGraw-Hill Education; 10th Edition, ISBN: 978-1259281594
6. Chaube, H.S. and Singh, R. 2015. Introductory Plant Pathology CBS Publishers, ISBN: 978-8123926704.
7. Rangasamy, G. 2006. Disease of crop plants in India (4th edition). Tata 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	1	2	1
CO3	3	3	3	3	3	3	1	3	1	3
CO4	3	3	2	2	3	3	2	1	2	1
CO5	3	3	3	3	3	3	3	2	3	2

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

ELECTIVE-I MUSHROOM CULTIVATION

Title of the Course	**MUSHROOM CULTIVATION**						
Paper Number	**ELECTIVE I**						
Category	ELECTIVE	**Year**	I	**Credits**	3	**Course Code**	**23PBTE1B**
		Semester	I				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		3	2	--	5		
Pre-requisite	Basic knowledge on structure and function of various groups of mushrooms.						
Learning Objectives	1.To teach the identification of mushrooms.						
	2.To differentiate the edible mushrooms with toxic and hallucinating fungi.						
	3.To study the cultivation technique of mushrooms						
	4.To learn the economic importance of mushroom in various fields.						
	5.To study how to establish mushroom cultivation as business enterprise.						
	6.To teach the identification of mushrooms.						

UNIT	CONTENTS
I	**INTRODUCTION:** Mushroom, Edible Mushroom, commercial production, medicinal value of mushrooms, nutraceuticals and dietary supplements
II	**MORPHOLOGICAL AND MICROSCOPICAL IDENTIFICATION OF EDIBLE AND POISONOUS MUSHROOMS**: Keys for identification of edible mushrooms: *Agaricus bisporus*, *Pleurotus sajorcaju*, *Volvariella volvcea* and *Calocybe indica*. Key for identifying hallucinogenic mushroom (*Psilocybe* sp.) Medicinal Mushroom – *Cordyceps*, *Ganoderma lucidum* and *Lentinus edodes.*
III	**CULTIVATION:** Substrate sterilization, bed preparation, cropping room and maintenance, raising of pure culture and spawn preparation, factors effecting button mushroom production (Temp, pH, air and water management, competitor moulds and other disease).

IV	**POST-HARVEST MANAGEMENT:** Harvest, storage, quality assurance of mushrooms. Pestmanagement.
V	World production edible mushroom, Legal and regulatory issues of introducing the medicinalmushrooms in different countries. Developing small scale industry and Government schemes. Mushroom Research Centres – International and National levels.

Course Outcomes: CO	**On completion of this course the student will be able to**	**Programme outcomes**
CO1	Knowledge on identification of edible and toxic mushrooms belonging toAscomycota and Basidiomycota.	K1, K3
CO2	Outline the nutraceutical properties of edible mushrooms.	K2, K4
CO3	Knowledge on cultivation techniques of edible and medicinal mushrooms.	K3, K6
CO4	Understand the harvest and post-harvest techniques of mushroom crops.	K4
CO5	Knowledge on the production and marketing strategies for mushrooms.	K5

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

1. Cheung, P. C.K. 2008. Mushrooms as functional food. A John Wiley & Sons, Inc., Publication.
2. Dijksterhuis, J. and Samson, R.A. 2007. Food Mycology: A multifaceted approach in fungiand food. CRC press, Newyork.
3. Hall., R.I., Stepheson, S.L., Buchanan, P.K., Yun, W. and Cole, A.L.J. 2003. Edible andpoisonous mushrooms of the world. Timber Press, Portland, Cambridge.
4. Ting, S. and Miles, P.G. 2004. Mushrooms: Cultivation, nutritional value, medicinal effectand nutritional environmental impact. CRC press, Newyork.
5. Verma, 2013. Mushroom: edible and medicinal: cultivation conservation, strain improvement with their marketing. Daya Publishing House.

Reference books:

1. Tiwari., SC., Pandey K. 2018. Mushroom cultivation. Mittal publisher, New Delhi.
2. Philips, G., Miles, Chang, S-T. 2004. Mushrooms: Cultivation, nutritional value, medicinaleffect and environmental effect. 2nd ed. CRC Press.

3. Diego, C.Z., Pando-Gimenez, A. 2017. Edible and medicinal mushrooms: Technology andApplication. Wiley-Blackwell publishers.
4. Nita Bahl. 2002. Handbook on Mushroom 4th edition Vijayprimlani for oxford & IBH publishing co., Pvt., Ltd., New Delhi. Dr.C. Sebastian Rajesekaran Reader in Botany Bishop Heber College, Trichy – 17.
5. Suman. 2005. Mushroom Cultivation Processing and Uses, M/s. IBD Publishers and Distributors, New Delhi.

Web resources:

1. https://www.amazon.in/Mushroom-Cultivation-India-B-C/dp/817035479X
2. http://nrcmushroom.org/book-cultivation-merged.pdf
3. http://agricoop.nic.in/sites/default/files/ICAR_8.pdf
4. http://www.agrimoon.com/mushroom-culture-horticulture-icar-pdf-book/
5. https://books.google.co.in/books/about/Mushroom_Cultivation_in_India.html?id=6AJx99OGTKEC&redir_esc=y

Mapping with Programme Outcomes:

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

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

ELECTIVE-II HERBAL TECHNOLOGY

Title of the Course	**HERBAL TECHNOLOGY**						
Paper Number	**ELECTIVE II**						
Category	ELECTIVE	**Year**	I	**Credits**	3	**CourseCode**	**23PBTE2A**
		Semester	I				

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	3	2	--	5

Pre-requisite	To understand the importance of herbal technology.
Learning Objectives	1.To understand various plants based drugs used inayurvedha, 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 theo in the making of herbal insecticides.

UNIT	**CONTENTS**
I	**PHARMACOGNOSY** Pharmacognosy scope and importance - source - Crude Drugs – Scope and Importance, Classification (Taxonomical, Morphological Chemical, Pharmacological); Cultivation, Collection and processing of crude drugs. Cultivation and utilization of medicinal and aromatic plants in India.
II	**PLANT TISSUE CULTURE AS SOURCE OF MEDICINES** Plant tissue culture as source of medicines, Role of plant tissue culture in enhancing secondary metabolite production (*Withania somnifera, Rauwolfia serpentina, Catheranthus roseus, Andrographis paniculata* and *Dioscorea sp*) - Elicitation - Biotransformation, Hairy root culture. Factors affecting secondary metabolites production. Biogenesis of phytopharmaceuticals.
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.
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.
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.

Course outcomes: able to: CO	**On completion of this course, the students will be**	**Programme outcomes**
CO1	Recollect the importance of herbal technology.	K1
CO2	Understand the classification of crude drugs from various botanical sources.	K2
CO3	Analyze on the application of secondary metabolites in modern medicine.	K3
CO4	Create new drug formulations using therapeutically valuable phytochemical compounds for the healthy life of society.	K4
CO5	Comprehend the current trade status and role of medicinal plants in socio economic growth.	K5 & K6

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

1. Kokate, C.K., Purohit, A.P and S.B. Gokhale. 1996. Pharmacognosy. NiraliPrakashan, 4th Ed.
2. Roseline, A. 2011. Pharmacognosy. MJP publishers, Chennai.
3. Tilgner, Sharol Marie. 2018. Herbal ABC's: The Foundation of Herbal Medicine.
4. Natural Products in medicine: A Biosynthetic approach. 1997. Wiley. Hornok, L. (ed.).
5. Chichister, U.K.J. 1999. Cultivation and Processing of Medicinal Plants, Wiley & Sons. Treaseand Evans.
6. Mukherjee, P.K. 2008. Quality control of herbal drugs. 3rd edition. Business Horizons

Pharmaceutical Publishers, New Delhi, India.
7. Kirthikar and Basu. 2012. Indian Medicinal Plants. University Bookstore, Delhi. India
8. Biswas, P.K. 2006. Encyclopedia of Medicinal plants (Vol. I-VII). Dominant Publishers, New Delhi.
9. Chaudhuri, A.B. 2007. Endangered Medicinal Plants. Daya Publishing House, New Delhi.
10. Tilgner, Sharol Marie. 2018. Herbal ABC's: The Foundation of Herbal Medicine.

Reference Books:

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

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

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

ELECTIVE-II HORTICULTURE

Title of the Course	**HORTICULTURE**						
Paper Number	**ELECTIVE II**						
Category	ELECTIVE	**Year**	I	**Credits**	3	**Course Code**	**23PBTE2B**
		Semester	I				

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	3	2	--	5

Pre-requisite	Students should know fundamental knowledge on horticulture applications.
Learning Objectives	1.Know about the brief history, divisions, classification and structure of horticultural plants.
	2.Acquire knowledge on plant growth processes and stages of plant growth.
	3.Understand the plant growth environment in relation to soil, nutrients, fertilizers, and bio inoculants.
	4.Study the sexual and vegetative propagation methods including propagation through specialized vegetative structures.
	5.Develop practical skills in micro propagation techniques and soil-less production of horticultural crops.

UNIT	**CONTENTS**
I	**INTRODUCTION TO HORTICULTURE** Definition; Brief History, Divisions of Horticulture, Classification of horticultural plants, Structure of Horticultural Plants –Cell and Tissue systems, Anatomy of stem root and leaf, Morphological structures, Plant growth processes-A brief account of Photosynthesis, Respiration, Transpiration and Translocation, Stages of plant growth.
II	**FACTORS AFFECTING PLANT GROWTH** Plant Growth Environment: Abiotic factors, Soil –Profile structure, Primary and Secondary nutrients and their functions, Organic matter, Fertilizers –organic, Inorganic and Potting Media, Bio inoculants, Methods of fertilizer application, Directing Plant growth-Training -Pruning and thinning.
III	**PLANT PROPAGATION** Plant propagation: Seeds –Advantages, Viability, Mechanism of Dormancy and Dormancy Breaking: Methods of Direct and Indirect Seedling Production in Nurseries and Transplantation; Propagation through specialized underground structures –Corm, Tuber, Sucker, Bulb, Bulbil, Rhizome; Vegetative Propagation – Cutting, Layering, Grafting and Budding.
IV	**MICROPROPAGATION TECHNIQUES** Stages, multiplication by shoot tip, Nodal culture and Callus culture-Application and Limitations, Somatic embryogenesis, Synthetic seeds –Preparation and Potential

	uses of artificial seeds, Embryo Rescue, Soil-less Production of Horticultural crops –Hydroponics, sand culture, gravel culture.
V	**AESTHETICS OF HORTICULTURE** Design: Elements and Principles of Design, Flower Arrangement, Terrarium Culture, Bonsai, Growing Plants Indoors, Turf Production, Landscaping-Principles, Types of Parks, Xeriscaping. Postharvest handling of Horticultural Products – Harvesting, Storage, Processing, Elements of Marketing. Robotics in Horticulture.

Course outcomes: **CO**	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Identify and categorize various horticultural plants and the conditions that affect their growth and productivity.	K1
CO2	Explain the various structures and growth processes of horticultural plants.	K2
CO3	Demonstrate the propagation, growth, and maintenance of plants in horticulture systems.	K3
CO4	Correlate the soil characteristics and fertility to good plant growth.	K4
CO5	Utilize the role plant tissue culture techniques in the production of quality planting stock in horticulture.	K5
CO6	Apply horticultural skills and knowledge to explore career opportunities in horticulture industry.	K6

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

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

Reference Books:

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

Web resources:

1. https://www.kobo.com/in/en/ebooks/horticulture
2. https://www.gale.com/gardening-and-horticulture
3. https://www.iaritoppers.com/p/horticulture-icar-ecourse-pdf-books.html
4. https://www.amazon.in/Introduction-Horticulture-N-Kumar-ebook/dp/B08M4289M6
5. https://www.researchgate.net/publication/316438576_Polyembryony_in_Horticulture_and_its_significance

Mapping with Programme Outcomes:

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

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

SEMESTER - II

CORE-IV TAXONOMY OF ANGIOSPERMS AND ECONOMIC BOTANY

Title of the Course	**PLANT TAXONOMY OF ANGIOSPERMS AND ECONOMIC BOTANY**						
Paper Number	**CORE IV**						
Category	Core	**Year**	I	**Credits**	4	**Course Code**	**23PBT4**
		Semester	II				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		3	2	--	5		
Pre-requisite		Prior knowledge on morphological, anatomical characteristics and uses of plants.					
Learning 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.					

UNIT	CONTENTS
I	**TAXONOMY AND SYSTEMATICS** Botanical exploration and contribution with special reference to India by William Roxburgh, J.D. Hooker, Robert Wright, Nathanial Wallich and Gamble, J.S. Principles of classification as proposed – Artificial – Linnaeus, Natural – Bentham and Hooker, Phylogenetic system - Hutchinson, Modern – Takhtajan. Botanical gardens and herbaria of world, preparation and maintenance of Herbarium, Botanical survey of India – its organization and role.
II	**MODERN TRENDS IN TAXONOMY** Modern trends in taxonomy, chemotaxonomy, numerical taxonomy, biosystemics. ICBN uninominal systems- genesis binomial nomenclature, importance and principle. Important articles, typification, principles of priority, effective and valid publication, author citation, recommendations and amendents of code. Glossories and dictionaries, Taxonomic literature (Index Kewensis)
III	**SYSTEMATIC ANALYSIS OF PLANTS-I** Polypetalae – Nympheaceae, Sterculiaceae, Portulaceae, Rhamnaceae, Vitaceae, Sapindaceae, Combretaceae, Turneraceae.
	SYSTEMATIC ANALYSIS OF PLANTS-II Gamopetalae – Sapotaceae, Oleaceae, Boraginaceae, Scrophulariaceae, Bignoniaceae, Convolvulaceae, Acanthaceae, Verbenaceae.

IV	Monochlamydeae – Nyctaginaceae, Aristolochiaceae, Casuarinaceae. Monocots – Orchidaceae, Amarylidaceae, Lilliaceae, Commelinaceae, Cyperaceae.
V	**ECONOMIC BOTANY** General account on utilization of selected crop plants: (i) Cereals (rice and wheat) – (ii) Pulses (red gram and black gram), (iii) Drug yielding plants (*Withaniasomnifera*and *Coleus aromaticus)* (iv) Oil yielding plants (Groundnut, sunflower). (v) Sugar yielding plants (sugarcane and sugar beet), (vi) Spices and condiments (cardamom, cinnamon). (vii) Commercial crops - fibre (jute), (viii) Timber (Teak and red sanders wood), (ix) Resins and gums (Asafoetida and gum arabic) – (x) Essential oils (lemon grass and menthol), (xi) Beverages (tea, coffee), (xii) Plants used as avenue trees for shade, pollution control and aesthetics (xiii) Energy plantation - uses of *Casuarina.*

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Recollect the basic concepts of morphology of leaves, flowers. Identify the types of compound leaves , inflorescence and fruits Describe their characteristic features	K1, K2 K3
CO2	Explain the principles of taxonomy. Summarize the taxonomic hierarchy. Define Binomial nomenclature. Group Activity – Construct key preparation	K1, K2 K5, K6
CO3	Explain the various types of classification. Distinguish its advantages and disadvantages Construction of floral formula anf floral diagram.	K1, K2 K3, K4
CO4	Illustrate and explain the characteristic features and list out the economic importance of the families Field trip to local botanical garden and regional botanical garden.	K1, K2 K3, K4
CO5	Illustrate and explain the characteristic featuresand list out the economic importance of the families.	K1, K2 K3, K5

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

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.
3. Singh, G. 2007. Plant systematics theory and practices. Oxford and IBH Publishing Co.

4. Jain, S.K and Rao R.R. 1993. A handbook of field and herbarium methods. Today and Tomorrow Publ.
5. Pandurangan, A.G., Vrinda, K.B and Mathew Dan. 2013. Frontiers in plant taxonomy. JNTBGRI, Thiruvananthapuram, Kerala.
6. Vardhana, R. 2009. Economic Botany. 1st ed. Sarup Book Publishers Pvt Ltd. New Delhi.
7. Subramaniam, N.S. 1997. Modern plant taxonomy. Vikas Publishing House, New Delhi.

Reference Books:

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

Web resources:

1.https://www.ipni.org/
2.http://www.theplantlist.org/
3.https://www.amazon.in/PLANT-TAXONOMY-Sharma/dp/0070141592
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	3	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	2	2	1	2	2
CO3	3	3	2	3	1	3	2	3	3	1
CO4	3	2	3	3	2	3	3	1	3	3
CO5	3	3	2	2	1	2	1	3	2	1

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

CORE-V PLANT ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS

Title of the Course	**PLANT ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS**						
Paper Number	**CORE V**						
Category	Core	**Year**	I	**Credits**	4	**Course Code**	23PBT5
		Semester	II				

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	3	2	--	5

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

UNIT	**CONTENTS**
I	**CELL WALL:** Morphological and physico-chemical changes; Plasmodesmata- types of pits – growth of cell wall – formation of intercellular spaces; Meristems: Classifications: Theories of shoot and root apices, Cytological zonation in shoot apex. Vascular Cambium: Composition and organization – multiplicative and additive divisions. Xylem: Primary and secondary xylem – tracheary elements and vessels – vesselless dicots – xylem rays and axial parenchyma of angiosperm wood; Dendrochronology – grain, texture and figure in wood; reaction wood; ring porous and diffuse porous wood. Phloem: Ultra structure and ontogeny of sieve tube elements and companion cell. Evolution of tracheary elements.
II	**PERIDERM:** Structure, organization and activity of phellogen. Polyderm and Rhytiderm – wound periderm. Normal secondary thickening in Dicots; Anomalous secondary growth in Dicots (Amaranthaceae, Aristolochiaceae, Bignoniaceae, Piperaceae, Nyctaginaceae) and arborescent Monocots. Primary thickening in palms; Ontogeny of leaf, Structure and types of Stomata; Leaf abscission; Major nodal types; Kranz anatomy and its significance. Microtechnique: Principle of killing

	and fixation, dehydration and rehydration of botanical specimens. Stains: Principle of double staining (fast-green and light green) of free hand sections; Protocol for serial sectioning of paraffin wax impregnated specimens; Mounting and mounting media.
III	**MICROSPORANGIUM AND MALE GAMETOPHYTE:** Structure and development of Anther; Ultrastructure and physiology of anther tapetum; Male gametophyte; Palynology: Morphology and ultrastructure of pollen wall, pollen kitt, pollen analysis, pollen storage, pollen sterility and pollen physiology.
IV	**MEGASPORANGIUM AND FEMALE GAMETOPHYTE:** Structure and development of Megasporangium; Types of ovules, Endothelium, obturator and nucellus. Megasporogenesis: Female gametophyte: Structure, types, haustorialbehavior and Nutrition of embryo sacs. Fertilization: Double fertilization and triple fusion; Endosperm: Development of endosperm, types, physiological efficiency of endosperm haustoria and functions; Ruminate endosperm. Embryogeny: Development of monocot (Grass) and dicot (Crucifer) embryos.
V	**POLYEMBRYONY:** Causes of Polyembryony, classification, induction and practical application. Apomixis and its significance. Seed and Fruit development and role of growth substances. Parthenocarpy and its importance.

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Learn the structures, functions and roles of apical *vs* lateral meristems in monocot and dicot plant growth.	K1& K2
CO2	Study the function and organization of woody stems derived from secondary growth in dicot and monocot plants.	K1&K4
CO3	Apply their idea on sectioning and dissection of plants to demonstrate various stages of plant development.	K2& K6
CO4	Understand the various concepts of plant development and reproduction.	K3& K6
CO5	Profitably manipulate the process of reproduction in plants with a professional and entrepreneurial mindset.	K5

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

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

Reference Books:

1. Krishnamurthy, K.V. 1988. Methods in Plant Histochemistry. S. Viswanathan & Co., Madras.
2. Swamy, B.G.L and Krishnamurthy. K.V 1990. From flower to fruits, Tata – McGraw Hill publishing Co Ltd, New Delhi.
3. Pullaiah, T., Lakshiminarayana, K and Hanumantha Rao, B. 2006. Text book of Embryology of Angiosperms. Regency Publications, New Delhi.
4. Bierhorst, D.W. 1971. Morphology of Vascular Plants. Macmillan publishers, New York.
6. Crang, R., Lyons-Sobaski, S and Wise, R. 2018. Plant Anatomy: A Concept-Based Approach to the Structure of Seed Plants. Springer International Publishing.
7. Cutler, D. F., Botha, T and Stevenson, D.W. 2008. Plant Anatomy: An Applied Approach. Blackwell Publishing, Malden, USA.
8. Eames, A.J and Mac Daniels, L.H. 2013. Introduction to Plant Anatomy, 3rd Edition. McGraw-Hill Inc., US.

Web resources:

1. https://www.ipni.org/
2. http://www.theplantlist.org/
3. https://faculty.etsu.edu/liuc/plant_anatomy_sites.htm
4. http://aryacollegeludhiana.in/E_BOOK/Botany/plant_anatomy.pdf
5. https://www.uou.ac.in/sites/default/files/slm/BSCBO-202.pdf
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	S	3	3	3	3	3	3	3	3	3
CO2	3	1	3	3	3	3	3	3	3	3
CO3	3	1	3	3	3	3	3	2	3	1
CO4	3	3	3	1	1	2	3	2	2	1
CO5	3	3	3	3	3	3	2	3	3	2

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

CORE-VII LABORATORY COURSE-II COVERING PAPERS, IV AND V

Title of the Course	**LABORATORY COURSE-II**						
Paper Number	**CORE VI**						
Category	Core	**Year**	I	**Credits**	4	**Course Code**	**23PBT6P**
		Semester	II				

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	3	-	2	5

Pre-requisite	Theoretical understanding of plant taxonomy, ecology and phytogeography, plant anatomy and embryology as well as basic laboratory skills for the relevant core course.
Learning Objectives	1.Understand and develop skill sets in plant morphological, floral characteristics and artificial key preparation.
	2.Expedite skilled workers to carry out research in frontier areas of plant science.
	3.Classify meristems and identify their structures, functions and roles in monocot and dicot plants growth and secondary growth of woody plants
	4.Learn the importance of plant anatomy in plant production systems.
	5Know about different vegetation sampling methods.

UNIT	**EXPERIMENTS**
I	**TAXONOMY AND ECONOMIC BOTANY OF ANGIOSPERMS** Preparation of artificial keys. Description of a species, based on virtual herbarium and live specimens of the families mentioned in the theory. Study the products of plants mentioned in the syllabus of economic botany with special reference to the morphology, botanical name and family. Solving nomenclature problems. **Field trip:** A field trip at least 3-4 days to a floristically rich area to study plants in nature and field report submission of not less than 20 herbarium sheets representing the families studied.
II	**ANATOMY** 1. Study of shoot apex of *Hydrilla* 2. Observation of cambial types. 3. Sectioning and observation of nodal types.

	4. Study of anomalous secondary growth of the following: STEM- *Nyctanthus, Bouerhhavia, Aristolochia, Bignonia, Piper* petal and *Mirabilis*. ROOT: *Acyranthus* 5. Observation of stomatal types by epidermal peeling. 6. Maceration of wood and observation of the components of xylem. 7. Double staining technique to study the stem anomali.
III	**EMBRYOLOGY** 1. Observation of T.S. of anther. 2. Observation of ovule types. 3. Observation of mature embryo sacs. 4. Dissection and observation of embryos (globular and cordate embryos). 5. Study of pollen morphology 6. Study of in vitro pollen germination. 7. Observation of endosperm types.

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	To gain recent advances in plant morphological and floral characteristics.	K1
CO2	Understand about different floral characteristics and artificial key preparation which employed for plant identification and conservation.	K2
CO3	Recall or remember the information including basic and advanced in relation with plant anatomy and embryology.	K4 &K5
CO4	Apply their idea on sectioning and dissection of plants to demonstrate various stages of plant development.	K3
CO5	Know about different vegetation sampling methods.	K3

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

1. Subramaniam, N.S. 1996. Laboratory Manual of Plant Taxonomy. Vikas Publishing House Pvt. Ltd., New Delhi.
2. Gokhale, S.B., Kokate, C.K. and Gokhale, A. 2016. Pharmacognosy of Traditional Drugs. NiraliPrakashan, 1st Edition. ISBN: 9351642062.
3. Joshi, S.G. 2018. Medicinal Plants. Oxford & IBH Publishing C., Pvt., Ltd., New Delhi. ISBN: 9788120414143.
4. Cutler, D.F., Botha, C.E.J., Stevenson, D.W., and William, D. 2008. Plant anatomy: an applied approach (No. QK641 C87). Oxford: Blackwell, UK.
5. Sundara, R. S. 2000. Practical manual of plant anatomy and embryology. Anmol Publ.

PVT LTD, New Delhi.
6. Panshin, A.J and C. de Zeeuw.1980.Textbook of wood technology. Structure, identification and uses of the commercial woods of the United States and Canada. Fourth Edition. New York: McGraw-Hill Book Company.
7. Sharma, H.P. 2009. Plant Embryology: Classical and Experimental, Bombay Popular Prakashan, ISBN-8173199698, 9788173199691.

Reference books:

1. Aler Gingauz. 2001. Medicinal Chemistry. Oxford University Press & Wiley Publications.
2. Mann J. Davidson, R.S and J.B. Hobbs, D.V. Banthorpe, J.B. Harborne. 1994. *Natural Products*. Longman Scientific and Technical Essex.
3. Gopalan, C., B.V. Ramasastri and S.C. Balasubramanian. 1985. Nutritive Value of Indian Foods. National Institute of Nutrition, Hyderabad.
4. Harborne. J.B. 1998. Phytochemical methods. A guide to modern techniques of Plant Analysis, Chapman and Hall publication, London.
5. Traditional plant medicines as sources of new drugs. P.J Houghton in Pharmacognosy.Trease and Evan's.16 Ed .2009.
6. Sundara Rajan, S, 2003. Practical Manual of Plant Anatomy and Embryology 1st ed, Anmol Publications, ISBN-812610668.
7. Katherine Esau. 2006. Anatomy of Seed Plants. 2nd edition, John Wiley and Sons.

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

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

ELECTIVE – III - PHYTOCHEMISTRY

Title of the Course	**PHYTOCHEMISTRY**						
Paper Number	**ELECTIVE III**						
Category	ELECTIVE	**Year**	I	**Credits**	3	**Course Code**	**23PBTE3A**
		Semester	II				

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	3	2	--	5

Pre-requisite	Basic understanding of plant metabolites.
Learning 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 andanimals**.**
	5.To understand the information of the traditional system of medicine.

UNIT	**CONTENTS**
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.
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.
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, flavour and cosmetic industries.

IV	**HERBALISM AND ETHNOBOTANY** Herbs and healing: Historical perspectives: local, national and global level; Herbalcultures: 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.
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: Historical 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 AyurvedicPharmacopoeia; *Vrikshayurveda.*

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Understand the role of plants in the survival of human beings and other Organisms.	K1
CO2	Recognition of the contribution made by primitive people in exploration of plantknowledge to alleviate common diseases and development of systems of medicine.	K2
CO3	Gaining knowledge on different classes of phytochemicals present in higher andlower plants species.	K3
CO4	Demonstrate the various aspects of extraction, isolation and characterization of secondary metabolites.	K4 & K5
CO5	Know the methods of screening of secondary metabolites for various biological properties.	K6

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

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 & 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 & 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 & 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. Nirali prakashan advancement of knowledge.
4. Braithwaite, A and F.J. Smith. 1996. *Chromatographic Methods* (5th Edition) Blackie Academic & Professional London.
5. Wilson, K and J. Walker (Eds). 1994. Principles and Techniques of Practical Biochemistry(4thEdition) 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	3	3	3	2	1	3	3	3	3
CO2	3	3	3	2	2	1	2	3	2	3
CO3	3	3	3	3	3	2	1	2	1	3
CO4	2	3	3	3	3	2	2	3	2	3
CO5	2	3	3	3	3	2	2	2	3	2

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

ELECTIVE-III RESEARCH METHODOLOGY, COMPUTER APPLICATIONS & BIOINFORMATICS

Title of the Course	**RESEARCH METHODOLOGY, COMPUTER APPLICATIONS & BIOINFORMATICS**						
Paper Number	**ELECTIVE III**						
Category	ELECTIVE	**Year**	I	**Credits**	3	**Course Code**	**23PBTE3B**
		Semester	II				

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	3	2	--	5

Pre-requisite	To impart expertise about analysis and research.
Learning Objectives	1.To equip students to collect, analyze and evaluate data generated by their own inquiries in a scientific manner.
	2.To provide an overview on modern equipments that they would help students gain confidence to instantly commence research careers and/or start entrepreneurial ventures.
	3.To develop interdisciplinary skills in using computers in botany to learn about the biological database.
	4.Students aware with the most recent technologies for sequencing and bioinformatics analysis and is able to apply them to the structural and functional genomics of plants.
	5.Operate various software resources with advanced functions and its open office substitutes.

UNIT	**CONTENTS**
I	Literature collection and citation: bibliography —bibliometrics (scientometrics): definition-laws — citations and bibliography - *biblioscape— plagiarism— project proposal writing — dissertation writing – paper presentation (oral/poster) - E-learning tools- monograph — introduction and writing-Standard operating procedure (SOP) – introduction and preparation — Research Institutions - National and International.
II	Basic principles and applications of pH meter, UV-visible spectrophotometer, centrifuge, lyophilizer, chromatography- TLC, Gas chromatography with mass spectrum (GC/MS), and HPLC-Scanning electron microscopy-Agarose gel Electrophoresis — Polyacrylamide Gel Electrophoresis –Polymerase chain reaction
III	Introduction to computers and Bioinformatics. Types of hardware and software operating systems. Fundamentals of networking, operation of networks, telnet, ftp, www, Internet. Biological Research on the web: Using search engines, finding scientific articles.
IV	Public biological databases, searching biological databases. Use of nucleic acid and protein data banks.

V	NCBI, EMBL, DDBJ, SWISSPORT, Protein prediction and Gene finding tools. Techniques in Bioinformatics- BLAST, FASTA, Multiple Sequence Analysis **.**

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Realize the need of centrifuges and chromatography and their uses in research	K1 & K2
CO2	Learn the principles and applications of electrophoresis.	K2 & K3
CO3	Construct the phylogenetic trees for similar characteristic feature of plant genomes and study *de novo* drug design through synthetic biology.	K5 & K6
CO4	Understand the concept of pairwise alignment of DNA sequences using algorithms.	K3 & K4
CO5	Interpret the features of local and multiple alignments.	K4 & K5

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

1. Veerakumari, L. 2017. Bioinstrumentation. MJP Publisher, India. p578.
2. SreeRamulu, V.S.1988. Thesis Writing, Oxford& IBH Pub. New Delhi.
3. Kothekar, V and T.Nandi. 2009. An introduction to Bioinformatics. Panima publishing crop, New Delhi.
4. Mani, K and N. Vijayaraj. 2004. Bioinformatics – A Practical Approach.1st Edn. Aparna publication, Coimbatore.
5. Gurumani, N. 2019. Research Methodology: For Biological Sciences, MP. Publishers.

Reference Books:

1. Jayaraman, J. 2000. Laboratory manual of Biochemistry, Wiley Eastern Limited, New Delhi 110 002.
2. Pevsner,J.2015.Bioinformaticsandfunctionalgenomics.Hoboken,NJ:Wiley-Blackwell.
3. Arthur Conklin W.M and Greg White, 2016. Principles of computer security. TMH. McGraw-Hill Education; 4 edition.
4. Irfan Ali Khan and Attiya Khanum (eds.). 2004. Introductory Bioinformatics. Ukaaz Publications, Hyderabad.
5. Arthur Conklin W.M., and Greg White. 2016. Principles of computer security. TMH., McGraw-Hill Education; 4th edition
6. Mishra Shanthi Bhusan. 2015. Handbook of Research Methodology - A Compendium for Scholars & Researchers, Ebooks2go Inc.

7. 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

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

ELECTIVE – IV – BIOSTATISTICS

Title of the Course	**BIOSTATISTICS**						
Paper Number	**ELECTIVE IV**						
Category	ELECTIVE	**Year**	I	**Credits**	3	**Course Code**	**23PBTE4A**
		Semester	II				

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	3	2	--	5

Pre-requisite	Fundamental knowledge on using in statistical tools and apply the tools to interpret the results.
Learning Objectives	1.To provide the student with a conceptual overview of statistical methods.
	2.To emphasis on usefulness of commonly used statistical software for analysis, research, and experimentation.
	3.To understand and evaluate critically the acquisition of data and its representation.
	4.To gain the knowledge about the probability and statistical inference are all topics that will be taught in order to obtain knowledge about the graphical representation of data.
	5.To learn more about how to organize, create, and carry out the distribution of scientific knowledge.

UNIT	**CONTENTS**
I	**INTRODUCTION TO STATISTICS** Introduction to biostatistics, basic principles, variables - Collection of data, sample collection and representation of Data - Primary and Secondary - Classification and tabulation of Data – Diagrams, graphs and presentation.
II	**DESCRIPTIVE STATISTICS** Mean, median and mode for continuous and discontinuous variables. Measures of dispersion: Range of variation, standard deviation and standard error and coefficient variation.
III	**PROBABILITY** Basic principles - types - Rules of probability - addition and multiplication rules. **PROBABILITY DISTRIBUTION** Patterns of probability distribution; binomial - Poisson and normal.
IV	**HYPOTHESIS TESTING** Chi-square test for goodness of fit; Null hypothesis, level of Significance - Degrees of Freedom. Student 't' test – paired sample and mean differences 't' tests.

	ANOVA. Basic introduction to Multivariate Analysis of Variance (MANOVA).
V	**CORRELATION AND REGRESSION** Correlation - types of correlation - methods of study of correlation - testing the significance of the coefficients of correlation. Regression and types. Sampling and experimental designs of research-Randomized block design and split plot design.

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Create and interpret visual representations of quantitative information, such as graphs or charts.	K5 & K6
CO2	Solve problems quantitatively using appropriate arithmetical, algebraic, or statistical methods	K3 & K5
CO3	Know the latest version using in statistical tools and apply the tools to interpret the results	K2
CO4	To develop their competence in hypothesis testing and interpretation.	K4
CO5	Understand why biologists need a background in statistics.	K1

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

1. Gurumani, N. 2005. Biostatistics, 2nd edn. MJP publications, India.
2. Datta, A.K. 2006. Basic Biostatistics and Its Applications. New Central Book Agency. ISBN 8173815038.
3. Pillai, R.S.N and Bagavathi, V.S. 2010. Statistics theory and practice. Chand & Co. Ltd, New Delhi.
4. Mahajan, B.K. 1984. Methods in Biostatistics for Medical students and Research works. Smt. Indu Mahajan, New Delhi.
5. Pillai, R.S.N and Bagavathi, V.S. 2010. Statistics theory and practice. Chand & Co. Ltd, New Delhi.
6. Khan, I.D and Khanum, A. 2004. Fundamentals of Biostatistics, Ukazsz Publications, Hyderabad, India.
7. Gupta, S.C. 2013. Fundamentals of statistics, Himalaya Publishers, Mumbai.
8. Kothari, C.R and Garg, G. 2014. Research methodology –Method and techniques. New Age International (P) Ltd. New Delhi.

Reference books:

1. Milton, J.S. 1992. Statistical method in Biological and Health Sciences. McGraw Hill Inc., New York.
2. Schefler, W.C. 1968. Statistics for biological sciences, Addision- Wesely Publication Co., London.
3. Spiegel, M.R. 1981. Theory and Problems of statistics, Schaum's Outline series McGraw-Hill International Book Co., Singapore.
4. Pillai, R.S.N and Bagawathi, V. 1987. Practical Statistics (For B.Com. and B.A., Students) S.Chand & Co. (Pvt.) Ltd., New York.
5. Sobl. R.R and Rohif, F.J. 1969. Biometry. The principles and Practice and Statistics in Biological Research. W.H. Freman and Co., San Francisco.
6. Zar, J.K. 2011. Biostatistical Analysis, Fourth Edition, Prantice-Hall International, New Jersey, USA.

Web resources:

1. nu.libguides.com/biostatistics
2. https://newonline courses.sciences.psu.edu/
3. https://bookauthority.org/books/beginner-biostatistics-ebooks
4. https://www.amazon.com/dp/1478638184?tag=uuid10-20
5. https://hastie.su.domains/ElemStatLearn/

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	2	1	3	3	3	3	1	3	1
CO 2	3	2	2	3	3	3	2	1	2	1
CO 3	3	1	2	3	3	3	3	2	2	2
CO 4	3	2	1	3	2	2	3	3	3	3
CO 5	3	2	3	3	3	3	3	1	3	1

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

ELECTIVE-IV INTELLECTUAL PROPERTY RIGHTS

Title of the Course	**INTELLECTUAL PROPERTY RIGHTS**						
Paper Number	**ELECTIVE IV**						
Category	ELECTIVE	**Year**	I	**Credits**	3	**Course Code**	**23PBTE4B**
		Semester	II				

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	3	2	--	5

Pre-requisite	Intent to understand the legal systems governing the knowledge economy. Basic understanding of how laws are structured and interpreted.
Learning Objectives	1.Cater to the needs of the stakeholders of knowledge economy is designed for those interested in managers and similar individuals.
	2.Create awareness of current IPR and innovation trends.
	3.Disseminate information on patents, patent system in India and overseas and registration related issues.
	4.Pursue a career in IPR, which offers chances for IP consultants and Attorneys.
	5.Develop skill sets to enable you to comprehend and assess the methods used in knowledge based economy and innovation ecosystems.

UNIT	**CONTENTS**
I	**INTRODUCTION TO IPR** History and Development of IPR. Theories on concept of property: Tangible *vs* Intangible. Subject matters patentable in India. Non patentable subject matters in India. Patents: Criteria of Patentability, Patentable Inventions - Process and Product. Concept of Copyright. Historical Evolution of Copyright Ownership of copyright, Assignment and license of copyright.
II	**OVERVIEW OF THE IPR REGIME AND DESIGN** International treaties signed by India. IPR and Constitution of India. World Intellectual Property Organization (WIPO): Functions of WIPO, Membership, GATT Agreement. Major Conventions on IP: Berne Convention, Paris Convention. TRIPS agreement. Industrial Designs – Subject matter of Design – Exclusion of Designs – Novelty and originality – Rights in Industrial Design.
III	**TRADE MARK, LEGISLATIONS AND PATENT ACT** History of Indian Patent Act 1970. Overview of IP laws in India. Major IP Laws in India. Patent Amendment Act 2005. WTO-TRIPS – Key effect on Indian Legislation. Organization of Patent System in India. Concept of Trademarks, Different kinds of marks, Criteria for registration, Non Registrable Trademarks, Registration of Trademarks. Infringement: Remedies and Penalties.

IV	**PRIOR ART SEARCH AND DRAFTING** Overview of Patent Search. Advantages of patent search. Open source and paid databases for Patent Search. International Patent classification system. Types of specifications: Drafting of Provisional specifications. Drafting of complete specifications. Drafting of claims.
V	**GI AND PATENT FILING PROCEDURES** Geographical Indications of Goods (Registration and Protection) Infringement – Offences and Penalties Remedies. Plant Variety and Farmers Right Act (PPVFR). Plant variety protection: Access and Benefit Sharing (ABS). Procedure for registration, effect of registration and term of protection. Role of NBA. Filing procedure for Ordinary application. Convention application. PCT National Phase application. Process of Obtaining a Patent. Infringement and Enforcement.

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Recall the history and foundation of Intellectual Property.	K1
CO2	Understand the differences of Property and Assets and Various Categories of Intellectual Creativity.	K2
CO3	Apply the methods to protect the Intellectual Property.	K3
CO4	Differentiate if the Said Intangible property be protected under law or protected by strategy.	K4
CO5	Create a recommendation document on the methods and procedures of protecting the said IP and search documents to substantiate them.	K5 & K6

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

1. Kalyan, C.K. 2010. Indian Patent Law and Practice, India, Oxford University Press.
2. Ahuja, V.K. 2017. Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.
3. Arthur Raphael Miller, Micheal Davis H. 2000. Intellectual Property: Patents, Trademarks and .Copyright in a Nutshell, West Group Publishers.
4. Margreth, B. 2009. Intellectual Property, 3nd, New York Aspen publishers.
5. Nithyananda, K.V. 2019. Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
6. Venkataraman M. 2015. An introduction to Intellectual property rights. Create space Independent Pub.North Charleston, USA.

Reference Books

1. World Intellectual Property Organization. 2004. WIPO Intellectual property Handbook. Retrieved from https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf Journal of Intellectual Property Rights (JIPR): NISCAIR.
2. Anant Padmanabhan. 2012. Intellectual Property Rights: Infringement and Remedies LexisNexis Butterworths Wadhwa.
3. Intellectual Property Law in the Asia Pacific Region. 2009. Kluwer Max Planck Series,
4. Pradeep, S. Mehta (ed.). 2005. Towards Functional Competition Policy for India, Academic Foundation, Related.
5. Ramakrishna B and Anil Kumar, H.S. 2017. Fundamentals of Intellectual Property Rights: For Students, Industrialist and Patent Lawyers, Notion Press, Chennai.
6. James Boyle, Jennifer Jenkins. 2018. Intellectual Property: Law & the Information Society—Cases and Materials, Create space Independent Pub. North Charleston, USA.
7. Damodar Reddy, S.V. 2019. Intellectual Property Rights -- Law and Practice, Asia Law House, Hyderabad.

Web resources:

1. http://cipam.gov.in/
2. https://www.wipo.int/about-ip/en/
3. http://www.ipindia.nic.in/
4. https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf.
5. https://swayam.gov.in/nd2_cec20_ge04/preview

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	3	3	3	3	2	3	2	3	2
CO 2	3	3	3	3	3	3	2	2	3	3
CO 3	3	2	3	2	2	3	3	3	2	1
CO 4	3	2	3	2	2	3	1	3	2	3
CO 5	3	2	1	3	2	3	2	3	2	3

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

SKILL ENHANCEMENT COURSE (SE2)

AGRICULTURE AND FOOD MICROBIOLOGY

Title of the Course	**AGRICULTURE AND FOOD MICROBIOLOGY-II**						
Paper Number	**Skill Enhancement-I**						
Category	SKILL ENHANCEMENT	**Year**	I	**Credits**	2	**CourseCode 23PBTSE1**	
		Semester	II				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		2	1	--	3		
Pre-requisite	To understand the benefits of microbes in agriculture and food industry.						
Learning Objectives	1.To provide comprehensive knowledge about plant – microbe interactions.						
	2.To provide basic understanding about factors affecting growth of microbes						
	3.To appreciate the role of microbes in food preservation.						
	4.To understand about the benefits of microbes in agriculture and food industry.						
	5.To gain knowledge about practices involved in food industry.						

UNIT	CONTENTS
I	**ROLE OF MICROORGANISMS IN AGRICULTURE** Role of symbiotic and free-living bacteria and cyanobacteria in agriculture., Mycorrhiza, Plant Growth Promoting Microorganims (PGPM) and Phosphate Solubilizing Microorganims (PSM).
II	**BIOCONTROL AND BIOFERTILIZATION** Biocontrol of plant pathogens, pests and weeds, Restoration of waste and degraded lands,Biofertilizers: Types, technology for their production and application, vermi-compost.
III	**FOOD MICROBIOLOGY** Intrinsic and extrinsic factors influencing growth of microorganisms in food, Microbes as source of food: Mushrooms, single cell protein.
IV	**FOOD MICROBIOLOGY** Microbial spoilage of food and food products: Cereals, vegetables, prickles, fish and dairy products. Food poisoning and food intoxication. Food preservation processes. Microbes and fermented foods: Butter, cheese and bakery products.

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

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Recognize the general characteristics of microbes and factors affecting its growth	K1
CO2	Explain the significance of microbes in increasing soil fertility	K2
CO3	Elucidate concepts of microbial interactions with plant and food.	K3
CO4	Analyze the impact of harmful microbes in agriculture and food Industry.	K4
CO5	Determine and appreciate the role of microbes in food preservation and as biocontrol.	K5 & K6

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

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

Reference Books:

1. Adams, M.R. and Moss M. O. 2008. Food Microbiology, 3rd Edition, Royal Society of Chemistry, Cambridge, U.K.
2. Sylvia D.M. 2004. Principles and Applications of Soil Microbiology, 2nd Edition, Prentice

Hall, USA.
3. Frazier, W.C. 1995. Food Microbiology, 4th Edition, Tata McGraw Hill Education, Noida, India.
4. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. 2001. Industrial Microbiology: An Introduction. 1st Edition, Blackwell Science, London, UK.
5. Das, S. and Saha, R. 2020. Microbiology Practical Manual. CBS Publishers and Distributors (P) Ltd., New Delhi, India.

Web resources:

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

Mapping with Programme Outcomes:

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

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

SEMESTER - III

CELL AND MOLECULAR BIOLOGY

Title of the Course	**CELL AND MOLECULAR BIOLOGY**						
Paper Number	**CORE VII**						
Category	Core	**Year**	II	**Credits**	4	**Course Code**	**23PBT7**
		Semester	III				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		3	2	-	5		
Pre-requisite	To acquire knowledge on cell and expose the students a fundamental of the various techniques used in molecular studies.						
Learning Objectives	1.Enable to learn various cell structures and functions of prokaryotes and eukaryotes and understand the salient features and functions of cellular organelles.						
	2.To understand the cell division and it molecular mechanism so as to appreciate and manipulate normal and abnormal cell and tissue growth.						
	3.To enlighten people of past molecular biology developments.						
	4.To comprehend the molecular processes.						
	5.A thorough examination of DNA structure, replication process, transcription process and translation processes.						

UNIT	CONTENTS
I	The dynamic cells, Concept of prokaryote and Eukaryote. Structural organization of plant cell, specialized plant cell types chemical foundation. Cell wall- Structure and functions, Plasma membrane; structure, models and functions, site for ATPase, ion carriers channels and pumps, receptors. Plasmodesmata and its role.
II	Chloroplast-structure and function, genome organization, gene expression, RNA editing, Mitochondria; structure, genome organization, biogenesis. Plant Vacuole - Tonoplast membrane, ATPases transporters as a storage organelle. Structure and function of other cell organelles- Golgi apparatus, lysosomes, endoplasmic reticulum and microbodies.
III	Nucleus: Structure and function nuclear pore, Nucleosome organization, euchromatin and heterochromatin. Ribosome- Structure and functional significance. RNA and DNA Structure. A, B and Z Forms. Replication, transcription, translation in prokaryotes and eukaryotes. DNA damage and repair (Thymine dimer, photoreactivation, excision repair). Cell cycle and Apoptosis; Control mechanisms, role of cyclin dependent kinases. Retinoblastoma and E2F proteins, cytokinesis and cell plate formation, mechanisms of programmed cell death.

IV	DNA replication (prokaryotes and eukaryotes), enzymes involved in replication, DNA repair. DNA sequencing. Transcription, enzymes involved in transcription, post transcription changes, reverse transcription, Translation. overlapping genes.
V	DNA/gene manipulating enzymes: endonuclease, ligase, polymerase, phosphatase, transcriptase, transferase, topoisomerase. Gene cloning: cloning vectors, molecular cloning and DNA libraries. Molecular genetic elements, insertion elements, transposons. Recombinant DNA. Direct and indirect gene transfer. Detection of recombinant molecule, production of gene products from cloned genes. Genome library, cDNA library.

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Recall a plant cell structure and explain its function.	K1
CO2	Illustrate and explain the structure of various cell organelles.	K2
CO3	Explain the structure and functional significance of nucleic acid.	K3
CO4	Compare and contrast the DNA replication (prokaryotes and eukaryotes), enzymes involved in replication, DNA repair	K4
CO5	Discuss and develop skills for DNA/gene manipulating and the enzymes involved.	K5 & K6

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

1. Roy, S.C and Kumar, K.D.C. 1977. Cell Biology, New Central Book Agency, Calcutta.
2. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments.6th edition. John Wiley & Sons.
3. Aminul, I. 2011. Text Book of Cell Biology. Books and Allied (P) Ltd, Kolkata, India.
4. Geoffrey M. Cooper. 2019. The Cell: A Molecular Approach, Oxford University Press.
5. Turner, P.C., Mclenann, A.G., Bates, A.D. and White, M.R.H. 2001. Instant notes on molecular biology.
6. Watson, J.D, Baker T.A., Bell S.P., Gann A., Levine M., Losick R. 2014. Molecular Biology of the Gene (7th edition), Pearson Press.
7. Snustad Peter, D. Michael J. Simmons. 2015. Principles of Genetics, John Wiley Sons.
8. Clark, D. 2010. Molecular Biology. Academic Press Publication.
9. David Freifelder. 2008. Essentials of Molecular Biology. Narosa Publishing house. New Delhi.
10. Geoffrey M. Cooper and Robert E. Hausman. 2015. The Cell: A Molecular Approach. 7

thedn. Sinauer Associates is an imprint of Oxford University Press.

Reference Books:

1. Alberts B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J. D. 1989. Molecular biology of the Cell (2nd edition). Garland Pub. Inc., New York.
2. Karp, G. 1999. Cells and Molecular Biology: Concepts & Experiments. John Wiley and Sons, Inc., USA.
3. Lodish S, Baltimore B , Berk, C and Lawrence K, 1995 , Molecular Cell Biology , 3rd edn, Scientific American Books, N.Y
4. De Robertis and De Robertis, 1988, Cell and Molecular Biology, 8th edn, Info-Med, Hongkong.
5. Lewin, B. 2000. GENE VII. Oxford University Press, New York, USA 7. Cooper G M and Hausman R E,2007 , The Cell: Molecular Approach 4th Edn, Sinauer Associates,USA.
6. Genes X– Benjamin Lewin, Jones and Bartlett, 2011 4. Molecular Biology of the Cell – Alberts, B, Bray, D, Raff, M, Roberts, K and Watson JD, Garland Publishers, 1999 5. Principles of Biochemistry – Lehninger, W.H. Freeman and Company, 200

Web resources:

1. https://www.pdfdrive.com/cell-biology-books.html
2. http://www.bio-nica.info/Biblioteca/Bolsover2004CellBiology.pdf
3. https://www.e-booksdirectory.com/listing.php?category=549
4. https://www.elsevier.com/books/molecular-biology/clark/978-0-12-813288-3
5. https://www.kobo.com/in/en/ebooks/molecular-biology

Mapping with Programme Outcomes:

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

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

GENETICS, PLANT BREEDING & BIOSTATISTICS

Title of the Course	**GENETICS, PLANT BREEDING & BIOSTATISTICS**						
Paper Number	**CORE VIII**						
Category	Core	**Year**	II	**Credits**	4	**Course Code**	**23PBT8**
		Semester	III				

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	3	2	-	5

Pre-requisite	To acquire knowledge on genetic traits and plant breeding techniques for crop improvement.
Learning Objectives	1.The students will be able to have conceptual understanding of laws of inheritance, genetic basis of loci and alleles and their linkage.
	2.Develop critical understanding of chemical basis of genes and their interactions at population and evolutionary levels.
	3.Familiarize with genetic basis of heterosis.
	4.Reflect upon the role of various non-conventional methods used in crop improvement.
	5.Solve problems quantitatively using appropriate arithmetical, algebraic, or statistical methods

UNIT	**CONTENTS**
I	Mendal's Law of inheritance. Gene interactions and modified dihybrid ratios. Quantitative inheritance. Sex determination in plants and theories of sex determination. Sex linked characters. Structure of Gene, Operon- inducible operon, Operator site, Promoter, Polycistronic m RNA, Regulator- regulator constitutive, Regulator super repressor, repressor, super repressor, inducer. Gene function and regulation in prokaryotes with reference to Lac operon and trp operon. Producer gene, structural gene and integrator gene. Gene Regulation eukaryotes –Britten and Davidson model, Arabidopsis- gene regulation in flowering.
II	Recombination: Homologous and non-homologous recombination, site-specific recombination. Holiday model of recombination. Transposable genetic elements: Ac element, transposase, transposon, simple transposon, composite transposon, Is element. Transposons in *Zea mays*. Transposable elements in prokaryotes. UV induced mutation and its repair mechanism. Mismatch DNA repair mechanism. Mutation types- frame shift mutation, addition, deletion, substitution, transition and transversion. Xeroderma pigmentosum.
	ABO blood group in humans. QTL mapping, Gene mapping methods**:** Linkage maps, tetrad analysis, mapping with molecular markers ,mapping by using

III	somatic cell hybrids. Extra chromosomal inheritance, maternal inheritance. Organelle genomes : Organization and functions of chloroplast and mitochondrial DNA.
IV	**PLANT BREEDING:** Objectives of plant breeding, characteristics improved by plant breeding, Genetic basis of breeding self and cross – pollinated crops. Pure line theory, pure line selection and mass selection, clonal selection methods. Hybridization ,Genetics and physiological basis of heterosis.
V	**BIOSTATISTICS:** Measures of central tendency (Mean , Median , Mode) and dispersal (Mean deviation , standard deviation) , standard errors ANOVA (One way).probability distributions (Binomial, Poisson andnormal); sampling distribution; difference between parametric and non-parametric statistics; confidence interval; errors; levels of significance; regression and correlation; t-test; analysis of variance; X2 test;; basic introduction to Multivariate statistics, etc.

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Understand the Mendal's Law of inheritance and gene interactions.	K1
CO2	Analyze the various factors determining the heredity from one generation to another.	K2
CO3	Explain Gene mapping methods**:** Linkage maps.	K3
CO4	Compare and contrast the genetic basis of breeding self and cross – pollinated crops.	K4
CO5	Discuss and develop skills for statistical analysis of biological problems.	K5 & K6

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

1. Benjamin, A. Pierce. 2012. Genetics- A conceptual Approach. W.H. Freeman and Company, New York, England.
2. Stansfield, W.D. 1969. Theory and problems of Genetics. McGraw-Hill
3. Sinnott, E.W.Dunn, L.E and Dobzhansky, T. 1973. Principles of Genetics. McGraw-Hill.New York.
4. Chaudhari, H.K.1984. Elementary Principles of Plant Breeding. Oxford & IBH Publishing Company.

5. Brown, T.A. 1992. Genetics a Molecular Approach, 2nd Ed. Chapman and Hall.
6. Chahal, G.S and Gosal, S.S. 2018. Principles and Procedures of Plant Breeding Biotechnological and Conventional Approaches, Narosa Publishing House, New Delhi.
7. Singh, B.D. 2013. Plant Breeding: Principles and Methods, Kalyani Publishers, New Delhi
8. Singh, P. 2017. Fundamentals of Plant Breeding, Kalyani Publishers.
9. Chaudhary, R.C. 2017. Introductory principles of plant breeding, Oxford IBH Publishers, New Delhi.
10. Gupta, P.K. 2009. Genetics. Rastogi publications, Meerut, New Delhi.
11. Gupta, S.C. 2013. Fundamentals of statistics, Himalaya Publishers, Mumbai.
12. Kothari, C.R and Garg, G. 2014. Research methodology –Method and techniques. New Age International (P) Ltd. New Delhi.
13. Gurumani, N. 2005. Biostatistics, 2nd edn. MJP publications, India.

Reference Books:

1. Watson, J.D. *et al.* 2003. Molecular Biology of the Gene. Fourth Edition. The Benjamin Cummings Pub. Co.
2. Lewin, B. 2003. Genes VIII. Oxford University Press.
3. Friefelder,D. 2005. Molecular Biology. Second Edition. NarosaPub.House.
4. Sobtir.C. and Gobe. 1991. Eukaryotic chromosomes. Narosa Publishinghouse.
1. Smith-Keary, P. 1991. Molecular Genetics. Macmillan Pub. Co. Ltd. London.
2. Acquaah, G.2007. Principles of Plant Genetics and Breeding. Blackwell Publishing.
3. William.S., Klug and Michael, R. Cummings, 2003. Concepts of Genetics. Seventh edition. Pearson Education (Singapore)Pvt.Ltd.
4. Simmonds, N.W. 1979. Principles of Crop improvement. Longman, London.
5. Lewin, B. 2000. Genes VII, Oxford University Press, USA.
6. Strickberger, M.W. 2005. Genetics (III Ed). Prentice Hall, New Delhi, India.
7. Allard, R.W. 2010. Principles of Plant Breeding. 2 nd ed. John Wiley and Sons, Inc. New Jersey, US.
8. Pillai, R.S.N and Bagawathi, V. 1987. Practical Statistics (For B.Com. and B.A., Students) S.Chand & Co. (Pvt.) Ltd., New York.
9. Sobl. R.R and Rohif, F.J. 1969. Biometry. The principles and Practice and Statistics in Biological Research. W.H. Freman and Co., San Francisco.
10. Zar, J.K. 2011. Biostatistical Analysis, Fourth Edition, Prantice-Hall International, New Jersey, USA.

Web Resourses

1. https://www.cdc.gov/genomics/about/basics.htm
2. https://ocw.mit.edu/courses/biology/7-03-genetics-fall-2004/lecture-notes/
3. http://galaxy.ustc.edu.cn:30803/zhangwen/Biostatistics/Fundamentals+of +Biostatistics+8th+edition.pdf
4. https://www.britannica.com/science/evolution-scientific-theory
5. https://www.britannica.com/science/cell-biology
6. https://medlineplus.gov/genetocs/understanding/basics/cell/

Mapping with Programme Outcomes:

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

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

CORE-IX ECOLOGY, PHYTOGEOGRAPHY, CONSERVATION BIOLOGY & INTELLECTUAL PROPERTY RIGHTS

<table>
<tr><td>Title of the Course</td><td colspan="7">ECOLOGY, PHYTOGEOGRAPHY, CONSERVATION BIOLOGY & INTELLECTUAL PROPERTY RIGHTS</td></tr>
<tr><td>Paper Number</td><td colspan="7">CORE IX</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2">23PBT9</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td>Lab Practice</td><td colspan="3">Total</td></tr>
<tr><td colspan="2"></td><td>3</td><td>2</td><td>--</td><td colspan="3">5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Understanding the environmental factors impacting biodiversity is crucial after taking this course and Basic understanding of how laws are structured and interpreted.</td></tr>
<tr><td colspan="2">Learning Objectives</td><td colspan="6">1.To analyze and comprehend the fundamental ideas of plant ecology as a scientific study of environment.</td></tr>
<tr><td colspan="2"></td><td colspan="6">2.To study the plant communities and plant succession stages.</td></tr>
<tr><td colspan="2"></td><td colspan="6">3.To be aware of the causes, impacts and control measures of pollution.</td></tr>
<tr><td colspan="2"></td><td colspan="6">4.To study biodiversity management and conservation.</td></tr>
<tr><td colspan="2"></td><td colspan="6">5.To enhance the knowledge of the students and equip them in evaluate and protecting invaluable components of nature and interactions with the environment.</td></tr>
<tr><td>UNIT</td><td colspan="7">CONTENTS</td></tr>
<tr><td>I</td><td colspan="7">ECOLOGICAL PRINCIPLES:
Introduction – History, scope, concepts. Diversity of plant life; growth form, life form. Basic concepts of population ecology– population dynamics – Regulation of population density. Basics concepts of community – characteristics, composition, structure, origin and development – community dynamics – trends of succession.</td></tr>
<tr><td>II</td><td colspan="7">ECOSYSTEM ECOLOGY AND RESOURCE ECOLOGY:
Introduction – kinds – major types – functional aspects of ecosystem: Food chain and food web, energy flow, laws of thermodynamics. Productivity – primary and secondary productivity – GPP & BPP.
Resource Ecology: Energy resources; renewable and non-renewable.
Soil: Formation, types and profile - erosion and conservation, Water resources – conservation and management.
Environment Deterioration: Climate change - Greenhouse effect and global warming, ozone depletion and acid rain. Waste management - Solid and e-waste, recycling of wastes. Eco-restoration/remediationecological foot prints - carbon foot print - ecolabeling - environmental auditing</td></tr>
</table>

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.
IV	**BIODIVERSITY AND CONSERVATION ECOLOGY:** Definition, types of biodiversity – values of biodiversity – Hot spots – Threats to biodiversity: habitat loss. Poaching of wild life – Invasion of exotic species, man and wild life conflicts - endangered and endemic plant species of India, Red list categories of IUCN, Biotechnology assisted plant conservation- *in situ* and *ex situ* methods.
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 – TRIPS, WIPO, WTO, GATTS. IPR in India genesis and development. Geographical Indication – introduction, types. Patent filing procedure for ordinary application.

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

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

1. Sharma, P.D. 2017. Ecology and Environment- Rastogi Publication, Meerut.
2. Pushpa Dahiya and Manisha Ahlawat. 2013. Environmental Science- A New Approach, Narosa Pub. House, New Delhi.pp.2.1-2.60.

3. Eugene Odum, 2017. Fundamentals of Ecology 5th Ed. Cengage, Bengaluru.
4. Sharma P.D. 2019. Plant ecology and phytogeography, Rastogi Publications, Meerut.
5. Neeraj Nachiketa. 2018 Environmental & Ecology A Dynamic approach. 2nd Edition GKP Access Publishing.
6. Chandra, A.M and Ghosh, S.K. 2010. Remote sensing and Geographical Information System, Narosa Publishing House Pvt. Ltd. New Delhi.

Reference Books:

1. Keddy, P.A. 2017. Plant Ecology: Origins, processes, consequences. 2nd ed. Cambridge
2. University Press. ISBN. 978-1107114234.
3. Krishnamurthy, K.V. 2004. An Advanced Text Book of Biodiversity- Principles and
4. Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi.
5. Ahuja, V.K. 2017. Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.
6. Nithyananda, K.V. 2019. Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
7. Venkataraman M. 2015. An introduction to Intellectual property rights. Create space Independent Pub.North Charleston, USA.
8. Kormondy, E.J. 2017. Concepts of Ecology. Prentice Hall, U.S.A. 4th edition.
9. 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
9. https://www.amazon.in/Intellectual-Property-Rights-Vijay-Durafe-ebook/dp/B08N4VRQ86

Mapping with Programme Outcomes:

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

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

LABORATORY COURSE-III (COVERING CORE PAPERS VIII, IX AND X)

Title of the Course	**LABORATORY COURSE- III (Covering Core Papers VIII, IX & X)**						
Paper Number	**CORE - X**						
Category	Core	**Year**	II	**Credits**	4	**Course Code**	**23PBT10P**
		Semester	III				

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	3	-	2	5

Pre-requisite	Practicals pertaining to above subjects is important to get knowledge on overall cell structure, cellular organelles and staining procedures and fundamental principles of genetics and plant breeding.
Learning Objectives	1.Observe the different stages of mitosis and chromosome behaviour and organization during various stages and to learn staining techniques of various plant tissues.
	2.Explain the principles of linkage, crossing over and the hereditary mechanisms.
	3.Expose the students to gain recent advances in molecular biology.
	4.Understand the principles of plant breeding to apply crop improvement programmes
	5.Understand the principles of rDNA techniques.

UNIT	**EXPERIMENTS**
I	**CELL AND MOLECULAR BIOLOGY** 1. Identification of different stages of mitosis from suitable plant material. (Onion root tips, garlic root tips). 2. Identification of meiosis from suitable plant material. (Onion /Tradeschantia floral buds). 3. Isolation of cell organelles : Mitochondria, Chloroplast, Nucleus, Lysosomes and there assay by succinate dehydrogenase activity (Mitochondria), acid phosphatase activity (Lysosome), acetocarmine staining (Nucleus) and microscopic observation (Chloroplast) 4. Study of mitotic index from suitable plant material. 5. Study of cyclosis in cells of suitable plant material. 6. To study plant vacuole in cells of onion leaf peel. 7. Restriction digestion of DNA samples using restriction endonucleases (RE). 8. To study the structure and organization of plant cell in various tissues of various plants (incl. leaf, stem and roots).
II	**GENETICS** 1. Problem solving on dihybrid phenotypic, genotypic and test cross ratios. 2. Incomplete dominance in plants. 3. Interactions of factors and modified dihybrid ratios.

	4. Multiple alleles in plants, blood group inheritance in human. 5. Sex linked inheritance in Drosophila and plants. 6. Quantitative inheritance in plants. 7. Tetrad analysis in Neurospora. 8. Complementation analysis to find out complementation groups in viruses. 9. Chromosome mapping from three point test cross data. Calculation of chiasmatic interference. 10. Calculate gene and genotypic frequency by Hardy- Weinberg equation.
III	**PLANT BREEDING** 1. Techniques in plant hybridization.
IV	**ECOLOGY,** 1. Determination of the quantitative characters of a plant community by random quadrat method (abundance, density, dominance, species diversity, frequency) in grazing land, forests. 2. Estimation of above ground and below ground biomass in a grazing land employing minimum size of quadrat. 3. To determine soil moisture, porosity and water holding capacity of soil collected from varying depth at different locations. 4. Determination of pH of soil and water by universal indicator (or) pH meter. 5. Determination of dissolvedoxygen. 6. Estimation of carbonate. Estimation of bicarbonate.
V	**PHYTOGEOGRAPHY, CONSERVATION BIOLOGY & 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 Meteorological Centre at Numgambakkam).

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Recall or remember the various aspects of cell biology, genetics, molecular biology, plant breeding and tissue culture.	K1
CO2	Understand various concepts of cell biology, genetics, plant breeding and tissue culture.	K2

CO3	Apply the theory knowledge gained into practical mode in order to acquire applied knowledge by day-to-day hands-on experiences.	K3
CO4	Analyze or interpret the results achieved in practical session in the context of existing theory and knowledge.	K4
CO5	Evaluate the theory and practical skills gained during the course.	K5 &K6

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

1. George M Malacinski. 2015. Freifelders Essentials of Molecular Biology (4th ed.). Jones & Bartlett.
2. Gupta P.K. 2017. Cell and Molecular Biology (5th ed.), Rastogi Publications, Meerut.
3. Gupta, P.K. 2018. Cytogenetics, Rastogi Publications, Meerut.
4. Kumar, H.D. 2007. Molecular Biology and Biotechnology, Vikas Publishing House, New Delhi.
5. Bharadwaj, D.N. 2012. Breeding of field crops (pp. 1-23). Agrobios (India).
6. Singh, R.J. 2016. Plant Cytogenetics. CRC press, US.
7. Jackson, S.A., Kianian, S.F., Hossain, K.G and Walling, J.G. 2012. Practical laboratory exercises for plant molecular cytogenetics. In Plant Cytogenetics (pp. 323-333). Springer, New York.
8. Shivakumar, S. 2002. Molecular analysis: Laboratory Manual. University press, Palkalai nagar, Madurai, India.

Reference Books:

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

University Press, Oxford, UK.
9. Gelvin, S.B., Schilperoort, R.A. (Eds.). 2000. Plant Molecualr Biology Manual.
10. Henry, RJ. 1997. Practical applications of plant molecular biology, Chapman & Hall, London.
11. Krebs, J.E., Goldstein E.S. and Kilpatrick S.T. 2017. Lewin's GENES XII (12thed.). Jones & Bartlett Learning.

Web sources:

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

Mapping with Programme Outcomes:

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

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

ELECTIVE V - APPLIED PLANT CELL & TISSUE CULTURE

Title of the Course	**APPLIED PLANT CELL & TISSUE CULTURE**						
Paper Number	**ELECTIVE V**						
Category	ELECTIVE	**Year**	I	**Credits**	3	**Course Code**	**23PBTE5A**
		Semester	III				

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	3	2	--	5

Pre-requisite	The course will equip students to either obtain employment in the field or start their own business there, depending on the needs of the industry.
Learning Objectives	1.To comprehend the basic principles and methodologies of plant tissue culture.
	2.To acquire knowledge on *in vitro* cultivation techniques to develop protocols targeted towards commercialization.
	3.To gain understanding of the various techniques of tissue culture for secondary metabolites production. .
	4.To recognize the worth of traditional germplasm and receive training in preserving and enhancing crop varieties to meet consumer demand and global legal policies.
	5.To impart practical information on plant tissue culture in order to produce labour suitable for the demands of the industry and research facilities

UNIT	**CONTENTS**
I	**BASIC PLANT TISSUE CULTURE:** Totipotency and concepts of plant tissue culture – Laboratory organization – Design of different laboratories and management - Aseptic techniques - Plant culture media – Inorganic nutrients – Macronutrients – Micronutrients - Carbon and energy sources – Organic supplements – Growth regulators – Solidifying agent – MS medium and B5 medium – Explant preparation - Methods of sterilization – Transfer and incubation of culture – Transplantation area.
II	**MICROPROPAGATION:** Micropropagation – Stages of micropropagation - Multiplication by axillary and apical shoots – Multiplication by adventitious shoots – Multiplication through callus culture – Organogenesis and somatic embryogenesis – Multiplication and Rooting - Hardening - Factors effecting micropropagation – Technical problems in micropropagation - Practical applications of micropropagation – Somaclonal & gametoclonal variation – synthetic seed technology - Shoot tip/Meristem culture for virus free plants.
III	**CELL AND PROTOPLAST CULTURES AND HAPLOID PRODUCTION:** Single cell and cell suspension culture – Applications - Production of haploids -

	Anther culture and pollen culture – Induction of haploids from un-pollinated ovaries and ovules – Role of haploids in Plant breeding - Protoplast culture: Protoplast isolation, purification – regeneration – culturing. Protoplast fusion techniques – somatic hybridization and cybridization - Applications of protoplast culture and hybridization.
IV	**METABOLIC ENGINEERING:** Application of cell culture systems in metabolic engineering - advantages of cell, tissue and organ culture as a source of secondary metabolites - Hairy root culture - Screening of high yielding cell lines - Procedures for extraction of high value industrial products – Alkaloids, food additives and insecticides in *in vitro* system.
V	**CRYOPRESERVATION AND BIOREACTORS:** Germplasm storage and conservation – Methods of in vitro conservation – Cryopreservation and steps involved in cryopreservation of plant materials - Types of bioreactors (Stirred tank and airlift) and their uses - Industrial scaling – Upstream and downstream processing - Manipulation in production profile by biotic and abiotic elicitation – Biotransformation – Food vaccines, bioplastics, plantibodies, plantigens - Applications of tissue culture in agriculture, Horticulture and forestry.

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Recall the principles and culture techniques of cells, callus, organs, pollen, anthers, embryos and protoplasts.	K1
CO2	Understand the techniques used in plant growth and regeneration under *in vitro* conditions.	K2
CO3	Apply the role plant tissue culture techniques in the production some secondary metabolites and planting stock in horticulture.	K3
CO4	Analyze the conditions that are suitable for direct and indirect plant regeneration.	K4
CO5	Evaluate the self-skills obtained during the course thorough internal and external assessment systems.	K5
CO6	Create idea to seek for suitable job in relevant industries/research centers or to become a potential entrepreneur based on knowledge achieved during the course.	K6

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and

	Transferrable Skill

Recommended Text:

1. Narayanaswamy, S. 1999. Plant cell and tissue culture. 8th edn. Tata McGraw Hill Publ. ISBN 0074602772.
2. Bhojwani, S.S and Razdan, M.K. 2004. Plant Tissue Culture, Read Elsevier India Pvt. Ltd. ISBN 818147 3256.
3. Trigiano, R.N and D.J. Gray (eds.). 2000. Plant tissue culture concepts and laboratory exercises. CRC Press. (Textbook). 2nd Edition.
4. Kyte, M and Kleyn, J. 1996. Plant from test tubes. Timber Press. Auge, R. et al., 1995. In vitro culture and its applications in horticulture. Science Publishers, Inc.
5. Auge, R. 1995. In vitro culture and its applications in horticulture. Science Publishers, Inc.
6. Gamborg, O.L. and G.C. Phillips (eds). 1995. Plant cell, tissue and organ culture. Springer Lab Manual.
7. Khasim, S.M. 2002. Botanical Microtechnique: Principles and Practice, Capital Publishing Company, New Delhi.
8. Srivastava, P.S. 1998. Plant Tissue Culture and Molecular Biology. N.R. Book Distributors, New Delhi.
9. Vinay Sharma and Afroz Alam. 2019. Plant Tissue Culture. Wiley.
10. Pullaiah, E., Rao, T., M.V. Subba, Sreedev. 2017. Plant Tissue Culture: Theory and Practicals. Scientific Publishers.
11. Chawla, H.S. 2009. Introduction to plant biotechnology, 3rd edition, Oxford and IBH publishing, New Delhi.
12. Gupta, S.D and Ibaraki, Y. 2006. Plant tissue culture engineering (Vol. 6). Springer Science & Business Media, Germany.
13. Razdan, M.K. 2015. Introduction to Plant Tissue Culture, 3rd edition. Oxford and IBH publishing, New Delhi.
14. Rober, H. Smith. 2013. Plant Tissue Culture: Techniques and Experiments, Academic Press, Elsevier.
15. Robert, N. Trigiano and Dennis, J and Gray (Eds.). 2011. Plant Tissue Culture, Development, and Biotechnology, CRC Press, Taylor & Francis Group.

Reference Books

1. Bhojwani, S. S and Dantu, P.K. 2013. Plant tissue culture: an introductory text (Vol. 318). New Delhi, India: Springer.
2. Vasil, I.K. and Thorpe, T.A. 1994. Plant Cell and Tissue Culture, Kluwer Academic Press, The Netherlands.
3. Loyola-Vargas, V.M. Ochoa-Alejo, N. 2016. Somatic embryogenesis: Fundamental aspects and applications, Springer international publishing, Switzerland.
4. Elhiti, M., Stasolla, C and Wang, A. 2013. Molecular regulation of plant somatic embryogenesis. In Vitro Cellular & Developmental Biology-Plant, 49(6), 631-642
5. Collins, H.A. and Edwards, S. 1998. Plant Cell Culture, Bios Scientific Publishers, Oxford, UK.
6. Hall, R.D. (Ed.). 1999. Plant Tissue Culture: Techniques and Experiments, Academic Press, New York.
7. Kartha, K.K. 1985. Cyropreservation of plant cells and organs. CRC Press, Boca Raton, Florida.

8. Rihan, H.Z., Kareem, F., El-Mahrouk, M.E., and Fuller, M.P. 2017. Artificial seeds (principle, aspects and applications). Agronomy, 7(4), 7.
9. Pullaiah, T. 2009. Plant Tissue Culture: Theory and Practicals, Scientific Publishers Journals Dept.Timir Baran Jha and Biswajit Ghosh. 2016. Plant Tissue Culture: Basic and Applied, Platinum Publishers; 2nd Edn.
10. Anis Mohammad and Ahmad Naseem. 2016. Plant Tissue Culture: Propagation, Conservation and Crop Improvement, Springer. Singapore.
11. Loyola-Vargas, V.M and Vázquez-Flota, F. 2006. Plant cell culture protocols (Vol. 318). USA: Humana Press, New Jersey.
12. Mba, C., Afza, R., Bado, S., and Jain, S.M. 2010. Plant Cell Culture: Essential Methods, John Wiley & Sons, UK.
13. Abdin, M.Z., Kiran, U., Kamaluddin, M., Ali, A. (Eds.). 2017. Plant Biotechnology: Principles and Applications, Springer publishers.
14. Fett-Neto, Arthur Germano (Ed.). 2016. Biotechnology of Plant Secondary Metabolism: Methods and Protocols, Springer publishers.
15. Smith, R.H. 2012. Plant tissue culture: techniques and experiments. Academic Press, UK.
16. Trigiano, R. N., and Gray, D. J. 2011. Plant tissue culture, development, and biotechnology. CRC Press, US.
17. Kartha, K.K. 1985. Cryopreservation of Plant Cells and Organs. CRC Press, Boca Raton, Florida, USA.

Web resources:

1. https://nptel.ac.in/courses/102/103/102103016/
2. http://ugcmoocs.inflibnet.ac.in/ugcmoocs/spoc.php?coordinator=574
3. https://www.youtube.com/watch?v=bi755vQVNx8
4. https://www.elsevier.com/books/plant-tissue-culture/park/978-0-12-821120-5
5. https://onlinelibrary.wiley.com/doi/book/10.1002/9780470686522

Mapping with Programme Outcomes:

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

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

ELECTIVE V - ENTREPRENEURIAL OPPORTUNITIES IN BOTANY

Title of the Course	**ENTREPRENEURIAL OPPORTUNITIES IN BOTANY**						
Paper Number	**ELECTIVE V**						
Category	ELECTIVE	**Year**	I	**Credits**	3	**Course Code**	**23PBTE5B**
		Semester	III				

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	3	2	--	5

Pre-requisite	To understand the importance of floriculture and nursery management.
Learning Objectives	1.Understand the different classifications of horticultural crops, nursery management, and use of technology in horticulture.
	2.Develop their competency on pre and post-harvest technology in horticultural crops.
	3.Analyze the different methods of weed control and harvest treatments of horticultural crops.
	4.Examine the economic implications of cultivation of tropical and sub-tropical vegetable crops.
	5.Evaluate the importance of floriculture and contribution spices and condiments on economy.

UNIT	**CONTENTS**
I	Organic manures and fertilizers. Composition of fertilizer, NPK content of various fertilizers. Common organic manures bone meal, cow dung, poultry waste, oil cakes, organic mixtures and compost. Preparation of compost, aerobic and anaerobic – advantages. Vermicompost preparation, vermiwash. Panchakaviyam.
II	Common garden tools. Methods of plant propagation by seeds. Vegetative propagation, cutting, grafting, budding and layering. Use of growth regulators for rooting.
III	Gardening – types of garden, ornamental, indoor garden, kitchen garden, terrace garden, vegetable garden for marketing. Rockery and artificial ponds. Ornamental garden designing, garden components flower beds, borders, hedges, edges, drives, paths, garden adornments.
IV	Packaging of fruits, vegetables. Preservation techniques drying, heat treatment, low temperature storage and by chemicals. Preparation of wine, vinegar and dairy products.
V	Significance of mushrooms. Types of mushrooms (button mushroom, oyster mushroom). Spawn isolation and preparation. Cultivation. Value added products from mushroom – pickles, candies and dried mushrooms.

Course outcomes: CO	On completion of this course, the students will be able to:	Programme outcomes
CO1	Students can acquire knowledge about organic farming and their advantages	K1
CO2	Analyze both the theoretical and practical knowledge in understanding various horticultural techniques.	K2
CO3	To develop kitchen garden or terrace garden in their living area.	K3
CO4	Evaluate the horticultural techniques to students can develop self employment and economical improvement.	K4
CO5	Create and develop skills for mushroom cultivation.	K5 & K6

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

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

Reference Books:

1. Adams, C.R. Banford, K.M. and Early, M.P. 1993. Principles of Horticulture.
2. Sathe,T.V. 2004. Vermiculture and Organic farming, Daya Publishers.
3. Peter, K.V. 2017. Basic Horticulture.
4. Hartman, H.T. and D.F. Kestler. 1976. Plant propagation principles and practice. Prentice Hall of India, New Delhi.
5. Jules Janick, 1982. Horticulture Science. Surjeet publications, New Delhi.

6. Ignacimuthu, S.1998. Plant Biotechnology. Tata Mc Graw Hill Ltd., New Delhi.

7. Gupta. P.K.,1998. Elements of Biotechnology. Rastogi publications, Meerut.

8. Edmond Musser and Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
9. Janick Jules. 1979. Horticultural Science. (3rd Ed.), W.H. Freeman and Co.,San Francisco, USA.

Web resources:

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

Mapping with Programme Outcomes:

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

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

Skill Enhancement (SE - II)

PROFESSIONAL COMPETENCY SKILL ENHANCEMENT

Title of the Course	**PROFESSIONAL COMPETENCY SKILL ENHANCEMENT**						
Paper Number	**SKILL ENHANCEMENT – ONLINE PAPER**						
Category	Skill Enhancment	**Year**	II	**Credits**	2	**Course Code**	**23PBTSE2**
		Semester	IV				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		2	2	-	4		
Pre-requisite	To understand the concept of skill enhancement.						
Learning Objectives	1.Understand the concept of agronomy and sustainable agriculture.						
	2.To gain knowledge about the cell, organelles and physiology.						
	3.To understand the biodiversity DNA recombination technology.						
	4.Describe the basic signal transduction pathway and to recognize the overarching principles of prokaryotic and eukaryotic cellular communication.						
	5.Understand the mechanism underling the shift from vegetative to reproductive phase.						

UNIT	CONTENTS
I	**MOLECULES AND THEIR INTERACTION RELEVANT TO BIOLOGY** Structure of atoms, molecules, and chemical bonds. Composition, structure, and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids, and vitamins). Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.). Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties). Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers. Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes Conformation of proteins (Ramachandran plot, secondary structure, domains, motif, and folds).Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA).Stability of proteins and nucleic acids. Metabolism of carbohydrates, lipids, amino acids nucleotides, and vitamins.
	CELLULAR ORGANIZATION Membrane structure and function: structure of model membrane, lipid bilayer, and membrane protein diffusion, osmosis; ion channels; active transport; membrane pumps; mechanism of sorting and regulation of intracellular transport; electrical properties of membranes.

II	Structural organization and function of intracellular organelles (cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of the cytoskeleton and its role in motility). Organization of genes and chromosomes: Operon, unique and repetitive DNA, interrupted genes, gene families, the structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons).Cell division and the cell cycle: mitosis and meiosis, their regulation, steps in the cell cycle, regulation, and control of the cell cycle. Microbial Physiology: Growth yield and characteristics, strategies of cell division, stress response.
III	**FUNDAMENTAL PROCESSES** DNA replication, repair, and recombination: Unit of replication, enzymes involved, replication origin and replication fork, the fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination. RNA synthesis and processing: Transcription factors and machinery, a formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure, and function of different types of RNA, RNA transport). Protein synthesis and processing: Ribosome, the formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proofreading, translational inhibitors, Post-translational modification of proteins). Control of gene expression at transcription and translation level: Regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, the role of chromatin in gene expression and gene silencing).
IV	**CELL COMMUNICATION AND CELL SIGNALING:** **Host-parasite interaction**: Recognition and entry processes of different pathogens like bacteria, viruses into animal and plant host cells, alteration of host cell behavior by pathogens, virus-induced cell transformation, pathogen-induced diseases in animals and plants, cell-cell fusion in both normal and abnormal cells. **Cell signaling**: Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component systems, light signaling in plants, bacterial chemotaxis, and quorum sensing. **Cellular communication:** Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation. **Cancer:** Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer, and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth. **Innate and adaptive immune system:** Cells and molecules involved in innate and adaptive immunity, antigens,

	antigenicity, and immunogenicity. B and T cell epitopes, structure, and function of antibody molecules. generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, humoral and cell-mediated immune responses, primary and secondary immune modulation, the complement system, Toll-like receptors, cell-mediated effector functions, inflammation, hypersensitivity and autoimmunity, immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiencies, vaccines.
V	**DEVELOPMENTAL BIOLOGY** **Basic concepts of development:** Potency, commitment, specification, induction, competence, determination, and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in the analysis of the development. **Gametogenesis, fertilization, and early development:** Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination. **Morphogenesis and organogenesis in animals:** Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in Drosophila, amphibia, and chick; organogenesis – vulva formation in Caenorhabditis Elegans, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post-embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination. **Morphogenesis and organogenesis in plants:** Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum Programmed cell death, aging, and senescence.

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	To learn about the structure of atoms, molecules, and chemical bonds.	K1
CO2	Demonstrate both the theoretical and practical knowledge in cell biology and molecular biology.	K2
CO3	Explain the methods of recombinant technology.	K3
CO4	Compare and contrast the physiological functions and metabolism.	K4
CO5	Discuss and develop skills for effective comprehension and communication.	K5 & K6

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

1. Bhojwani, S.S. Bhatnagar, S.P and Dantu, P.K. 2015. The Embryology of Angiosperms (6th revised and enlarged edition). Vikas Publishing House, New Delhi.
2. Maheshwari, P. 1963. Recent Advances in Embryology of Angiosperms. Intl. Soc. Plant Morphologists, New Delhi.
3. Roy, S.C and Kumar, K.D.C. 1977. Cell Biology, New Central Book Agency, Calcutta.
4. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments.6th edition. John Wiley & Sons.
5. Ramavat, K.G. 2006. Plant Biotechnology. S. Chand and Co. Ltd., New Delhi.
6. Trivedi, P.C. 2000. Plant Biotechnology-Recent Advances. Panima Publication Corporation, New Delhi.
7. Chawla, H.S. 2009. Introduction to Biotechnology. 2nd edn. Oxford IBH, ISBN: 978-81-204- 1732-8.

Reference books:

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. Gupta. P.K. 2000. Cell and Molecular Biology, Rastogi Pub. Meerut.
3. Ignacimuthu, S. 2005. Basic Bioinformatics, Narosa publishing house.
4. Lesk, A.M. 2002. Introduction to Bioinformatics. Oxford University press.
5. Rastogi. 1996. Cell and molecular biology. New age international publishers.
6. Elliott, W.H. and Ellioff. 1997. Biochemistry and molecular biology. Oxford.
7. Freifelder D., 1987. Molecular Biology. Narosa publishing house.
8. Rastoji, S.C., Mendiratta,N., Rastogi, P. 2009. Bioinformatics : Methods and Applications, PHI, Third Edition.

Web resources:

1. https://www.nature.com/scitable/topic/cell-biology
2. https://plato.stanford.edu/entries/molecular-biology/
3. https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/bioinformatics
4. https://.britannica.com/technology/biotechnolog/

5. https://nptel.ac.in/courses/102/107/102107075/
6. https://plantae.org/plant-physiology-top-articles-of-2020-based-on- altmetric-scores/

Mapping with Programme Outcomes:

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

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

INDUSTRY MODULE - INDUSTRIAL BOTANY

Title of the Course	**INDUSTRIAL BOTANY**						
Paper Number	**Core**						
Category	Industry	**Year**	II	**Credits**	3	**Course Code**	**23PIT**
		Semester	III				

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	1	-	3	4

Pre-requisite	The course will equip students to either obtain employment in the field or start their own business there, depending on the needs of the industry.
Learning Objectives	1.To learn the applied aspects of industrial application of algae, fungi, bacteria, plants, molecular biology and recombination technology.
	2.The student would be competent to work in industries.
	3.To educate people about the widespread commercial uses of fungi.
	4.To know about the economic importance of plants.
	5.To acquire knowledge on *in vitro* cultivation techniques to develop protocols targeted towards commercialization.

UNIT	**CONTENTS**
I	**ALGAE IN INDUSTRIES:** Fertilizer industry-Seaweeds, pharmaceutical industry – antibiotics, agar, carageenin, alginin, diatomate earth, mineral industry, fodder industry
II	**FUNGI IN INDUSTRIES:** Beneficial use of yeast, Fermentation of alcohol, preparations of enzyme, organic acid preparation, cheese production, protein manufacture, vitamins, fats.
III	**PLANT PRODUCTS:** Fibres and Fibre-Yielding Plants, wood and cork, tannins and dyes, rubber, fatty oils and Vegetable fats, sugars and starches, pulp and paper, gums and resins.
IV	**BACTERIA IN INDUSTRY:** Food industry, dairy products, bioleaching, biogas production**,** bioremediation
V	**RECOMBINANT PLANTS:** Tissue culture: Micropropagation, somatic seeds, cell culture.
Extended Professional Component (is a part of internal component	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)

only, Not to be included in the External Examination question paper)	
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Understand the basics of algae in industrial applications.	K1
CO2	Demonstrate and to recollect the uses in fungi in industries.	K2
CO3	Explain bacterial role in industries.	K3
CO4	Compare and contrast the use of plants in industries.	K4
CO5	Discuss and develop skills for working in industries specializing in biomolecules.	K5 & K6

Recommended Text:

1. Trivedi, P.C. 2001. Algal Biotechnology. Point publisher, Jaipur. India.
2. Dinabandhu, S and Kaushik. B.D. 2012. Algal Biotechnology and Environment. I.K. International, New Delhi.
3. Poonam Singh and Ashok Pandey. 2009. Biotechnology for agro-Industrial residues utilization. Springer.
4. Dilip K. Arora. 2003. Handbook of Fungal Biotechnology. CRC Press book.
5. Vardhana, R. 2009. Economic Botany. 1st ed. Sarup Book Publishers Pvt Ltd. New Delhi.
6. Dubey R.C. 2004. A text book of Biotechnology aspects of microbiology, British Sun Publication.
7. Pelzer, M.J., Chan, E.C.S and Krieg, N.R. 1983. Microbiology , Tata MaGraw Hill Publishing House, New Delhi.
8. Narayanaswamy, S. 1994. Plant Cell and Tissue Culture. Tata McGraw Hill Ltd. New Delhi

Reference books:

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

Plant Pathology, Industrial Microbiology and Bryophyta. S Chand & Company.

8. Chichister, U.K.J. 1999. Cultivation and Processing of Medicinal Plants, Wiley & Sons
9. William Charles Evans.1989. Pharmacognosy, 14th ed. Harcourt Brace & Company.
10. Kumar,H.D.1999. Introductory Phycology.Affiliated East-West Press, Delhi.
11. Das,SandSaha,R.2020. Microbiology Practical Manual.CBS Publishers and Distributors (P) Ltd., New Delhi, India.
12. Willie, J and Sherwood, L. 2016. Prescott's Microbiology McGraw-Hill Education; 10th Edition, ISBN: 978-1259281594
13. Reinert, J. Bajaj. T.P.S. 1977. Applied and Fundamental Aspects of Plant cell, tissue and organ Culture. Springer – Verlaug.

Web resources:

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

Mapping with Programme Outcomes:

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

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

SEMESTER - IV

PLANT PHYSIOLOGY AND BIOCHEMISTRY

Title of the Course	**PLANT PHYSIOLOGY AND BIOCHEMISTRY**						
Paper Number	**CORE XI**						
Category	Core	**Year**	II	**Credits**	4	**Course Code**	**23PBT11**
		Semester	IV				

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	3	2	-	5

Pre-requisite	Basic knowledge on physiological processes in plants.
Learning Objectives	1.To acquire knowledge on the functional aspects of plants.
	2.To understand the biophysical and biochemical processes of plants.
	3.To study the metabolism of plants.
	4.To learn the plant growth regulations.
	5.To know the adaptive mechanisms of plants in adverse environmental conditions.

UNIT	**CONTENTS**
I	Water Relations: Physical and chemical properties of water –Components of water potential - Plasmolysis - water absorption by roots – Apoplast and Symplast concept - water transport through the xylem — Transpiration and evapotranspiration- stomatal structure and function – mechanism of stomatal opening and closing – mineral nutrition – essential nutrients – macro and micro nutrients – deficiencies and plant disorders – absorption of solutes – translocation of solutes – pathways and mechanisms. phloem loading and unloading - translocation of photosynthates – source- sink relationship – partitioning of assimilates and harvest index
II	Photosynthesis: The physical nature of light – the absorption and fate of light energy – absorption and action spectra- photoreceptors- Ultrastructure and biochemical compartmentation of Chloroplast; Photosynthetic Electron Transport and Photophosphorylation (cyclic and noncyclic): Photosystems and reaction centres - Light Harvesting complexes - Photosystem I & II and Oxidation of Water; Carbon metabolism: C3, C4 and CAM pathways and their distinguishing features - photorespiration and its significance. An overview of plant respiration – Glycolysis – TCA cycle– Electron Transport – oxidative phosphorylation and ATP synthesis – Chemiosmotic Theory - Pentose Phosphate Pathway– Respiration and its significance in crop improvement. Nitrogen fixation. (Biological - symbiotic and non-symbiotic),

III	Growth and development – Auxins, gibberellins, cytokinins, abscisic acid, ethylene, brassinosteroids, physiological effect and mechanism of action in agricultural and horticultural crops - Photoperiodism – Classification of plants and mechanism of flowering – Phytochrome and their action on flowering – Vernalization- Mechanism and its practical application, biological rhythms and movements. Seed dormancy and causes and Seed germination and their biochemical changes. Plant senescence. Plant response to environmental stress
IV	Atomic structure: chemical bonds - ionic bond, covalent bond, coordinate covalent bond, hydrogen bond, hydrogen ion concentration (pH), buffers. Classification of carbohydrates; Structure and properties of monosaccharides, Oligosaccharides, Polysaccharides – Glycoproteins. Protein and Amino acids: Structure, Classification and properties; Peptides - Structure: Primary, secondary, Ramachandran plot, tertiary and quaternary structures. Classification of Lipids: Structure and properties of fatty acids, phospholipids, glycolipids, lipoproteins, cholesterol - structure and functions.
V	Enzymes- Classification and nomenclature chemical nature of enzymes – factors affecting enzyme action – Michaelis – Menton constant, MM equation, Lineweaver Burk plot, Enzyme inhibition, co enzymes- mechanism of enzyme action, isoenzymes. Thermodynamics principle, First Law of Thermodynamics a) energy (b) Enthalpy (ii) second law of thermodynamics (a) Spontaneity and disorder (b) entropy (c) free energy, redox potential, dissociation and association constant, activation energy, binding energy

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Relate understand properties and importance of water in biological system, nutrients and its translocation.	K1
CO2	Demonstrate the importance of light in plant growth and the harvest of energy.	K2
CO3	Explain the energy requirement and nitrogen metabolism.	K3
CO4	Compare the various growth regulators that influence plant growth.	K4
CO5	Discuss the senescence and plant response to environmental stress.	K5 & K6
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)		Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved

	(To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

1. Gauch, H.G.1972. Inorganic Plant Nutrition. Hutchinson & Dowd. New York.
2. Govindji. 1982. Photosynthesis. AP. New York.
3. Jacob, W.P. 1979. Plant Hormones and Plant Development. Cambridge University Press. Cambrigde
4. Khan, A.A. 1982. The Physiology and Biochemistry of Seed development, Dormancy and Germination. Elesiver. Amsterdam.
5. Salisbury, F. B.C.W. Ross.1991. Plant Physiology. Wassworth Pub. Co. Belmont.
6. Ting, I.P. 1982. Plant Physiology. Addison Wesley Pb. Philippines.
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19. Heldt, H-W. 2005. Plant Biochemistry, 3rd Edition. Elsevier Academic Press.
20. Buchanan, B.B., Grissem, W. and Jones, R.L. 2000. Biochemistry and molecular biology of plants. 5th Edition. Wiley-Blackwell.
21. Jain, J.L., Jain, S. and Jain, N. 2016. Fundamentals of Biochemistry. Chand Publishing, New Delhi.
22. Chawla, H.S. 2009. Introduction to Biotechnology, 2nd edn. Oxford IBH, ISBN:978-81-204-1732-8.
23. Halford, N. 2015. Plant Biotechnology: Current and Future Applications of Genetically Modified Crops, John Wiley and Sons.

Web resources:

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4. https://apan.net/meetings/apan45/files/17/17-01-01-01.pdf
5. https://basicbiology.net/plants/physiology
6. https://learn.careers360.com/biology/plant-physiology-chapter/4
7. https://swayam.gov.in/nd2_cec20_bt01/preview
8. https://www.nature.com/subjects/plant-physiology
9. http://priede.bf.lu.lv/grozs/AuguFiziologijas/Augu_biokimija/Plant%20Biochemistry 204.pdf
10. http://www.brainkart.com/subject/Plant-Biochemistry_257/
11. https://swayam.gov.in/nd2_cec20_bt12/preview
12. https://www.biorxiv.org/content/10.1101/660639v2
13. https://www.scribd.com/document/378882955/
14. https://nptel.ac.in/courses/102/107/102107075/
15. https://plantae.org/plant-physiology-top-articles-of-2020-based-on- altmetric-scores/
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17. 9. https://manavrachna.edu.in/blog/scope-of-biotechnology/

Mapping with Programme Outcomes:

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

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

LABORATORY COURSE- IV COVERING CORE PAPERS XI

Title of the Course	**LABORATORY COURSE- IV** Covering Core Papers XI					
Paper Number	**CORE XII**					
Category	Core	**Year**	II	**Credits**	4	**CourseCode 23PBT12P**
		Semester	IV			

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	3	-	2	5

Pre-requisite	Practicals pertaining to above subjects is important to get knowledge on various physiological functions of plants.
Learning Objectives	1.Extract bimolecule of diverse nature from different sources so that they will be able to assess the metabolic profile of their source material.
	2.Recognize the role that water plays in several physiological processes in plants.
	3.To learn the fundamental and applications of Plant Biotechnology.
	4.Learn about chromatographic techniques.
	5.Expose the students to gain recent advances in molecular biology.

UNIT	**EXPERIMENTS**
I	**PLANT PHYSIOLOGY** 1. Determination of osmotic potential by plasmolytic method. 2. Determination of water potential using gravimetric method. 3. Determination of water potential using dye method (Chardakov's method). 4. Extraction and estimation of carotenoids in plant tissues. 5. Extraction and estimation of phenol in plant tissues.
II	**PLANT PHYSIOLOGY** 1. Effect of temperature on protoplasmic membrane. 2. Estimation of chlorophyll content using Arnon's method. 3. Determination of rate of photosynthesis using O_2 electrode. 4. Experiment to study the rate of Hill activity of isolated chloroplast by dye-reduction.
III	**BIOCHEMISTRY** 1. Rice coleoptile growth test for Indole Acetic Acid. 2. Effect of auxin on root initiation. 3. Separation of chloroplast pigments using paper chromatographic technique.
	BIOCHEMISTRY 1. Estimation of Lipid content. 2. Estimation of Protein by Lowry's method.

IV	3. Determination of Relative Water Content. 4. Estimation of Amylase activity.

Course outcomes: On completion of this course, the students will be able to: **CO**	**Programme outcomes**
CO1 Perform quantitative tests for all major macro molecules and file a report of chemical profile of a plant cell.	K1
CO2 Analyze the structure and properties of various enzymes.	K2
CO3 Understand the fundamentals of water and its relation to plants.	K1 & K3
CO4 Understand the role of pigment in photosynthetic mechanism and related events of plants.	K4
CO5 Evaluate the theory and practical skills gained during the course and create idea to seek for suitable job in relevant industries.	K5 & K6

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

1. Plummer, D. 1988. An introduction to Practical Biochemistry, Tata McGraw–Hill Publishing Company Ltd., New Delhi.
2. Palanivelu, P. 2004. Laboratory Manual for analytical biochemistry and separation techniques, School of Biotechnology, Madurai Kamaraj University, Madurai.
3. Jayaraman.J.1981. Laboratory Manual in Biochemistry. Whiley Eastern Limited, New Delhi.
4. Bendre, A.M. and Ashok Kumar, 2009. A text book of practical Botany. Vol. I & II. Rastogi Publication. Meerut. 9th Edition.
5. Manju Bala, Sunita Gupta, Gupta NK. 2012. Practicals in Plant Physiology and Biochemistry. Scientific Publisher.

6. Joy, P.P., Surya, S and Aswathy, C. 2015. Laboratory Manual of Biochemistry, Agricultural University, Pineapple Research Station, Ernakulam, Kerala.
9. Poonam Sharma – Natu, Vijay Paul and P.S. Deshmukh. 2021. Laboratory manual Experimental Plant Physiology. Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi.
10. George M Malacinski. 2015. Freifelders Essentials of Molecular Biology (4th ed.) Jones & Bartlett.
11. Gupta P.K. 2017. Cell and Molecular Biology (5th ed.), Rastogi Publications, Meerut.
12. Kumar, H.D. 2007. Molecular Biology and Biotechnology, Vikas Publishing House, New
Delhi.
13. Shivakumar, S. 2002. Molecular analysis: Laboratory Manual. University press, Palkalai nagar, Madurai, India.

Reference books:

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

Web resources:

1. file:///C:/Users/User/Downloads/2021%20Botany%20Syllabus%20after%20BoS%20formatted1%20(1).pdf
2. https://kau.in/document/laboratory-manual-biochemistry

3. https://www.amazon.in/Practical-Manual-on-Plant-Biochemistry/dp/6200539790
4. https://www.amazon.in/Laboratory-Manual-Physiology-Mukesh-Amaregouda/dp/6133993502
5. https://www.kopykitab.com/A-Laboratory-Manual-of-Plant-Physiology-Biochemistry-and-Ecology-by-Akhtar-Inam
6. https://www.kopykitab.com/Cell-And-Molecular-Biology-A-Lab-Manual-by-K-V-Chaitanya

Mapping with Programme Outcomes:

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

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

PROJECT: GROUP PROJECT

Title of the Course	**PROJECT: GROUP PROJECT**						
Paper Number	**Skill Enhancement**						
Category	Skill Enhancment	**Year**	II	**Credits**	3	**Course Code**	**23PBTP**
		Semester	IV				

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	2	-	2	4

Pre-requisite	To allow students to demonstrate the personal abilities and skills required to produce and present an extended piece of work and as well as to practice writing thesis.
Learning Objectives	1.To recognize the concept of research and its various forms in the context of botany.
	2.To improve abilities relating to scientific experiments.
	3.To become proficient in data collection and the documentation of scientific findings.
	4.To prepare students for entry-level positions or professional training programmes in any field of Botany.
	5.Compare the various reporting and writing styles used in science.

UNIT	**CONTENTS**
I	7. Each student will be allotted a Project Guide from the faculty of the department concerned by lot method. 8. The topic of the dissertation shall be assigned to the candidate before the beginning of third semester. 9. After the completion of the project work, the student has to submit four copies of dissertation with report carrying his/her project report for evaluation by examiners. After evaluation, one copy is to be retained in the College Library. 10. Project work will be evaluated by both the external and the internal (Project Guide) examiners for the maximum of 100 marks in total on the scale of the maximum of 50 marks for the internal and the external each. Viva-voce will be conducted by the panel comprising, External examiner and Internal Examiner for the maximum of 100 marks in total on the scale of the maximum of 50 marks for the internal and the external each.
II	All the candidates of M.Sc (Botany) are required to undergo a major project and submit the following: 1. Dissertation/Thesis based on the work done by the student. 2. Soft copy of the project on CD/DVD.

	PROJECT EVALUATION GUIDELINES: **The project is evaluated on the basis of following heads:** For Viva-Voce maximum is 60 marks which will be conducted by both the internal and external examiners during end semester university practical examinations. **Internal:** 40 marks I Review – Selection of the field of study, topic and literature collection - 15 marks II Review – Research design and data collection - 10 marks III Review – Analysis and conclusion, preparation of rough draft - 15 marks **External:** 60 marks Thesis/ Dissertation - 30 marks Presentation - 15 marks Viva-voce - 15 marks	
III	**Suggested areas of work:** Algae, fungi, microbiology, biocontrol agents, plant tissue culture, plant physiology, phytochemistry, biochemistry, anatomy, plant taxonomy, Ethnobotany, ecology, sustainable agriculture, herbal formulations, cytogenetics, molecular biology, biotechnology, bioinformatics, nanotechnology and applied botany.	
IV	**Methodology:** **Each project should contain the following details:** 1. Brief introduction on the topic 2. Review of Literature 3. Materials and Methods 4. Results and Discussion – evidences in the form of figures, tables and photographs. 5. Summary 6. Bibliography	
Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	For students in those pertinent core areas, the project is preparing	

	them to become professionals after graduation.	K1
CO2	Compile data and familiarize yourself with techniques for planning and carrying out tests.	K2
CO3	Collect data and educate yourself on how to evaluate the analyzed results of your scientific studies.	K3 & K5
CO4 gy.	In-the-moment industrial exposure helps them become more knowledgeble and skilled in the latest technology.	K4
CO5 .	Improving communication skills and coming up with creative ideas are crucial components of training that help someone become an entrepreneur.	K5 & K6

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Texts:

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

5. Rodney Boyer. 2000. Modern Experimental Biochemistry, 3rd Edition. Published by Addison Wesley Longman. Singapore.

Reference Books:

1. Dawson, C. 2002. Practical research methods. UBS Publishers, New Delhi.
2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. 1995. Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.

3. Ruzin, S.E. 1999. Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A.
4. Wilson and Goulding. 1987. Principles of biochemical techniques, Oxford University Press.
5. Mukherji, S. and Ghosh, A.K. 2005. Plant Physiology. First Central Edition, New Central Book Agency (P) Ltd., Kolkata.
6. Taiz, L and Zeiger, E. 2010. Plant Physiology. 5th Edition. Sinauer Associates, USA.
7. Heldt, H.W and Piechulla, B. 2010. Plant Biochemistry, 4th Edition. Academic Press, NY.

Wilson, K and Walker, J. 2010. Principles and Techniques of Biochemistry and Molecular Biology, Seventh edition, Cambridge University Press, USA.

Web resources:

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

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	3	3	1	3	3	3	3	3	3
CO 2	3	3	3	3	3	3	2	1	3	2
CO 3	3	3	3	3	3	3	2	1	3	2
CO 4	3	2	3	3	3	3	3	2	3	3
CO 5	3	3	3	3	3	3	3	3	3	3

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

LECTIVE VI-ORGANIC FARMING

Title of the Course	**ORGANIC FARMING**						
Paper Number	**ELECTIVE VI**						
Category	Elective	**Year**	II	**Credits**	3	**Course Code**	**23PBTE6A**
		Semester	IV				

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	3	2	-	5

Pre-requisite	To understand the students about the organic farming.
Learning Objectives	1To study various aspects of organic farming.
	2.To understand the relevance of organic farming, its advantages and short comings against conventional high input agriculture.
	3.To know the importance of organic farming in the present scenario and its impact on environment and soil health.
	4.Awareness on the importance of organic farming in the present scenario and its impact on environment and soil health.
	5.Expose the students to about quality aspect and grading.

UNIT	**CONTENTS**
I	**AGRONOMY:** Organic farming- concept, characteristics, significance, organic ecosystem, scope of organic farming in India - Principles and types of organic farming. Choice of crops & varieties in organic farming - Initiative by Govt/NGOs/Other organizations for promotion of organic farming Operational structure of NPOP (National Programme for Organic Production) - Concept of dryland agronomy Organic nutrient resources & their fortification, restriction to nutrient use in organic farming - Organic production methods for cereals, vegetables and fruit crops
II	**SOIL SCIENCE:** Organic farming for sustainable agriculture; Manures- compost, methods of composting - Green manuring, vermicompost and biofertilizer Harmful effect of non-judicious chemical fertilization - Organic farming practices for improving soil health Quality parameters of organic manures and specifications - Soil fertility in organic farming systems Manure preparation methodology - Soil improvement
III	**FUNDAMENTAL OF ORGANIC FARM MANAGEMENT:** Land management in organic farming - Water management in organic farming. Organic insect disease management - Organic pest disease management. Preventive and cultural methods for insects and pest control - Identification of different fungal and bacterial biocontrol agents

	Indigenous technical knowledge for insects-pest, disease - Weed and nutrient management in organic farming
IV	**POST HARVEST MANAGEMENT:** Processing, labeling of organic produce - Storage and transport of organic produce.
V	**ORGANIC QUALITY CONTROL STANDARDS:** Certification- types, process & procedure and agencies. Quality aspect and grading - Packaging and handling. Economic considerations and viability of organic products - Export of organic product and marketing

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Knowledge on various aspects of organic farming.	K1
CO2	Understand the relevance of organic farming, its advantages.	K2
CO3	Explain the short comings against conventional high input agriculture.	K3
CO4	Compare the packaging methods of harvest.	K4
CO5	Discuss and develop skills for post harvest management.	K5 & K6

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

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

Reference books:
1. Reddy, S.R. 2019. Fundamentals of Agronomy Kalyani Publications, Uttar Pradesh
2. Tolanur, S. 2018. Fundamentals of Soil Science IIndEdition , CBS Publishers , New Delhi
3. Reddy, S.R. 2017. Principles of Organic Farming Kalyani Publishers , New Delhi
4. Dongarjal, R.P and Zade, S.B. 2019. Insect Ecology and Integrated Pest Management Akinik Publications, New Delhi.
5. Ahmad Mehraban. 2013. The Basis of Organic Fertilizers, LAP LAMBERT Academic Publishing.
Web resources:
1. https://www.amazon.in/Healthy-earth-organic-Hari-prasad-ebook/dp/B08L5KFKDV
2. https://www.kobo.com/in/en/ebook/organic-farming-for-sustainable-agriculture
3. https://www.elsevier.com/books/organic-farming/chandran/978-0-12-813272-2
4. https://link.springer.com/book/10.1007/978-3-030-04657-6
5. https://www.afrimash.com/product-category/livestock-section/book/organic-farming-ebooks/

Mapping with Programme Outcomes:

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

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

ELECTIVE VI- GENE CLONING AND GENE THERAPY

Title of the Course	**GENE CLONING AND GENE THERAPY**						
Paper Number	**ELECTIVE VI**						
Category	Elective	**Year**	II	**Credits**	3	**CourseCode**	**23PBTE6B**
		Semester	IV				

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	3	2	-	5

Pre-requisite	To know about the gene cloning and gene therapy.
Learning Objectives	1.To give a clear knowledge of genetic engineering, cloning vectors, enzymes involved in cloning.
	2.To understand the procedure involved in recombinant DNA technology and restriction mapping.
	3.To focus on the application of gene cloning in plants and animals.
	4.To enable the students to information on Gene Therapy.
	5.To raise student to create transgenic plants for hybrid seed production and molecular farming.

UNIT	**CONTENTS**
I	Definition of genetic engineering, gene cloning and recombinant DNA cloning vectors: plasmids, bacteriophages, plant and animal vectors.
II	Gene cloning in prokaryotes and eukaryotes, Isolation of DNA to be cloned, insertion of DNA fragment into vector. Use of Restriction Linkers: use of Homopolyer tails, Transfer of recombinant DNA into Bacteria cell. Selection of clones.
III	Gene Therapy: Definition, Germ cell and Somatic cell. Amniocentesis in human; patient therapy, embryo therapy.
IV	Restriction mapping –. Random amplified polymorphic DNA using PCR. DNA finger printing; Gene Tagging. Physical methods of gene delivery. Gene transfer techniques.. Genetic counselling – Eugenics, Euthenics.
V	Transgenic plants with herbicide resistance, insect resistance, virus resistance andresistance against bacterial and fungal pathogens. Transgenic plants for hybrid seed production and molecular farming.

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Recollect the basic concepts of gene cloning.	K1
CO2	Demonstrate and to identify the selection of clones.	K2
CO3	Acquire knowledge on the gene therapy.	K3

CO4	Compare and understand the concept of gene therapy.	K4
CO5	Discuss and develop skills for hybrid seed production and molecular farming.	K5 & K6
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)	
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill	

Recommended Text:

1. Das, H.K. 2010. Textbook of Biotechnology (4th edition). Wiley India Pvt. Ltd. New Delhi
2. Gamborg, O.L and G.C. Phillips (eds). 1995. Plants, genes and agriculture. Jones and Bartlett Publishers.
3. Verma, P.S and Agarwal V.K. 2009. Genetic Engineering. S.Chand & Co. Ltd. New Delhi
4. Kreuzer, H and A. Massey. 1996. Recombinant DNA and biotechnology. A guide for teachers. ASM Press.
5. Ramavat, K.G. 2006. Plant Biotechnology. S. Chand and Co. Ltd., New Delhi.
6. Chawla, H.S. 2009. Introduction to Biotechnology. 2nd edn. Oxford IBH, ISBN: 978-81-204- 1732-8.
7. Halford, N. 2015. Plant Biotechnology: Current and Future Applications of Genetically Modified crops, John Wiley and Sons.
8. Kumar, Pradeep. 2018. Advances in Microbial Biotechnology: Current Trends and Future Prospects. 10.1201/9781351248914.
9. Thieman. 2014. Introduction to Biotechnology 3rd Edition. Pearson Education India.
10. Khan. I.A. and A. Khanum .2004. Fundamentals of Biotechnology – Forensic Science Genetic Engineering. Ukaaz publication, Hyderabad.
11. Gupta. P.K. 1998. Elements of Biotechnology. Rastogi publications, Meerut.

Reference books:

2. Smith. J.K. 1996. Biotechnology – 3rd Ed. Cambridge Univ. Press, Cambridge.
3. Slater, A. Scott, N and Fowler, M. 2008. Plant Biotechnology: The Genetic Manipulation of Plants. Oxford University Press Inc.
4. Reynolds, P.H.S. 1999. Inducible Gene Expression in Plants. CABI Publishing, U.K.
5. Chawla, H.S. 2009. Introduction to Biotechnology, 2nd edn. Oxford IBH, ISBN:978-81-204-1732-8.
6. Halford, N. 2015. Plant Biotechnology: Current and Future Applications of Genetically Modified Crops, John Wiley and Sons.
7. Brown T.A. 2001. Gene Cloning and DNA Analysis- An Introduction (4th edition). Blackwell Science. Oxford.
8. Clark, D.P and Pazdernik, N.J. 2009. Biotechnology- Applying the Genetic Revolution. Elsevier Academic Press. USA.
9. Glick B.R and J. J. Pasternak. 2009. Molecular Biotechnology, Panima Publication Co.
10. Harisha, S. 2007. Biotechnology Procedures and Experiments Handbook. Infinity Science Press Llc. Hingham. MA.
11. Mosier N.S and Ladisch M.R. 2009. Modern Biotechnology- Connecting Innovations in Microbiology and Biochemistry to Engineering Fundamentals. John Wiley & Sons Inc. New Jersey.
12. Primrose S., Twyman R. and Old B. 2001. Principles of Gene Manipulation (6th ed.). Blackwell Science. Oxford.

13. Ignacimuthu, S.1998. Applied Plant Biotechnology. Tata Mc Graw Hill, publishing company Ltd., New Delhi.
14. Neal Stewart, Jr. 2008. Plant Biotechnology and Genetics: Principles, Techniques and Applications. JohnWiley & sons Inc.

Web resources:

1. https://www.amazon.in/Gene-Cloning-Manipulation-Christopher-Howe-ebook/dp/B000SK4YLI
2. https://www.amazon.in/Gene-Cloning-Steve-Minchin-ebook/dp/B000SHTUT2
3. https://www.futuremedicine.com/doi/book/10.2217/9781780842134
4. https://www.researchgate.net/publication/51144570_Introduction_to_Gene_Therapy_A_Clinical_Aftermath
5. https://link.springer.com/book/10.1007/978-88-470-1643-9

Mapping with Programme Outcomes:

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

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

SKILL ENHANCEMENT (SE2)

NURSERY AND GARDENING

Title of the Course	**NURSERY AND GARDENING**						
Paper Number	**SKILL ENHANCEMENT II**						
Category	Skill Enhancement	**Year**	I	**Credits**	2	**Course Code**	**23PBTSE3**
		Semester	I				

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	2	1	--	3

Pre-requisite	Students should know nursery and gardening practices.
Learning Objectives	1.To recognize the importance of nursery and gardening
	2.To gain an understanding of nursery management.
	3.To develop skills necessary to manage a wholesale nursery.
	4.To acquire knowledge regarding theory and practice of rising plants.
	5.To develop an interest to become an entrepreneur.

UNIT	**CONTENTS**
I	**NURSERY:** Definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants.
II	**SEED:** Structure and types - Seed dormancy; causes and methods of breaking dormancy - Seed storage: Seed banks, factors affecting seed viability, genetic erosion - Seed production technology - seed testing and certification.
III	**VEGETATIVE PROPAGATION:** Air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings - Hardening of plants - green house - mist chamber, shed root, shade house and glasshouse.
IV	**GARDENING:** definition, objectives and scope - different types of gardening - landscape and home gardening - parks and its components - plant materials and design - computer applications in landscaping.
V	**GARDENING OPERATIONS:** Soil laying, manuring, watering, management of pests and diseases and harvesting. Sowing/raising of seeds and seedlings: Transplanting of seedlings - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes, and carrots - Storage and marketing procedures.

Course outcomes: CO	On completion of this course, the students will be able to:	Programme outcomes
CO1	Recognize the basic process required for growing and maintaining plants in nurseries.	K1
CO2	Explain the different methods of plant propagation and various gardening styles.	K2
CO3	Apply techniques for effective hardening of plants and computer applications for creative gardening.	K3& K6
CO4	Compare and contrast cultivation of different vegetables and growth of plants in nursery and gardening.	K4
CO5	Develop new strategies to enhance growth and quality of nursery plants.	K5 & K6

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

1. Bose T.K and Mukherjee, D. 1972. Gardening in India, Oxford & IBH Publishing Co., New Delhi.
2. Sandhu, M.K. 1989. Plant Propagation, Wile Eastern Ltd., Bengaluru.
3. Kumar, N. 1997. Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
4. Edmond Musser and Andres. 1957. Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
5. Agrawal, P.K. 1993. Hand Book of Seed Technology, Dept. of Agriculture and Cooperation, National Seed Corporation Ltd., New Delhi.

Reference Books:

1. N.L. Patel, S.L. Chawla, T.R. Ahlawat: Commercial Horticulture‖, 2016, ASPEE College of Horticulture, Navsari Agricultural University, Navsari 396 450, Gujarat,
2. Prasad S & Kumar U. 2005. Greenhouse Management for Horticultural Crops. 2nd Ed. Agrobios.
3. George Acquaah, 2002, Horticulture-principles and practices. Prentice-Half of India pvt. Ltd., New Delhi.
4. Abraham, A and Vatsala, P. 1981. Introduction to Orchids. Trop. Bot. Garden, Trivandrum.
5. Hartman, H.T and Kester, D.E. 1989. Plant propagation. Printice Hall Ltd., New Delhi.

Web resources:

1. https://www.kopykitab.com/Nursery-And-Gardening-SEC-by-Prof-C-D-Patil-Dr-G-M-Rane-Dr-S-A-Patil
2. https://www.wonderslate.com/nursery-and-gardening-management/ebook-details?siteName=books&bookId=38078&preview=true
3. https://books.google.co.in/books/about/Nursery_Hindi_Book_Bonsai_Plants_Nursery.html?id=-nfDDwAAQBAJ&redir_esc=y
4. https://www.amazon.in/Gardening-Books/b?ie=UTF8&node=1318122031

5 . https://www.worldcat.org/title/handbook-of-horticulture/oclc/688653648

Mapping with Programme Outcomes:

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

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

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