PERIYAR UNIVERSITY

PERIYAR PALAKALINAGAR

SALEM -636011

DEGREE OF MASTER OF SCIENCE

CHOICE BASED CREDIT SYSTEM

SYLLABUS FOR M.Sc ., BOTANY

(FOR THE STUDENTS ADMITTED FROM THE ACADEMIC YEAR 2023-2024 ONWARDS)

PERIYAR UNIVERSITY, SALEM -636011

M.Sc BOTANY – SYLLABUS

(Academic year 2023-2024 onwards)

Content

PERIYAR UNIVERSITY, SALEM -636011

Programme: M.Sc. Botany	
Duration: 2years	
Programme Outcomes(PO)	
M.Sc. Botany program is designed to achieve the following objectives	
PO1	To impart knowledge on the fundamental, advanced and emerging concepts in Botany.
PO2	To provide upto date theoretical knowledge on various forms of plants, their interactions with biotic and abiotic entities in the ecosystem and relevant practical skills.
PO3	To comprehend and interpret various facets of Botany including the importance and judicious utilization of plant sources.
PO4	To address various criticall issues in conserving the biodiversity with special reference to economically important plants and the plants listed in RED data.
PO5	To understand the principles and applications of various traditional and modern techniques used in Botany.
PO6	To disseminate knowledge on the design and execution of experiments in Botany with emphasis on the operation of relevant sophisticated instruments.
PO7	To impart knowledge on the economic importance of plant/microbial resources and their products and to promote entrepreneurship skill.
PO8	To promote proficiency in designing the research problems, review of literature, laboratory experiments, data analyses and preparation of reports with professional ethics.
PO9	To motivate the students to take up innovative and cutting-edge research in frontier areas of Botany and related biology subjects.
PO10	To enable the students to take up various qualifying examinations concerning Botany and to face the challenges in career opportunities.

Program Specific Outcomes(PSO)	
On successful completion of the M.Sc. Botany program, the students are expected to	
PSO1	Familiarize with the fundamental, advanced and emerging concepts in Botany.
PSO2	Understand the role of plants and their interactions with other organisms in various ecosystems.
PSO3	Identify the potency of plant resources in contemporary research and visualize future thrust areas in Botany.
PSO4	Design scientific experiments independently and to generate useful information to address various issues in Botany.
PSO5	Acquire basic knowledge on principles and applications of laboratory instruments and adequate skills to handle them.
PSO6	Choose and apply appropriate tools, techniques, resources, etc.to perform various experiments in Botany.
PSO7	Carryout scientific experiments independently or in collaboration with inter-disciplinary or multidisciplinary approaches.
PSO8	Disseminate knowledge on conservation of biodiversity and protection of environment.
PSO9	Awareness on the sustainable utilization of plant/microbial resources following the bioethical norms.
PSO10	Demonstrate proficiency in communicating with various stakeholders like students, teachers, scientists and society.

PERIYAR UNIVERSITY, SALEM -636011

M.Sc., Botany – Syllabus

(Academic year 2023-2024 onwards)

Course structure

Semester	Course	Course code	COURSE TITLE	Credits	Contct hrs /week	CAA mark	External mark	Total Mark
I			**First Year – Semester I**					
	Core-I	**23UPBOT1C01**	Plant Diversity-I (Algae, Fungi, Lichens and Bryophytes)	**5**	**6**	**25**	**75**	**100**
	Core-II	**23UPBOT1C02**	Plant Diversity - II (Pteridophytes, Gymnosperms & Paleobotany)	**5**	**6**	**25**	**75**	**100**
	Core – **Laboratory course- I:**	**23UPBOT1P01**	Practical -01 (Covering Core Papers - I & II)	**4**	**6**	**40**	**60**	**100**
	Elective -1 **(Group A)** (one from each course)	**23UPBOT1E01**	Microbiology, Immunology& Plant pathology	**3**	**5**	**25**	**75**	**100**
		23UPBOT1E02	Conservation of Natural Resources & Policies					
		23UPBOT1E03	Mushroom Cultivation					
		23UPBOT1E04	Phytopharmacognosy					
	Elective -II (**Group B)** (one from each course)	**23UPBOT1E05**	Algal Technology	**3**	**5**	**25**	**75**	**100**
		23UPBOT1E06	Ethno botany, Naturopathy & Traditional healthcare					
		23UPBOT1E07	Horticulture					
		23UPBOT1E08	Herbal Technology					
			Library		**1**			
			Garden		**1**			
				20	**30**			**500**
			First Year – Semester II					
II	Core-III	**23UPBOT2C03**	Taxonomy of Angiosperms & Economic botany	**4**	**4**	**25**	**75**	**100**
	Core-IV	**23UPBOT2C04**	Plant anatomy & Embryology of Angiosperms	**4**	**4**	**25**	**75**	**100**
	Core – V	**23UPBOT2C05**	Ecology, phytogeography, conservation Biology & Intellectual property rights	**4**	**4**	**25**	**75**	**100**
	Core – **Laboratory course- II**	**23UPBOT2P02**	Practical 02 (covering core papers III, IV and V)	**2**	**6**	**40**	**60**	**100**

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	Elective III (Group C (one from each course)	**23UPBOT2E09**	Medicinal Botany	**3**	**4**	**25**	**75**	**100**
		23UPBOT2E10	Phytochemistry					
		23UPBOT2E11	Research Methodology, Computer Applications & Bioinformatics					
		23UPBOT2E12	Bio pesticide technology					
	Elective IV (Group D) (one from each course)	**23UPBOT2E13**	Applied bioinformatics	**3**	**4**	**25**	**75**	**100**
		23UPBOT2E14	Biostatistics					
		23UPBOT2E15	Intellectual property rights					
		23UPBOT2E16	Nano biotechnology					
	Skill Enhancement Course SEC1)	**23UPBOT2S01**	Nursery and gardening	**2**	**2**			
			Human Rights	1	2	25	75	100
			Library		**1**			
			Garden		**1**			
				25	**32**			**700**
			Second Year Semester III					
III	. Core- VI	**23UPBOT3C06**	Cell and Molecular Biology	**4**	**4**	**25**	**75**	**100**
	Core-VII	**23UPBOT3C07**	Genetics, Plant breeding & Biostatistics	**4**	**4**	**25**	**75**	**100**
	Core –VIII	**23UPBOT3C08**	Recombinant DNA Technology and Industrial Applications	**4**	**4**	**25**	**75**	**100**
	Core – **Laboratory course- III**	**23UPBOT3P03**	Practical 03 (covering core papers VI,VII&VIII)	**3**	**6**	**40**	**60**	**100**
	Core -IX	**23PBOT3C09**	Industrial Botany	**4**	**4**	**25**	**75**	**100**
	Elective V(Group E) (one from each course)	**23UPBOT3E17**	Secondary Plant Products & Fermentation Biotechnology	**3**	**4**	**25**	**75**	**100**
		23UPBOT3E18	Entrepreneurial Opportunities in Botany					
		23UPBOT3E19	Applied Plant Cell & Tissue Culture					
		23UPBOT3E20	Silviculture & Commercial Landscaping					
	Skill Enhancement Course SEC 2	**23UPBOT3S02**	Agriculture and Food Microbiology	**2**	**2**			
			Library		**1**			
			Garden		**1**			
	Internship/ Industrial Activity		Internship/Industrial Activity(Carried out in Summer Vacation at the end of I year– 30	**2**	**-**			

			hours					
				26	**30**			**600**
			Second Year Semester IV					
IV	Core-X	**23UPBOT3C10**	Plant physiology and Plant metabolism	**4**	**5**	**25**	**75**	**100**
	Core-XI	**23UPBOT3C11**	Biochemistry & Applied Biotechnology	**4**	**5**	**25**	**75**	**100**
	Core – **Laboratory course- IV**	**23UPBOT4P04**	**Practical - 04** **(**Covering Core Papers X & XI)	**2**	**6**	**40**	**60**	**100**
	Elective IV- industry Entrepeneurship (Group F) (one from each course)	**23UPBOT4E21**	Organic Farming	**3**	**3**	**25**	**75**	**100**
		23UPBOT4E22	Forestry and wood technology					
		23UPBOT4E23	Gene cloning and Gene therapy					
		23UPBOT4E24	Farm sciences- Green wealth					
	Project with Viva-Voce	**23UPBOT4PR1**	Project with Viva-voce	**5**	**6**	**40**	**60**	**100**
	Skill Enhancement Course - SEC 3	**23UPBOT4S03**	Skill enhancement course iii /professional competency	**2**	**3**			
			Library		**1**			
			Garden		**1**			
	Extension Activity			**1**	**-**			
				21	**30**			**500**
	Total			**92**	**92**			**2300**

Practical Examinations would be held on end of 2&4 semesters

Non CGPA: Soft skill-8, Industrial training-2, Internship-3, Skill Enhancement-13

PERIYAR UNIVERSITY, SALEM -636011

M.Sc., Botany – Syllabus

(Academic year 2023-2024 onwards)

ELECTIVE COURSE OFFERED

Semester	Course code	COURSE TITLE	Credits
I	**ELECTIVE –I (GROUP A)**		
	23UPBOT1E01	MICROBIOLOGY, IMMUNOLOGY& PLANT PATHOLOGY	
	23UPBOT1E02	CONSERVATION OF NATURAL RESOURCES & POLICIES	
	23UPBOT1E03	MUSHROOM CULTIVATION	**3**
	23UPBOT1E04	PHYTOPHARMACOGNOSY	
	ELECTIVE –II (GROUP B)		
	23UPBOT1E05	ALGAL TECHNOLOGY	
	23UPBOT1E06	ETHNOBOTANY, NATUROPATHY & TRADITIONAL HEALTHCARE	**3**
	23UPBOT1E07	HORTICULTURE	
	23UPBOT1E08	HERBAL TECHNOLOGY	
ELECTIVE –III (GROUP C)			
II	**23UPBOT2E09**	MEDICINAL BOTANY	
	23UPBOT2E10	PHYTOCHEMISTRY	**3**
	23UPBOT2E11	RESEARCH METHODOLOGY, COMPUTER APPLICATIONS &BIOINFORMATICS	
	23UPBOT2E12	BIOPESTICIDE TECHNOLOGY	
	ELECTIVE –IV (GROUP D)		
	23UPBOT2E13	APPLIED BIOINFORMATICS	**3**
	23UPBOT2E14	BIOSTATISTICS	
	23UPBOT2E15	INTELLECTUAL PROPERTY RIGHTS	
	23UPBOT2E16	NANOBIOTECHNOLOGY	
ELECTIVE – V (GROUP E)			
III	**23UPBOT3E17**	SECONDARY PLANT PRODUCTS & FERMENTATION BIOTECHNOLOGY	**3**
	23UPBOT3E18	ENTREPRENEURIAL OPPORTUNITIES IN BOTANY	
	23UPBOT3E19	APPLIED PLANT CELL & TISSUE CULTURE	
	23UPBOT3E20	SILVICULTURE & COMMERCIAL LANDSCAPING	
ELECTIVE – V (GROUP F)			
IV	**23UPBOT4E21**	ORGANIC FARMING	**3**
	23UPBOT4E22	FORESTRY AND WOOD TECHNOLOGY	
	23UPBOT4E23	GENE CLONING AND GENE THERAPY	
	23UPBOT4E24	FARM SCIENCES- GREEN WEALTH	

CREDIT DISTRIBUTIONFOR PG PROGRAMME IN BOTANY

First Year: Semester-I

	Courses	Credit	Hours per Week(L/T/P)
Part A	Core Courses 3(CC1,CC2,CC3)	14	18
Part B (I)	Elective Courses 2 (Group A& B)	6	10
Part C	Library		1
	Garden		1
		20	**30**

Semester-II

	Courses	Credit	Hours per Week(L/T/P)
Part A	Core Courses 4(CC4,CC5,CC6, CC7)	16	18
Part B (I)	Elective Course 2 (Group C& D)	6	8
Part B(II)	Skill EnhancementCourse-SEC1	2	2
	Human Rights	1	2
Part C	Library		1
	Garden		**1**
	Total	**25**	**32**

Second Year: Semester-III

	Courses	**Credit**	**Hours per Week(L/T/P)**
Part A	Core Courses 4(CC8,CC9,CC10, CC11)	15	18
	Core Industry Module	4	4
Part B (I)	Elective Course (Group E)	3	3
Part B (II)	Skill Enhancement Course-SEC2	2	3
	Internship/Industrial Activity(Carried out in Summer Vacation at The end of I year– 30 hours)	2	
Part C	Library		1
	Garden		1
	Total	**26**	**30**

Semester-IV

	Courses	**Credit**	**Hours per Week(L/T/P)**
Part A	Core Courses 3 (CC12,CC13,CC14)	10	16
Part B (I)	Elective Course1(Group F)	3	3
	Project with Viva voce(CC13)	5	6
Part B (II)	Skill Enhancement SEC3 Professional Competency	2	3
Part C	Library		1
	Garden		1
	Extension Activity(Can be carried out from Sem II to Sem IV)	**1**	
		21	**30**

COMPONENT WISE CREDIT DISTRIBUTION

Credits	Sem I	Sem II	Sem III	Sem IV	Total
Part A	14	16	19	10	59
Part B (i) Elective Course)/Project	6	6	3	8	23
(ii) Skill enhancement course	0	2	2	2	08
(iii) Summer Internship / Industrial Training			2		
Human Rights		1			
Part C				1	1
Total	20	25	26	21	92

Part A component and Part B (i) will be taken into account for CGPA calculation for the post graduate programme and the other component Part B (II&III) and Part C have to be completed during the duration of the programme as per the norms, to be eligible for obtaining PG degree.

EXAMINATION PATTERN

University examination (EA)	Internal Assessment (CIA)
75 marks	25 marks

1. **Internal Assessment**

Theory Course: For theory courses there shall be three tests conducted by the faculty concerned and the average of the best two can be taken as the Continuous Internal Assessment (CIA) for a maximum of 25 Marks.The duration of each test shall be one/one and a half hour.

Laboratory Courses:

For Laboratory Courses, there shall be Continuous Internal Assessment Test and Record. One test in Laboratory part, attendance and class participation.The CIA for a maximum of 40marks.The duration of each test shall be 4 hours.

Methods of Evaluation Practical's	
Continuous Internal Assessment Test	40 Marks
Attendance and Class Participation	
End Semester Examination	50 Marks
Record	10 Marks

There is no improvement for CIA of both theory and laboratory, and, also for University End Semester Examination.

Project work and Vice voce

Credits -5; Marks-100

Marks Distribution:

Internal -40 Marks

External- 60 Marks

Thesis/Dissertation : 30 marks

Periodical presentation: 15 Marks

Viva-voce : 15 marks

CORE COURSE I

PLANT DIVERSITY – I

Title of the Course	PLANT DIVERSITY – I (ALGAE, FUNGI, LICHENS AND BRYOPHYTES)					
Paper Number	**Core I**		**Credits**	**5**	**Course code**	**23UPBOT1C01**
Category	**Year**	**I**				
Core	**Semester**	**I**				
Instructional Hours/week	**Lecture**	**Tutorial**	**Lab practice**	**Total**		
	4	**2**	**-**	**6**		
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,lichen and bryophytes . To expose the beneficial and harmful view point.					

UNITS	CONTENTS
Unit I	**ALGAE:** Introduction and history of phycology. Algology in India (Contributions of eminent Indian Algologists (T.V.Desikachary, V.Krishnamurthy and V.S. Sundaralingam), Habit and habitat of algae, Range of thallus organization, Reproduction and life cycle pattern of Algae. Phylogeny and Evolutionary trend in algae, origin and evolution of sex in algae. Classification of algae by F.E. Fritsch (1935-45) & Silva (1982) - Criteria used for algae classification. Salient features, reproduction and Life cycle pattern of Cyanophyceae,

	Chlorophyceae, Xanthophyceae, Chrysophyceae, Dinophyceae, Chloromonadinaeae, Euglenophyceae, Charophyceae, Bacillariophyceae, Phaeophyceae, Rhodophyceae. Structure, reproduction and life histories of the following genera: *Oscillatoria, Scytonema, Ulva, Codium, Nitella, Vaucheria Diatoms, Dictyota* and *Gelidium.*Fossil alage
Unit 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 interrelationship of *Mastigomycotina, Zygomycotina, Ascomycotina, Basdiomycotina and Deuteromycotina* – Spore dispersal mechanism in fungi . Heterothallism and para sexuality in fungi – Sex hormones and pheromones in Fungi. Structure, reproduction and life histories of the following genera: *Plasmodiophora, Phytophthora, Pilobolus, Rhizopus, Xylaria Taphrina, Polyporus* and *Colletotrichum.*
	LICHENS: Introduction to lichen - Classification of Lichens (Hale 1969)- Occurrence and interrelationship of Phycobionts and Mycobionts, Structure and reproduction in lichens.
	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: *Marchantia,, Lunularia, Porella Anthoceros, Sphagnum* and *Polytrichum*. *Pogonatum.* fossil bryophytes.
	ECONOMIC IMPORTANCE **Economic importance of Algae:** Algae as food, fodder, bio fertilizer, medicine, industrial uses, and other useful products. Harmful effects of algae. Toxicity and

	parasitism, red tides. Bio -fouling of marine vessels, Importance in municipal water supplies: algae bloom. Use of Algae in experimental studies. **Economic importance of Fungi** – Food industries and medicine. **Economic importance of Lichen** — Lichens as indicator of pollution – Role of lichens in soil formation, **Economic importance of Bryophytes** – Ecological and economic importance – industry, horticulture and medicine

Course out come 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 Examinationquestion 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 thiscourse	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Text books for Algae

1. Sharma, O.P. (2011). Diversity of microbes & Cryptogams – Algae, Tata McGraw Hill Education Private Limited, New Delhi
2. Kumar, H.D. (1985). Introductory Phycology - East West Press, New Delhi.
3. Kumar, H.D and Singh, H.N. (1982). A textbook of Algae. Affiliated East West Press, New Delhi.

4. Sambamurty, A.V.S.S. (2005). Textbook of Algae, I K International Publishing House.
5. Vashishta, B.R. *et al.* (2008). Botany for Degree Students - Algae. S. Chand and Co. New Delhi.

Reference books

1. Bold, H.C and Wyne M.J. (1978). Introduction to algae – Structure & reproduction Prentice hall, New Jersey
2. Chapman, V.J and Chapman. (1973). The algae – ELBS & MacMillan, London
3. Fritsch, F.E. (1935). The Structure & Reproduction of The Algae (Vol - 1 & 2) Cambridge University Press, England
4. Round, F.E. (1982). The Ecology of algae, Cambridge University press, London
5. Lee, R.E. (2008). Phycology - IV Edition, Cambridge University Press, New Delhi
6. Venkataraman G.S *et al.*, (1974). Algae form and Function – Today and Tomorrow Publishers, New Delhi.

FUNGI

Text books

1. Sharma, O.P. (2011). Fungi and allied microbes The McGraw –Hill companies, New Delhi
2. Alexopoulus, C.J and Mims, C.W. (1979). Introductory Mycology, Wiley Eastern ltd., New Delhi
3. Dube, H.C. (1990). An Introduction of Fungi. Vikas Publication House Ltd, New Delhi
4. Dube, H.C (1983). Introduction of Modern Mycology. Blackwell Science Publication. Oxford
5. Sharma, P.D (2003). The Fungi. Rastogi Publications, Meerut

Reference Books

1. Burnett, J.H. (1971). The fundamentals of Mycology. ELBS Publication, London
2. Bessey, E.A (1979). Morphology and Taxonomy of fungi, Vikas publishing House Pvt. Ltd , New Delhi.
3. Mehrotra R.S and Aneja K.R. (1990). An Introduction to Mycology, New Age International Pub, New Delhi
4. Sundararajan, S. (2004). Practical manual of fungi, Anmol publications Pvt. Ltd, New Delhi.

LICHENS

Text & Reference Books

1. Muthukumar S and Tarar, J.L. (2006). Lichen Flora of Central India, Eastern book Corporation, New Delhi.
2. Awasthi, D.D. (2000). A Handbook of Lichens Vedams eBooks (P) Ltd. New Delhi.
3. Hale, M.E. (1983). The Biology of Lichens. Edward Arnold, London
4. Nash, T.H (1996). Lichen Biology. Cambridge University Press, London

BRYOPHYTES

Text Books

1. Rashid, A. (1998). An introduction to bryophyte. Vikas Publishing Co. New Delhi.
2. Vashishta, Sinha A.K and Adarsh Kumar. (2011). Bryophytes, S. Chand & Company ltd., New Delhi.
3. Sharma O.P (2020). Bryophyta. Third edition, McGraw Hill Education (India) Pvt. Ltd.

Reference books

1. Cavers, F. (1971). The interrelationship of Bryophyta, Dawsons of Pall Mall, London.
2. Chopra, R N. (1998). Topics in Bryology, Allied Published Ltd, Mumbai
3. Chopra, R.N and Kumar P.K. (1988). Biology of Bryophytes, John Wiley, New York
4. Graham, L.E. (1993). Origin of land Plants. John Wiley, New York
5. Prem Puri, P. (1990). Bryophytes: Morphology, Growth and Differentiation.
6. Smith, A.J.E. (1982). Bryophyte Ecology. Chapman and Hall. London
7. Watson E.V. (1968). British Mosses and Liverworts, Hutchinson and Co., London
8. Watson, E.V. (1970). Structure and life of Bryophytes. Hutchinson and Co, London
9. Parihar, N.S. (1972). An Introduction to Embryophyta - I: Bryophyta. Central Book, Depot, Allahabad.

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

MappingwithProgrammeOutcomes:

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

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

CORE COURSE II

PLANT DIVERSITY – II

Title of the Course	PLANT DIVERSITY – II (PTERIDOPHYTES, GYMNOSPERMS & PALEOBOTANY)					
Paper Number	Core II		Credits	5	Course code	23UPBOT1C02
Category	Year	I				
Core	Semester	I				
Instructional Hours/ week	Lecture	Tutorial	Lab practice	Total		
	4	2	-	6		
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.					

UNITS	CONTENTS
I	**Pteridophytes:** General characteristics and Classification of Pteridophytes (Remier. 1954), Comparative morphology, anatomy, reproductive biology and evolutionary studies of the following groups: *Psilopsida, Lycopsida, Sphenopsida* and *Pteropsida.* Fossil Pteridophytes– *Rhynia, Sphenophyllum, Lepidocarpon, Cladoxylon , Pentoxylon, Botryopteris*
II	**Evolutionary Approach in Pteridophytes** Phylogenetic trends in Pteridophytes - Evolution of Stele, Sorus – Origin of

	sporangium - Heterospory and seed habit –Alternation of generation – Affinities of various classes of Pteridophytes, Apogamy and Apospory in Pteridophytes, Economic importance of Pteridophytes
III	**Evolutionary Approach in Gymnosperm & extinct gymnosperms** General character, classification of gymnosperms (Sporne, K.R. 1956). Origin and Evolution of gymnosperms with special reference to Progymnosperms, Devonien pre ovules and origin of seed. Salient feature, morphology, anatomy, reproductive structure and Phylogeny of extinct gymnosperms order – *Pteridospermales, Bennenttiales, Pentoxylales, Cycadales, Cordaitales, Coniferales.*
IV	**Living gymnosperm & Economic important :** Comparative study of vegetative, anatomical and reproductive characteristics of extant order of *Cycadaceae, Ginkgolaes, coniferales, Gnetales*. Economic importance of gymnosperms Affinities with Angiosperms and Pteridophytes, Global distribution of gymnosperms with special reference to Indian plants
V	**Paleobotany:** Concept of Paleobotany - Geological time scale- contribution of Birbal sahni– Technique for paleobotanical studies. Fossilization process, Types of fossils, the fossil records: systematic reconstruction and nomenclature of fossil plants, Determination of Age of Fossils, Fundamentals of Paleo Floristics, Palaeogeography and Palaeoclimatology. Role fossil in oil exploration, Paleopalynology

Course out come CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
Co1	Recall on classification, recent trends in phylogenetic relationship, General characters of Pteridophytes and Gymnosperms.	**K1**
Co2	Learn the morphological/anatomical organization, life history of major types of Pteridophytes and Gymnosperms.	**K2**
Co3	Learned economic importance of Pteridophytes, Gymnosperms and fossils.	**K3**

Co4	Understanding the evolutionary relationship of Pteridophytes and Gymnosperms.	**K4**
Co5	Awareness of fossil types, fossilization and fossil records of Pteridophytes and Gymnosperms.	**K5&K6**

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)	Questionsrelatedtotheabovetopics,fromvariouscompetitiveexaminationsUPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/otherstobesolved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving,Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

PTERIDOPHYTES

Text books

1. Vashishta, P.C, Sinha and Anilkumar (2010). Pteridophytes, S. Chand & company Ltd, New Delhi
2. Sharma.O.P. (1990). Textbook of Pteridophyta, MacMillan India Ltd., New Delhi
3. Smith, G.M. (1955). Cryptogamic Botany Vol. II, Tata Mcgraw Hill Publishing Co., Ltd., New Delhi.
4. Rasheed, A. (1999). An Introduction to Pteridophyta, Vikas Publishing Co., New Delhi.
5. Vashishta.P.C. (1990). Pteridophyta, S. Chand & Co. Ltd, New Delhi
6. Johri, R.M. Sneh Lata and Sandhya Sharma, (2004). A Textbook of Pteridophyta. Vedams Books (P) Ltd., New Delhi

Reference books

1. Eames, A.J. (1936). Morphology of Vascular Plants - Lower groups, Tata Mcgraw Hill Publishing company Ltd., New Delhi.
2. Sporne, K.R. (1972). The Morphology of Pteridophytes, B.I. Publications, Madras
3. Sporne, KR. (1970). The morphology of Pteridophytes (The structure of Ferns and Allied Plants), Hutchinson University, London.
4. Bower. F.O (1939). The Ferns (Vol. I,II,III), Today & tomorrow's Printers, New Delhi

GYMNOSPERMS

Text books

1. Sharma, O.P. (2017). Gymnosperms, 4th Edition, Pragati Prakashan, Meerut, India
2. Bhatnagar and Moitra, (1996). Gymnosperms. New age International Publishers, New Delhi
3. Johri, R.M, Lata S, Tyagi, K. (2005). A text book of Gymnosperms , Dominate pub and Distributor, New Delhi

4. Biswas, C. and Johri, B.M. (2004). The Gymnosperms. Narosa Publishing House, New Delhi.
5. Vashista P.C. (1990). Gymnosperms,S. Chand & Co. Ltd., New Delhi

Reference books

1. Bierhost, D.W. (1971). Morphology of Vascular plants. McMillan Company, New York.
2. Chamberlain, C.J. (1934). Gymnosperms: Structure and Evolution. Chicago (Reprinted 1950) New York.
3. Delveloryas, T. (1962). Morphology and evolution of fossil plants.
4. Doyle, W.T. (1970). Non Vascular Plants: Form and function. Belmont, California.
5. Foster and Gifford, J.R. (1962). Comparative Morphology of Vascular Plants. Allied Pacific Pvt. Ltd., Bombay.

PALEOBOTANY

1. Atchlay, W.R & Woodnuff, D.S. (1981). Evolution and speciation, Cambridge University Press, Cambridge.
2. Kimura, M. (1983). The natural theory of molecular evolution, Cambridge University Press, Cambridge.
3. Arora, M.P. (1990). Evolutionary biology, Himalaya Publication House, Delhi.
4. Arnold, C.A (1947).An Introduction to Paleobotany, McGraw Hill Book Company Inc. New York & London
5. Kirkaldy, J.E. (1963). The study of Fossils. Hutchinson Educational, London
6. Steward W.NPalaeobotany and evolution of plants. Cambridge University Press, New York.
7. Stewart, W.N and Rothwell, G.W. (2013). Palaeobotany and the evolution of plants. 2 ed. Cambridge University Press, Ltd, New Delhi
8. Edith L. Taylor, Thomas N. Taylor and Michael Krings (2009). Palaeobotany: The Biology and Evolution of Fossil Plants. 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

MappingwithProgrammeOutcomes:

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

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

CORE LABORATORY COURSE-I

Title of the Course	PRACTICAL -I COVERING THEORY PAPERS I & II					
Paper Number	**Core lab course -1**		**Credits**	**4**	**Course code**	**23UPBOT1P01**
Category	**Year**	**I**				
Core lab	**Semester**	**I**				
Instructional Hr/week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
	-	**-**	**6**	**6**		
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. T o 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	CONTENTS
Unit I	**Study of the Morphology and Anatomy of the vegetative and Reproductive parts of the following** **I. lgae** *a)* Cyanobacteria : *Oscillatoria, Scytonema* *b)* Chlorophyceae : *Ulva, Codium,* *c)* Xanthophyceae : *Vaucheria* *d)* Charophyceae : *Nitella* e) Bacillariophyceae : *Cyclotella, Navicula (Diatoms*) *f)* Phaeophyceae : *Dictyota* *g)* Rhodophyceae : *Gelidium*

	Preparation of culture media and culture of green algae and blue green algae in the laboratory (Demonstration).
Unit II	**FUNGI** *a)* Myxomycotina : *Plasmodiophora* *b)* Mastigomycotina : *Phytopthora* *c)* Zygomycotina : *Pilobolus, Rhizopus* *d)* Ascomycotina : *Tapharina, Xylaria* *e)* Basidiomycotina : *Polyporus* *f)* Deuteromycotina : , *Colletotrichum* Isolation and identification of fungi from soil, air, and Baiting method. Preparation of culture media. **LICHENS** Study of morphological and reproductive structures of the genera *Usnea, Parmelia*
	BRYOPHYTES *a)* Marchantiales : *Marchantia, Lunularia* *b)* Jungermaniales : *Porella* *c)* Anthocerotales : *Anthoceros,* *d)* Sphangales : *Sphagnum* *e)* Polytrichales *: Polytrichum, Pogonatum*
	PTERIDOPHYTES *a)* Psilopsida : *Psilotum* *b)* Lycopsida : *Selaginella, Isoetes* *c)* Sphenopsida : *Equisetum* *d)* Pteridopsida : *Ophioglossum, Osmunda , Gleichenia, Azolla* *e)* Fossil Pteridophytes : *Rhynia, Sphenophyllum, Lepidocarpon, Cladoxylon, Pentoxylon, Botryopteris*
	GYMNOSPERMS *a.* Cycadaceae : *Cycas sp* *b.* Ginkgolaes : *Gingobiloba* *c.* Coniferales : *Araucaria, Podocarpus, Ephedra* *d.* Gnetales : *Gnetum* *e.* Fossil Gymnosperms *: Lyginopteris, Lagenostoma, Cordaites*

Note

A) Submission of 15 herbarium sheets from Algae / Fungi / lichens / Bryophytes / Pteridophytes / Gymnosperms

B) Field trip to hill stations and Coastal area for a minimum period of Five days for the collection of herbarium specimens and to observe and study the lower plants in their natural habitat.

C)) Certified record work done in the laboratory during practical classes

Course out come CO	On completion of this course, the students will be able to:	Programme outcomes
Co1	Recall and applying the basic keys to distinguish at species level Identification of important algae and fung ithrough its structural organizations.	**K1**
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.	**K4**
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

Text books

1. Kumar,H.D.1999. IntroductoryPhycology.Affiliated East-WestPress,Delhi.
2. Das,SandSaha,R.2020.MicrobiologyPracticalManual.CBSPublishersandDistributors(P) Ltd., New Delhi,India.
3. Sharma,O.P.2012. Pteridophyta,Tata McGraw-Hills Ltd,NewDelhi.
4. SharmaO.P and S, Dixit.2002.Gymnosperms.PragatiPrakashan.

5. Johri, R.M, Lata, S, Tyagi, K. 2005. A text book of Gymnosperms, Dominate pub and Distributer, New Delhi.

Reference Books:

1. Chmielewski, J.G and Krayesky,D. 2013.GeneralBotany laboratory Manual.AuthorHouse,Bloomington, USA.
2. Webster,J andWeber,R.2007.IntroductiontoFungi,3rdEd.CambridgeUniversityPress,Cambridge.
3. Sharma,O.P.2017. Bryophyta,MacMillanIndia Ltd,NewDelhi.
4. Ashok, M. Bendre and Kumar. 2010. A text book of Practical Botany, Algae, Fungi, Lichen, Bryophyta, Pteridophyta, Gymnosperms and Palaeobotany. Revised edition. Published by Rakesh Kumar Rastogi publication.

5.Gangulee, H.C and A.K. Kar. 2013. College Botany. Vth Edition. S. Chand.

Web resources

1. https://www.frontiersin.org/articles/10.3389/fmicb.2017.00923/full
2. https://microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175e.pdf
3. http://www.cuteri.eu/microbiologia/manuale_microbiologia_pratica.pdf
4. https://www.amazon.in/Manual-Practical-Bryophyta-Suresh-Kumar/dp/B0072GNFX4
5. https://www.amazon.in/Practical-Manual-Pteridophyta-Rajan-Sundara/dp/8126106883
6. https://www.google.co.in/books/edition/Gymnosperms/3YrT5E3Erm8C?hl=en&gbpv=1 &dq=gymnosperms&printsec=frontcover

7.https://www.amazon.in/Paleobotany-Biology-Evolution-Fossil-Plants/dp/0123739721

MappingwithProgrammeOutcomes:

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 COURSE I: (GROUP –A)

MICROBIOLOGY, IMMUNOLOGY AND PLANT PATHOLOGY

Title of the Course	**MICROBIOLOGY, IMMUNOLOGY AND PLANT PATHOLOGY**					
Paper Number	ELECTIVE I		**Credits**	**3**	**Course code**	**23UPBOT1E01**
Category	**Year**	**I**				
Elective: I (Group A)	**Semester**	**I**				
InstructionalHours perweek	**Lecture**	**Tutorial**	**Lab practice**	**Total**		
	4	**1**	**-**	**5**		
Pre-requisite						
Learning Objectives	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. 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	**General microbiology and Bacteria:** History, Scope and branches of microbiology – General characteristics of bacteria - classification of bacteria (Bergey, 1923) – Structure and organization bacterial cell, Gram positive and Gram negative bacterial cell wall, Motility, flagella and pili –Growth and Nutrition, growth curve, kinetics of growth , sterilization and disinfection methods and their quality control. Types of culture media and applications – preservation of microbial culture. Types of staining – simple, differential. Special and spore staining, Economic importance of Extremophiles.
II	**VIRUSES:**

	History of Viruses – Classification (Harrison et al., 1971) Structure and chemical composition of double strand DNA viruses, Double strand RNA viruses, Cauliflower mosaic virus – Tobacco mosaic viruses. Bacteriophage – Classification, Morphology, Structure and reproduction, isolation and purification of plant viruses, - Emerging viral disease, SARS coronavirus disease, Ebola virus disease and chikungunya.
III	**Applied microbiology** **Food microbiology**: The role of microorganism in food – spoilage of fruits, vegetables, meats, poultry, egg, bakery products, dairy products and canned foods – food borne disease - detection of foodborne pathogen, controlling food spoilage pathogen, food preservation. **Industrial microbiology:** Microbes in industrial process-Structure, function, Fermentation techniques – Microbiology of fermented foods – cheese production, Alcoholic beverages. Antibiotic, Vitamins, citric acid, organic acid, amino acid, and single cell protein – factor affecting fermentation process**. Agriculture microbiology** - Microbial inoculants in agriculture, Bio-fertilizer, Bio-control agents- Bio-pesticides, Biodegradation of Chemical pesticides – Sewage treatment
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. Immuno diagnosis –Blood Grouping, Widal test, Enzyme-Linked Immuno sorbent Assay (ELISA), Immuno electrophoresis and Immuno diffusion.
V	**PLANT PATHOLOGY:** Introduction to plant pathology – disease – concept, component and causes, classification of disease, brief account on general symptoms of Plant disease – modes of Infection and dissemination, defence mechanisms in plants, phytoalexin, pathogen related protein, Systemic Acquired Resistance (SAR) - Plant diseases forecasting – Plant disease management – plant quarantine, chemical, cultural and

	biological control, Bioformulation, integrated disease management. Important disease of crop plant in India, bacterial blight of Paddy, Bunchy top of Banana, Late blight potato, little leaf of brinjal

Course out come CO	On completion of this course, the students will be able to:	Programme outcomes
Co1	Recognize the general characteristics of microbes, plant defence 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	Questionsrelatedtotheabovetopics,fromvariouscompetitiveexaminationsUPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/otherstobesolved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

BACTERIA & PLANT PATHOLOGY

Text books

1. Pelczar, H.J., Chan, C.S. and Kreig, N.R. (1996). Microbiology concepts and applications. McGraw Hill Inc
2. Dubey, R.C, Maheswari, D.K. (2013). A Textbook of Microbiology, 4/e S. Chand & company, New Delhi
3. Powar, C.B. and Dagniwala, H.F. (2010). General Microbiology.2/E , Himalaya Publishing House, Bombay

4. Freifelder, D. (1990). Microbial genetics. 2/e, Narosa Publishing House, New Delhi.
5. Bilgrami, K.S. and Dube H.C. (1990). A text book of Modern Plant Pathology – Vikas Publishing House (P) Ltd., New Delhi.
6. Sharma, P.D. (1992). Microbiology – Rastogi & Co., Meerut
7. Dube, H.C. (2014). Modern Plant Pathology, Agrobios (India) Behind Nasrani Cinema Chopasani Road, Jodhpur.

Reference Books

1. Stainer, R.Y., Adelberg, E.A and Ingram, J.L. (1978). General Microbiology, MacMillan & Co, London.
2. Prescott, Harley and Klein S. (2008). Microbiology 7th edition, McGraw hill international Edition, New York
3. Alexander, (1978). Introduction to soil Microbiology, Wiley Eastern Private Ltd., New Delhi.
4. Carpenter, P.L. (1977). Microbiology, W.B. Saunders Co., London.
5. Darglos, J. (1975). Bacteriophages. Chapman & Hall Ltd., London.
6. Ketchum, P.A. (1988). Microbiology: Concepts and application, John Wiley and Sons, New York.
7. Mandahar, C.L. (1978). An Introduction to Plant Viruses. S. Chand & Co., New Delhi.
8. Mehrotra R.S. and Ashoka Agarwal. (2003). Plant Pathology. TATA McGraw-Hill Publishing Co., Ltd., New Delhi.
9. Rangasami, G. (1972). Diseases of Crop Plants in India. Prentice Hall India (Pvt.) Ltd., New Delhi.
10. Singh, R.S. (1980). Plant Diseases. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
11. Subba Rao, N.S. (1977). Soil Microorganisms and Plant growth. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
12. Gardner E.J, Simmons M.J. and Snustad D.P. (2010) Principle of Genetics (VIII Edition), WSE India Pvt. Ltd , New Delhi
13. Gunasekaran, P. (1995). Laboratory manual in Microbiology, New age (P) Ltd Publisher.

VIRUSES

Text Books

1. Cooper, J.J. (1995). Viruses and the environment (2nd edition) Chapman & Hall London.
2. Nayudu, M.V. (2008). Plant viruses, Tata McGraw-Hill Education, New Delhi
3. Smith, K.M. (1974). Viruses, Cambridge University Press.

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

MappingwithProgrammeOutcomes:

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-(GROUP A)

CONSERVATION OF NATURAL RESOURCES AND POLICIES

Title of the Course	CONSERVATION OF NATURAL RESOURCES AND POLICIES					
Paper Number	ELECTIVE I		Credits	3	Course code	23UPBOT1E02
Category	Year	I				
Elective I (Group A)	Semester	I				
Instructional Hours /week	Lecture	Tutorial	Lab practice	Total		
	4	1	-	5		
Pre-requisite	To create awareness of environmental problems and their consequences					
Learning Objectives	1. Explain the term natural resources. 2 .Describe the reasons for degradation of natural resources and suggest Measures to prevent these. 3. List the various endangered species of animals and plants 4. State the various environmental laws passed to conserve the natural resources 5. Explain sustainable development and justify its need; and describe the various conventional as well as non-conventional sources of energy					

UNITS	CONTENTS
Unit I	**Introduction to Natural Resource Bases:** Concept of resource, classification of natural resources. Factors influencing resource availability, distribution and uses. Interrelationships among different types of natural resources. Concern on Productivity issues. Ecological, social and economic dimension of resource management.
II	**Forest Resources:** Forest cover in India and the World – Importance – Desertification – Forest Wealth – Afforestation – Vanasamrakshna Samithi– Agroforestry – Social Forestry – Joint Forest Management Strategy for Forest Conservation. **Wild Life:** Resources – Importance – Benefits – Wild life Extinction – Causes for Extinction – List of Endanger species in India and in the World – Ecological approach in wild life management – Eco Tourism – Wild Life projects in India – Sanctuaries and National Parks In India – Man and Bio sphere

	Programme.
III	**Land and soil resources:** Land as a resource, types of lands, conservation of land forms, deforestation, and effect of land use changes. Soil health, ecological and economic importance of soil, impact of soil degradation on agriculture and food security, need for soil conservation, sustainable land use planning. Water resources: Use and over-utilization of surface and ground water, floods, drought, Conflicts over water, dams-benefits and problems. Water ecology and management.
IV	**Mineral Resources:** Use and exploitation – Environmental effects of extracting and using mineral resources – Restoration of mining lands – Expansion of supplies by substitution and conservation. Food Resources: World Food Problems – Changes caused by agriculture – overgrazing effects of modern agriculture – Fertilizer-Pesticide problems – Water Logging – Salinity – Sustainable agriculture, life stock breeding and farming.
V	**Environmental policy in india:** Overview of legal policy instruments in Natural Resource Management: National Forest Policy of 1988, National Environment Policy of 2004, National Conservation Policy, National Action Plan on Climate Change of 2008, Coastal Protection Act. Wildlife Protection Act of 1972, Forest Protection Act of 1980, Environment Protection Act of 1986, ICZM-Indian Coastal zone management, Water Act, 1981. Biological Diversity Act of 2002 and Rule 2004, Forest Rights Act of 2006. Green Tribunal Act, 2009. The precautionary principle and common responsibilities.

Course out come CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
Co1	Understand the concept of different natural resources and their utilization.	**K1**
Co2	Critically analyze the sustainable utilization land, water, forest and energy resources	**K2**

Co3	Evaluate the management strategies of different natural resources	**K3**
Co4	Reflect upon the different national and international efforts in resource management and their conservation.	**K4**
Co5	State the various environmental policy passed to conserve the natural resources.	**K5&K6**

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

Text Books

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

Reference Books:

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

Web resources:

1. https://www.amazon.in/conservation-natural-resources-Gifford-Pinchot-ebook/dp/B07HX76TVN
2. https://books.google.co.in/books/about/Natural_Resource_Conservation_and_Enviro.html?id=T2SRuhxpUW8C&redir_esc=y
3. https://www.kobo.com/ww/en/ebook/natural-resources-conservation-law
4. https://www.scribd.com/book/552185119/Natural-Resources-Conservation-and-Advances-for-Sustainability
5. https://www.scribd.com/document/354699536/Conservation-of-Natural-Resources

MappingwithProgrammeOutcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	M	S	M	S	M	S
CO2	S	S	S	S	M	M	L	S	L	S
CO3	S	S	S	M	M	M	L	S	L	S
CO4	S	S	S	M	M	M	L	S	L	S
CO5	S	S	S	M	M	M	L	S	L	S

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

ELECTIVE I (GROUP A)

MUSHROOM CULTIVATION

Title of the Course	MUSHROOM CULTIVATION					
Paper Number	ELECTIVE I		Credits	3	Course code	23UPBOT1E03
Category	Year	I				
Elective I (Group A)	Semester	I				
Instructional Hours /week	Lecture	Tutorial	Lab Practice	Total		
	4	1	-	5		
Pre-requisite	Basic knowledge on structure and function of various groups of mushrooms					
Learning Objectives	1. To teach the scope of Mushroom cultivation 2 .To understand the commercial important mushroom 3.To study the cultivation technique of mushrooms 4. To learn the disease control in mushroom cultivation 5. To study how to establish mushroom cultivation as business enterprise.					

UNITS	CONTENTS
Unit I	**Introduction:** History and Scope of Mushroom Cultivation, Taxonomical rank of Mushroom; Vegetative characters of edible and poisonous mushroom.
II	**Common edible Mushrooms:** Button Mushroom (*Agaricus bisporous*), Oyster mushroom (*Pleurotus sajorcaju),* paddy straw mushroom (*Volvariella volvacea*), Milky Mushroom (*Calocybe indica*); Other economically important and medicinal mushroom-Shiitake Mushroom (*Lentinula edodes),* Kabul Dhingri (*King Oyster*) Mushroom.
III	**Cultivation Technology** : Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation -

	paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation - Low cost technology, Composting technology in mushroom production.
IV	**Disease , Pest Management and storge mushroom** : Dry Bubble and wet bubble- Major diseases of cultivated mushroom; Major insect pests Mushroom flies / nematodes / mites. **Storage -** Short-term storage (Refrigeration - up to 24 hours) Long term Storage (canning, pickels, papads), drying, storage in salt solutions
V	**Nutrition and Value addition of Mushroom** Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content – Vitamins. Value added products / recipes, Quality assurance, Packing and packaging, Market opportunities

Course out come CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
Co1	Knowledge on identification of edible and toxic mushrooms belonging to Ascomycota and Basidiomycota.	**K1**
Co2	Outline the nutraceutical properties of edible mushrooms.	**K2**
Co3	Knowledge on cultivation techniques of edible and medicinal mushrooms.	**K3**
Co4	Understand the harvest and post- harvest techniques of mushroom	**K4**
Co5	Knowledge on the production and marketing strategies for mushrooms.	**K5&K6**

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination Question paper)	Questionsrelatedtotheabovetopics,fromvarious competitiveexaminationsUPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/otherstobesolved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability ,Professional Competency, Professional Communication and Transferrable Skill

Text book

1. Cheung,P.C.K.2008. Mushrooms as functiona lfood.AJohnWiley&Sons, Inc.,Publication.
2. Dijksterhuis, J. and Samson, R.A. 2007. Food Mycology: A multifaceted approach in fungiandfood. CRC press, Newyork.

3. Hall.,R.I.,Stepheson,S.L.,Buchanan,P.K.,Yun,W.andCole,A.L.J.2003.Edibleandpoisonous mushrooms of theworld. TimberPress,Portland, Cambridge.
4. Ting,S.andMiles,P.G.2004.Mushrooms:Cultivation,nutritionalvalue,medicinal effect and nutritional environmental impact. CRC press, Newyork.
5. Verma, 2013.Mushroom: edible and medicinal: cultivation conservation, strain improvement with their marketing. DayaPublishingHouse

Reference books:

1. Tiwari.,SC.,PandeyK. 2018.Mushroomcultivation.Mittalpublisher,NewDelhi.
2. Philips,G.,Miles,Chang,S-T. 2004.Mushrooms:Cultivation, nutritionalvalue, medicinaleffectand environmentaleffect. 2nded. CRCPress.
3. Diego,C.Z.,Pando-Gimenez,A.2017.Edibleandmedicinalmushrooms:TechnologyandApplication.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

MappingwithProgrammeOutcomes:

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 I (GROUP A)

PHYTOPHARMACOGNOSY

Title of the Course	**PHYTOPHARMACOGNOSY**					
Paper Number	ELECTIVE I		Credits	3	Course code	23UPBOT1E04
Category	Year	I				
Elective I (Group A)	Semester	I				
Instructional /hrs/week	Lecture	Tutorial	Lab practice	Total		
	4	1	-	5		
Pre-requisite	Students should aware of traditional use of plant derived drugs in world.					
Learning Objectives	1. Acquire the knowledge about understanding of Principle and Treatment methods of various Traditional systems of medicines. 2. learn the identification, pharmacological importance and processing of medicinal plants based on their classification and characterization. 3. Analyze the suitable conservation method for medicinal plants using Modern biotechnology tools to ensure the sustainable utilization. 4. Evaluate the medicinal plants based drug efficacy and its various applications for different ailments 5. Create new drug formulations using phytochemical compounds for the healthy life of society.					

UNITS	**CONTENTS**
I	**Introduction** : Traditional and alternative system of medicine-Principle, practice, short history and merits of herbal medicine- Siddha, Ayurveda, Homeopathy, Chinese medicine, Unani, Naturopathy, Aromatherapy and acupuncture. Status of Indian medicinal plant trade, medicinal plants prohibited from export, leading companies in India in trade of medicinal plants
II	**Classification of crude drugs** - Alphabetical, taxonomical, morphological, chemical, pharmacological (Therapeutically). Medicinal plants - Mass Cultivation methods for sustainable utilization, Collection and processing of herbal raw material for drugs

	Preparation-Post Harvesting care, Drying, Dressing, Packing and Storage.
III	**Medicinally useful plant parts:** Root –*Hemidesmus indicus, Withania somnifera* and *Rauvolfia serpentina; Rhizome* - *Zingiber officinalis*, *Acorus calamus* and *Curcuma* longa; Stem- *Tinospora cordifolia, Santalum album;* Bark – *Terminalia arjuna, Cinnamomum verum* and *Saraca asoca*; Leaf – *Adhatoda vasica*, *Ocimum sanctum* and *Cynodon dactylon;* Flowers – *Crocus sativus*, *Syzygium aromaticum* and *Leucus aspe*ra; Fruits – *Phyllanthus emblica, Piper longum* and *Terminalia chebula;* Seeds – *Azadirachta indica, Trigonella foenum-graecum* and *Ricinus communis*..
IV	**Herbal preparation methods** - bolus, capsules, compresses, creams, decoctions, extracts, infusions, herbal tea, ointments, massage oils, medicinal vinegar, poultice & plasters, powders, salves, syrups, tinctures, tonic, maceration and baths and bathing remedies and dry extract (pills or capsules). Application of herbal formulations for the treatment of certain diseases- Jaundice, Fever, Cardiac, Infertility, Diabetics, Blood pressure, Skin care and Respiratory diseases
V	**Pharmaceutical plant products**- alkaloids, glycosides, terpenoids, tannins, flavonoids, lipids, proteins. Nutraceuticals, cosmeceuticals, pharmaceuticals - fibre, sutures, surgical dressings, adaptogens, rasayana. Drug adulteration and methods of evaluation-physical, chemical and microscopic. NMPB, CDRI, CIMAP, CIPLA; WHO regulation and Guidelines for quality control and trade of herbal medicine.

Course out come CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
Co1	Review on the traditional knowledge and classification of plant derived drugs.	**K1**
Co2	Knowdge on identification, pharmacological importance and processing of medicinal plants based on their classification and characterization.	**K2**
Co3	Knowdge on conservation of medicinal plants using modern biotechnology	**K3**
Co4	Knowdlge on herbal drug perparion and mode of action	**K4**
Co5	Knowdglge on new drug formulations using phytochemical compounds for the healthy life of society.	**K5&K6**

Text books

1. Shah, B.N. and Seth, A.K. (2010). Textbook of pharmacognosy and phytochemistry, published by Elsevier, a division of reed Elsevier India Pvt. Ltd
2. Gokhale, S.B, Kokate, C.K and Gokhale, A. (2016). Pharmacognosy of traditional drugs, Nirali prakashan, 1/Ed
3. Harborne, A.J. (2008). Phytochemical methods. A guide to modern techniques of plant analysis. Chapman and Hall publisher.
4. Hornok, L. (1992). Cultivation and Processing of Medicinal Plants. Wiley-Blackwell.
1. Joshi, S.G. (2018). Medicinal Plants. Oxford & IBH Publishing C., Pvt., Ltd., New Delhi.
2. Qadry, J.S. 2014. A textbook of Pharmacognosy Theory and Practicals. CBS Publishers & Distributors, 17th Edition.

Reference Books

1. Ahmad, I., Aqil, F., and Owais, M. (2006). Modern phytomedicine: Turning medicinal plants into drugs. John Wiley & Sons, New Jersey.
2. Khan, M.S. A., Ahmad, I., and Chattopadhyay, D. (2018). New Look to Phytomedicine: Advancements in Herbal Products as Novel Drug Leads. Academic Press.
3. Khare, C.P. (2004). Indian herbal remedies: rational Western therapy, ayurvedic, and other traditional usage, Botany. Springer science & business media, Germany.
4. Mangathayaru, K. (2013). Pharmacognosy: an Indian perspective. Pearson Education India.
5. Chand Kuldip. (1996). Medicinal Plants Source Book India. International Library Association, Switzerland.
6. Premendra singh. (2013). Medicinal plants: conservation, cultivation and utilization, days publishing house – A division of astral international Pvt. Ltd.

Web resources:

1. https://pharmabookbank.files.wordpress.com/2019/03/14.2.pharmacognosy-by-biren-shahavinash-seth-1.pdf
2. https://www.pdfdrive.com/pharmacognosy-books.html
3. https://www.amazon.in/Textbook-Pharmacognosy-Phytochemistry-Kumar-Jayaveera-ebook/dp/B06XKSY76H
4. https://www.amazon.in/Pharmacognosy-Dr-C-K-Kokate-ebook/dp/B07JHNNMWB

5.https://www.amazon.in/EXPERIMENTAL-PHYTOPHARMACOGNOSY-Comprehensive-Guide-Khadabadi-ebook/dp/B07ZFMYQK8

MappingwithProgrammeOutcomes:

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

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

ELECTIVE II- (GROUP B)

ALGAL TECHNOLOGY

Title of the Course	ALGAL TECHNOLOGY					
Paper Number	ELECTIVE II		Credits	3	Course code	23PBOT1E05
Category	Year	I				
Elective II (Group B)	Semester	I				
Instructional Hours/week	Lecture	Tutorial	Lab Practice	Total		
	4	1	-	5		
Pre-requisite	Students should be familiar with the basic and applied knowledge on algal biotechnology					
Learning Objectives	1. To provide a basic overview of algae cultivation techniques and Resource potentials. 2. To educate people about the widespread commercial uses of algae. 3. To educate people about the therapeutic uses of algae. 4. To enrich the current knowledge of how algae are used In basic research and technological applications. 5. To spread awareness of the value of algae biotechnology and its Applications in diverse industries.					

UNIT	CONTENTS
I	**Introduction to algal technology**: Resource potential of algae; commercial utility of algae. Algae as a source of food and feed; Algae as a source of pigments, fine chemicals, fuel and bio-fertilizers. Distribution of economically important algae in India..
II	**Algal production and utilization:** Strain selection; Algal growth curve; Culture media; indoor cultivation methods and scaling up. Measurement of algal growth. Large scale cultivation of algae - Photo bioreactor, Open pond and Raceway ponds. Evaporation and uniform dispersal of nutrients; Harvesting algae. Drying. **Utilization:** Therapeutic uses - antioxidant, anti-ulcerogenic, antifungal, antibiotics, antitumor and antiviral compounds. Production of pigments.
III	**Generalized uses of seaweeds**: Human food, Seaweed Baths, Cosmetics, Seaweed

	as agricultural fertilizers, Liquid Seaweed Extracts, Seaweed industrial gums: Alginates, Agars, Carrageenans, other polysaccharides and their Medicinal Uses. Biodiesel from algae: algae producing biodiesel
IV	**Immobilization and rDNA technology in algae** Algal immobilization and its applications - culturing for metabolite production and natural compounds. Methods of immobilization - alginate beads-extraction of compounds. Recombinant DNA technology in algae - Transformation systems in algae. Isolation of protoplasts, regeneration of fusion of macro algae. Role of algae in nano biotechnology.
V	**Role of Algae in Environment Management** Microalgae in liquid waste management's, Biological waste treatment, Algae-bacteria interaction , Phytoremediation- heavy metal removal, algae as indicators in assessing water quality and pollution; Saprobic index; Monitoring, assessment, restoration and management of coastal and marine ecosystem environment. Algal culture collection centres in India and abroad and their importance.

Course out come CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
Co1	Understand the applied facet of botany and acquire a complete knowledge about the cultivation methods in algae.	**K1**
Co2	Realization of the commercial potential of algal products.	**K2**
Co3	Analyze emerging areas of algal biotechnology for identifying therapeutic importance of algal products and their uses.	**K3**
Co4	Gain more information about algae genetics.	**K4**
Co5	Translate various algal technologies for the benef the ecosystem.	**K5&K6**

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination Question paper)	Questionsrelatedtotheabovetopics,fromvarious competitiveexaminationsUPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/otherstobesolved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Text books

1. Trivedi, P.C. 2001. Algal Biotechnology. Point publisher, Jaipur.India.
2. Bold, H.C and Wynne, M.J. 1978. Introduction to the Algae: Structure and Function. Prantice Hall of India New Delhi.
3. Sahoo, D. 2000. Farming the ocean: seaweed cultivation and utilization. AravaliInternational, New Delhi.
4. Bast, F. 2014. An Illustrated Review on Cultivation and Life History of Agronomically Important Sea plants. In Seaweed: Mineral Composition, Nutritional and Antioxidant Benefits and Agricultural Uses, Eds. Vitor Hugo Pomin, 39-70. Nova Publishers, New York. ISBN: 978-1-63117-571-8.
5. Trivedi, P.C. 2001. Algal Biotechnology. Point publisher, Jaipur.India.
6. Bold, H.C and Wynne, M.J. 1978. Introduction to the Algae: Structure and Function. Prantice Hall of India New Delhi.
7. Sahoo, D. 2000. Farming the ocean: seaweed cultivation and utilization. AravaliInternational, New Delhi.
8. Bast, F. 2014. An Illustrated Review on Cultivation and Life History of Agronomically Important Sea plants. In Seaweed: Mineral Composition, Nutritional and Antioxidant Benefits and Agricultural Uses, Eds. Vitor Hugo Pomin, 39-70. Nova Publishers, New York. ISBN: 978-1-63117-571-8.
9. Rapouso, M.F.J., Morais, R.M.S.C., Morais, A.M.M.B. 2013. Bioactivity and applications of sulphated polysaccharides from marine microalgae. Marine Drugs, 11, 233-252.
10 . Bajpai, Rakesh, K., Prokop,Ales,Zappi,Mark,E.2014.AlgalBiorefineriesVolume1

Reference Books:

1. Kumar H.D and H.N. Singh.1982. A text Book on Algae. Affiliated East- West Press Pvt. Ltd
2. Suganya, T and Renganathan, S. 2015. Biodiesel production using algal technology. Academic Press. ISBN: 0128009713.
3. Bajpai, Rakesh K., Prokop, Ales, Zappi, Mark E. 2014. Algal Biorefineries Volume 1: Cultivation of Cells and Products. Springer. ISBN: 9400774931.
4. Hojnacka, K., Wieczorek, P.P., Schroeder, G., Michalak, I. (Eds.). 2018. Algae Biomass: Characteristics and Applications. Developments in Applied Phycology.
5. Aziz, Farhad and Rasheed, Rezan. 2019. A Course Book of Algae. Publisher: University of Sulaimani. ISBN: 978-9922-20-391-1.

6. Dinabandhu, S and Kaushik. B.D. 2012. Algal Biotechnology and Environment. I.K. International, New Delhi.
7. Trivedi, P.C. 2001. Algal Biotechnology. Point publisher, Jaipur. India.
8. Becker. E.W. 1994. Micro algae Biotechnology and Microbiology.Cambridge University press.
9. Borowitzka, M.A. and borowizka, L.J. 1996. Microalgal Biotechnology. Cambridge University Press, Cambridge,
10. Bast, F. 2014. Seaweeds: Ancestors of land plants with rich diversity. Resonance, 19(2) 1032-1043 *ISSN*: 0971-8044.
11. Faizal,BandYusuf, C. 2016.Algalbiotechnology: Productsandprocesses. Springer.
12. Gouveia, L. 2011. Microalgae as a feedstock for biofuels. Springer Briefs in Microbiology, London.

Web resources:

1. https://www.springer.com/gp/book/9783319123332
2. https://www.researchgate.net/publication/318449035_Algae_Biotechnology
3. https://www.energy.gov/sites/prod/files/2015/04/f21/algae_marrone_132100.pdf
4. https://www.amazon.in/Prospects-Challenges-Algal-Biotechnology-Tripathi-ebook/dp/B0779BF366
5. https://www.degruyter.com/view/product/177050
6. https://www.amazon.in/Algal-Biotechnology-Mihir-Kumar-Das/dp/B0072I61LA
7. https://www.elsevier.com/books/algal-biotechnology/ahmad/978-0-323-90476-6
8.https://www.appleacademicpress.com/phycobiotechnology-biodiversity-and-biotechnology-of-algae-and-algal-products-for-food-feed-and-fuel/9781771888967

MappingwithProgrammeOutcomes:

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

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

ELECTIVE II - (GROUP B)

ETHNOBOTANY, NATUROPATHY AND TRADITIONALHEALTHCARE

Title of the Course	ETHNOBOTANY, NATUROPATHY AND TRADITIONAL HEALTHCARE					
Paper Number	ELECTIVE II		Credits	3	Course code	23UPBOT1E06
Category	Year	I				
Elective – II Group B	Semester	I				
Instructional Hours/week	Lecture	Tutorial	Lab Practice	Total		
	4	1	-	5		
Pre-requisite	The training imparts the knowledge and abilities required to conduct field studies on how humans use plants.					
Learning Objectives	1.Understand the concept of ethnobotany and the life style and traditional practices of plants 2.Emphasize the importance of non-timber forest products for Indian tribal people livelihoods 3. Evaluate the various research techniques to gather tribal knowledge of ethnobotany. 4. Use strategies to turn ethno botanical knowledge into goods with value additions. 5.Tosave and document ethno botanicalsin order to use plant resources sustainably.					

UNIT	CONTENTS
I	**Concept of Ethnobotany** History of Ethnobotany– Definition, scope and objectives, Ethnobotany studies in the world and in India – interdisciplinary approaches, knowledge of following sociological and anthropological terms of culture, values and norm, institution, culture diffusion and ethnocentrism.
II	**Ethnic community in India** Distribution of ethnic groups in India – basic knowledge of following Ethnic groups in Tamil Nadu (Irulas, Kanis, Paliyars, Badagas, Kurumbres, Thodas and Malayali) – lifestyle and traditional practices of the above ethnic group.
III	**Botanical knowledge and practice:**

	Ethnobotanical knowledge and communities – Folk taxonomy – plants associated with culture and socio- religious activities. Non – timber forest products (NTFP) and livelihood – Sustainable harvest and value addition -**Source of Ethnobotanical data**: Primary-Archaeological source and inventories. Secondary– Travelogues, folklore and literary source, herbaria, Medicinal text and official records. Method in Ethno botanical research – Prior informed consent –PRA techniques – Interviews and questionnaire methods – choice of resource persons.
IV	**Naturopathic Medicine:** Role of plants in naturopathy- Importance and relevance of medicinal drugs in India. Indian Systems of Medicine (Ayurveda, Siddha, Allopathy, Homeopathy, Unani, Tibetan, Yoga and Naturopathy). Disease diagnosis, treatment, and cure using natural therapies including dietetics, Botanical medicine, Homeopathy, fasting, exercise, lifestyle counselling, detoxification, and chelation, clinical nutrition, hydrotherapy, naturopathic manipulation, spiritual healing, environmental assessment, **Traditional health care:** Health practices, approaches, knowledge and beliefs incorporating plant, animal and mineral based medicines, spiritual therapies, manual techniques and exercises, applied singularly or in combination to treat, diagnose and prevent illnesses
V	**Bio prospecting and Value Addition:** Bio prospecting and commercial use of traditional knowledge, developing research partnership codes of ethics and research guidelines, equitable research relationship, traditional knowledge (TK) in Relation to Intellectual property Right and Bio piracy. Equitable benefit sharing models of the world – problems in equitable benefit sharing

Course out come CO	On completion of this course, the students will be able to:	Programme outcomes
Co1	Recall or remember concept of ethnobotany.	**K1**
Co2	Understand the life style and traditional practices of plants by Indian tribals.	**K2**
Co3	Highlight the role of Non-Timber Forest products for livelihood of tribal people of India	**K3**
Co4	Assess the methods to transform ethnobotanical knowledge into value added products.	**K4**
Co5	Build idea to make digitization of ethnobotanical knowledge.	**K5&K6**

Extended Professional Component (is a part of in internal component only, Not to be included the External Examination question paper)	Questionsrelatedtotheabovetopics,fromvarious competitiveexaminationsUPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/otherstobesolved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

RecommendedText:

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

Joshi, S.G. 2018. Medicinal Plants. Oxford & IBH Publishing C., Pvt., Ltd., New Delhi.

Reference Books:

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

7. Albuquerque, U.P., Ramos, M.A., Júnior, W.S.F., and De Medeiros, P.M. 2017. Ethnobotany.

Web resources:

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

7.http://www.frlht.org/

MappingwithProgrammeOutcomes:

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

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

ELECTIVE II – (GROUP B)

HORTICULTURE

Title of the Course	**HORTICULTURE**					
Paper Number	ELECTIVE II		Credits	3	Course code	23UPBOT1E07
Category	Year	I				
Elective-II (Group B)	Semester	I				
Instructional Hours /week	Lecture	Tutorial	Lab practice	Total		
	4	1	-	5		
Pre-requisite	Students should be familiar with the basic and fundamental knowledge on horticulture applications					
Learning Objectives	1. Know about the brief history, divisions, classification and structure of Horticultural plants. 2.Understand the plant growth environment in relation to soil, nutrients, fertilizers, and bio inoculants 3. Study the sexual and vegetative propagation methods including Propagation through specialized vegetative structures. 4. Study the garden Designing and management 5. Study the special type of garden designing, Bonsai techniques					

UNIT	CONTENTS
I	**Basics of Horticulture** History, Scope and Importance of Horticulture. Divisions of Horticulture – Plant growth environment – soil and climate factor – Plant growing structure - Hot beds , Gold Frames , green houses conservarty Glass house, Poly house - Net house , hydroponics ,Drip culture and gravel culture
II	**Nurtition of Horticulture crop**: organic manures and substrate – Farmyard manure, compost, Leaf mould, oil cake , Meat meals, Blood meal, Horn and Hoof meal - Liquid Manure, Bio-fertilizers and Plant growth regulators in root initiation, flowering, fruit setting and development. Water Irrigation -types- sprinkler irrigation, trickle irrigation- surface, furrow, surge, and pitcher.
III	**Plant propagation method & Nursery management**

	Plant Propagation: Natural method: propagation through Seed and Vegetative structure -Artificial method: Cutting, Budding, Grafting and Layering. Stock–scion relationship – Micro propagation. Nursery techniques – Preparation of soil bed – method of digging – bed size, types, spacing, and rotation. Media for propagating nursery plants
IV	**Ornamental Horticulture:** Gardening formal, informal and kitchen – principle and design, landscaping. Aftercare of plants: weeding, Pruning, Top dressing and Topiary. Lawn making, Hedge, Edgese, climbers, cut flowers, flower arrangement Japanese – Ikebana - Bouquet and garland making - Dry flower arrangement..
V	Special Type of gardens: Rockery, water garden, Roof garden –Types , design and style , Terrace garden, shade garden Terrarium, Bottle and dish gaerden ,window garden Indoor gardening, Bonsai

Course out come 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	Knowledge on organic manure used in Horticulture practices	**K2**
Co3	Demonstrate the propagation, growth, and maintenance of plants in horticulture systems.	**K3**
Co4	Knowledge on gardening management , landscaping, lawn making	**K4**
Co5	Knowledge on special type of Garden making	**K5**
CO6	Apply horticultural skills and knowledge to explore career opportunities in horticulture industry.	**K6**

Extended Professional Component (is a part of in internal component only, Not to be included the External Examination question paper)	Questionsrelatedtotheabovetopics,fromvarious competitiveexaminationsUPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/otherstobesolved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Text book

1. Prasad, S. and Kumar, U. (2010). Principles of Horticulture. Agrobios (India). Jodhpur.

2. Edmond Senn, Arews, Halfacre. (1987). Fundamentals of Horticulture, Tata McGraw Hillbook Co., Ltd. New Delhi
3. Manibhushan Rao, K (1991). Text Book of Horticulture, Macmillan Publications, Hyderabad.
4. Kumar, N. (1977). Introduction to Horticulture, Rajalakshmi Publications, Nagercoil, India.

Reference books

1. Arora, JS. (1990). Introductory Ornamental Horticulture, Kalyani Publications
2. Bailey, L.H. (1901). The Standard Cyclopaedia of Horticulture Volume 1,2 and 3, Macmillan Publications
3. Chauhan, V.S (1972). Vegetable production in India, Ram Prasad & Sons
4. Shujnrnoto, (1982). The Essentials of Bonsai, David & Charles
5. Bose, T.K. and Mukherjee, D. (1972). Gardening in India, Oxford & 1BH Publishing Co., Kolkata, Mumbai, NewDelhi.
6. Pratibha, P. and Trivedi. (1987). Home gardening, ICAR Publication, New Delhi.
7. Randhawa, (1997). Ornamental Horticulture in India, Today & Tomorrow Publishers, New Delhi.

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

MappingwithProgrammeOutcomes:

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)

ELECTIVE II – (GROUP B)

HERBAL TECHNOLOGY

Title of the Course	**HERBAL TECHNOLOGY**					
Paper Number	ELECTIVE II		Credits	3	Course code	23UPBOT1E08
Category	Year	I				
Elective II (Group B)	Semester	I				
InstructionalHours /week	Lecture	Tutorial	Lab practice	Total		
	4		1	5		
Pre-requisite	To understand the importance of herbal technology					
Learning Objectives	1. To understand various plants based drugs used in ayurvedha, unani, homeopathy 2. To apply the knowledge to cultivate medical plants. 3. To know the pharmacological importance of medicinal plants. 4.To enlist phytochemical and secondary metabolites of market and commercial 5. To design and develop their own business prepositions such as theo in the making of herbal insecticides.					

UNIT	CONTENTS
	Herbs as raw materials: Definition of Herb, herbal medicine, herbal medicinal product, herbal drug preparation, Source of Herbs, Selection, identification and authentication of herbal materials, Processing of herbal raw material. Biodynamic Agriculture-Good agricultural practices in cultivation of medicinal plants including, Organic farming. Pest and Pest management in medicinal plants: Biopesticides/Bioinsecticides. Indian Systems of Medicine a) Basic principles involved in Ayurveda, Siddha, Unani and Homeopathy b) Preparation and standardization of Ayurvedic formulations vizAristas and Asawas, Ghutika,Churna, Lehya and Bhasma.
II	**Nutraceuticals** General aspects, Market, growth, scope and types of products available in the market. Health benefits and role of Nutraceuticals in ailments like Diabetes, CVS diseases,

	Cancer, Irritable bowel syndrome and various Gastro intestinal diseases. Study of following herbs as health food: *Alfaalfa, Chicory, Ginger, Fenugreek, Garlic*, Honey, *Amla, Ginseng, Ashwagandha, Spirulina* **Herbal-Drug and Herb-Food Interactions:** General introduction to interaction and Classification. Study of following drugs and their possible side effects and interactions: *Hypercium, kava-kava, Ginkobiloba, Ginseng, Garlic, Pepper & Ephedra.*
III	**Herbal Cosmetics:** Sources and description of raw materials of herbal origin used via, fixed oils, waxes, gums, colours, perfumes, protective agents, bleaching agents, antioxidants in products such as skin care, hair care and oral hygiene products. Herbal Excipients – Significance of substances of natural origin as excipients – colorants, sweeteners, binders, diluents, viscosity builders, disintegrants, flavors& perfumes. **Herbal formulations** :Conventional herbal formulations like syrups, mixtures and tablets and Novel dosage forms like phytosomes
IV	**Herbal drugs industry**: Present scope and future prospects. A brief account of plant based industries and institutions involved in work on medicinal and aromatic plants in India. Schedule T – Good Manufacturing Practice of Indian systems of medicine Components of GMP (Schedule – T) and its objectives Infrastructural requirements, working space, storage area, machinery and equipments, standard operating procedures, health and hygiene, documentation and records. .
V	**Evaluation of Drugs** : WHO & ICH guidelines for the assessment of herbal drugs Stability testing of herbal drugs. Patenting and Regulatory requirements of natural products: a) Definition of the terms: Patent, IPR, Farmers right, Breeder‘s right, Bioprospecting and Biopiracy b) Patenting aspects of Traditional Knowledge and Natural Products. Case study of Curcuma & Neem. Regulatory Issues - Regulations in India (ASU DTAB, ASU DCC), Regulation of manufacture of ASU drugs - Schedule Z of Drugs & Cosmetics Act for ASU drugs

Course out come CO	On completion of this course, the students will be able to:	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 in internal component only, Not to be included 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

Text books

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

Tilgner, SharolMarie. 2018. Herbal ABC's: The Foundation of Herbal Medicine.

ReferenceBooks:

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.

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

MappingwithProgrammeOutcomes:

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)

CORE COURSE -III

TAXONOMY OF ANGIOSPERMS AND ECONOMIC BOTANY

Title of the Course	**TAXONOMY OF ANGIOSPERMS AND ECONOMIC BOTANY**					
Paper Number	**Core III**		**Credits**	**4**	**Course code**	**23PBOT2C03**
Category	**Year**	**I**				
Core III	**Semester**	**II**				
Instructional Hours/week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
	4		**-**	**4**		
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 Systematic. 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 systematic. 4.To provide information on various classification systems 5. To know about the economic importance of plants.					

UNIT	**CONTENTS**
I	**Classification system in Angiosperm:** A brief historical account on the classification of Angiosperms up to the present day – Principles - Classification of angiosperms, Linnaeus, Bentham and Hooker, Engler and Prantl, Bessy, Takhtajan, Angiosperm phylogeny group (APG)-IV – Merits and demerits. Phenetics - Cladistics - Concepts of Taxonomic hierarchy – Species concept – Systematic Evidence: Morphology, Anatomy, Palynology, Embryology, Cytology, Chemotaxonomy, Numerical taxonomy, Sero taxonomy and Molecular taxonomy – DNA barcoding – Molecular markers in taxonomy – Computer applications in plant systematic .
II	**Botanical Nomenclature** Nomenclature and taxonomic techniques: Binomial nomenclature – Principles of ICN – Typification - Principles of priority - Author citation – Retention, rejection and

	changing of names - Synonyms - Effective and valid publication – Monographs, Icones, Journal, Periodicals, Floras, Electronic flora and Manuals - Plant Identification: Herbarium preparation and data information - Taxonomic keys- indented key, Bracketed key, written description, specimen comparison - Botanical gardens, Botanical Survey of India (BSI) Unified biological nomenclature – Draft Biocode, Phylocode
III	**Arrangement of the families in UNIT III & IV according to the classification of APG IV (2016)** **UNIT III - Systematic study of Basal angiosperms, Magnoliids & Eudicots** Study of Systematic Position, salient features, description, distribution of economic importance of the following families, **Basal angiosperm** - Nymphaeaceae**, Magnoliids :** Magnoliaceae, Aristolochiaceae. **Monocots**: Araceae, Orchidaceae, Commelinaceae, zingiberaceae , Cyperaceae, **Eudicots**: Menispermaceae, **Superrosids:** Crassulaceae. .
IV	**Systematic study of Rosids & Asterids families:** Study of Systematic Position, salient features, description, distribution of economic importance of the following families - **Rosids:** Combretaceae, Lythraceae, Casuarinaceae, Moraceae, Rosaceae, Meliaceae, Sapindaceae. **Superasterids**: Nyctaginaceae, Polygonaceae, Portulacaceae, **Asterids**: Sapotaceae, Boraginaceae, Rubiaceae, Bignoniaceae, Pedaliaceae, Convolvulaceae
V	**ECONOMIC BOTANY** General account on economic value , cultivation and utilization of selected crop plants : Cereals (Rice and wheat) – Pulses (Red gram and Black gram) – Sugar yielding plants (sugarcane and sugar beet) – Spices and condiments (Cardamom, Cinnamon) - Fiber (Jute), Timber (Teak and Red sanders wood), Resin and Gums (Asafoetida and Gum Arabic) – Essential oils (lemongrass and eucalyptus Beverages (coffee and tea) – oil yielding plants (Groundnut, sunflower) - Drug yielding plant (Cinchona, Withania and Gloriosa), Energy plantation - uses of *Casuarina.*

Course out come 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**
Co2	Explain the principles of taxonomy. Summarize the taxonomic hierarchy. Define Binomial nomenclature. Group Activity – Construct key preparation	**K2**
Co3	Explain the various types of classification. Distinguish its Advantages and disadvantages Construction of floral formula and floral diagram.	**K3**
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.	**K4**
Co5	Illustrate and explain the characteristic features and list out the economic importance of the families.	**K5&K6**

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questionsrelatedtotheabovetopics,fromvarious competitiveexaminationsUPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/otherstobesolved (To be discussed during the Tutorial hour
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Text books

1. Lawrence, G.H.M. (1995). The Taxonomy of vascular Plants (Vol I-IV), Central Book, Dept, Allahabad
2. Heywood V.H. (1967). Plant Taxonomy, Edward Arnold, London.
3. Jeffery C. (1982). An introduction to Plant Taxonomy, J & A Churchill Ltd., London
4. Mathew, K.M. (1983). The Flora of Tamil Nadu Carnatic, The Rapinat Herbarium, Trichy.
5. Sivaraajan, V.V. (1989). Introduction to Principle of Plant Taxonomy, Oxford and IBH, New Delhi.
6. Pandey, BP. (2017). Taxonomy of Angiosperms, S. Chand & Co., New Delhi.
7. Singh, V. and Jain, K.K. (1989). Taxonomy of Angiosperms, Rastogi, Meerut.
8. Vashista, PC. (1990). Taxonomy of Angiosperms, S. Chand & Co., New Delhi.
9. Sharma, OP. (2017). Plant taxonomy, McGraw Hill Publishers.
10. Sambamurthy, A.V.S.S and Subramanium, N.S. (2016). A text book of Modern Botany, CBS publishers.

11. Gurcharan Singh. (2020). Plant systematic – Theory and Practices 4th Edition, Oxford & IBH, Publishing co. Pvt. Ltd, New Delhi.
12. Gurcharan Singh. (2015). Plant systematic –Theory and Practices 3rd Edition, Oxford & IBH, Publishing co. Pvt. Ltd, New Delhi.

Reference books

1. APG IV (2016). An Update of the Angiosperm Phylogeny Group Classification for the Orders and Families of Flowering Plants. Botanical Journal of the Linnean Society, 181, 1-20.
2. Hutchinson, J. (1973). The Families of Flowering plants, Oxford Univ.press, London.
3. Gamble, J.S, Fisher, L.E.F. (1967). The Flora of The presidency of madras (Vol-III) BSI, Calcutta.
4. Davis, P.H and Heywood, V.M. (1965). Principles of Angiosperm Taxonomy, Oliver and Boyd Edinburgh.
5. Kress J.W, Wurdack, K.J., E.A.C., Zimmer, L.A., Weight and Janzen D.H. (2005). Use of DNA barcodes to identify flowering plants. Proc. Natl. Acad. Sci, 102-374.
6. Stoeckle, M. (2003). Taxonomy, DNA and the bard code of life. Biosci, 53: 796-797.
7. Simpson, M.G. (2006). Plant systematic, Elsevier Academic Press, USA.
8. Takhtajan, AL. (1969). Flowering Plants – Origin and dispersal – Oliver & Boyed.
9. Takhtajan, A.L. (1991). Evolutionary trends in flowering plants, Bishen Singh Mahendra Pal Singh, DehraDun.

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

MappingwithProgrammeOutcomes:

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 COURSE IV

PLANT ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS

Title of the Course	**PLANT ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS**					
Paper Number	**Core IV**		**Credits**	**4**	**Course code**	**23UPBOT2C04**
Category	**Year**	**I**				
Core IV	**Semester**	**II**				
Instructional Hours / week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
	4		**-**	**4**		
Pre-requisite	To acquire knowledge on the anatomical structure and reproductive phase of angiosperms					
Learning Objectives	1. To study the structure and functional development of cells , tissues and organs 2. Trace the development of male and female gametophyte in Angiosperm plants 3. To know the tools and techniques used in Anatomical studies 4. To study the male and female gametophyte development in angiosperm plants 5. Understand the incompatibility barriers and evolve methods to overcome 6. Highlight the physiological role of endosperm in the morphogenesis of embryo					

UNIT	**CONTENTS**
I	**Anatomy of Angiosperms :** Meristems – characters, classification, various concepts of Apical organization of shoot and root apices - Vascular cambium – origin, types, structure and etiology – origin, structure, development and ontogeny of xylem and Phloem .wood anatomy – variation in wood structure – tyloses, Sap and heart wood – compression and tension wood. Shoot and root transition – Nodal anatomy, Anomalous secondary growth in dicots and Monocots.
II	**Leaf ontogeny** – initiation, Apical, intercalary, marginal and adaxial growth, plate meristem and development of vascular plasto chronic index, transfer cell – structure, development and function. Classical concept of flower: floral anatomy and its role in classification, plant galls. Types, structure and development, role of

	polarity in cell differentiation and symmetry, role of sucrose in vascular differentiation.
III	**UNIT III - Micro techniques** Microscopy - Principle and application, Light microscope, Bright field, Dark field, Phase contrast microscopy – Fluorescence Microscope, Electron microscope (TEM & SEM) – Microtome's - types –Principles and operating mechanisms, Maceration, Squashes, Smears, Whole mount and clearing techniques. Fixation and fixatives, dehydration, clearing, infiltration, Embedding, Block making and sectioning. Stains and staining techniques, Camera Lucida – types, Principles and their uses.
IV	**Embryology of angiosperms** Microsporangium - Microsporogenesis, Microspores - morphology - ultrastructure - Micro gametogenesis – pollen wall development, Pollen - Stigma interaction - Incompatibility - Methods to overcome incompatibility - Megasporangium - Megagametogenesis - Female gametophyte - Monosporic - Bisporic and Tetrasporic - Nutrition of embryo sac and fertilization.
V	**Post pollination events** Endosperm - Types - Endosperm haustoria - Cytology and physiology of endosperms, functions of endosperms - Embryo development in Dicot and Monocot, Nutrition of embryo - Polyembryony - Causes, Apomixis - Causes, Apospory - Their role in plant improvement programs and seed development

Course out come 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**
Co2	Study the function and organization of woody stems derived from secondary growth in dicot and monocot plants.	**K2**
Co3	Apply their idea on sectioning and dissection of plants to demonstrate various stages of plant development.	**K3**
Co4	Understand the various concepts of plant development and reproduction.	**K4**
Co5	Profitably manipulate the process of reproduction in plants with a professional and entrepreneurial mindset.	**K5&K6**

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questionsrelatedtotheabovetopics,fromvarious competitiveexaminationsUPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/otherstobesolved (To be discussed during the Tutorial hour
Skills acquired from this course	Knowledge, Problem Solving ,Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

ANATOMY OF ANGIOSPERMS

Text Book

1. Pandey, B.P. (2015). Plant Anatomy, S. Chand Publ. New Delhi.
2. Vashista, P.C (1984). Plant Anatomy, Pradeep Publication , Jalandhar
3. Pijush Roy, (2010). Plant Anatomy, New central Book Agency, Pvt. Lit, New Delhi.
4. Singh, V, Pande, P.C. & Jain D.K. (1987). Anatomy of seed plants – Rastogi Publications, Meerut.

Reference books

1. Cutter, E.G. (1970). Plant Anatomy: Experimental and interpretation. Edward, Arnold Pub. Ltd., London.
2. Cutter, E.G. (1971). Plant Anatomy, Edward Arnold Pub. Ltd., London.
3. Cutter, E.G. (1978). Plant Anatomy, Experimental and Interpretation. Edward Arnold Pub.Ltd., London
4. Esau, K. (1960). Plant Anatomy, Wiley Eastern Private Ltd., New Delhi.
5. Esau, K. (1977). Anatomy of seed plants. Wiley Eastern Publication, New Delhi.
6. Fahn, A. (1989). Plant Anatomy. Macmillan Publication (P) Ltd, Singapore.

EMBRYOLOGY

Text Book

1. Bhatnagar, S.P, Dantu, P.K, Bhojwani SS. (2014). The Embryology of Angiosperms 6th Edition Vikas Publishing House. Delhi
2. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, 5th Edition, Vikas Publishing House. Delhi.
3. Pandey, A.K. (2000). Introduction to Embryology of Angiosperms 1st Edition: CBS; New Delhi

4. Maheswari, P. (1976). An introduction to the Embryology of Angiosperms. TATA McGraw-Hill Publishing Co., Ltd., New Delhi.

Reference books

1. Austin, (1968). Fertilization. Prentice Hall of India, New Delhi.
2. Davis, G.L. (1966). Systematic Embryology of the Angiosperms.
3. Dwivedi, J.N. (1988). Embryology of Angiosperms. Rastogi & Co., Meerut.
4. Johri, B.M. (1984). Experimental Embryology of Vascular plants
5. Rahavan, V. (1976). Experimental Embryogenesis in Vascular plants, Academic Press, London
6. Shivanna, K.R. and B.M. Johri. (1985). The Angiosperm pollen structure and functions. Wiley- Eastern Ltd.
7. Sporne, K.R. (1972). The Evolution of pollen types in Dicotyledons. New Phytol.71:181-185.

MICROTECHNIQUES

Text Books

1. Marimuthu, R. (2011). Microscopy and Microtechnique. MJP publishers Chennai.
2. Patki, L.R, Bhalchandra, B.L. and Jeevaji, I.H. (1987). An introduction to Microtechnique, S.Chand and company (Pvt) Ltd, New Delhi.

Reference Books

1. Johansen, D.A. (1940). Plant Microtechnique, TATA McGraw Hill Book Co., Ins., New Delhi.
2. Peter Gray, (1964). Handbook of Basic Microtechnique. McGraw hill publication, New York
3. Steven Ruzin, (2005). Plant Microtechnique and Microscopy. Oxford University press, London

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

https://www.askiitians.com/

MappingwithProgrammeOutcomes:

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-V

ECOLOGY, PHYTOGEOGRAPHY, CONSERVATION BIOLOGY & INTELLECTUAL PROPERTY RIGHTS

Title of the Course	**ECOLOGY, PHYTOGEOGRAPHY, CONSERVATION BIOLOGY & INTELLECTUAL PROPERTY RIGHTS**					
Paper Number	**Core V**		**Credits**	**4**	**Course code**	**23UPBOT2C05**
Category	**Year**	**I**				
Core V	**Semester**	**II**				
Instructional Hours /week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
	4		**-**	**4**		
Pre-requisite	Understanding the environmental factors impacting biodiversity is crucial after taking this course and Basic understanding of how laws are structured and interpreted.					
Learning Objectives	1. To analyze and comprehend the fundamental ideas of plant ecology as a Scientific study of environment. 2. To study the plant communities and plant succession stages. 3. To be aware of the causes, impacts and control measures of pollution. 4. To study biodiversity management and conservation. 5.To enhance the knowledge of the students and equip them in evaluate and protecting invaluable components of nature and interactions with the environment					

UNIT	**CONTENTS**
I	**Autecology and Synecology** History and scope of ecology**,** **Autecology**: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured population, **Synecology** – Characteristics of community, composition and structure, origin and development, ecotone, edge effect, ecological niche. Ecological interdependence and interaction - positive and negative interaction. Competition – interspecific and intraspecific. Ecological Succession: Types, mechanisms, concept of climax.
II	**Concept of ecology :** Concept and dynamics of Ecosystem: Types of Ecosystem, components, Food chain,

	food webs. Concept of trophic level, Ecological pyramids, Energy flow ecosystem. Mineral cycling (C, N, P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, Estuarine).
III	**Biodiversity conservation & Environment Deterioration:** Conservation-need for conservation- in situ conservation - sanctuaries, national parks, biosphere reserves; ex situ conservation- Gene banks, seed banks, Pollen banks, and Cryopreservation -Role of indigenous people in conservation of sacred species, sacred groves; Human and animal conflicts in Biodiversity conservation, social movement for conservation – Chipko movement, Narmada bachao and olan, Red List categories of IUCN. Forest conservation through laws - the biological diversity Act (2002) in force. **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/remediation ecological foot prints - carbon foot print – eco labelling - environmental auditing
IV	**Phytogeography:** Phytogeography – Principle of plant geography - Phytogeographic region of India, Dispersal and migration barrier hypothesis, Willis age and area hypothesis. Continues range, cosmopolitan, circumboreal and circum austral, pantropical, Discontinuous distribution Wegner‘s theory continental drift hypothesis, land bridges hypothesis, Endemism, hotspot region of India and world.
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 out come CO	On completion of this course, the students will be able to:	Programme outcomes
Co1	Understand the scope and importance of population ecology,	**K1**

	Plant communities and ecosystem ecology.	
Co2	Understand the applied aspect of environmental botany.	**K2**
Co3	Students will spot the sources and pollution and seek remedies to mitigate and rectify them.	**K3**
Co4	Identify different plant communities, categorize plant biomes and identify threatened, endangered plant species and create awareness program in protection of biodiversity.	**K4**
Co5	Analyze insight into the vegetation types, species interaction and their importance and the factors influencing the environmental conditions.	**K5&K6**

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questionsrelatedtotheabovetopics,fromvarious competitiveexaminationsUPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/otherstobesolved (To be discussed during the Tutorial hour
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Text books

1. Sharma, P.D. (2009). Ecology and Environmental, Rastogi Publishers, Meerut.
2. Ambasht, R.S. (1988). A text book of plant ecology. Students, Friends & Co., Varanasi.
3. Kormondy, EJ. (2004). Concepts of Ecology, 4th Edi. Prentice –Hall of India Pvt. Ltd., New Delhi.
4. Sharma, P.D. (2015). Ecology and environment. Rastogi Publications, New Delhi.

References books

1. Edward, J. Kormondy, (1996). Concept of Ecology, Prentice Hill of India Pvt, Ltd. New Delhi.
2. Emil T. Charlett. Environmental Protection. Tata Mc Graw Hill New Delhi.
3. George, L. Clarke, (1954). Elements of Ecology. John Wiley & Sons. Inc., New York.
4. Misra, K.C. (1980). Manual of plant ecology (second edition). Oxford and IBH Publishing Co., New Delhi.
5. Odum, E.P. (1971). Fundamentals of ecology, W.B. Saunders Co., Philadelphia, London.
6. Perkins, H.C. (1974). Air pollution, McGraw Hill Kongotusta Ltd, Tokyo.
7. Robert Smith, (1977). Elements of ecology and field biology, Harper and Raw Publishers, New York, London.
8. Michael, P. (1984). Ecological methods for field and laboratory investigations, Tata McGraw Hill publishing company Ltd., New Delhi.

9. Misra, R. (1986). Ecology workbook, Oxford and IBH publishing company, New Delhi.
10. Coull, J. Cronstant, (1974). Water pollution. Hancount pracojavanocichetne, New York, Atlanta.

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

MappingwithProgrammeOutcomes:

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)

CORE LABORATORY COURSE-II

(COVERING PAPERS, III, IV & V)

Title of the Course	PRACTICAL II					
Paper Number	**Core lab course II**		**Credits**	**4**	**Course code**	**23UPBOT2P02**
Category	**Year**	**I**				
Core lab course	**Semester**	**II**				
Instructional Hours /week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
			6	**6**		
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	CONTENTS
I	**TAXONOMY AND ECONOMIC BOTANY OF ANGIOSPERMS** 1. Identification of Specimen at family, generic and specific level belonging to the following families based on APG IV 2016 classification **Basal angiosperm** - Nymphaeaceae**, Magnoliids:** Magnoliaceae, Aristolochiaceae. **Monocots**: Araceae, Orchidaceae, Commelinaceae, Zingiberaceae, Cyperaceae, **Eudicots**: Menispermaceae, **Superrosids:** Crassulaceae, **Rosids:** Combretaceae, Lythraceae, Casuarinaceae, Moraceae, Rosaceae, Meliaceae, Sapindaceae. **Superasterids**: Nyctaginaceae, Polygonaceae, Portulacaceae, **Asterids**: Sapotaceae, Boraginaceae, Rubiaceae, Bignoniaceae, Pedaliaceae, Convolvulaceae ● Familiarity with the use of Flora ● Identify the families mentioned in the syllabus by noting their vegetative and floral character

	● Preparation of Dichotomous key using locally available plants. 2. Study of economically important plants and parts mentioned in syllabus ● A field trip of not less than four days to a place of luxuriant vegetation to study ● The flora and to study the different types of vegetation. ● Submission of a tour report and 25 herbarium sheets (Specimens collected from Tour Collection / locally available plants during the internal practical Examination. ● Certified record work done in the laboratory during practical classes
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: *Aristolochia, Bignonia. Dracaena* 5. Observation of stomatal types by epidermal peeling. 6. Maceration of wood and observation of the components of xylem.
	MICROTECHNIQUES 1Students are expected to be thorough with the following techniques. (a) Preparation of semi permanent slides (b) Preparation of permanent slides. (c) Preparation of whole mounts. (d) Maceration. (e) Preparation of fixatives (FAA, Carnoy's Fluid). (f) Preparation of dehydration series (Alcohol, Acetone, TBA). (g) Preparation of paraffin blocks. h)Preparation of serial sections with Microtomy 2.Candidates should prepare and submit 10 permanent slides in which the following categories should be included; 1. Free hand sections (single/double stained). 2. Serial sections (single/double stained). 3. Wood sections and whole mounts 3. Micrometry: Calibrate the ocular micrometer stage micrometer on a light microscope and measure the size of an object (e.g., diameter of

	spore/pollen grains/ width of algal filaments/xylem/phloem) 4. Demonstrate the drawing tool Camera Lucida
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.
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 Dissolved oxygen content 6.Estimation of carbonate content in water
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).
	Note ● Field study of an area (not less than a period of 4 days) to document environmental assets and study the ecosystems and different types of vegetation (Forest / Grassland / Mountain / National parks / Sanctuary /Botanical garden / Lake / Pond / River / Waterfalls / Estuary / Mangrove / Sea coast) submit a tour report (during the internal practical examination). ● Certified record of work done in the laboratory during practical classes

Course out come 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.	**K3**
Co4	Apply their idea on sectioning and dissection of plants to demonstrate various stages of plant development.	**K4**
Co5	Know about different vegetation sampling methods.	**K5&K6**

ELECTIVE-III – (GROUP C)

MEDICINAL BOTANY

Title of the Course						
Paper Number	**Elective III**		**Credits**	**3**	**Course code**	**23UPBOT2E09**
Category	**Year**	**I**				
Elective III (Group C)	**Semester**	**II**				
Instructional Hours /week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
	4			**4**		
Pre-requisite	Understanding the uses of medicinal plants and its conservation.					
Learning Objectives	1.To understand the uses and effects of medicinal plants and herbal supplements. 2.Togain knowledge about the historical and modern uses of plants in medicine 3.To gain insights into the perspectives of ethnobotanical research. 4 To know the various methods of harvesting, drying and storage of Medicinal herbs. 5. To create new strategies to enhance growth and quality check of medicinal herbs.					

UNIT	CONTENTS
I	**History and Traditional Systems Of Medicine:** Historical Perspectives – European, African, American, Southeast Asian Practices. Scope and Importance of Medicinal Plants; Traditional systems of medicine - Definition and Scope. Classical health traditions - Naturopathy, Siddha, Ayurveda, Homeopathy, Unani and MateriaMedica. Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in Ayurvedic treatments, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umoor-e-tabiya, tumors treatments/ therapy, polyherbal formulations.
II	**Phytochemistry and Pharmacognosy:** Phytochemistry, important phytoconstituents, their plant sources, medicinal properties. Histochemistry – definition, principles, staining methods. Biological stains – Bright field dyes and flurochromes, detection and localization of

	phytochemicals. Raw drugs, authenticity, study through physical, microscopic and analytical methods. Different types of formulations. Adulteration and Admixtures.
III	**Active principle &Drug discovery:** Brief description of selected plants, Active principles, biochemical properties and medicinal uses of Guggul (*Commiphora*) for hypercholesterolemia, *Boswellia* for inflammatory disorders, Arjuna (*Terminalia arjuna*) for cardio protection, turmeric (*Curcuma longa*) for wound healing, antioxidant and anticancer properties, Kutaki (*Picrorhiza kurroa*) for hepatoprotection, Opium Poppy for analgesic and antitussive, *Salix* for analgesic, *Cinchona* and *Artemisia* for Malaria, *Rauwolfia* as tranquilizer, *Belladona* as anticholinergic, *Digitalis* as cardiotonic, *Podophyllum* as antitumor, *Stevia rebaudiana* for antidiabetic, *Catharanthus roseus* for anticancer. Bioprospecting, drug discovery from plants with reference to diabetes and cancer.Product development and quality control.
IV	**Conservation and augmentation:** Significance of Cultivation, management, policies for conservation and sustainable use of medicinal plants. Conservation of endemic and endangered medicinal plants, Red list criteria; *In situ* conservation: Biosphere reserves, sacred groves, National Parks; *Ex situ* conservation: Botanic Gardens, Ethno medicinal plant Gardens. Propagation of Medicinal Plants: seeds, cuttings, layering, grafting and budding.
V	**Ethno botany and folk medicine:** Concepts and definition of Ethno botany and folk medicines. A brief history of ethnobotanical studies – globally & locally. Methods to study ethno botany; Applications of Ethno botany: Folk medicines of ethno botany, ethno medicine, ethno ecology, ethnic communities of India. Understanding the traditions of tribes in Tamil Nadu – Irulas and Kanis. Repository of Ethnobotanical data – Archeology, inventories, folklore and literature. Traditional Knowledge Sharing - Prior information consent, interviews, questionnaires and knowledge partners.Plants associated with culture, social, religious and medicinal purposes.Commercial use of traditional knowledge – ethics, IPR, biopiracy, equitable benefit sharing models.

Course out come CO	**On completion of this course, the students will be able to:**	**Programme outcomes**

Co1	Recognize plants and relate to their medicinal uses	**K1**
Co2	Explain about the phytochemistry, pharmacognosy and bioprospecting of medicinal plant extracts.	**K2**
Co3	Apply techniques for conservation and propagation of medicinal plants.	**K3**
Co4	Analyze and decipher the significance of various methods of harvesting, drying and storage of medicinal herbs.	**K4**
Co5	Develop new strategies to enhance growth and quality check of medicinal herbs considering the practical issues pertinent to India.	**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

Text Book

1. AYUSH (www.indianmedicine.nic.in). 2014. *About the systems—An overview of Ayurveda*, *Yoga and Naturopathy*, *Unani*, *Siddha and Homeopathy*. New Delhi: Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (AYUSH), Ministry and Family Welfare, Government of India.

2. Bhat, S.V., Nagasampagi, B.A., & Meenakshi, S. 2009. Natural Products – Chemistry and Applications. Narosa Publishing House, India Ltd.
3. CSIR- Central Institute of Medicinal and Aromatic Plants, Lucknow. 2016. *AushGyanya*: Handbook of Medicinal and Aromatic Plant Cultivation.

4. Kapoor, L. D. 2001. Handbook of Ayurvedic medicinal plants. Boca Raton, FL: CRC Press.

5. Saroya, A.S. 2017. Ethno botany. ICAR publication.

6. Sharma, R. 2003. Medicinal Plants of India-An Encyclopedia. Delhi: Daya Publishing House.

7. Sharma, R. 2013. Agro Techniques of Medicinal Plants. Daya Publishing House, Delhi.

8. Thakur, R. S., H. S. Puri, and Husain, A. 1989. *Major medicinal plants of India*. Central Institute of Medicinal and Aromatic Plants, Lucknow, India.

Reference Books:

1. Akerele, O., Heywood, V and Synge, H. 1991. The Conservation of Medicinal Plants. Cambridge University Press.
2. Evans, W.C. 2009. Trease and Evans Pharmacognosy, 16th edn. Philadelphia, PA: Elsevier Saunders Ltd.
3. Jain, S.K. and Jain, Vartika. (eds.). 2017. Methods and Approaches in Ethnobotany: Concepts, Practices and Prospects. Deep Publications, Delhi
4. Amruth. 1996. The Medicinal plants Magazine (All volumes) Medicinal plant Conservatory Society, Bangalore.
5. Bhattacharjee, S.K. 2004. Hand Book of Medicinal plants. Pointer Publishers, Jaipur.

Handa, S.S and V.K. Kapoor. 1993. Pharmacognosy. VallabhPrakashan, New Delhi.

Web resources:

1. https://www.amazon.in/Medical-Botany-Plants-Affecting-Health/dp/0471628824
2. https://www.amazon.in/Current-Trends-Medicinal-Botany-Muhammad/dp/9382332502
3. https://link.springer.com/book/10.1007/978-3-030-74779-4
4. https://www.elsevier.com/books/medicinal-plants/da/978-0-08-100085-4
5. https://www.pdfdrive.com/medicinal-plants-books.html

MappingwithProgrammeOutcomes:

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

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

ELECTIVE-III (GROUP C)

PHYTOCHEMISTRY

Title of the Course	PHYTOCHEMISTRY					
Paper Number	**Elective III**		**Credits**	**3**	**Course code**	**23UPBOT2E10**
Category	**Year**	**I**				
Elective III Group C	**Semester**	**II**				
Instructional Hours/week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
	4	**-**	**-**	**4**		
Pre-requisite	Understanding the uses of medicinal plants and its conservation.					
Learning Objectives	1. To understand the phytochemical compound available in plants 2.To gain knowledge about extraction and identification of phytochemical compound 3. To gain knowledge on drug evaluation 4 To know the bio synthetic pathway of secondary metabolites 5 .To know the bioactive mechanism of secondary metabolites.					

UNIT	CONTENTS
I	**Secondary metabolites and Classification** Phytochemistry - Definition, history, principal, secondary metabolites: Definition, classification, occurrence and distribution in plants, their function, chemical constituents. Alkaloids, Terpenoids, flavonoids, steroids coumarins, volatile oils and other related compounds.
II	**Extraction and quantification of Phytochemical :** Extraction methods of phytochemical: organic solvent extraction, extraction with supercritical gas, steam distillation, soxhlet extraction, Purification, concentration, lyophilization. Qualitative screening of phytochemical compounds. Quantification compound: TLC, HPLC, GC-MS, LC-MS .Characterization of phytochemical spectroscopic analysis UV-VIS, IR, NMR and MASS Spectra, FTIR.
III	**Crude drug evaluation:** Types of crude drugs-organized and unorganized types; Adulteration of drugs of natural origin; Evaluation of plant drugs-organoleptic, microscopically, chemical, physiological and biological methods

IV	**Biosynthetic pathway of phytochemical and its applications** Biosynthetic pathway of secondary metabolites: Shikimic acid pathway, Acetate-Mevalonate pathway, pathway for commercially important phytochemicals: Ephedrine, taxol and Vinca Alkaloids. Application of phytochemicals in medicine, pharmaceuticals, food, flavor and cosmetic industries.
V	**Biologically active secondary metabolites** Biological source, uses and chemical constituents of bio active compounds: carbohydrate and derived compound – gums (Acacia gum, Indian gum and gum Arabic, isabgol), pectin –Ghatti gum). Glycosides (Alove, Digitalis, Olender, Dioscorea, Ginseng, Vanilla, Shatavari). Cyanogenic glycosides – (Amygdalin). Alkaloids (Belladonna, Ergot; Rauwolfia, Cinchona, Opium, Holarrhenna, Ashwagandha, Cocao). Tannins (Malbar Kino, Arjuna, Black catechu). Volatile oil (Peppermint, Pudina, Sandalwood oil, Chinese cinnamon, Citronella oil, Clove, Gaultheria oil. Resins (Indian cannabis, Ginger). Lipid – (Almond oil, Rice bran oil, Safflower oil). Enzymes and protein drugs - Bromelin, Papain, Malt extract, Gelatinum, Ficin).

Course out come CO	On completion of this course, the students will be able to:	Programme outcomes
Co1	Gaining knowledge on different classes of phytochemicals present in higher and lower plants species	**K1**
Co2	Demonstrate the various aspects of extraction, isolation and characterization of secondary metabolites.	**K2**
Co3	Know the methods of screening of secondary metabolites for various biological properties.	**K3**
Co4	Understand the pathway of secondary metabolites synthesis	**K4**
Co5	Understand the bioactive compound in 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

Text Books

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 andPawar. 2018.Practicalbookof pharmacognosyandphytochemistry-EverestPublishinghouse.
3. Varsha TiwariandShamim Ahmad. 2018.Apracticalbookofpharmacognosyand phytochemistry.Niraliprakashanadvancementofknowledge.
4. Braithwaite,AandF.J.Smith.1996.*ChromatographicMethods*(5thEdition)BlackieAcademic& ProfessionalLondon.
5. Wilson,KandJ.Walker(Eds).1994.PrinciplesandTechniquesofPracticalBiochemistry(4thEditi on)CambridgeUniversityPress,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

MappingwithProgrammeOutcomes:

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- (GROUP C)
RESEARCH METHODOLOGY, COMPUTER APPLICATIONS & BIOINFORMATICS

Title of the Course	**RESEARCH METHODOLOGY, COMPUTER APPLICATIONS & BIOINFORMATICS**					
Paper Number	**Elective III**		**Credits**	**3**	**Course code**	**23UPBOT2E11**
Category	**Year**	**I**				
Elective III (Group C)	**Semester**	**II**				
Instructional Hours/week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
	4	**-**	**-**	**4**		
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 starts 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
1	**Research methodology** Choosing the research problem - Literature Collection - bibliography - indexing and abstracting. Writing the research report - the components of a research report - title Authors and address - abstract - summary - synopsis - key words introduction - materials and methods, results & discussion. Publications in research journals, breeders‘ journals, monographs – Reference Management Software reprints – proof correction – Full paper – Short Communication – Review paper, Oral and poster presentation. Outline of plagiarism, UGC care list
II	**Analytical techniques based on optical principles** Photomicrography: Camera as the remote sensing device – types – shutter speed –

	aperture – depth of field – photographic techniques – printing (photographic emulsion, enlarger, developer and fixer). Spectrophotometer : Principles, Beer Lambert's Law, components and working mechanism – Colorimetric, UV visible and InfraRed (IR), nuclear magnetic resonance (NMR), electron paramagnetic resonance (EPR), atomic absorption spectroscopy (AAS)
	Quantitative procedures based on physical principles Centrifugation - Principles, components, Mechanism and application of Clinical, Ultra Centrifuges, Chromatography - principles and applications of paper Chromatography, TLC, HPTLC, Column Chromatography, Ion Exchange, affinity Chromatography, HPLC. Agarose gel Electrophoresis, PAGE, Zymogram and ImmunoElectrophoresis. pH meter- pH concept, electrodes
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	**History, scope and applications of bioinformatics** - Biological databases (BDB) - Nucleotide sequence (EMBL), GENBANK, DDBJ) Protein sequence, (PIR, SWISS-PROT, TrEMBL), Secondary data bases (Prosite, Prints, Blocks). Computational biology and bioinformatics - sequence similarity, homology. Sequence alignment - Pairwise and multiple sequence alignments, score matrices - PAM and BLOSUM series, BLAST and FASTA algorithms. Phylogenetic trees - distance based method (UPGMA, NJ), Maximum parsimony and maximum likelihood method.

Course outcome CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
Co1	Obtain knowledge on basic concepts in Research and in Biostatistics.	**K1**
Co2	Acquire knowledge on sampling techniques; evaluate literature, collection of data and thesis writing.	**K2**
Co3	Acquire knowledge on handling biological instruments	**K3**
Co4	outline the basics of sequence alignment and analysis.	**K4**
Co5	classify different types of biological databases	**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

Test Books

2. Palanivelu P (2013). Analytical biochemistry and separation techniques, 20th century Publication, Palkalai Nagar, Madurai
3. Jayaraman, J. (1985). Laboratory Manual in Biochemistry Wiley Eastern Ltd., New Delhi.
4. Khan, I.A, and Khannum, A. (1994). Fundamentals of Biostatistics, Vikas Pub, Hyderabad.
5. Gurumani, N. (2011). Research Methodology: For Biological Sciences,Mjp Publishers, Chennai.
6. Attwood, T.K and Parry Smith D.J. (1999). Introduction to bioinformatics, Addison Wesley Longman Ltd., England.

Reference Books

1. Bryan Bergeron, M.D. (2006). Bioinformatics computing, Prentice Hall of India, New Delhi.
2. Kothari. C.R, (1991). Research Methodology Methods and techniques, Wiley Eastern Ltd., New Delhi.
3. Pavel. A, Pevzner (2005). Computational Molecular Biology Algorithmic approach, prentice, Hall of India Pvt., Ltd.,
4. Zar, JH, (1984). Biostatistical analysis, Prentice Hall international, New Jersey.
5. Sree Ramulu, V.S (1988). Thesis Writing Oxford, and IBH, Pub, New Delhi.
6. Wilson, K. and Walker, J. (2000). Principles and Techniques of Practical Biochemistry (5th Edition), Cambridge University Press, Cambridge.

Web resources:

https://www.kobo.com/in/en/ebook/bioinstrumentation-1

1. https://www.worldcat.org/title/bioinstrumentation/oclc/74848857
2. https://www.amazon.in/Bioinstrumentation-M-H-Fulekar-Bhawana-Pandey-ebook/dp/B01JP3M9TW
3. https://en.wikipdia.org/wiki/bioinstrumentation
4. https://www.britannica.com/science/chromatography

https://en.wikipedia.org/wiki/electrophoresis

MappingwithProgrammeOutcomes:

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-III – (GROUP C)
BIOPESTICIDE TECHNOLOGY

Title of the Course	**BIOPESTICIDE TECHNOLOGY**					
Paper Number	**Elective III**		**Credits**	**3**	**Course code**	**23UPBOT2E12**
Category	**Year**	**I**				
Elective III (Group C)	**Semester**	**II**				
Instructional Hours/week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
	4	**-**	**-**	**4**		
Pre-requisite	Prior knowledge on impact of chemical pesticides on environment and bio pesticides.					
Learning Objectives	1. To understand the value and applications of bio pesticides. 2. To comprehend the various issues related to the use of chemical pesticides in horticulture, forestry, and agriculture. 3. To gain knowledge about several biopesticides (bio-insecticides, bio-fungicides, bio-bactericides, bio-nematicides and bio-herbicides). 4.To gain knowledge of the techniques for mass production of selected biopesticides 5.To be aware of the application strategies and weeds, nematodes, and disease					

UNIT	**CONTENTS**
1	**Introduction:** Introduction of biopesticides. Biological control, History and concept of biopesticides. Importance, scope and potential of biopesticide. Advantages for the use of biopesticides.- Effect of biopesticide to non target oargnism
II	**Types f Biopesticides** C**O**lassification of biopesticides, Botanical pesticides and biorationales. Mass production technology of bio-pesticides. Major classes-Properties and uses of Bioinsecticides, biofungicides, biobactericides, bionematicides and bioherbicides. Importance of neem in organic agriculture.
III	**Important Bioinsecticides:** *Bacillus thuringiensis*, NPV, entomopathogenic fungi (*Beauveria, Metarhizium, Verticillium, Paecilomyces*). Biofungicides: *Trichoderma, Gliocladium,* non-

	pathogenic *Fusarium, Pseudomonas* spp., *Bacillus* spp. Biobactericides: *Agro bacterium radiobacter*. Bionematicides: *Paecilomyces, Trichoderma*, Bioherbicides: *Phytophthora, Colletotrichum*.
IV	**Standardization of Biopesticides:** Target pests and crops of important biopesticides and their mechanisms of action. Testing of quality parameters and standardization of biopesticides.
V	**Formulation:** Mass multiplication and formulation technology of bio pesticides. Prospects and problems in commercialization and efficiency of bio pesticides. Commercial products of bio pesticides .

Course out come CO	On completion of this course, the students will be able to:	Programme outcomes
Co1	Understand the issues in use of chemical pesticides and their harmful effects on life.	**K1**
Co2	Aware the significance of biopesticides and their beneficial role in controlling insect pests,diseases,nematodes and weeds.	**K2**
Co3	Knowledge on identification of promising bio pesticides and their mechanisms of action against insect pests, diseases, nematodes and weeds.	**K3**
Co4	Learn the mass production and formulation technology of selected bio pesticides.	**K4**
Co5	Knowledge on product development for commercialization of biopesticides.	**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

Text book:

1. Johri,J.2020.Recent Advances in Biopesticides: Biotechnological Applications.New IndiaPublishing Agency (NIPA), NewDelhi.
2. Kaushik,N.2004.Biopesticidesforsustainableagriculture:prospectsandconstraints.TERIPress,New Delhi.
3. Sahayaraj,K.2014.BasicandAppliedAspectsofBiopesticides.SpringerIndia,NewDelhi.

4. Tebeest,D.O.2020.MicrobialControlofWeeds.CBSPublishersandDistributors,New Delhi.
5. Joshi, S.R. 2020. Biopesticides: A Biotechnological Approach. New Age International (P) ltd. New Delhi.

Reference Books:

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

11.Gnanamanickam,S.S.2019.BiologicalControlofCropDiseases.CRCPress,Florida,USA.

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

MappingwithProgrammeOutcomes:

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

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

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

ELECTIVE IV – (GROUP D)

APPLIED BIOINFORMATICS

Title of the Course	APPLIED BIOINFORMATICS					
Paper Number	**Elective IV**		**Credits**	**3**	**Course code**	**23PBOT2E13**
Category	**Year**	**I**				
Elective (Group D)	**Semester**	**II**				
Instructional Hours / week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
	4	**-**	**-**	**4**		
Pre-requisite	Basic knowledge in molecular biology. Familiarity with operations of computers and MS					
Learning Objectives	1. To learn about the bioinformatics databases, databanks ,data format and data retrieval from the online sources. 2. To explain the essential features of the interdisciplinary field of Science for better understanding biological data. 3. To outline the types of biological data bases. 4. To demonstrate different online bioinformatics tools. 5.To summarize the strong foundation for performing further research in bioinformatics.					

UNITS	CONTENTS
1	**Bioinformatics and Internet:** Internet Basics-FileTransfer Protocol-TheWorldWideWeb-InternetResources–databases–types-Applications-NCBI DataModel-SEQ-Ids–Biosequences-Biosequencesets–Sequence annotation–Sequence description.
II	**Genbank sequence database:** **Introduction**- Primary And Secondary Databases - Format Vs.Content-Genbank Flatfile-Submitting DNASequences to the Databases -DNA/RNA-Population ,Phylogenetic, and Mutation Studies - Protein-Only Submissions - Consequences of DNA Model -EST/STS/GSS/HTG/SNP and Genome Centres -Contact points for submission of sequence data toDBJ/EMBL/Genbank.
III	**Structure Databases:** Introduction to Structures- Protein Data Bank (PDB) – Molecular Modeling Database

	at NCBI Structure File Formats - Visualizing Structural Information –Data base Structure Viewers –Advanced Structure Modelling-Structure Similarity Searching.
IV	**Sequence comparison and database searching:** Scoring matrices: pairwise alignment – dot plot, global, local, multiple sequence alignment: BLAST and FASTA searches: statistical and functional significance.
V	**Nucleic acid sequence analysis**: DNA sequencing, assembly, restriction mapping, primer design, ORF prediction, transcriptional and translational signals, gene identification. Protein sequence analysis: composition, molecular weight, Pl, extinction coefficient, peptide mapping, hydrophobicity analysis of protein secondary structure, motifs.

Course out come CO	On completion of this course, the students will be able to:	Programme outcomes
Co1	Familiarize with the tools of DNA sequence analysis.	**K1**
Co2	Use and explain the application of bioinformatics.	**K2**
Co3	Master the aspects of protein-protein interaction, BLAST and PSI-BLAST.	**K3**
Co4	Describe the features of local and multiple alignments.	**K4**
Co5	Interpret the characteristics of phylogenetic methods and Bioinformatics applications.	**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

Text Books

1. Baxevanis,A.D.&Ouellette,B.F.2001.Bioinformatics:Apracticalguidetotheanalysisofgenesa nd proteins. NewYork: Wiley-Interscience.
2. Bourne,P.E.,&Gu,J.2009. Structuralbioinformatics.Hoboken, NJ:Wiley-Liss.
3. Lesk,A.M.2002. Introductiontobioinformatics.Oxford: Oxford UniversityPress.
4. Mount,D.W.2001.Bioinformatics:Sequenceandgenomeanalysis.ColdSpringHarbor,NY:Col dSpring HarborLaboratory Press.

Pevsner,J.2015.Bioinformaticsandfunctionalgenomics.Hoboken,NJ:Wiley-Blackwell.

ReferenceBooks:

1. Campbell,A.MandHeyer,L.J.2003.Discoveringgenomics,proteomics,andbioinformatics.SanFrancisco: Benjamin Cummings.
2. Green,M.RandSambrook,J.2012.Molecularcloning:Alaboratorymanual.ColdSpringHarbor, NY: Cold Spring HarborLaboratory Press.
3. Liebler,D.C.2002.Introduction to proteomics: Tools for the new biology. Totowa,NJ:HumanaPress.
4. Old,R.W.,Primrose,S.B.,andTwyman,R.M.2001.Principlesofgenemanipulation:Anintroductionto geneticengineering. Oxford:Blackwell ScientificPublications. Primrose,S.B.,Twyman,R.M.,Primrose,S.B.,andPrimrose,S.B.2006.Principlesofgene manipulationandgenomics.Malden,MA:BlackwellPub.

Web resources:

1. Bioinformatics:Algorithms&ApplicationsbyProf.M.MichaelGromihaIIT-Madras. https://nptel.ac.in/courses/102/106/102106065/#.
2. ChristopherBurge,DavidGifford,andErnestFraenkel. *7.91*.JFoundationsofComputationalandSystems*Biology*. Spring2014.MassachusettsInstituteofTechnology:MITOpenCourseWare,https://ocw.mit.edu
3. https://link.springer.com/book/10.1007/978-3-540-72800-9.
4. https://www.amazon.in/Applied-Bioinformatics-Paul-Maria-Selzer-ebook/dp/B001AUOYY2.
5. ttps://books.google.co.in/books/about/Applied_Bioinformatics.html?id=PXZZDwAAQBAJ&redir_esc=y

MappingwithProgrammeOutcomes:

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

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

ELECTIVE IV (GROUP D)

BIOSTATISTICS

Title of the Course	BIOSTATISTICS					
Paper Number	**Elective IV**		**Credits**	**3**	**Course code**	**23UPBOT2E14**
Category	**Year**	**I**				
Elective IV (Group D)	**Semester**	**II**				
Instructional Hours /week	**Lecture**	**Tutorial**	**lab practice**	**Total**		
	4	**-**	**-**	**4**		
Pre-requisite	Fundamental knowledge on using in statistical tools and apply the tools to interpret					
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
1	**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 out come 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.	**K1**
Co2	Solve problems quantitatively using appropriate arithmetical, algebraic, or statistical methods	**K2**
Co3	Know the latest version using in statistical tools and apply the tools to interpret the results	**K3**
Co4	To develop their competence in hypothesis testing and interpretation.	**K4**
Co5	Understand why biologists need a background in statistics.	**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

Text book

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.Dand Khanum, A. 2004. Fundamentals of Biostatistics, Ukazsz Publications, Hyderabad, India.
7. Gupta, S.C. 2013. Fundamentals of statistics, Himalaya Publishers, Mumbai.

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

https://hastie.su.domains/ElemStatLearn

MappingwithProgrammeOutcomes:

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

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

ELECTIVE-IV (GROUP D)

INTELLECTUAL PROPERTY RIGHTS

Title of the Course	INTELLECTUAL PROPERTY RIGHTS					
Paper Number	**Elective IV**		**Credits**	**3**	**Course code**	**23UPBOT2E15**
Category	**Year**	**I**				
Elective IV (Group D)	**Semester**	**II**				
Instructional Hours /week	**Lecture**	**Tutorial**	**Lab practice**	**Total**		
	4	**-**	**-**	**4**		
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
1	**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 out come 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 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

Text book

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

ReferenceBooks

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 RemediesLexisNexis 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
CO1	3	3	3	3	3	2	3	2	3	2
CO2	3	3	3	3	3	3	2	2	3	3
CO3	3	2	3	2	2	3	3	3	2	1
CO4	3	2	3	2	2	3	1	3	2	3
CO5	3	2	1	3	2	3	2	3	2	3

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

ELECTIVE-IV- (GROUP D)
NANOBIOTECHNOLOGY

Title of the Course	**NANOBIOTECHNOLOGY**					
Paper Number	**Elective IV**		**Credits**	**3**	**Course code**	**23UPBOT2E16**
Category	**Year**	**I**				
Elective IV (Group D)	**Semester**	**II**				
Instructional Hours /week	**Lecture**	**Tutorial**	**Lab practice**	**Total**		
	4	**-**	**-**	**4**		
Pre-requisite	To provide an insight into the principles of nanotechnology in biological and medical					
Learning Objectives	1.To introduce the learners to the basic concepts in the emerging frontiers of nanotechnology 2. To give perspective to researchers and students who are interested in nanoscale physical and biological systems and their applications in medicine. 3.To introduce the concepts in nonmaterial and their use with bio components interact with larger systems 4. To impart knowledge on the most recent molecular diagnostic and therapeutic tools used to treat various diseases. .5.Incorporate sustainability in to account when you develop nanotechnology responsibly					

UNIT	**CONTENTS**
1	**Basic concepts :** History and development nano science– Bio-nanotechnology and Nano biotechnology - timeline of nanotechnology - types, magnitude of particles, shape and phase of molecules – Moore‘s law - top down and bottom up approaches, delivery systems – liposome Blood Brain Barrier.
II	**Diversity in nanosystems:** Carbon based nanaostructures - fullerences, nanotubes, nanoshells, buckyballs – biomolecules and nanoparticles, nanosensors, nanomaterials -Classification based on dimensionality- quantum dots, wells and wires – metal based nano materials (gold, silver and oxides) - Nanocomposites- Nanopolymers – Nanoglasses –Nano ceramics.

III	**Fabrication of Nanostructures:** Photolithography and its limitation-Electron beam lithography (EBL)- Nanoimprint – Soft lithography patterning, optical lithography – characterization – Bionanostructures and their properties - DNA nanowires Peptide nanowires and nanotubes - Protein nanoparticles - Bioinspired nanomaterials – DNA as a nano structure – silk protein - biomineralisation (diatoms) - lotus effect – nanomotors (ATPase, flagella).
IV	**Nanobiotechnology**: Nanodevices and nanomachines based on biological nanostructures - Protein and DNA nanoarrays, tissue engineering - medical applications - nanotechnology for reducing energy consumption and pollution
V	**Applications of Nanobiotechnology:** Solar energy conversion and catalysis, biosensors – Nanomedicine - Nanoparticles in bone substitutes and dentistry. Nanotoxicology - challenges. Nanotechnology in agriculture (fertilizer, pesticides and food), cosmetics (gels, sun-screen, shampoos and hair conditioners) – dispersions for UV protection using titanium oxide – color cosmetics - commercial exploration. Biosafety and bioethics.

Course out come CO	On completion of this course, the students will be able to:	Programme outcomes
Co1	Recall the essential features of biology and nanotechnology that are on verging to create the new area of bio nanotechnology.	**K1**
Co2	Formulate procedures for the synthesis of nano particles which are of medical importance which could be used to treat specific diseases.	**K2**
Co3	Characterize the various types of nano particle synthesis and Advocate promotes the use of nano materials and anno composites.	**K3**
Co4	Analyze and apply the important of nanoparticles in plant diversity.	**K4**
Co5	Construct various types of nanomaterial for application and evaluate the impact on environment.	**K5&K6**

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination	Questions related to the above topics,from various competitive examinations UPSC/TRB/NET/UGC–

questionpaper)	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

RecommendedText:

1. Dupas, C, Houdy, P., Lahmani, M. 2007. Nanoscience: ―Nanotechnologies and Nanophysics‖, Springer-Verlag Berlin Heidelberg.
2. Sharon, M and Sharon, M. 2012. Bio-Nanotechnology- Concepts and Applications, CRC Press.
3. Atkinson, W.I.2011. Nanotechnology. Jaico Book House, New Delhi.
4. Nalwa, H.S. 2005. Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology. American Scientific Publ.
5. Lindsay, S.M. 2011. Introduction to Nanoscience, Oxford universal Press, First Edition.
6. Jain K.K. 2006. Nanobiotechnology molecular diagnostics: Current techniques and application (Horizon Bioscience).Taylor & Francis 1st edition.
7. Pradeep, T. 2012. Textbook of Nanoscience and Nanotechnology, McGraw Hill Education(India)Private Limited.
8. XiuMeiWang,MuruganRamalingam,XiangdongKongandLingyunZhao.2017.Nanobiomaterials: Classification, Fabrication and Biomedical Applications, Wiley-VCHVerlagGmbH & Co. KGaA.

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ReferenceBooks:

1. Claudio Nicolini. 2009. Nanotechnology Nanosciences, Pon Stanford Pub.Pvt.Ltd,
2. Robert, A and Ferias, Jr. 1999.Nanomedicine, Volume I: Basic capabilities,Landes Bioscience.
3. Barbara Panessa-Warren. 2006 Understanding cell-nanoparticle interactions making nanoparticles more biocompatible. Brookhaven National Laboratory.
4. European Commission, SCENIHR. 2006. Potential risks associated with engineered and adventitious products of nanotechnologies, European Union.
5. Gysell Mortimer, 2011. The interaction of synthetic nanoparticles with biological systems PhD Thesis, School of Biomedical Sciences, Univ.of Queensland.
6. Murty, B.S.,Shankar, P., Raj, B., Rath,B.B.,Murday, J. 2013. Textbook ofNanoscience andNanotechnology.SpirngerPublication.
7. Prashant Kesharwani. 2019. Nanotechnology-Based Targeted Drug Delivery Systems for Lung Cancer. Academic Press. An imprint of Elsevier.

Web resources:

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

6. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC419715/
7. https://phys.org/news/2014-10-endless-possibilities-bio-nanotechnology.html
8. http://www.particle-works.com/applications/controlled-drug-release/Applicatio

MappingwithProgrammeOutcomes:

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

SKILL ENHANCEMENT COURSE (SEC1)

NURSERY AND GARDENING

Title of the Course	**NURSERY AND GARDENING**					
Paper Number	Skill Enhancement I		Credits	2	Course code	**23UPBOT2S01**
Category	Year	I				
Skill Enhancement(SEC1)	Semester	I				
Instructional Hours /week	Lecture	Tutorial	Lab Practice	Total		
	2		-	2		
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 out come 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**
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)	Questionsrelatedtotheabovetopics,fromvarious competitiveexaminationsUPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this ourse	Knowledge,ProblemSolving,Analyticalability, Professional,Competency,ProfessionalCommunication and Transferrable Skill

Text book

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

MappingwithProgrammeOutcomes:

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)

II YEAR

SEMESTER III

Core course VI

CELL AND MOLECULAR BIOLOGY

Title of the Course	**CELL AND MOLECULAR BIOLOGY**					
Paper Number	Core VI		**Credits**	**4**	**Course code**	**23PBOT3C06**
Category	**Year**	**I**				
Core VI	**Semester**	**III**				
Instructional Hours /week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
	4		**-**	**4**		
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**
1	**General features of Cells** Cell structure, organization of prokaryotic and Eukaryotic cell, cell theory, ultra structure and molecular organization of cell wall, Plasma membrane, Nucleus, mitochondria, lysosomes, Ribosome, Endoplasmic reticulum, plastids, vacuoles, , Cell division and cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle, and control of cell cycle.
II	Cell communication: General principles, Signaling molecules and their receptors. Receptors: Cell surface receptors - ion-channel linked receptors, G-

	protein coupled receptors, and Tyrosine-kinase linked receptors (RTK), Programmed cell death**.**
III	**Genome organization and function :** Organization of nuclear genome: DNA as genetic material – prokaryotic and eukaryotic DNA- chromatin – chromosomes - Gene, C -value paradox – transposons – evolution of DNA - Replication of DNA (Structure – types – melting curve – types of replication – enzymes in replication – formation of replication fork – synthesis of daughter strands – repair mechanisms). Organelle Genome: endosymbiotic theory – organization in chloroplast and mitochondria – synthesis and assembly of RUBISCO – interaction with nuclear genome.
IV	**Transcription and Gene regulation:** Transcription: RNA polymerases and their role. Transcription signals - promoters and terminators. Detailed account of transcription in E. coli (lac and trp operons of E. coli) and eukaryotes. Differences between the prokaryotic and the eukaryotic transcription, Post transcriptional modifications of mRNA (5‘CAP formation, poly adenylation, spliciosome assembly, splicing editing). Organization of mRNA, RNA editing, mRNA export
V	**Translation:** Genetic code – introduction, important features of the genetic code, exceptions to the standard code. Mechanism of translation in prokaryotes and eukaryotes. Differences between prokaryotic and eukaryotic protein synthesis. Protein sorting and translocation: Posttranslational modification of proteins, Protein folding-self-assembly and role of chaperones .

Course out come 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

CELL BIOLOGY

Text books

1. Ajoy Paul, (2009). Text book of cell and Molecular biology, Books and allied (P) Ltd., Kolkata.
2. Kumar, H.D. (2000). Molecular biology, Vikas Publishing House Pvt., Ltd., New Delhi.
3. Singh, B.D. (2015). Plant breeding, Principles and Methods, Kalyani Publications.
4. Verma P.S. and Agarwal V.K. (2007). Cell biology, Genetics, Molecular biology and Evolution, S. Chand and Company Ltd., New Delhi.
5. David Freifelder (1958). Essentials of Molecular Biology, Narosa Publishing House, New Delhi.

Reference Books

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Robers, Peter Walter (2002). Molecular biology of the cell (IVth Edition). Garland Science, Taylor and Francis group, New York.
2. Cooper, G.M., Hausman, R.E. (2013). The cell : A Molecular Approach 6th Edition ASM Press & Sunderland, Washington, D.C, Sinauer Associates, MA.
3. De Robertis and De Robertis (1998). Cell and Molecular Biology, B.I. Waverly Pvt. Ltd., New Delhi.
4. Karp, G (2018).Cell and Molecular biology, Concepts and experiments, 6th edition John Wiley & Sons, Inc.
5. Lewin, (2017). Gene XII, Jones and Bartlett Pub.
6. Lodish, et al., (2000), Molecular and cell biology, W.H. Freeman & Co, New York.
7. Strickberger, M.W. (2010). Genetics (3rd Edi.) PHI Learning Pvt., Ltd.,
8. Stansfield, W.D, Colome J.S and Cano R.J. (2010). Molecular biology and cell biology, TATA McGraw Hill Education Pvt Ltd, India

Web resorces:

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

MappingwithProgrammeOutcomes:

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)

CORE COURSE VII-

GENETICS, PLANT BREEDING & BIOSTATISTICS

Title of the Course	**GENETICS, PLANT BREEDING & BIOSTATISTICS**					
Paper Number	Core VII		**Credits**	**4**	**Course code**	**23UPBOT3C07**
Category	**Year**	**I**				
Core VII	**Semester**	**III**				
Instructional Hours /week	**Lecture**	**Tutorial**	**Lab practice**	**Total**		
	4		**-**	**4**		
Pre-requisite	To acquire knowledge on genetic traits and plant breeding techniques for crop					
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					

UNIT	**CONTENTS**
1	**Classical genetics :** Mendel‘s Law of inheritance, non mendelian inheritance, Chromosomal basis of inheritance, Gene interactions - complementary genes, Lethal genes, Epistasis, Quantitative inheritance, Gene Linkage and crossing over- Kinds of linkage, types of crossing over mechanism. Model for homologous recombination, construction of Genetic map , Two point test cross ,three point test cross . Cytoplasmic inheritance organelle heredity with reference to chloroplast and mitochondrial mutants – male sterility in plants
II	**Cytogentics :** Chromosome: Structure and nomenclature, centromere and telomere; Sex determination: mechanisms, sex chromosomes; Chromosomal aberrations: Duplications, deficiencies/deletions, inversions, interchanges/translocations; Role of chromosomal

	aberrations in crop evolution; Ploidy changes: Haploids, polyploids and aneuploids; Genome analysis in crop plants; Molecular Cytogenetic: FISH, GISH, FIBER-FISH, Flow Cytogenetic, Flow karyotyping, Applications of molecular cytogenetics
III	**Population Genetics** –Gene pool, Gene Frequencies, Mutation, Selection, Migration, genetic drift, Hardy –Weinberg law, Mutation, types Gene Mutation - Molecular basis of Mutation, Mutagenic agents and their mode of action. Biochemical mutants in bacteria and *Neurospora* , Transposons and their use in mutagenesis and gene tagging in plant systems;
IV	**PLANT BREEDING:** Objectives of Plant breeding, plant introduction – history, agencies, procedure, germplasm collection – Selection: mass, pure line and clonal selection. Heterosis and inbreeding depression. Hybridization techniques, role of polyploids in plant breeding, Special breeding techniques – mutation breeding, breeding for abiotic and biotic stresses, Plant breeder‘s rights and regulations for plant variety protection and farmer rights.
V	**BIOSTATISTICS:** Measures of central tendency (Mean , Median , Mode) and dispersal (Mean deviation , standard deviation) , standard errors ANOVA (One way).probability distributions (Binomial, Poisson and normal); sampling distribution; difference between parametric and non-parametric statistics; confidence interval; errors; levels of significance; regression and correlation; t-test; analysis of variance; (chi-square / basic introduction to Multivariate statistics, etc.

Course out come 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

Text books

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

Reference Books:

1. Watson, J.D. *et al.* 2003. Molecular Biology of the Gene. Fourth Edition. TheBenjamin Cummings Pub. Co.
2. Lewin, B. 2003. Genes VIII. Oxford University Press.
3. Friefelder,D. 2005. Molecular Biology. Second Edition. 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. BlackwellPublishing.
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
   https://medlineplus.gov/genetocs/understanding/basics/cell/

MappingwithProgrammeOutcomes:

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 COURSE VIII

RECOMBINANT DNA TECHNOLOGY &INDUSTRIAL APPLICATIONS

Title of the Course	RECOMBINANT DNA TECHNOLOGY &INDUSTRIAL APPLICATIONS					
Paper Number	Core VIII		**Credits**	**4**	**Course code**	**23UPBOT3C08**
Category	**Year**	**I**				
Core VIII	**Semester**	**III**				
Instructional Hours / week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
	4		**-**	**4**		
Pre-requisite	To understand the basis of genes and their interactions at population and evolutionary levels.					
Learning Objectives	1.Students should be familiar with the basics of genetics and molecular Biology. 2.To develop critical understanding of chemical basis of genes and their Interactions at population and evolutionary levels. 3.To learn the applied aspects of molecular biology and recombination Technology, gene insertion and production of recombined new plants. 4. To impart knowledge that leads to comprehensive understanding of the Principles, tools and practices of rDNA technology. 5. To enable students to gain basic understanding of rDNA techniques and its Applications.					

UNIT	CONTENTS
1	**Genetic engineering tools :** Brief history, principles of rDNA technology. Molecular tools in Genetic engineering - DNA polymerases, S1 nucleases, Restriction endonucleases, DNA ligases and alkaline phosphatases. Cloning vectors - Plasmids - types, Mechanism of plasmids, Isolation of plasmids. Cosmids and phage vectors. Construction of Genomic library, polymerase chain reaction (PCR), Molecular Markers (RAPD, RFLP and AFLP). Blotting techniques (Southern, Northern and Western blot). Sequencing of DNA. Chemical Method, Enzymatic, Pyrosequencing and Microarray technology.

II	**Genetic transformation method:** Method of gene transfer in plants - aims, strategies for development of transgenic plants - specific and non-specific methods of gene transfer - organization of Ti plasmid *in Agrobacterium tumefaciens* - Ti plasmid mediated gene transfer. DNA transfer by particle bombardment, micro and macro injection methods - lipofection - electroporation. Transfer of nitrogen fixing genes (nif genes) to legume
III	**Application of recombinant DNA in Agriculture :** Genes of agronomic interest and transgenic crops- Golden rice, Edible vaccines, Insect resistance (Bt cotton and Bt brinjal), terminator seed technology- antisense RNA(flavr savr) and RNAi technology – disease resistance, herbicide resistance, salt and stress tolerance, enhancement of shelf life of flowers and fruits.
IV	**Application of recombinant DNA in pharmaceutical industry:** In medicine and Industry: Production of small biomolecules: vitamin-C, amino acids and indigo. Production of insulin, human growth hormone and its variants. Hepatitis-B virus vaccine. Production of monoclonal antibody, Engineered antibodies-Humanized antibodies-monoclonal antibodies for cancer diagnostics and theraphy-Immunotoxins. Biopolymers production. Marshalling recombinant DNA to fight AIDS.
V	**Bio technology: Ethical, social & Bio safety aspects** : Socio-economic and ethical aspects of biotechnology. Environmental laws; Intellectual property rights; World Intellectual Property Organization (WIPO) GATT, TRIPS, PBR and Farmers rights ,and its role; Objective of patent system, patentable subjects and protection in biotech; Basic Principles of patent system, UPOV for plant protection. GLP/GMP. Objectives and levels of bio safety: Objectives; recombinant DNA safety; biological containment; risk groups and risk analysis. Cartagena Protocol; OECD guidelines. Govt of India guidelines for r-DNA technology and GMO‘s. Ecological impact and bio safety issues of GM crops.

Course out come CO	On completion of this course, the students will be able to:	Programme outcomes
Co1	Understand the basics of recombinant DNA technology.	**K1**
Co2	Demonstrate and to recollect the production of vitamins.	**K2**
Co3	Analyze the production of antibiotics.	**K3**
Co4	Compare and contrast the recombined organism and natural Organisms.	**K4**
Co5	Create and develop skills for rDNA techniques and in producing hybrids varieties.	**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

Text books

1. Dubey, R.C. (2001). A textbook of biotechnology. S. Chand & Co., New Delhi.
2. Gupta, P.K. (1994). Elements of Biotechnology. Rastogi Publications, Meerut.
3. Ignacimuthu, S.J. (2003). Plant Biotechnology. Oxford & IBH Publishing, New Delhi.
4. John Jothi Prakash, E. (2005). Outlines of Plant Biotechnology. Emkay Publishers, New Delhi.
5. Kalyan Kumar, De. (2008). Plant tissue culture. New Central Book Agency, Calcutta.
6. Kumar H.D. (1993). Molecular Biology and Biotechnology. Vikas Publishers, New Delhi.
7. Sathyanarayana, B.N and Varghese, D.B. (2000). Plant tissue culture- Practices and new experimental protocols, ILK Publ. New Delhi

Reference books

1. Bhojwani, S.S. & Razdan, M.K. (2004), Plant Tissue Culture, Read Elsevier India Pvt., Ltd.
2. Glick, B.R. & J.J. Pasternak, (2009). Molecular biotechnology, Panima Pub.co.,
3. Hammond, J.C., McGarvey and V. Yusibov, (2009). Plant biotechnology, Springer Verlag, New York.
4. Sambrook, J and Russel, D.W. (2001). Molecular Cloning, A laboratory Manual, Cold Spring Harbour Publi.

5. Satyanarayana, U. (2005). Biotechnology, Books and allied (P) Ltd., Kolkata.
6. Brown, T.A. (2001). Gene Cloning and DNA analysis: An Introduction, Sixth edition Wiley - Blackwell Publication.

Web references

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://onlinelibrary.wiley.com/doi/book/10.1002/9780470686522
5.https://books.google.co.in/books?id=oe_liIY_tVsC&printsec=frontcover#v=onepage&q&f=fals

MappingwithProgrammeOutcomes:

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

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

LABORATORY COURSE-III

(COVERING CORE PAPERS VI, VII &VIII)

Title of the Course	PRACTICAL III					
Paper Number	**Core lab**	**III**	**Credits**	**3**	**Course code**	**23UPBOT3P03**
Category	**Year**	**II**				
Core laboratory - III	**Semester**	**III**				
Instructional Hours /week	**Lecture**	**Tutorial**	**Lab practice**	**Total**		
			6	**6**		
Pre-requisite	Practical's pertaining to above subjects are 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	CONTENTS
1	**CELL AND MOLECULAR BIOLOGY** 1.To observe the plant cell structure with onion peel out 2.Microscopic views of cell organelles in plant cell Chloroplast (Hydrilla , leaf), Nucleus (Onion peel out) 3. Identification of meiosis stage from suitable plant material. (Onion /Tradeschantia floral buds). 4. Identification of different stages of mitosis from suitable plant material. (Onion root tips, garlic root tips 5. Isolation of cell organelles: Mitochondria, Chloroplast. 6. Study of mitotic index from suitable plant material. 7. Study of cyclosis in cells of suitable plant material. 8. To study plant vacuole in cells of onion leaf peel.

	9. Restriction digestion of DNA samples using restriction endonucleases (RE). 10. DNA, RNA Model through visual chart 11. Observe the Transcription and translation mechanism through web sources
II	**GENETICS** 1. Problem solving a dihybrid phenotypic, Genotypic and test cross ratios (Mendelian hypothesis). 2. Incomplete dominance in plants. 3. Mendelian Modified ratios (Complementary, supplementary, Epistasis and Polygenic inheritance). 4. Multiple alleles in plants, blood group inheritance in humans. 5. Chromosome mapping from three point test cross. 6. Calculate gene and genotype frequency by Hardy Weinberg law. 7. Isolation of auxotrophs by UV mutagenesis (Demonstration). 8. Techniques in plant hybridization (Demonstration). .
III	**PLANT BREEDING** 1. Techniques in plant hybridization.
IV	**rDNA TECHNOLOGY** 1. Isolation of plasmid DNA from Bacteria. 2. Analysis of plasmid DNA in Agarose Gel electrophoresis. 3. Preparation of competent *E.coli* cells. 4. Transformation and recovery of plasmid clones. 5. Isolation of plasmid DNA. 6.
V	**rDNA TECHNOLOGY** 1.Cloning vector 2. Expression vector 3. Integration vector 4.Recombinant selection (Blue – white Screening), antibiotic selection

Course out come 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 ofexisting 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,f rom 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

Text Book

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

MappingwithProgrammeOutcomes:

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)

CORE COURSE IX

INDUSTRY MODULE- INDUSTRIAL BOTANY

Title of the Course		**INDUSTRIAL BOTANY**					
Paper Number		**Industry**		**Credits**	**4**	**Course code**	**23UPBOT3C09**
Category	**Core**	**Year**	**I**				
		Semester	**III**				
Instructional Hours perweek		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		4		**-**	**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
1	**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	**Generation of Plants through tissue culture :** Tissue culture: Micro propagation, synthetic seeds, cell culture. Hairy root culture

Course out come 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 theuses 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**

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

Text Book

1. Trivedi, P.C. 2001. Algal Biotechnology. Point publisher, Jaipur.India.
2. Dinabandhu, S and Kaushik. B.D. 2012. Algal Biotechnology and Environment. I.K. International, New Delhi.
3. Poonam Singh and Ashok Pandey. 2009. Biotechnology for agro-Industrial residues utilization. Springer.
4. Dilip K. Arora. 2003. Handbook of Fungal Biotechnology. CRC Press book.
5. Vardhana, R. 2009. Economic Botany. 1st ed. Sarup Book Publishers Pvt Ltd. New Delhi.
6. Dubey R.C. 2004. A text book of Biotechnology aspects of microbiology, British Sun Publication.
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. EssayinPlant Taxonomy,AcademicPress, 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. IntroductoryPhycology.Affiliated East-WestPress,Delhi.
11. Das,SandSaha,R.2020.MicrobiologyPracticalManual.CBSPublishersandDistributors(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 – Verlau

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

https://link.springer.com/book/10.1385/0896031616

MappingwithProgrammeOutcomes:

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)

ELECTIVE V- (GROUP E)

SECONDARY PLANT PRODUCTS AND FERMENTATION BIOTECHNOLOGY

Title of the Course	**SECONDARY PLANT PRODUCTS AND FERMENTATION BIOTECHNOLOGY**					
Paper Number	**Elective V**		**Credits**	**3**	**Course code**	**23UPBOT3E17**
Category	**Year**	**II**				
Elective V (Group E)	**Semester**	**III**				
Instructional Hours /week	**Lecture**	**Tutorial**	**Lab practice**	**Total**		
	3		**-**	**3**		
Pre-requisite	To know about the microbial culture in the manufacture of value added products.					
Learning Objectives	1. To familiar with the basics of biochemistry and fermentation. 2. Understand secondary metabolites. 3. To enhance the knowledge and skills needed for self-employment using the microbial derived products. 4. Apply the microbial culture in the manufacturing of value added products. 5. Critically analyze the types of bioreactors and the fermentation process.					

UNIT	CONTENTS
1	**Secondary metabolites:** A brief account of acetate malonate, acetate mevalonate and shikimic acid pathways. Categories of phytochemicals – Phenols, alkaloids, flavonoids, terpenoids, steroids, glycosides, carbohydrates, proteins, amino acids, lipids, pigments, vitamins and other related compounds.
II	**Microbial growth:** Factors affecting microbial growth; Stoichiometry: mass balances; Stoichiometry: energy balances; Growth kinetics; Measurement of growth.
III	**Bioreactors:** Introduction to bioreactors; Batch and Fed-batch bioreactors, Continuous bioreactors;

	Immobilized cells; Bioreactor operation; Sterilization; Aeration; Sensors; Instrumentation; Culture-specific design aspects: plant/mammalian cell culture reactors. Bio separations: Biomass removal; Biomass disruption; Membrane-based techniques; Extraction; Adsorption and Chromatography Industrial Processes and Process economics: Description of industrial processes; Process flow sheeting; Process economics.
IV	**Downstream processing:** Biomass removal and disruption; Centrifugation; sedimentation; Flocculation; Microfiltration; Sonication; Bead mills; Homogenizers; Chemical lysis; Enzymatic lysis; Membrane based purification: Ultra filtration ; Reverse osmosis; Dialysis ; Diafiltration ; Pervaporation; Perstraction; Adsorption and chromatography: size, charge, shape, hydrophobic interactions, Biological affinity; Process configurations (packed bed, expanded bed, simulated moving beds); Precipitation (Ammonium Sulfate, solvent); Electrophoresis(capillary); Crystallization; Extraction (solvent, aqueous two phase, super critical), Drying; Case studies
V	**Important products through fermentation:** Organic acids citric acid acetic acid, enzymes – amylase, protease, lipase, antibiotics – penicillin, vitamins – B12, amino acids – glycine, glutamic acid, organic solvenst – ethanol, butanol, acetone, alcoholic beverages – wine, beer, biomass – baker‘s yeast, biosurfactants, biopesticides, biopolymers.

Course out come CO	On completion of this course, the students will be able to:	Programme outcomes
Co1	Critically analyze the types of bioreactors and the fermentation process.	**K1**
Co2	Evaluate the role of microorganisms in industry.	**K2**
Co3	Analyze the types of bioreactors.	**K3**
Co4	Create to understand the significance of intrinsic and extrinsic factors on growth of microorganism.	**K4**
Co5	Evaluate the concept of downstream processing.	**K5&K6**

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination	Questions related to the above topics,from various competitive examinations UPSC/TRB/NET/UGC–

question paper)	CSIR/GATE/TNPSC/others to be solved (To be discussed during theTutorial hour
Skills acquired from this course	Knowledge, ProblemSolving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Text Book

1. Shuler, M. L and F. Kargi. 2002. Bioprocess Engineering, Prentice Hall Inc.

2. Doran, P.M. 1995. Bioprocess Engineering Principles, Elsevier.

3.Kaufman, P.B. L. J. Cseke, S. Warler, J. A. Duke, and H. L. Brielmann. 1999. Natural Products from Plants, CRC Press LLC.

4. Casia, J.R.L.E. 2009. Industrial Microbiology. New Age International (P) Ltd. Publisher, New Delhi.

5.Stanbury, P. F., Whitaker, A. and Hall, S.J. 1979. Principles of Fermentation Technology.

Aditya Books (P) Ltd., New Delhi.

6. Potter, N. N. 2007. Food Science. CBS Publishers

Reference books:

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

Varzakas, T and Tzia, C. 2016. Handbook of Food Processing. CRC Press.

Web resources:

1. https://link.springer.com/book/9783642673627
2. https://www.elsevier.com/books/secondary-plant-products/stumpf/978-0-12-675407-0
3. https://www.amazon.in/Secondary-Plant-Products-Comprehensive-Biochemistry-ebook/dp/B01E3II0E2
4. https://www.pdfdrive.com/principles-of-fermentation-technology-e40900163.html

https://link.springer.com/book/10.1007/978-3-030-16230-6

MappingwithProgrammeOutcomes:

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-(GROUP E)

ENTREPRENEURIAL OPPORTUNITIES IN BOTANY

Title of the Course	**ENTREPRENEURIAL OPPORTUNITIES IN BOTANY**					
Paper Number	Elective V		**Credits**	**3**	**Course code**	**23UPBOT3E18**
Category	**Year**	**II**				
Elective V (Group E)	**Semester**	**III**				
Instructional Hours /week	**Lecture**	**Tutorial**	**Lab practice**	**Total**		
	4		**-**	**4**		
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**
1	**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. Vermi compost preparation, vermiwash. Panchakaviyam.
II	**Plant propagation method:** Propagtion throgh 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, and drives, paths, garden adornments.
IV	**Fruit preservation** : Packaging of fruits & vegetables, Preservation techniques drying, heat treatment, low temperature storage and by chemicals. Preparation of wine, vinegar and dairy products.
V	**Mushroom cultivation**: Types of mushrooms (button mushroom, oyster mushroom). Spawn isolation and preparation. Cultivation. Value added products from mushroom – pickles, candies and dried mushrooms.

Course out come 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 theTutorial hour
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Text book

1. Chmielewski, J.G andKrayesky,D. 2013.GeneralBotany laboratory Manual.AuthorHouse, Bloomington, USA.
2. Russell, T. 2012. Nature Guide: Trees: The world in your hands(Nature Guides). Mukherjee D. Gardening in India, Oxford IBH publishing co, New Delhi.
3. Kumar, N. 1997. Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
4. Webster,JandWeber,R.2007.IntroductiontoFungi,3rdEd.CambridgeUniversityPress, Cambridge.

5. Bendre, M.Ashok and AshokKumar,A. 2020.TextBook of PracticalBotany (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

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)**

ELECTIVE V- (GROUP E)

APPLIED PLANT CELL & TISSUE CULTURE

Title of the Course	**APPLIED PLANT CELL & TISSUE CULTURE**					
Paper Number	Elective V		**Credits**	**3**	**Course code**	**23UPBOT3E19**
Category	**Year**	**II**				
Elective V- (GROUP E)	**Semester**	**III**				
Instructional Hours /week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
	4		**-**	**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 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
1	**Basic plant tissue culture:** Basic of plant tissue culture - Totipotency and concept of plant tissue culture, Laboratory organization, Aseptic techniques, plant culture Media - MS Medium and B_5 Medium, Explants Preparation. Methods of sterilization. Transfer and incubation of culture - Transplantation area.
II	**Micro propagation:** Callus induction, Cell suspension culture, somatic embryogenesis, Micropropagation

	- stages of micro propagation - multiplication by shoots and callus. Hardening, a factor affecting micropropagation. Synthetic seed technology.
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 out come 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&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

Text Book:

1. Narayanaswamy, S. 1999. Plant cell and tissue culture. 8th edn.Tata McGraw Hill Publ. ISBN 0074602772.
2. Bhojwani, S.S and Razdan, M.K. 2004. Plant Tissue Culture, Read Elsevier India Pvt. Ltd. ISBN 818147 3256.
3. Trigiano, R.N and D.J. Gray (eds.). 2000. Plant tissue culture concepts and laboratory exercises. CRC Press. (Textbook). 2nd Edition.
4. Kyte, M and Kleyn, J. 1996. Plant from test tubes. Timber Press. Auge, R. et al., 1995. In vitro culture and its applications in horticulture. Science Publishers, Inc.
5. Auge, R. 1995. In vitro culture and its applications in horticulture. Science Publishers, Inc.
6. Gamborg, O.L. and G.C. Phillips (eds). 1995. Plant cell, tissue and organ culture. Springer Lab Manual.
7. 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.

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.

Kartha, K.K. 1985. Cryopreservation of Plant Cells and Organs. CRC Press, Boca Raton, Florida, USA.

Web resourees

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

https://onlinelibrary.wiley.com/doi/book/10.1002/9780470686522

MappingwithProgrammeOutcomes:

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 – (GROUP E)

SILVICULTURE AND COMMERCIAL LANDSCAPING

Title of the Course	SILVICULTURE AND COMMERCIAL LANDSCAPING					
Paper Number	Elective V		**Credits**	**3**	**Course code**	**23UPBOT3E20**
Category	**Year**	**I**				
Elective V (Group E)	**Semester**	**III**				
Instructional Hours /week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
	4		**-**	**4**		
Pre-requisite	Students should know about the fundamental concepts of silvi culture and landscaping					
Learning Objectives	1. To understand the basic concepts of silviculure 2. To learn the Silvicultural system 3. To learn the tree cultivated under siliviculture system 4. To learn the afforestration 5. To learn Commercial Landscaping					

UNIT	CONTENTS
1	**Introduction:** Definition of forest and forestry. Classification of forest and forestry, branches of forestry and their relationships. Definition, objectives and scope of Silviculture. Status of forests in India and their role. Role of climatic factor, edapicc factor and topagarphy forest vegetation. Biotic factors - influence of plants, insects, wild animals, man and domestic animals on vegetation. Impacts of controlled burning and grazing. Influence of forests on environment
II	**Growth and development**. Trees and their distinguishing features. Forest reproduction - flowering, fruiting and seeding behaviour. Natural, artificial and mixed regeneration. Natural regeneration - seed production, seed dispersal, germination and establishment. Requirement for natural regeneration. Dieback in seedling with examples. Plant succession, competition and tolerance. Forest types of India and their distribution.
III	**Silvicultural system**: Definition, scope and classification. . High forest – Even-

	aged and Uneven-aged Stand - integrating –Reserves‖ within a Silvicultural Systems- The Clearcut System- Patch Cut System - Retention System- Seed Tree System - uniform Seed Tree System- Group Seed Tree System – Combination- Seed Tree System with Reserves - Shelterwood System - Variations of Shelterwoods - Uniform Shelterwood - Group Shelterwood - Strip Shelterwood ,irregular Shelterwood ,natural shelterwood , Nurse-tree Shelterwood, Shelterwood System with Reserves, Selection Systes -single Tree Selection ,group selection..Tending operations - weeding, cleaning, thinnings, definitions, objectives and methods, increment felling and improvement felling. Prunning and lopping. Control of climbers and undesirable plants.
IV	**Silviculture of some Important Indian Trees:** Origin, distribution, general description, phenology, silvicultural characters, regeneration methods, silvicultural systems and economic importance of the following conifer and broadleaved tree species of India. *Conifers: Abies pindrow, Cedrus deodara, Pinus roxburghii, Pinus gerardiana*. Broad leaved species: *Tectona grandis, Shorea robusta, Dalbergia sissoo, Quercus spp. Alnus spp. Populus spp, Eucalyptus spp. Terminalia spp., Santalum album, Azardirachta indica, Madhuca indica, Leucaena leucocephala and Bamboos*
V	**Commercial Landscaping :** Basic Principles of landscape gardening, designing landscapes, basic style, formal – informal, tree style- mogul garden, garden in hills, plains, botanical garden, garden, park, small home, school and industrial gardens, road side gardens – highways, dams, roof garden, balcony garden, terrariums, Japanese garden. Laws making.

Course out come CO	On completion of this course, the students will be able to:	Programme outcomes
Co1	Acquired the basis knowledge on forest trees and types	**K1**
Co2	To understand the importance of silviculture	**K2**
Co3	Knowledge on silviculture system	**K3**
Co4	Knowledge on afforestation and regeneration trees	**K4**
Co5	Discuss and develop skills for effective understanding on Landscaping and components of gardens.	**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

Text Book

Text books

2. Negi, S.S., (1994). India‘s Forests, Forestry and Wildlife, Indus publishing Co., New Delhi.
3. Khanna, S. (1984). Principles and practices of silviculture. Khanna Bandhu, DehraDun
4. Lal, J.B. (1989). India‘s Forests Myth & Reality. Nataraj Publishers, DehraDun.
5. Ramprakash, (1986). Forest management. IBD Publishers, Debra Dun.
6. Dwivedi, A.P. (1992). Agroforestry – Principle and practices. Oxford and IBH Publishing Co., New Delhi.
7. Chaturvedi, A.N and Khanna, L.S. (2015). Hand book of forestry 5/ed
8. Sagreta, K.P (2000). Forest and Forestry, National book trust India, New Delhi.
9. Parthiban, K.T (2018). Introduction to forestry & agro forestry.

Reference books

1. Frederick S. Backer, (1950). Principles of silviculture, McGraw Hill Book Co. New York
2. Donald Bruce and Francis X. Schumacher. (1950). Forest mensuration, McGraw Hill Book Co. New York.
2. Bor, N.L. (2010). A Manual of Indian Forest Botany,(Second Edition) Asiatic pub., New Delhi.
3. Benu Singh, (2010). A Modern Book on Forestry and Horticulture, Vista International Pub. New Delhi.
4. Stebbing E.P. (1982). The forest of India, A.J. Reprints agency, New Delhi.
5. FAO (1987). Forestry Extension Methods, SLNo. 80, FAO Publication, Caracal, Rome, Italy.

6. Jha, L.K. and Sen Sarma, P.K. (1996). A manual of Forestry Extension Education, APH Publishing Corporation, New Delhi

Web Resources:

1. https://courses.opened.uoguelph.ca/contentManagement.do?method=load&code=CM000019
2. www.teachervision.com/gardening
3. https://pace.oregonstate.edu/catalog/master-gardener-series-oregon-master-gardener-program
4. https://www.amazon.in/Gardening-Landscape-Design-and-Botanical-

Garden/s?rh=n%3A1318122031%2Cp_27%3Aand+Botanical+Garden

5. https://www.overdrive.com/subjects/gardening

6. https://www.scribd.com/book/530538456/Opportunities-in-Landscape-Architecture-Botanical-Gardens-and-Arboreta-Careers

MappingwithProgrammeOutcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	1	2	1	2	2	3	1
CO2	3	3	2	2	3	3	2	3	3	2
CO3	2	2	3	3	1	2	1	3	2	3
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 COURSE (SEC2)

AGRICULTURE AND FOOD MICROBIOLOGY

Title of the Course	AGRICULTURE AND FOOD MICROBIOLOGY					
Paper Number	Skill Enhancement-II		Credits	2	Course code	23UPBOT3S02
Category	Year	I				
Skill Enhancement (SEC2)	Semester	II				
Instructional Hours /week	Lecture	Tutorial	Lab Practice	Total		
	3	-	-	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
1	**Soil Microbiology:** Microbial groups in soil, microbial transformations of carbon, nitrogen, phosphorus and sulphur, Biological nitrogen fixation. Microflora of Rhizosphere and Phyllosphere microflora, microbes in composting. Importance of mycorrhizal inoculums, types of mycorrhizae associated plants, mass inoculums. Production of VAM, field applications of Ectomycorrhizae and VAM.
II	**Beneficial microorganisms in Agriculture:** Biofertilizer (Bacterial Cyanobacterial and Fungal), microbial insecticides, Microbial agents for control of Plant diseases, Biodegradation, Biogas production, Biodegradable plastics, Plant – Microbe interactions. Diseases caused by bacteria and

	fungi to various commercial and food crops,Management of soil biota for maintaining soil fertility. Convertion of waste lands into fertile lands. Management of soil nutrient..
III	**Food Microbiology:** Introduction - History and important food microorganism. Factors affecting the microbial growth of a food- Intrinsic & Extrinsic factors -pH, moisture, water activity, oxidation-reduction potential, nutrient contents, Microbes as source of food: Mushrooms, single cell protein.
IV	**Food poisoning, Food-borne diseases : f**ood borne diseases (causative agents, foods involved, symptoms and preventive measures *Food intoxications: Staphylococcus aureus, Clostridium botulinum and mycotoxins;* Food infections*: Bacillus cereus, Vibrio parahaemolyticus, Escherichia coli, Salmonellosis, Shigellosis, Yersinia enterocolitica, Listeria monocytogenes and Campylobacter jejuni*
V	**Food preservation & Food quality assessment:** Food preservation: Principles, physical methods of temperature (low, high, canning, and drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins. Food quality assessment: Standards of food Quality. Pathogens test & Spoilage indicators. Chemical test – pesticides, antibiotics, heavy metals & adulterants. Nutritional testsquality indicators, and labeling. Processed Food Audits - Good Manufacturing Practice (GMP)- Quality Management System & ethics.

Course out come 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**

Text books

1. Pelczar M.J., Chan E.C.S. and Krieg N.R. 2003. Microbiology. 5th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi.
2. 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.,HarleyJ.P.,KleinD. A. 2005.Microbiology,McGrawHill,India. 6thedition.
5. Goldman,E.andGreen,L.H.2015.PracticalHandbookofMicrobiology(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.

Das,S.andSaha,R.2020.MicrobiologyPracticalManual.CBSPublishersandDistributors(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

https://www.amazon.in/Food-Microbiology-Martin-R-Adams-ebook/dp/B01D6B7V6A

MappingwithProgrammeOutcomes:

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)

INTERNSHIP/INDUSTRIAL ACTIVITY

Title of the Course	**INTERNSHIP/INDUSTRIALACTIVITY**					
Paper Number	**Internship**		**Credits**	**2**	**Course code**	**23UPBOT3IO01**
Category	**Year**	**II**				
Internship	**Semester**	**III**				
Instructional Hours /week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		-	**-**			
Pre-requisite	The summer internship programme will give students the chance to experience real-world organisational situations, learn about processes and rules, and grasp the operations of the industry					
Learning Objectives	1. The main goal of the internship programme is to give students exposure to industry and help them comprehend current management techniques by having them work for at least fifteen days in an industry/institution over the summer 2. To comprehend how theoretical ideas are applied in many sectors and Industries. 3. To create a foundation for industry-integrated education, as well as to give students better practical knowledge and hands-on experience, improve their leadership qualities, and sharpen their problem-solving and management skills. 4. The internship must focus on practice. The college will require the students to visit the offices of the research lab/industry/institution it has a memorandum of understanding (MOU) with in order to receive on-the-job training in the many different areas of those businesses' operations. 5. Internships provide students with practical experience in a variety of fields, including manufacturing, productivity, development, and quality analysis. These experiences prepare students for competitive hiring processes in reputable MNC industries.					

UNIT	CONTENTS

1	**Guidelines for Internship Programme:** 1. To give students the opportunity to spend at least fifteen days on their own during the II Semester vocation in order to acquire exposure to research labs, industry, and respected institutions and comprehend contemporary research procedures. 2. Individual instruction is provided for the internship. The internship programme must be completed in order to receive a credential. 3. Students are required to indentify a research labs/industry/recognized institution for their Internship Programme Coordinator in consultation with and approval of their faculty guide. The choice of the research labs/industry/recognized institution should be intimated to the Internship coordinator before commencement of the Internship. Simultaneously, students should also have identified a guide within the research labs/industry/recognized institution (industry guide) under whose supervision and guidance they would carry out their Internship Program. 4. Students are expected to learn about the history of the research labs, industry, and recognized institution during their time. They must also learn about its founders or shareholders, the nature of business, organizational structure, reporting relationships, and how the various management functions (such as finance, HR, marketing, sales, and operations) operate. This list is merely illustrative and not comprehensive. Students should collect and gather as much as possible of written materials, published data, and related matter. 5. Before leaving the research labs/industry/recognized institution, obtain the Internship Programme completion certificate on the letterhead of a research lab/industry/, or an accredited institution. 6. Maintain Internship Programme record with details on activities and personal learning during their project period. 7. The department head and the coordinator of the internship programme form a committee to ensure that the internship is followed. 8. At least two copies of the report must be prepared by the intern at the conclusion of the internship program—one for submission to the college and one copy for the student. If the organization, the guide, or both request additional copies, more copies may be made. The sources from which the information was gathered should be made crystal apparent in the report.

	Every page needs to have a number, which should be centred at the bottom of the page. All tables, figures, and appendices must be appropriately labelled and consecutively numbered or lettered. The report must be printed, bound (ideally with soft binding), and contain at least 25 pages. 9. The internship training report should be submitted to the department within a month from the date of commencement of third semester. 10. However, such submission shall not be accepted after the end of third semester Examinations.
II	**Evaluation of the Internship:** i. The internship program will be assessed by the assigned Internship Programme Coordinator from the host institute. ii. Evaluation will be done by the Internship Programme Coordinator of the host institute and through seminar presentation/viva-voce. iii. The presentation should be specific, clear and well analyzed, and indicate the specific sources of information. iv. According to the statement of the draft the evaluation of the interns will be done as per the sincerity and research output of the students. In addition the evaluation will also be assessed according to the activity of the log book, format of presentation, quality of the report made by the interns, uniqueness, skill sets and evaluation report of the internship coordinator.

III	**College Guide Manual – Summer Internship Program** 1. The Internship Programme Coordinator should give proper procedures to the intern before and after the Internship. 2. The Internship Programme Coordinator should interact with the research labs/industry/recognized institution at least once before completion of the internship. 3. The weekly report submitted by the student should be reviewed and reported to the Internship Programme coordinator.
IV	**Internal:**100 marks Internship Programme Completion certificate } 30 marks Internship report- 30 marks Presentation - 20 marks Viva-voce - 20 marks
V	Title page Page for supervisory committee Table of Acknowledgement Internship Certificate Executive Summary Introduction of the Report Overview of the Organization What I have Learned Analyses Summary Recommendations and Conclusion References Appendices

Course out come CO	On completion of this course, the students will be able to:	Programme outcomes
Co1	For students in those pertinent core areas, the internship is preparing them to become professionals after graduation.	**K1**
Co2	Compile data and familiarize yourself with techniques for planni and carrying out tests.	**K2**
Co3	Collect data and educate yourself on how to e the analy results of your scientific studies.	**K3**
Co4	This in-the-moment industrial exposure helps them become mor	**K4**

	Knowledgeable and skilled in the latest technology.	
Co5	Improving communication skills and coming up with creative id are crucial components of training that help someone become an entrepreneur.	**K5&K6**

Text books

1.Dawson, C. 2002. Practical research methods. UBS Publishers, New Delhi.

2. 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.

MappingwithProgrammeOutcomes:

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

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

IV SEMESTER

CORE COURSE-X

PLANT PHYSIOLOGY AND PLANT METABOLISM

Title of the Course	**PLANT PHYSIOLOGY AND PLANT METABOLISM**					
Paper Number	**Core X**		**Credits**	**4**	**Course code**	**23UPBOT4C10**
Category	**Year**	**II**				
Core X	**Semester**	**IV**				
Instructional Hours /week	**Lecture**	**Tutorial**	**Lab practice**	**Total**		
	4		**-**	**4**		
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**
1	**Plant water relations and mineral nutrition :** Water relations of plants: physical and chemical properties of water – Imbibitions, diffusion, osmosis, component of water potential. Transpiration and evapotranspiration - Stomatal structure and function – mechanism of stomatal opening and closing. Absorption of water by root - Apoplast and symplast concept – water transport through the xylem. Mineral nutrients and deficiency symptoms, mineral ion uptake. Various mechanisms of solute transport. Organization conducting tissue, source sink relation – phloem loading and unloading –theories translocation
II	**Photosynthesis** Fine structure of photosynthetic machinery – Light harvesting protein complex – light absorption and photosynthetic electron transport, Emerson enhancement effect and cyclic, non-cyclic and pseudo cyclic photophosphorylation. Oxygen Evolving

	Complex (OEC), photosynthetic carbon reduction cycles (PCR cycles): C_3, C_4 and CAM pathway and their distinguishing feature, photorespiration and its significance. Structure and function of Rubisco and PEP Carboxylase..
III	**Respiration and nitrogen metabolism** Respiration – Aerobic and anaerobic respiration, Glycolysis, TCA cycle, mitochondrial electron transport and oxidative phosphorylation, chemiosmotic proton circuit, ATP*ase* complex, mechanisms ATP synthesis, electron transport inhibitors and uncouplers, cyanide resistant respiration, Respiratory quotient, pentose phosphate pathway. Nitrogen fixation: Sources of Nitrogen, Types – Physical and Biological nitrogen fixation - Biochemistry of Nitrogen fixation – Nitrogenase, nif gene, Assimilation of nitrate and ammonium ion - NR, NIR, GDH, GS/GOGAT pathways. Integration of nitrogen and carbohydrate metabolisms
IV	**Plant Growth and development** : Phases of plant growth – growth types- Growth substances - Auxins, gibberellins, cytokinins, abscisic acid, ethylene, brassinosteroids - physiological effect and mechanism of action in agricultural and horticultural crops – Photomorphogenesis –phytochrome mediated responses –physiology of flowering and fruit ripening,.Vernalization- Mechanism and its practical application, biological rhythms and movements. Mechanism of senescence and Abscission. Seed dormancy and causes and Seed germination and their biochemical changes.
V	**Plant response to environmental stress**: Stress physiology: Concepts – water-drought, flooding and salt, ionizing and non-ionizing radiation stress temperature-heat, frost-adaptive mechanism to various stress –stress responsive protein – anti-oxidative mechanisms..

Course out come 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

Text Books

1. Devlin, RM, (2017). Outline of Plant Physiology. Medtech; 1/ed
2. Jain, V.K. (2017). Fundamentals of Plant Physiology. S Chand & Co Ltd, New Delhi
2. Noggle, G.R, Fritz, G.J. (2013). Introductory plant physiology (2/ed) PHI learning, Pvt, Ltd, Delhi
3. Pandey, S.N. and Sinha, B.K. (2005). Plant Physiology, (4/ed) Vikas Publication House Pvt. Ltd, New Delhi.
4. Salil Bose, S. (1982). Elementary Biophysics. Vijaya Printers, Madurai.
5. Verma, V. (2008). Text book of plant Physiology, Ane's student edition, New Delhi
6. Raman, K. (1996). Transport phenomenon in plants. Narosa Publications.

Reference books

1. Beevers, L. (1976). Nitrogen metabolism in plants. William & Sons Ltd. London.
2. Bray, C.M. (1983). Nitrogen Metabolism in Plants, Longman.
3. Kramer, P.J. (1969). Plant and soil water relationship, A Modern Synthesis.
4. Salisbury, F.B and Ross, C.W. (1986). Plant Physiology. Third edition, CBS Publishers and Distributors, New Delhi
5. Bidwell, R.G.S. (1974). Plant physiology, Mac Million Publisher, Boston
6. Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A. (2015). Plant Physiology and Development 6th Edition. Sinauer Associates, Sunderland, CT.
7. Davies, P.J. (2010). Plant Hormones: Biosynthesis, Signal Transduction, Action. 3rd ed. Springer, Dordrecht
8. Hopkins, W.G. (2006). Photosynthesis and Respiration. Chelsea House Publishers, NY.
9. Lawlor D.W. (2001). Photosynthesis 3/ed., Viva Books Pvt. Ltd.

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Web resources:

1. https://www.sciencedirect.com/topics/agriculture-and0biological-sciences/plant-physiology.
2. https://learn.careers360.com/biology/plant-physiology-chapter/
3. https://www.biologydiscussion.com/plants/plant-physiology/top-6-processes-of-plant- physiology/24154.
4. https://apan.net/meetings/apan45/files/17/17-01-01-01.pdf

5. https://basicbiology.net/plants/physiology
6. https://learn.careers360.com/biology/plant-physiology-chapter/4
7. https://swayam.gov.in/nd2_cec20_bt01/preview

https://www.nature.com/subjects/plant-physiology

Mapping with Programme Outcomes:

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

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

CORE COURSE-XI

BIOCHEMISTRY & APPLIED BIOTECHNOLOGY

Title of the Course	BIOCHEMISTRY & APPLIED BIOTECHNOLOGY					
Paper Number	**Core XI**		**Credits**	**4**	**Course code**	**23UPBOT4C11**
Category	**Year**	**II**				
Core XI	**Semester**	**IV**				
Instructional Hours /week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
	4	**0**	**-**	**5**		
Pre-requisite	Basic knowledge on Bio molecules structure and enzymes and To empower students recognize and appreciate the basic principles that sustain biotechnology as an interdisciplinary domain of learning and research.					
Learning Objectives	1. To study the fundamentals and significance of Plant Biochemistry. 2. To know the structure and properties of plant bio molecules. 3. To learn the fundamental and applications of Plant Biotechnology. 4. To study the mechanism of enzyme action and inhibition. 5. To expose the students on the fundaments of genetic transformation.					

UNIT	CONTENTS
1	**Atomic structure& Biophysics**: Atomic structure: Chemical bonds – ionic bond, covalent bond, metallic bond. Weak interaction - hydrogen bond, hydrogen bond in biological system - hydrophobic bond- van der waals interaction. Water – structure, properties, ionization of water. Acid and bases. pH concept – buffer, Molarity, Molality and Normality Biophysics: Energy, laws of thermodynamics**,** Enthalpy, entropy and free energy free energy changes of chemical reaction. Oxidation - redox reactions in biological systems and its importance, oxidation-reduction potential -Redox couple, redox potential, standard redox potential.
II	**Bio molecules: Carbohydrate:** Structure, Physico - chemical properties and biological significance of Monosaccharides, Oligosaccharides and Polysaccharides. Structure and function of glycoprotein. Gluconeogenesis, Glycogen Metabolism. **Lipids:** Structure, classification and properties, biosynthesis of Membrane lipids

	Biological significance of lipids. **Vitamins** – types and biological function. Secondary metabolism in plants: Structure, classification and properties of Alkaloids, Terpenoids, Flavonoids, Tannins, Phenols and their biochemical importance. Shikimic acid pathway and mevalonic acid pathway.
III	**Amino acid, Protein ,Nuclice acid Enzyme** **Amino acids** – classification and peptide bonds, Ramachandran Plot, properties of Amino acid - Amino acid metabolism, non protein amino acids, amines and their role in cell function. **Proteins:** classification, structure – primary, secondary, tertiary and quaternary, properties of protein. **Nucleic acids**: Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids – Biosynthesis of Nucleotide – De novo synthesis and salvage pathway – Nucleotide degradation **Enzymes** - general feature, naming and classification - Factors affecting enzyme activities. Enzyme kinetics - Michaelis and Menten equation, V max and Michaelis constant – Line weaver Burk plot. Enzyme inhibition, Mechanism of enzyme action, isoenzymes
IV	**Development of Transgenic plants:** Herbicidal and Disease resistant plants, Abiotic and biotic stress tolerant, in improving crop yield, food quality- Golden rice, Edible vaccines, Virus and Bacteria based transient gene expression systems. Virus induced gene complementation, Virus induced gene silencing. Cytoplasmic male sterility and fertility restoration, RNAi and antisense RNA technology for extending shelf life of fruits and flowers (ACC synthase gene and polygalactoronase); delay of softening and ripening of fleshy fruits (tomato, banana, watermelons). Plants as factories for useful products and pharmaceuticals.
V	**Industrial application of enzymes:** Fermentation techniques- Types. Industrial Production of enzymes- amylase, protease & lipase and their applications. Immobilization for enzymes production. Antibiotic Penicillin production. Amino acid - Glutamic acid production. Production of Alcohol and Xanthan Gum. Bioreactors for

	culturing Plant cells and production of Secondary metabolites, Super bug and its role in biodegradation. Bioremediation - *In situ* and *Ex situ*.

Course outcome CO	On completion of this course, the students will be able to:	Programme outcomes
Co1	Knowledge on the fundamentals and significance of Plant Biochemistry	**K1**
Co2	Understanding on the structure and properties of plant bio molecules.	**K2**
Co3	Understanding the role of enzymes in plants.	**K3**
Co4	Compare and contrast the methods of transgenic plants production and natural plants.	**K4**
Co5	Discuss and develop skills for effective utilization of microbial/plant enzymes and their role in biological cells.	**K5&K6**

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

RecommendedText:

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

Reference Books

1. Bonner, J. and Warner, W.H. 1961. Plant Biochemistry. Academic Press. Inv. New York.

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

Web sources:

1. http://priede.bf.lu.lv/grozs/AuguFiziologijas/Augu_biokimija/Plant%20Biochemistry 204.pdf
2. http://www.brainkart.com/subject/Plant-Biochemistry_257/
3. https://swayam.gov.in/nd2_cec20_bt12/preview
4. https://www.biorxiv.org/content/10.1101/660639v2
5. https://www.scribd.com/document/378882955/
6. https://nptel.ac.in/courses/102/107/102107075/
7. https://plantae.org/plant-physiology-top-articles-of-2020-based-on- altmetric-scores/
8. https://.britannica.com/technology/biotechnolog/
9. https://manavrachna.edu.in/blog/scope-of-biotechnology

MappingwithProgrammeOutcomes:

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

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

LABORATORY COURSE- IV

(COVERING CORE PAPERS X & XI)

Title of the Course	**PRACTICAL IV**					
Paper Number	**Core laboratory IV**		**Credits**	**2**	**Course code**	**23UPBOT4P04**
Category	**Year**	**II**				
Lab Core IV	**Semester**	**IV**				
Instructional Hours /week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
	5	**1**	**-**	**6**		
Pre-requisite	Practical's pertaining to above subjects are important to get knowledge on various physiological functions of plants.					
Learning Objectives	1. Extract bimolecular 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	CONTENTS
1	**PLANT PHYSIOLOGY** 1. Determination of osmotic potential by plasmolytic method. 2. Determination of water potential using gravimetric method. 3. Determination of water potential using dye method (Chardakov's method). 4. Effect of Monochromatic light on apparent photosynthesis. 5. Effect of CO_2 concentration on apparent photosynthesis.
II	**PLANT PHYSIOLOGY** 1. Effect of temperature on protoplasmic membrane. 2. Separation of chloroplast pigments using paper chromatographic technique. 3. Estimation of chlorophyll content using Arnon's method. 4. Experiment to study the rate of Hill activity of isolated chloroplast by dye-reduction.

	5. Determination of Stomatal Frequency and stomatal index. 6. Estimation of total acidity in CAM plants 7..Estimation of Leg- hemoglobin content 8.Estimation of nitrogen by Nessler‘s method
III	. 1.Demonstration of Apparent photosynthesis 2.Estimation of Photosystem II activity C3,and C4 anatomy, C4 subtype 3.Experiment to compare the rate of absorption with the rate of transpiration: 4.Demonstration on aerobic respiration 5. In vivo assay of NR, NiR. 6.Estimation of IAA
IV	**BIOCHEMISTRY** 1.Preparation of phosphate and citrate buffers. 2.Estimation of DNA by Diphenylamine method. 3.Estimation of reducing sugars by the DNS method (Dinitrosali cyclic acid). 4.Estimation of Carbohydrate by Anthrone method. 5.Estimation of proteins by Lowry‘s method. 6.Estimation of total phenols. 7.Assay of catalase and peroxidase. 8 Estimation of amino acids by ninhydrin method 9 Estimation of Proline
V	**APPLIED BIOTECHNOLOGY** 1. Demonstration immolization enzyme techniques 2. Production of Ethanol and its optimization 3. Genetically Engineered vaccines/insulin 4. solid state fermentation demonstration

Course out come CO	On completion of this course, the students will be able to:	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.	**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

Text books

1. Plummer,D.1988.AnintroductiontoPracticalBiochemistry,TataMcGraw–HillPublishing CompanyLtd.,New Delhi.
2. Palanivelu,P.2004.LaboratoryManualforanalyticalbiochemistryandseparation techniques,SchoolofBiotechnology,MaduraiKamarajUniversity,Madurai.
3. Jayaraman.J.1981.Laboratory Manual in Biochemistry.Whiley Eastern Limited,NewDelhi.
4. Bendre,A.M.andAshokKumar,2009.AtextbookofpracticalBotany.Vol.I&II.RastogiPublication.Meerut.9th Edition.
5. ManjuBala,SunitaGupta,GuptaNK.2012.PracticalsinPlantPhysiologyandBiochemistry.ScientificPublisher.
6. Joy, P.P., Surya, S and Aswathy, C. 2015. Laboratory Manual of Biochemistry, Agricultural University, Pineapple Research Station, Ernakulam, Kerala.
8. 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.
9. George M Malacinski. 2015. Freifelders Essentials of Molecular Biology (4th ed.) Jones & Bartlett.
10. Gupta P.K. 2017. Cell and Molecular Biology (5th ed.), Rastogi Publications, Meerut.
11. Kumar, H.D. 2007. Molecular Biology and Biotechnology, Vikas Publishing House, New Delhi.
12. 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,KandJ.Walker(Eds).1994.PrinciplesandTechniquesofPracticalBiochemistry(4th Edition)CambridgeUniversityPress,Cambridge.
3. Bendre,A.MandAshokKumar.2009.AtextbookofpracticalBotany.Vol.I&II.RastogiPublication.Meerut.9th Edition.
4. ManjuBala,SunitaGupta,Gupta,N.K.2012.PracticalsinPlantPhysiologyandBiochemistry.Sci

entificPublisher.
5. Wilson,KandJ.Walker.2005.PrinciplesandTechniquesofPracticalBiochemistry,5thEdition. CambridgeUniversitypress,NewYork.
6. RodneyBoyer.2000.ModernExperimentalBiochemistry, 3rdEdition.PublishedbyAddisonWesleyLongman. Singapore.
7. Bala, M., Gupta, S., Gupta, N.K and Sangha, M.K. 2013. Practicals in plant physiology and biochemistry. Scientific Publishers (India).
8. ManjuBala,SunitaGupta,Gupta,N.K.2012.PracticalsinPlantPhysiologyandBiochemistry.Sci entificPublisher.
9. Wilson,KandJ.Walker.2005.PrinciplesandTechniquesofPracticalBiochemistry,5thEdition. CambridgeUniversitypress,NewYork.
11. RodneyBoyer.2000.ModernExperimentalBiochemistry, 3rdEdition.PublishedbyAddisonWesleyLongman. Singapore.Glick, B.R and J.E. Thompson. 1993. Methods in Plant Molecular Biology and Biotechnology. CRC Press, Boca Raton, Florida.
12. 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.
13. 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.

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

https://www.kopykitab.com/Cell-And-Molecular-Biology-A-Lab-Manual-by-K-V-Chaitanya

MappingwithProgrammeOutcomes:

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 WITH VIVA VOCE

Title of the Course	PROJECT					
Paper Number	Project		**Credits**	**5**	**Course code**	**23UPBOT4PR1**
Category	**Year**	**II**				
Project	**Semester**	**IV**				
Instructional Hours /week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
			6	**6**		
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.					

1. Each student will be allotted a Project Guide from the faculty of the department concerned by lot method.
2. The topic of the dissertation shall be assigned to the candidate before the beginning of third semester
3. After the completion of the project work, the e student has to submit four copies of dissertation with report carrying his/her project report for evaluation by examiners. After evaluation, one copy is to be retained in the College Library
4. a. Project work will be evaluated by one 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.
5. 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
6. All the candidates of M.Sc (Botany) are required to undergo a major project and submit the following:

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 - 15marks

External: 60 marks
Thesis/ Dissertation - 30 marks
Presentation - 15 marks
Viva-voce - 15 marks

Suggested areas of work:
Algae, fungi, microbiology, bio control 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.

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 out come 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	**K1**
Co2	Compile data and familiarize yourself with techniques for planni and carrying out tests.	**K2**

Co3	Collect data and educate yourself on how to evaluate the analyzedresults of your scientific studies.	**K3**
Co4	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	**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 theTutorial hour
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Texts Book

10. Wilson,KandJ.Walker(Eds).1994.PrinciplesandTechniquesofPracticalBiochemistry(4th Edition)CambridgeUniversityPress,Cambridge.
11. Bendre,A.MandAshokKumar.2009.AtextbookofpracticalBotany.Vol.I&II.RastogiPublication.Meerut.9thEdition.
12. ManjuBala,SunitaGupta,Gupta,N.K.2012.PracticalsinPlantPhysiologyandBiochemistry.ScientificPublisher.
13. Wilson,KandJ.Walker.2005.PrinciplesandTechniquesofPracticalBiochemistry,5thEdition. CambridgeUniversitypress,NewYork.
5. RodneyBoyer.2000.ModernExperimentalBiochemistry, 3rdEdition.PublishedbyAddisonWesleyLongman. 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
https://kau.in/document/laboratory-manual-biochemistry

MappingwithProgrammeOutcomes:

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

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

ELECTIVE VI-(GROUP F)

ORGANIC FARMING

Title of the Course	ORGANIC FARMING					
Paper Number	Elective VI		**Credits**	**3**	**Course code**	**23UPBOT4E21**
Category	**Year**	**II**				
Elective VI (Group F)	**Semester**	**IV**				
Instructional Hours /week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
	3		**-**	**3**		
Pre-requisite	To understand the students about the organic farming.					
Learning Objectives	1. To 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
1	**Organic farming**: Concepts and scope of organic farming, Requirements for organic farming, Farm components for an organic farm. Choice of crops & varieties in organic farming Conversion to organic farming- Process, green card systems and subsidies. Fundamentals of Livestock farming, animal behaviour, Poultry management.
II	**Types of Farming,:** Concept of different cropping systems in relation to Organic Farming (Inter cropping), nutrient uptake and balanced nutrient supply, organic manure, green and liquid manure, bio fertilizers and their method of use, Compost: decomposition, manure – Types vermicompost: Scope and importance, use of vermi castings in organic farming, Potentials and constraints for vermin culture in India.
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 bio control agents , Indigenous technical knowledge for insects-pest, disease - Weed and nutrient management in organic farming
IV	**Organic crop production methods and Post harvest management:** sugarcane, mango, ginger, medicinal and ornamental crops. Green labels, Bio-fuel crops, Processing, labelling 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, Integrated Nutrient Management (INM) and Integrated Plant Nutrient Supply System (IPNS). Organic produce quality considerations, certification, accreditation process, marketing and Economics.

Course out come 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

Text Books

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

MappingwithProgrammeOutcomes:

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-(GROUP F)

FORESTRY AND WOOD TECHNOLOGY

Title of the Course	FORESTRY AND WOOD TECHNOLOGY					
Paper Number	**ELECTIVE VI**		**Credits**	**3**	**Course code**	**23UPBOT4E22**
Category	**Year**	**II**				
ELECTIVE VI-(GROUP F)	**Semester**	**IV**				
Instructional Hours /week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
	3		**-**	**3**		
Pre-requisite	Prior knowledge on trees, forests and their importance					
Learning Objectives	1. To study various aspects of Forest Botany. 2. To understand the importance and different forests and plants species. 3. To know the ecological significance of forests. 4. To enable the students to information on forests laws. 5. To raise student awareness of the need to create a sustainable way of living and the current Global issues with forestry caused by human Interference.					

UNIT	CONTENTS
1	**Introduction and scope of Forest Botany** : World and Indian forest scenario; Forest types of India; Factors that influences forest and forest protection. Rare and endangered species. Conservation strategies; Exotics and its significance; Silviculture - principles and practices; Genetic Engineering and its application in forestry; remote sensing and GIS in forestry.
II	**Forest Resources and utilization:** Forest products; Forest laws and policies, people and Forest; Social and community forestry; Forest industries; Role of social forestry in cottage industry; Role of forestry

	in Indian economy. Biomass conversion strategies-energy plantations.
III	**Nature and properties of wood :** Physical, chemical, mechanical and anatomy of wood, Durability of wood, Wood seasoning and preservation. Defects and abnormalities of wood; types of commercial wood species of India. Wood deterioration - fungi, insects and other agents; Wood protection - Practical methods for preserving and protection, Chemical processing of wood. Composite wood: adhesives - manufacture, properties and uses; manufacture and uses of plywood, fibre boards and particle boards. Present status of composite wood, paper and rayon industries. Present position of supply of raw materials to industries and wood substitution
IV	**Forest protection:** Principles of forest protection- factors affecting forest health , outbreak of diseases and insect attack, droughts and floods, anthropogenic activities, pollution, biotic pressures, urbanization and industrial expansion - Forest fires, Fire protection methods, biological, chemical and integrated pest management methods, forest protection through people committee
V	**Forest Menstruation and Forest act :** Forest Mensuration: Methods of measuring - diameter, girth, height and volume of trees; form-factor; volume estimation of stand, current annual increment; mean annual increment. Sampling methods and sample plots. Yield calculation; yield and stand tables, forest cover monitoring through remote sensing; Geographic Information Systems for management and modeling. Forest laws and policies - Indian Forest Policy of 1894, 1952 and 1988. Recent Policies and Acts – Tribal Bill, 2007, Biodiversity Bill, 2002, National Agroforestry Policy 2014

Course out come CO	On completion of this course, the students will be able to:	Programme outcomes
Co1	Knowledge on various aspects of Forest Botany	**K1**
Co2	Understand the importance and of different forests.	**K2**
Co3	Analyze the ecological significance of forests	**K3**
Co4	To understand the dynamics of the forest.	**K4**

Co5	Understanding on various Indian forests laws and acts.	**K5&K6**

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

Text books

FORESTRY

Text books

10. Negi, S.S., (1994). India‘s Forests, Forestry and Wildlife, Indus publishing Co., New Delhi.
11. Khanna, S. (1984). Principles and practices of silviculture. Khanna Bandhu, DehraDun
12. Lal, J.B. (1989). India‘s Forests Myth & Reality. Nataraj Publishers, DehraDun.
13. Ramprakash, (1986). Forest management. IBD Publishers, Debra Dun.
14. Dwivedi, A.P. (1992). Agroforestry – Principle and practices. Oxford and IBH Publishing Co., New Delhi.
15. Chaturvedi, A.N and Khanna, L.S. (2015). Hand book of forestry 5/ed
16. Sagreta, K.P (2000). Forest and Forestry, National book trust India, New Delhi.
17. Parthiban, K.T (2018). Introduction to forestry & agro forestry.

Reference books

1. Frederick S. Backer, (1950). Principles of silviculture, McGraw Hill Book Co. New York
2. Donald Bruce and Francis X. Schumacher. (1950). Forest mensuration, McGraw Hill Book Co. New York.
6. Bor, N.L. (2010). A Manual of Indian Forest Botany,(Second Edition) Asiatic pub., New Delhi.
7. Benu Singh, (2010). A Modern Book on Forestry and Horticulture, Vista International Pub. New Delhi.
8. Stebbing E.P. (1982). The forest of India, A.J. Reprints agency, New Delhi.
9. FAO (1987). Forestry Extension Methods, SLNo. 80, FAO Publication, Caracal, Rome, Italy.
10. Jha, L.K. and Sen Sarma, P.K. (1996). A manual of Forestry Extension Education, APH Publishing Corporation, New Delhi.

Web resources:

1. http://wwwwds.worldbank.org/external/default/WDServer/WDSP/IB/2006/10/19/000112742_2006 1019150049/Rendered/PDF/367890Loggerheads0Report.pdf.
2. https://www.britannica.com/science/forestry
3. https://en.wikipedia.org/wiki/Forestry.
4. https://www.biologydiscussion.com/forest/essay-forest-importance.major-products-and-its-conservation/25119
5. https://academic.oop.com

https://www.sciencedirect.com/topics/agriculture-and-biological-science-forest-product.

MappingwithProgrammeOutcomes:

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 VI-(GROUP F)

GENE CLONING AND GENE THERAPY

Title of the Course	GENE CLONING AND GENE THERAPY					
Paper Number	ELECTIVE VI		**Credits**	**3**	**Course code**	**23UPBOT4E23**
Category	**Year**	**II**				
ELECTIVE VI (GROUP F)	**Semester**	**IV**				
Instructional Hours /week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
	3		**-**	**3**		
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
1	**Introduction :** Concept of gene cloning -DNA cloning approche – cell based DNA Cloning- cell Free DNA cloning -Gene cloning - DNA and RNA purification – Enzyme for manipulation -- Enzymes for rDNA technique- Restriction endonucleases -DNA ligases- alkaline phosphatase- polynucleotide kinase- terminal deoxynucleotidyl transferase- S1 nuclease- DNA Polymerase I .vectors –Vector for E.coli , Cloming vector based on Viral DNA , cosmids, cloning vector based on M13 phage , vector for Eukaryotes , vector of plants and animals
II	**Construction of recombinant DNA molecules:** RE Digestions - preparation of vectors - construction of recombinant using cohesive & blunt end ligation- linkers & adapters - homopolymer tailing. Gene transfer mechanisms -Direct and vector mediated transfer mechanisms in bacteria, plant and animals: Bacteria- Ca2+ mediated- electroporation- lipofection; Yeasts and fungi- Lithium acetate- PEG mediated- Frozen yeast protocol- protoplast transformation- gene gun; Plants- Agrobacterium mediated- biolistics- electroporation- viral

	transformation; Animals- microinjection- viral transformation
III	**Recombinant selection and screening:** (i) Direct and indirect methods- Probe preparation (Radio labeling and non- radio labeling)- Southern hybridization- colony and plaque hybridization- in situ hybridization- Northern -Western- South western subtractive colony and plaque hybridization- In situ chromosomal hybridization- chromosomal walking and jumpingAntibody screening- Expression screening
IV	**Expression of cloned DNA** : Expression vectors- Expression in heterologous system- Secretion of cloned productsPurification and refolding- characterization of recombinant proteins Modification of cloned DNA (i) Site directed mutagenesis- Protein engineering- Gene knock-outs and knock-in technology Genome sequencing (i) Genome sizes- Genomic and cDNA library- strategies for genome sequencing- Gene tagging- Promoter analysis- DNA foot printing Antisense technology (i) Antisense RNA- MicroRNA- RNA
V	**Gene therapy**: Introduction and Methods, Types of gene therapy – somatics gene therapy , germaline gene thererpy – Gene therapy staragies , Gene theory approaches, Method of gene therapy – Ex vivo, in vivo, Gene targeting and silencing. Vector for gene gene therapy , Gene therapy for inherited diseases- Cystic fibrosis, Duchnne muscular dystrophy, Bleeding disorders, Tyrosinemia. Severe combined immunodeficiency syndrome (SCID), Gene therapy of non heritable disorders, -Recent advancement in Gene Therapy. Cancer gene therapy, RNA-DNA chimera, Gene therapies for Criglar-Najjar syndrome I. ses, Challenges and future of gene therapy ethics of gene therapy.

Course out come 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	**K5&K6**

	molecular farming.	

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

Text book

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:

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

10. 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.
11. Primrose S., Twyman R. and Old B. 2001. Principles of Gene Manipulation (6th ed.). Blackwell Science. Oxford.
12. Ignacimuthu, S.1998. Applied Plant Biotechnology. Tata Mc Graw Hill, publishing company Ltd., New Delhi.
13. 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

https://link.springer.com/book/10.1007/978-88-470-1643-9

MappingwithProgrammeOutcomes:

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)

ELECTIVE VI-(GROUP F)

FARM SCIENCES: GREEN WEALTH

Title of the Course	FARM SCIENCES: GREEN WEALTH					
Paper Number	ELECTIVE VI		**Credits**	**3**	**Course code**	**23UPBOT4E24**
Category	**Year**	**II**				
Elective –IV (GROUP F)	**Semester**	**IV**				
Instructional Hours /week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
	3		**-**	**3**		
Pre-requisite	To understand the concept of fertilizers in crop production.					
Learning Objectives	1. Understand the concept of agronomy and sustainable agriculture. 2. Evaluate the importance of crop management technology. 3. To develop their understanding on the concept of fertilizers. 4. Develop the integrated management for better crop production by using fertilizers. 5. Develop the skills for cultivation of plants and their value added processing/storage/quality control.					

UNIT	CONTENTS
1	**Introduction :** History and development of agriculture – green reveloution -Farming system, scope importance, and concept- Types of farming system - Indigenous Farming - Subsistence farming system- Conventional farming system - Alternative Farming System- Specialized Farming System -Integrated Farming.. Farming system components and their maintenance, Special Farm Equipments. Agro-ecosystems - Impact of climate change on Agriculture, Effect on crop yield, and effect on Soil fertility.
	Agricultural Practices – Types of crops -Kharif Crops Rabi Crops. Basic Practices of Crop Production- Preparation of Soil- Agricultural Implements- Plough- Hoe- Cultivator. Sowing- Selection of Seed - Traditional tool - Seed drill. Adding Manure and Fertilizers: Advantages of Manure: Irrigation- Sources of irrigation -Modern Methods of Irrigation-Protection from Weeds-Harvesting-Storage- silos and granaries

III	**Agro forestry**: Objective of Agro forestry - Types of Agro forestry Systems- Structural Basis – Nature of components- Agrisilvicultural systems - Silvopastoral systems, Agrosilvopastoral systems. Arrangement of components - Spatial arrangement, Temporal arrangement. Functional basis- Productive functions, Protective functions classification of Agro foresty - Socio-Economic Classification- .Ecological Classification- Benefits of Agro forestry System
IV	**Agricultural waste management and Polices and Programmes for sustainable Agriculture and Food Security:** Types of agriculture wastes - classification of agro wastes composting – methods of composting , value addition , application. Biomass Briquetting – Methods, Appliances for Biomass briquettes. Biochar production- Biogas and Bio Ethanol production. Food And Crop Production Polices – Agricultural Credit Policy – Crop Insurance – Policies of Natural Resources use – Policies For Sustainable Livelihoods – Virtual Water And Trade - Sustainable Food Security Action Plan
V	**Fodder and Forage Crops**: Fodder crops - sorghum, oats, cowpea, rice bean, berseem, cluster bean, maize, Dinanath. Forage crops/grasses – napier, panicum, cenchrus. Fodder production and management. Preservation and utilization of forage crops -Principles and methods of hay and silage making.

Course out come CO	On completion of this course, the students will be able to:	Programme outcomes
Co1	To identify the importance of agriculture science	**K1**
Co2	Gain the knowledge on Agricultural Practices	**K2**
Co3	Understand the basic knowledge on Agroforesty	**K3**
Co4	Acquire knowledge on agro waste management	**K4**
Co5	Acquire knowledge on Fodder and Forage Crops	**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

Text Books

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

References books:

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

Web resources:

1. https://www.amazon.in/Green-Wealth-Unusable-Moneymaking-Assets-ebook/dp/B004D2AYPW
2. https://www.kobo.com/us/en/ebook/green-wealth
3. https://nishat2013.files.wordpress.com/2013/11/agronomy-book.pdf
4. https://www.kobo.com/in/en/ebook/weed-2
5. https://www.amazon.in/Handbook-Fertilizers-Sources-Make-Up-Effects-ebook/dp/B00D45LHAK
6.

MappingwithProgrammeOutcomes:

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

CO5	3	3	2	2	3	2	2	3	3	3

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

SKILL ENHANCEMENT COURSE (SEC3)

PROFESSIONAL COMPETENCY SKILL ENHANCEMENT

Title of the Course	**PROFESSIONAL COMPETENCY SKILL ENHANCEMENT**					
Paper Number			**Credits**	**2**	**Course code**	**23UPBOT4S03**
Category	**Year**	**II**				
Skill Enhancement **SEC3**	**Semester**	**IV**				
Instructional Hours /week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
	3	**0**	**-**	**3**		
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**
1	**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.(repeated in other course)

II	**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.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 cellgrowth. **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	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 out come 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

RecommendedText:

1. Bhojwani, S.S. Bhatnagar, S.P and Dantu, P.K. 2015. The Embryology of Angiosperms (6^{th}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.6^{th} 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.

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. 6^{th} 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/

https://plantae.org/plant-physiology-top-articles-of-2020-based-on- altmetric-scores/

Mapping withProgrammeOutcomes:

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)

BOTANY FOR ADVANCED RESEARCH
BOTANY FOR ADVANCED STUDIES (4 HOURS)

Title of the Course	**BOTANY FOR ADVANCED STUDIES**					
Paper Number			**Credits**	**2**	**Course code**	
Category	**Year**	**II**				
Skill Enhancment SEC03	**Semester**	**IV**				
Instructional Hours /week	**Lecture**	**Tutorial**	**LabPractice**	**Total**		
	3		**-**			
Pre-requisite	Students should to improve their career prospects, or pursuing a passion					
Learning Objectives	1. To be familiar with the basic concepts and principles of plant Systematic. 2 . Learn the importance of plant anatomy in plant production systems. 3. To expose the students a fundamental of the various techniques used in molecular studies. 4. To learn about the physiological processes that underlie plant metabolism. 5. To know the energy production and its utilization in plants.					

UNIT	**CONTENTS**
1	**Molecular Biology of gene expression:** Brief overview of the Central Dogma and Transcription in prokaryotes and eukaryotes. Types and structure of RNA polymerase, Different types of RNA, Regulatory sequences and transcription factors involved. Mechanism: Initiation, elongation and termination. Split genes and RNA splicing in eukaryotes. Translation in prokaryotes and eukaryotes. Salient features, exceptions, tRNA-suppressor mutations. Mechanism of translation: Chain initiation, elongation and termination, proteins involved, factors affecting translation accuracy. Molecular mechanism of mutation, cancer biology, human cytogentics **Molecular mechanism of Gene Regulation:** Regulation in prokaryotes, Regulation in Eukaryotes, Epigenetic mechanisms: methylation and transcriptional inactivation, cosuppression through transcriptional silencing, genome imprinting. RNA processing- alternative splicing, RNA stability, RNA interference. Translational

	regulation: Gene amplification, mating type inter conversion. **Genomics:** Structural genomics, Genetic and physical mapping (RFLP), microsatellite maps, cytogenetic maps, physical maps, positional cloning, chromosome walks and jumps, Genome sequencing, genome databases, human genome sequencing project. Functional genomics. transcriptome, proteome and metabolome, Microarrays and gene-chips. Comparative genomics. Functional and evolutionary relationships prokaryotes, organelles and eukaryotes, orthologues and paralogues. Metabolomics: Identification and quantification of cellular metabolites in biological samples. Pharmacogenomics and drug designing
II	**ADVANCED TRENDS IN SYSTEMATICS** **1.Basic concepts of:** a**).** Morphology - History, general morphology, types of data, methods of gathering data b). Anatomy - History, general anatomy, types of data, methods of gathering data, c) Embryology – History, types of data, methods of gathering data; d). Palynology: History, general palynological characters, types of data, methods of gathering data; e). Cytology and Cytogenetics: History, general cytological and cytogenetic characters, types of data, methods of gathering data; f) Ecology, History, general ecology, types of data, methods of gathering data (**At least two examples from each section should be studied to substantiate the taxonomic significance**) **(i) Chemotaxonomy:** a). History, general chemical and chemotaxonomic characters, types of data, Methods of gathering data. b) Identification of the major classes of the pharmaceutically important secondary metabolites from natural sources 8 (phenolics, steroids, terpenoids glycosides and alkaloids). c) Applications: Phytochemicals in cosmetics, aromatherapy, disease prevention, biotechnology in the production of phytochemicals. Phytochemical databases

	(ii) **Molecular trends in Biosystematics:** a**)** Molecules and genomes in plant systematics, techniques used in molecular taxonomy, molecular systematics in crop evolution b). Serology in relation to plant taxonomy- Methods, role of serology in taxonomy. c) Cladistics and Phenetics (iv) Molecular trends in Reproductive Biology: (i) Apomixis – Types, cytogenetic basis and induction of apomixes, applications. (ii)Biochemistry and genetics of incompatibility, methods to overcome incompatibility, pollen viability tests, molecular basis of incompatibility (iii) Sterility – Male sterility, CMS, GMS, CGMS, temperature sensitive and photosensitive male sterility, transgenic male sterility, female sterility and zygotic sterility
III	**PLANT PHYSIOLOGY** (i) Modern concepts Photosynthesis – Environmental and agricultural relevance; Respiration – Biochemical control of respiration (ii) Photomorphogenesis Phytochrome genes and their expression, control of photo-morphogenic responses. Dose-response relations in photomorphogenesis, light induced chloroplast differentiation, effect of photoreceptors. iii) Biological clock: Circadian rhythms, rhythm responses to environment, clock mechanism iv) Photoperiodism General principles , florigen concept v) Plant growth and development Patterns of growth and differentiation; Gene expression and mutations regulating meristem function, embryogenesis, seedling, root, leaf and flower development. Homeotic genes, ABCD model in Arabidopsis flower, hormonal control of plant tissue development, effect of auxins on root and root formation, gibberellin promoted growth of plants, ethylene and triple response mutants, brassinosteroids and photomorphogenesis.
IV	**Biochemistry :** i) Enzymes: General account: Importance and properties of enzymes in biological sciences, the classification and nomenclature of enzymes with examples, Mechanism of enzyme action role of enzyme in chemical action, various factors affecting the enzyme activity, Environmental plant physiology, Stress physiology

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

Course out come CO	On completion of this course, the students will be able to:	Programme outcomes
Co1	Understand of the basic principles of systematic, including identification, nomenclature, classification, and the inference of evolutionary patterns from data	**K1**
Co2	Learn the structures, functions and roles of apical *vs* lateral meristems in monocot and dicot plant growth.	**K2**
Co3	Understand the organization of nuclear genome	**K3**
Co4	Understand the various steps involved in the basic functioning of plant growth and the nutritive value of food.	**K4**
Co5	Gain awareness about the various process involved in the energy production in plants and metabolic pathways.	**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

Text books

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

Bruce, A. et. al. 2002. Molecular Biology of the Cell. Garland Publishing. New York

Reference books:

1. Mabberley, J.D. 2014. Mebberley‘s Plant-Book: A portable dictionary of plants, their classification and uses, 3rd ed. Cambridge University Press, Cambridge, U.K. 1021pp.

2. Pandey.B.P. 1999. Economic Botany. S. Chand Limited, New Delhi.

3. Bhojwani, S.S. and Soh, W.Y. 2013. Current trends in the embryology of angiosperms. Springer Science & Business Media, Germany.
4. Cutler, D. F., Botha, T and Stevenson, D.W. 2008. Plant Anatomy: An Applied Approach. Blackwell Publishing, Malden, USA.
5. Steward, F.C. 2012. Plant Physiology Academic Press, US.
6. Hopkins, W.G and Huner, N.P. 2009. Introduction to Plant Physiology (4th ed.). John Wiley & Sons. U.S.A.
7. Noggle G.R and G.J. Fritz. 2002. Introductory Plant Physiology. Prentice Hall of India, New Delhi.
8. Anthony J . F. G .2000. An Introduction to Genetic Analysis. W. H. Freeman &Co. New York.

9. Hartl, .D.L & Jones E. W. 2000. Genetic analysis of Genes and Genomes Jones and Bartlett Pub, Boston.

10. Klug .S.W. & Cummings, M.R. 2003. Concepts of Genetics . Pearson Education Pvt. Ltd., Singapore. Kreezer et al . 2001. Recombinant DNA and Biotechnology. American Society for Cell Biology, New York.

11. Lodish Harvey. 1999. Molecular Cell Biology. W.H. Freeman &Co. New York.

12. Russell, P.J. 2005. Genetics: A Molecular Approach (2nd edition). Pearson/Benjamin Cumming, San Francisco.

Snustad, D. P. & Simmons M.J. 2003.Principles of Genetics. John Hailey & Sons Inc. U.S.

Web resources:

1. http:// www.ornl.gov.

2. http:// ash. gene. ncl. ac .nk..

3. http://tor. cshl. org. http:www. gdb. org.

4. http: //www. neg r. org.

5. http: // www. genetics. wustl. edu.

http: // genome. imb- jena. dc.

MappingwithProgrammeOutcomes:

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

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

NAAN MUDHALVAN SCHEME

www.naanmudhalvan.tn.gov.in

COMPUTING SKILLS FOR INDUSTRY 4.0

Title of the Course	**COMPUTING SKILLS FOR INDUSTRY 4.0**					
Paper Number			**Credits**	**4**	**Course code**	
Category	**Year**	**I**				
	Semester	**IV**				
Instructional Hours perweek	**Lecture**	**Tutorial**	**LabPractice**	**Total**		
	4	**1**	**-**	**5**		
Pre-requisite	Basic Knowledge on computer gained through higher secondary class.					
Learning Objectives	1. To learn about the basics and functions of computer, Study about internet and communication. 2. To facilitate students to learn about Microsoft Word and Excel. 3. To find out more about Microsoft PowerPoint, database management systems and MS Access. 4. To introduce AI and ML for Biology students. 5. To know about big data and data analytics.					

UNIT	CONTENTS
1	**BASICS OF COMPUTER** Computer - Functions and Components of Computer – Operating System - Windows – Android – Intranet & Internet – www - Browser - Email - URL -Search engines - Websites & Web pages.
II	**MICROSOFT OFFICE – I** Microsoft word: Creation of document – Formatting of page - Formatting of paragraph -Formatting of text - Creation and formatting of table. Microsoft Power Point: Creation and Designing of slides – Animation options -Applications of MS Word and MS Power point.
III	**MICROSOFT OFFICE – II** **Microsoft** Excel: workbook – work sheet – Formatting of row, column and cell - Creation and formatting of table - Creation and formatting of charts Microsoft Access: Database Management System (DBMS) – Creation and designing of form – Management of data in table – Generation of report Applications of MS Excel and

	MS Access.
IV	**ARTIFICIAL INTELLIGENCE** Artificial Intelligence: Artificial Intelligence (AI) - What and Why? - Foundation of AI - The AI environment - Social Influence of AI - Applications and Future.
V	**BIG DATA AND DATA ANALYTICS** Big Data: Evolution - Data evolution - Big Data Definitions - Merits and Advantages of Big Data - Big Data Characteristics - Big Data Applications - Introduction to Data Analytics - Data Analysis Vs. Data Analytics - Types of Data Analytics - Application of Data Analytics.

Course out come CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
Co1	Learn how to use computerInternet, e-mail, Web browser, Web server, and Search engines.	**K1**
Co2	Create Documents, Tables and Spreadsheets.	**K2**
Co3	Know about creation and use of PowerPoint presentations, DBMS and MS Access.	**K3**
Co4	Acquire knowledge about AI and ML.	**K4**
Co5	Implement the knowledge in big data and data analytics.	**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 discuses during the Tutorial hour
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency ,Professional Communication and Transferrable Skill

Texts books

Rajaraman, V and N. Adabala, (6th Edition). 2015. Fundamentals of Computers, Prentice Hall of India Pvt. Ltd. New Delhi.

Anita Goel. 2010. Computer Fundamentals, Pearson Education.

Sinha, P.K. 2004. Computer Fundamentals, BPB Publications New Delhi 6th Edition.

Reema Thareja. 2014. Fundamentals of Computers, Oxford University Press.

Mooris mano. 1996. –Digital Design‖ Prentice Hall of India PVT Ltd., New Delhi.

References Books:

Forouzan, B. A. 2013. Data Communication and Networking, 5th Edition, TMH.

Arthur Conklin W.M., and Greg White. 2016. Principles of computer security. TMH., McGraw-Hill Education; 4th edition

Balagurusamy, E. 2011. Fundamentals of computers, Tata Mc Grw-Hill, New Delhi.

Harley Hahn. The Internet-Complete Reference, Tata Mc Grw-Hill, New Delhi.

Kaliraj, P and Devi, T. 2020. Higher Education for Industry 4.0 and Transformation of Education 5.0

Web Resources:

https://swayam.gov.in/nc_details/NPTEL

https://www.classcentral.com/report/swayam-moocs-course-list 4

https://swayam.gov.in/nd1_noc20_cs52/preview 6

https://www.classcentral.com/institution/npte

https://swayam.gov.in

MappingwithProgrammeOutcomes:

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

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

PU- M.Sc., Botany (College), 2023-2024

MODEL QUESTION PAPER

(For the candidates admitted from 2023–2024 onwards)

M.Sc. DEGREE EXAMINATION

SEMESTER

TITLE: ……

Time: 3Hrs. **Max. Marks: 75**

PART – A

I. Choose the correct answer (One question from each unit) **(5 X 1 =5)**

1. a) b) c) d)
2. a) b) c) d)
3. a) b) c) d)
4. a) b) c) d)
5. a) b) c) d)
6. a) b) c) d)
7. a) b) c) d)
8. a) b) c) d)
9. a) b) c) d)
10 a) b) c) d)
11. a) b) c) d)
12. a) b) c) d)
13. a) b) c) d)
14. a) b) c) d)
15. a) b) c) d)

PART – B (2 X 5 =10 Marks)

Answer Any Two questions out of five (One question from each unit)

16.
17.
18.
19.
20.

PART – C (5 X 10 = 50 marks)

Answer All question (either or type questions (**One question from each unit)**

21. a)

or

b)

22. a)

or

b)

23 a)

or

b)

24. a)

or

b)

25. a)

PU-M.Sc., Botany (College), 2023-2024

MODEL QUESTION PAPER

(For the candidates admitted from 2023–2024 onwards)

SEMESTER –II

CORE LABORATORY COURSE - I

PRACTICAL –I (Covering Course I & II)

(ALGAE, FUNGI, LICHENS, BRYOPHYTES, PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY)

Time: 4 Hrs.

Max. Marks: 60 marks
Practical: 50 marks
Record: 05 marks
Viva – Voce: 05 marks

1. Make suitable micro preparations of **A, B, C, D** and **E**. draw and identify, give the reasons, Submit the slides for valuation	5 × 4 = 20 marks
2. Make suitable micro preparations of **F** and **G**. draw and identify, give the reasons, Submit the slides for valuation	2 × 5 = 10 marks
3. Name the group ,species of any two algae from the given algal mixture **H**	2 × 3= 6 marks
4. Name the genus and group of the given specimens **I, J, K, L, M, N**	6 ×2 =12 marks
5. Identify and write notes on economic importance of **O**	2 marks

Key:

Q.No	Specimen	Marks Distribution	Total marks
1.	A. Algae B. Fungi C. Bryophytes D. Pteridophytes E. Gymnosperms	Each sub question carry 4 mark, Preparation -1, Identification -1 Diagram -1, Reason -1 mark	4×5=20 marks

2.	Reproductive parts of F. Pteridophytes G. Gymnosperms	Each sub question carry - 5 mark, Preparation -1, identification -1, Diagram -1, Reason -2 mark	5×2=10 Marks
3.	H. Mixture of three micro algae	Identification group – 1 mark, Identification species – 1 mark, Diagram – 1 mark	2×3= 6 marks
4.	Macroscopic part / Slide of I. Bryophytes J. Pteridophytes K. Gymnosperms L. Fungi M. Lichens N. Fossil	Each sub question carry - 2 marks Identification group – 1 mark, Genus - 1 mark	2×6= 12 marks
5.	O. Any algae or fungi product	Identification -1 mark, Uses – 1 mark	2 mark

Note:

- Submission of minimum 15 herbarium sheets from Algae / Fungi / Lichens / Bryophytes /Pteridophytes / Gymnosperms (during the internal practical examination).
- Field trip to a hill station and coastal area for a minimum period of five days for the
- Collection of specimens and to study the plants in their natural habitat.
- Certified record work done in the laboratory during practical classes

PU-M.Sc., Botany (College), 2023-2024

MODEL QUESTION PAPER
(For the candidates admitted from 2023–2024 onwards)
SEMESTER –II
CORE LABORATORY COURSE -II

PRACTICAL –II (Covering Course III, IV& V)

(TAXONOMY OF ANGIOSPERMS AND ECONOMIC BOTANY, PLANT ANATOMY EMBRYOLOGY OF ANGIOSPERMS, ECOLOGY, PHYTOGEOGRAPHY, CONSERVATION BIOLOGY & INTELLECTUAL PROPERTY RIGHTS

Time: 4 Hrs**.** **Max. Marks: 60 marks**
Practical: 50 marks
Record: 05 marks
Viva – Voce: 05 marks

1	Find out the binomials of **A** & B	3 x 2 = 6 Marks
2	Refer specimens **C** to their respective families; give the reasons at each level of hierarchy.	4 x 1 = 4 Marks
3	Construct a key using **D, E, F, G H.& I**	6 Marks
4	Write the economic importance of plant **J**	2 x 1 = 2 Marks
5	Cut transverse section of **K**. Identify the anomaly by giving reasons. Draw labeled sketches and submit the slides for valuation	4 marks
6	Macerate **L',** identifies the elements and measures the length or breadth using a Micrometer.	3 marks
7	Dissects and displays any two stages of embryo in **M'** mention the stage, Submit the slides for valuation.	4 marks
8	Find out the abundance, frequency and density of species from the vegetation given as **N** by using quadrat method. Record your observation and interpret the results	6 Marks
9	Determine the content of the given Sample **O**	5 Marks
10	Write notes of interest on **'P, Q, R** ,**S** and **T**	2 x 5=10 mark

Key:

Q.No	Specimen	Marks Distribution	Total marks
1.	A & B Families prescribed in the syllabus	Each sub question carry - 3 mark, Genus, species, author citation and page number in flora	3x2=6marks
2.	C - Flowering plants from families prescribed in the syllabus.	Taxonomical hierarchy – 2 marks, Reasons – 2 marks	4x1=4 marks
3.	, D, E, F, G, H & I- Flowering twigs.	Construct the dichotomous key	6 marks
4.	J - Economic importance of plants mentioned in syllabus	Name of plant -1 mark, Edible part & uses -1 marks	2x1=2 marks
5.	K- Stem showing anomalous growth, prescribed in the syllabus	Preparation -1, Identification -1 Diagram -1 Reason -1 mark	4 marks
6.	L- Macerate wood specimen given in practical syllabus	Preparation - 1 Measurement, calculation and result -2 mark,	3 marks
7.	M- Dissect embryo from *Tridax* flower	Submission any two stage 2×2 =4	4 Marks
8.	Find out the abundance, frequency and density of species from the vegetation given as **N** by using quadrat method. Record your observation and interpret the results	Abundance, -2 mark Frequency -2 mark Density – 2 mark	6 marks
9.	Determine the content of the given Sample **P**	Procedure: 3 marks Results : 2 marks	**5 marks**
10.	Q - Anatomy R – Microtechnique S - Embryology T- Ecology U- Phytogeogaohy	Identification and reason - 2 marks 5x2=10 marks	10 marks

Note:

1. Submission of 5 double stained permanent slides (Microtome or free hand sections – 2, Cleared material - 1, Peel – 1 and Maceration - 1).
2. Certified record work done in the laboratory during practical classes.
3. Submission of a tour report and 25 herbarium sheets (Specimens collected from Tour Collection / locally available plants during the internal practical Examination.

PU-M.Sc., Botany (College), 2023-2024

MODEL QUESTION PAPER
(For the candidates admitted from 2023–2024 onwards)
SEMESTER –IV
CORE LABORATORY COURSE -III

PRACTICAL –III (Covering Course VI, VII & VIII)

(CELL AND MOLECULAR BIOLOGY, GENETICS, PLANT BREEDING & BIOSTATISTICS, RECOMBINANT DNA TECHNOLOGY AND INDUSTRIAL APPLICATIONS)

Time: 4 Hrs**.**

Max. Marks: 60 marks
Practical: 50 marks
Record: 05 marks
Viva – Voce: 05 marks

1	Prepare a smear of the given onion root **A** and identify any two stages of mitosis. Draw labeled sketches. Submit the slides for valuation.	5 marks
2	Prepare a squash of **'B'**. Display any two stages of meiosis. Draw labeled sketches	5 marks
3	Construct a chromosome map; calculate interference and coefficient of variation from three point test cross data given in **_C**	7 marks
4	Solve the genetic problem **_D**' and **'E'**	6 marks
5	For the given data **F** perform student –t' test and prove the statement	6 marks
6	Workout the problem **G**, find out mean , mode , standard deviation	6 marks
7	Isolation of plasmid DNA from **H**	5 marks
8	Write notes of interest on **'I, J, K**,L and **M**	10 mark

Key:

Q.No	Specimen	Marks Distribution	Total marks
1.	A- onion root tip	Submission any two stage -2×2 =4 Diagram -1	5 Marks
2.	B. Flower bud onion or Rhoeo	Submission any two stage -2×2 =4 Diagram -1	5 Marks
3.	C - Three point test cross data	Find out distance -3 marks, Gene order -2 mark, Construct the chromosome map -2 mark	7 Marks
4.	D & E - Genetic problem given in the practical	Phenotype/genotype ratio 2×3=6	6 Marks
5.	Provide the statistical data F	Calculation – 3 marks, Results,2 interpretation - 1 marks	6 Mark
6.	G.Provide seeds or leaves sample (50 number)	Mode – 2 mark, Mean – 2 mark, Standard division – 2 marks	6 Mark
7.	Isolation of DNA from given sample H	Procedure – 3 marks, result 2 mark	5 Mark
8.	I - Cellbiology J – Molecular biology K - Genetics L.Plant Breeding M- Recombinant DNA Technology	Identification and reason - 2 marks	5X 2=10 marks

PU-M.Sc., Botany (College), 2023-2024

MODEL QUESTION PAPER

(For the candidates admitted from 2023–2024 onwards)

SEMESTER –IV

CORE LABORATORY COURSE -IV

PRACTICAL –IV (Covering Course X and XI)

PLANT PHYSIOLOGY, PLANT METABOLISM, BIOCHEMISTRY AND APPLIED BIOTECHNOLOGY

.Time: 4 Hrs

Max. Marks: 60 marks
Practical: 50 marks
Record: 05 marks
Viva – Voce: 05 marks

1	Conduct the physiological experiment **A** Assigned to you. Record your observation and interpret the Results .Leave the set up for valuation.	10 Marks
2	Comment on the setup **B**.	6 Marks
3	Writes notes of physiological interest of **C, D, E**	3x3= 9 Marks
4	Conduct the Biochemistry experiment (**F)** assigned to you. Record your results. Leave the set up valuation	10 marks
5	Comment on the setup **G**	6 marks
6	Write notes of Biochemistry Applied Biotechnology interest **H, I, J**	3x3=9 Marks

Key:

Q.No	Experiment / Spotters	Marks Distribution	Total marks
1.	**A.** Draw lots from the list of physiology experiments provided in syllabus	Principle – 2 marks, Procedure – 3 mark, Material & Methods – 2, marks, Results – 2, Comments/ Interpretation – 1 marks	10 marks
2	**B-**Physiology experiment setup provided in syllabus	Identification -1 mark, principle–1, Reason -3 marks, Diagram -1 mark	6 marks
3	Plant physiology - Charts/Figures/Graphs/tables/Instruments/Apparatus, Chemicals/ Models/photographs **C, D & E**	Identification -1 marks, Reason-2 mark	3×3=9 marks
4	**F.** Draw lots from the list of Biochemistry experiments provided in syllabus	Principle – 2 marks, Procedure – 3, mark, Material & Methods – 2 marks, Results – 2, Comments/ Interpretation – 1 marks	10 marks
5	**G-**Biochemistry experiment setup provided in syllabus	Identification -1 mark, principle-1, Reason -3marks, Diagram -1 mark	6 marks
6	H. Biochemistry J. Applied Biotechnolgy tools K. Biotechnology product	Identification -1 marks, Reason -2 mark	3×3=9 marks