SRI MEENAKSHI GOVERNMENT ARTS COLLEGE FOR WOMEN (AUTONOMOUS)

MADURAI - 625 002.

DEPARTMENT OF BOTANY

Syllabus for M.Sc. Botany

For students who are admitted for the academic year 2023-2024

CONTENT

1. Introduction: PO & PSO

Programme Outcome, Programme Specific Outcome and Course Outcome

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

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

	PO2: Decision Making Skill Foster analytical and critical thinking abilities for data-based decision-making. **PO3: Ethical Value** Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities. **PO4: Communication Skill** Ability to develop communication, managerial and interpersonal skills. **PO5: Individual and Team Leadership Skill** Capability to lead themselves and the team to achieve organizational goals. **PO6: Employability Skill** Inculcate contemporary business practices to enhance employability skills in the competitive environment. **PO7: Entrepreneurial Skill** Equip with skills and competencies to become an entrepreneur. **PO8: Contribution to Society** Succeed in career endeavors and contribute significantly to society. **PO 9 Multicultural competence** Possess knowledge of the values and beliefs of multiple cultures and a global perspective. **PO 10: Moral and ethical awareness/reasoning** Ability to embrace moral/ethical values in conducting one's life.

Programme Specific Outcomes (PSOs)

Programme Specific Outcomes (PSOs)	**PSO1 – Placement** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions. **PSO 2 - Entrepreneur** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations. **PSO3 – Research and Development** Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development. **PSO4 – Contribution to Business World** To produce employable, ethical and innovative professionals to sustain in the dynamic business world. **PSO 5 – Contribution to the Society** To contribute to the development of the society by collaborating with stakeholders for mutual benefit.

EVALUATION PATTERN FOR INTERNSHIP:

- Attendance (mandatory) - 40 marks
- Field work and performance - 40 marks
- Report writing - 20 marks

Total - 100 Marks

EVALUATION PATTERN FOR EXTENSION ACTIVITY

Extension activities should be carried out beyond the class hours for a minimum of 15 hours.

- Attendance - 50 marks
- Participation - 25 marks
- Report - 25 marks

Total - 100 Marks

EVALUATION PATTERN FOR PROJECT WITH VIVA VOCE

Internal maximum: 60 marks; External maximum: 40 marks.

Evaluation criteria for Internal (60 marks):

The 60 marks for internals can be given for three reviews of 20 marks each.

Review- I

Problem Selection / Choice of the Topic	Methodology / Technology used	Effective content delivery	Interaction / Answering questions	Total
5	5	5	5	20

Review- II

Work Progress	Development of ideas	Effective content delivery	Interaction / Answering questions	Total
5	5	5	5	20

Review- III

Final outcome of the project	Implementation & execution	Effective content delivery	Interaction / Answering questions	Total
5	5	5	5	20

Evaluation criteria for External (40 marks):

Organisation of ideas	Effective content delivery	Report	Total
10	10	20	40

Code:

Sri Meenakshi Government Arts College for Women (A), Madurai-2

M.Sc. Degree Examination - Nov 2023

(For those who joined in 2023)

TITLE OF THE PAPER:

Duration: 3 hours

Maximum Marks: 75

Section-A **(5x5=25 Marks)**

Answer all Questions **Choosing either A or B** (Each answer not exceeding Two pages)

(Q.No:1-5)

Section-B **(5x10=50Marks)**

Answer all Questions **Choosing either A or B** (Each answer not exceeding Four pages)

(Q.No:6-10)

Blue Print

Section / Unit	I	II	III	IV	V
A	2	2	2	2	2
B	2	2	2	2	2

LIST OF DISCIPLINE SPECIFIC ELECTIVE PAPERS OFFERED BY DEPARTMENT OF BOTANY - PG

S.NO	COURSE CODE	TITLE OF THE COURSE
1	P23DBO1	Microbiology, Immunology and Plant Pathology
2	P23DBO2	Conservation of Natural Resources and Policies
3	P23DBO3	Ecology, Phytogeography, Conservation biology and Intellectual Property Rights
4	P23DBO4	Algal technology
5	P23DBO5	Mushroom cultivation
6	P23DBO6	Phytopharmacognosy
7	P23DBO7	Ethnobotany, Naturopathy and Traditional Healthcare
8	P23DBO8	Horticulture
9	P23DBO9	Herbal Technology
10	P23DB10	Research Methodology, Computer Applications and Bioinformatics
11	P23DB11	Biopesticide Technology
12	P23DB12	Nanobiotechnology
13	P23DB13	Applied Bioinformatics
14	P23DB14	Medicinal Botany
15	P23DB15	Phytochemistry
16	P23DB16	Biostatistics
17	P23DB17	Intellectual Property Rights
18	P23DB18	Recombinant DNA technology and Industrial applications
19	P23DB19	Silviculture and Commercial Landscaping
20	P23DB20	Secondary Plant Products and Fermentation Biotechnology
21	P23DB21	Entrepreneurial Opportunities in Botany
22	P23DB22	Applied Plant cell & Tissue culture
23	P23DB23	Organic farming
24	P23DB24	Forestry and Wood technology
25	P23DB25	Gene Cloning and Gene Therapy
26	P23DB26	Farm Sciences- Green Wealth

SRI MEENAKSHI GOVT. ARTS COLLEGE FOR WOMEN (AUTONOMOUS), MADURAI-2

CURRICULUM FRAMEWORK FOR M.Sc. BOTANY (2023-2025 BATCH)

SEMESTER–I

Course Code	Course Type	Title of the Course	Hrs/ Week	Credits	Exam Hrs	Marks		
						Int	Ext	Total
P23CB1	CC1	Plant Diversity - I: Algae, Fungi, Lichens and Bryophytes	6	6	3	25	75	100
P23CB2	CC 2	Plant Diversity - II: Pteridophytes, Gymnosperms and Paleobotany	6	6	3	25	75	100
P23CB3P	CC 3 (P)	Laboratory course - I: Algae, Fungi, Lichens, Bryophytes, Pteridophytes, Gymnosperms and Paleobotany	6	4	3	25	75	100
P23DB01	GEC/ DSEC1	Microbiology, Immunology and Plant Pathology	6	3	3	25	75	100
P23DB03	GEC/ DSEC2	Ecology, Phytogeography, Conservation Biology and Intellectual Property Rights	6	3	3	25	75	100
	Total		30	22				500

SEMESTER–II

Course Code	Course Type	Title of the Course	Hrs/ Week	Credits	Exam Hrs	Marks		
						Int	Ext	Total
P23CB4	CC4	Taxonomy of Angiosperms and Economic Botany	6	5	3	25	75	100
P23CB5	CC5	Plant Anatomy and Embryology of Angiosperms	6	5	3	25	75	100
P23CB6P	CC6 (P)	Laboratory course - II: Taxonomy of Angiosperms, Economic Botany, Plant Anatomy and Embryology of Angiosperms	6	4	3	25	75	100
P23DB10	GEC/ DSEC3	Research Methodology, Computer Applications and Bioinformatics	5	3	3	25	75	100
P23DB12	GEC/ DSEC4	Nanobiotechnology	5	3	3	25	75	100
P23SEB1	SEC1	Agriculture and Food Microbiology	2	2	3	25	75	100
	Total		30	22				600

SEMESTER–III

Course Code	Course Type	Title of the Course	Hrs/ Week	Credits	Exam Hrs	Marks		
						Int	Ext	Total
P23CB7	CC7	Cell and Molecular Biology	6	5	3	25	75	100
P23CB8	CC8	Genetics, Plant Breeding and Biostatistics	6	5	3	25	75	100
P23CB9P	CC9(P)	Laboratory course - III: Cell & Molecular Biology, Genetics, Plant Breeding and Biostatistics	6	4	3	25	75	100
P23CB10	CC10	Core Industry Module- Industrial Botany	5	3	3	25	75	100
P23DB18	GEC/ DSEC5	Recombinant DNA technology and Industrial applications	5	3	3	25	75	100
P23SEB2	SEC2	NME- Gardening	2	2	3	25	75	100
		Internship/Industrial Activity	-	2		-	--	100
	Total		30	24				700

SEMESTER–IV

Course Code	Course Type	Title of the Course	Hrs/ Week	Credits	Exam Hrs	Marks		
						Int	Ext	Total
P23CB11	CC11	Plant Physiology and Plant Metabolism	6	5	3	25	75	100
P23CB12	CC12	Biochemistry and Applied Biotechnology	6	5	3	25	75	100
P23BPW	CC13	Project with Viva voce	10	7	-	60	40	100
P23DB23	GEC/ DSEC6	Organic farming	5	3	3	25	75	100
P23SEB3	SEC3	Professional Competency Skill- Botany for Competitive Examinations	3	2	3	25	75	100
P23EAB		Extension Activity	-	1	-	--	--	100
	Total		30	23				600

DEPARTMENT OF BOTANY

Template for P.G Programmes

Semester–I	Credit	Hours	Semester-II	Credit	Hours	Semester-III	Credit	Hours	Semester–IV	Credit	Hours
1.1. Core-I	6	6	2.1. Core-IV	5	6	3.1. Core-VII	5	6	4.1. Core-XI	5	6
1.2 Core-II	6	6	2.2 Core-V	5	6	3.2 Core-VII	5	6	4.2 Core-XII	5	6
1.3 Core – III	4	6	2.3 Core – VI	4	6	3.3 Core – IX	4	6	4.3 Project with viva voce	7	10
1.4 Discipline Centric Elective -I	3	6	2.4 Discipline Centric Elective – III	3	5	3.4 Core – X	3	5	4.4Elective - VI (Industry / Entrepreneurship)	3	5
1.5 Generic Elective-II:	3	6	2.5 Generic Elective -IV:	3	5	3.5 Discipline Centric Elective - V	3	5	4.5 Skill Enhancement course / Professional Competency Skill	2	3
			2.6 **SEC**	2	2	3.6 NME I	2	2	4.6 Extension Activity	1	
						3.7 Internship/ Industrial Activity	2	-			
	22	**30**		**22**	**30**		**26**	**30**		**23**	**30**
Total Credit Points -91											

DEPARTMENT OF BOTANY

Choice Based Credit System (CBCS), Learning Outcomes Based Curriculum Framework (LOCF) Guideline Based Credits and Hours Distribution System

Post Graduate Botany Course including Lab Hours

First Year – Semester – I

Part	List of Courses	Credits	No. of Hours
	Core – I	6	6
	Core – II	6	6
	Core – III	4	6
	Elective – I	3	6
	Elective – II	3	6
		22	**30**

Semester-II

Part	List of Courses	Credits	No. of Hours
	Core – IV	5	6
	Core – V	5	6
	Core – VI	4	6
	Elective – III	3	5
	Elective – IV	3	5
	Skill Enhancement Course [SEC] - I	2	2
		22	**30**

Second Year – Semester – III

Part	List of Courses	Credits	No. of Hours
	Core – VII	5	6
	Core – VIII	5	6
	Core – IX	4	6
	Core (Industry Module) – X	3	5
	Elective – V	3	5
	Skill Enhancement Course - II	2	2
	Internship / Industrial Activity [Credits]	2	-
		24	**30**

Semester-IV

Part	List of Courses	Credits	No. of Hours
	Core – XI	5	6
	Core – XII	5	6
	Project with VIVA VOCE	7	10
	Elective – VI (Industry Entrepreneurship)	3	5
	Skill Enhancement Course – III / Professional Competency Skill	2	3
	Extension Activity	1	-
		23	**30**

Total 91 Credits for PG Courses

M.Sc. BOTANY CURRICULUM

COREI PLANT DIVERSITY - I: ALGAE, FUNGI, LICHENS AND BRYOPHYTES

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">PLANT DIVERSITY - I: ALGAE, FUNGI, LICHENS AND BRYOPHYTES</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">CORE I</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">6</td><td rowspan="2">Course Code</td><td rowspan="2">P23CB1</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td>Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">5</td><td>1</td><td colspan="2">--</td><td>6</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Students should be familiar with the basics of Algae, Fungi, Lichens and Bryophytes.</td></tr>
<tr><td colspan="2" rowspan="5">Learning Objectives</td><td colspan="6">1. To learn about the classification, distinguishing traits, geographic distribution, and reproductive cycle of algae, fungi, lichens, and bryophytes.</td></tr>
<tr><td colspan="6">2. To gain knowledge about the ecological and economic importance of algae, fungi, lichens and bryophytes.</td></tr>
<tr><td colspan="6">3. To spark interest in the evolutionary roots of plant development.</td></tr>
<tr><td colspan="6">4. To study the biodiversity by describing and explaining the morphology and reproductive processes of algae, fungi, bryophytes and microorganisms.</td></tr>
<tr><td colspan="6">5. To expose the beneficial and harmful view point.</td></tr>
<tr><td>UNIT</td><td colspan="7">CONTENTS</td></tr>
<tr><td>I</td><td colspan="7">ALGAE:
General account of algology, Contributions of Indian Phycologist (T.V.Desikachary, V.Krishnamurthy and V.S. Sundaralingam), Classification of algae by F.E. Fritsch (1935-45) & Silva (1982). Salient features of major classes: Cyanophyceae, Chlorophyceae, Xanthophyceae, Chrysophyceae, Cryptophyceae, Dinophyceae, Chloromonadineae, Euglenophyceae, Charophyceae, Bacillariophyceae, Phaeophyceae and Rhodophyceae. Range of thallus organization, algae of diverse habitats, reproduction (vegetative, asexual and sexual) and life cycles. Phylogeny and inter-relationships of algae, origin and evolution of sex in algae. Structure, reproduction and life histories of the following genera: Oscillatoria, Ulva, Codium, Diatoms and Gelidium.</td></tr>
<tr><td>II</td><td colspan="7">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), Phylogeny and inter-relationships of major groups of fungi. General characters of major classes: Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina.</td></tr>
</table>

	Heterothallism in fungi, sexuality in fungi, Para sexuality, sex hormones in fungi. Structure, reproduction and life histories of the following genera: *Plasmodiophora, Phytophthora, Rhizopus, Polyporus* and *Colletotrichum.*
III	**LICHENS:** Introduction and Classification (Hale, 1969). Occurrence and inter-relationship of phycobionts and mycobionts, structure and reproduction in Ascolichens, Basiodiolichens and Deuterolichens.
IV	**BRYOPHYTES:** General characters and Classification of Bryophytes by Watson (1971). Distribution, Structural variations and evolution of gametophytes and sporophytes in Bryopsida, Anthoceropsida and Mosses. General characters of major groups - Marchantiales, Jungermaniales, Anthocerotales, Sphagnales, Funariales and Polytrichales. Reproduction - Vegetative and sexual, spore dispersal mechanisms in bryophytes, spore germination patterns in bryophytes. Structure, reproduction and life histories of the following genera: ***Marchantia*****,** *Anthoceros ,Porella* and *Polytrichum.*
V	**ECONOMIC IMPORTANCE:** Algae - Economic importance in Food and feed - Single cell protein, Industrial products (Agar-Agar, Carrageenan, Alginic acid, Iodine, biofertilizers, Vitamins and biofuel), Medicinal value and Diatomaceous earth. Fungi - Economic importance in food, industries and medicine. Lichen - economic importance and as indicator pollution. Bryophytes - Ecological and economic importance - industry, horticulture and medicine.

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

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

	Professional Competency, Professional Communication and Transferrable Skill

Recommended texts:

1. Kumar, H.D.1999. Introductory Phycology. Affiliated East-West Press, Delhi.
2. Barsanti, L. and Guadtieri, P. 2014. Algae: Anatomy, Biochemistry and Biotechnology, 2nd Edition, CRC Press, ISBN: 1439867321.
3. Sharma, O.P. 2011. Fungi and Allied Microorganisms, Mc Graw Hill, ISBN:9780070700383, 0070700389
4. Kevin K. 2018. Fungi biology and Application, 3rd Edition, Wiley Blackwell.
5. Pandey, P.B. 2014. College Botany-1: Including Algae, Fungi, Lichens, Bacteria, Viruses, Plant Pathology, Industrial Microbiology and Bryophyta. Chand Publishing, New Delhi.
6. Singh, Pandey and Jain. 2020. A text book of Botany, 5th Edition, Rastogi Publication, Meerut.
7. Sharma, O.P. 2014. Bryophyta, Mcgraw Hill, ISBN: 9781259062872, 1259062872

Reference Books:

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

Web resources:

1. https://www.britannica.com/science/algae
2. https://en.wikipedia.org/wiki/Bryophyte
3. https://www.britannica.com/plant/bryophyte/Ecology-and-habits
4. https://www.livescience.com/53618-fungus.html.
5. http://www.uobabylon.edu.iq/eprints/paper_11_20160_754.pdf
6. https://www.youtube.com/watch?v=vcYPI6y-Udo
7. https://www.youtube.com/watch?v=XQ_ZY57MY64
8. http://www-plb.ucdavis.edu/courses/bis/1c/text/Chapter22nf.pdf

Mapping with Programme Outcomes:

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

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

COREII PLANT DIVERSITY - II: PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY

Title of the Course		**PLANT DIVERSITY - II: PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY**					
Paper Number		**CORE II**					
Category	**Core**	**Year**	**I**	**Credits**	**6**	**Course Code**	**P23CB2**
		Semester	**I**				
Instructional Hours Per 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.					

UNIT	CONTENTS
I	**PTERIDOPHYTES:** General characteristics and classification (Reimer, 1954). Range of structure, reproduction and evolution of the gametophytes, Gametophyte types – sex organs. Apogamy and Apospory. Life cycles. Stellar evolution. Heterospory and seed habit, Telome theory, morphogenesis, Economic importance of Pteridophytes.
II	**PTERIDOPHYTES:** Structure, anatomy, reproduction and life histories of the following genera: *Isoetes, Equisetum Angiopteris, Pteris* and *Azolla.*
III	**GYMNOSPERMS:** General characters - A general account of distribution of Gymnosperms. Morphology, anatomy, reproduction, phylogeny and classification (K.R.Sporne, 1965). Economic importance of Gymnosperms.

IV	**GYMNOSPERMS:** Structure (Exomorphic and endomorphic), anatomy, reproduction and life histories of the following genera: *Cycas, Cupressus, Araucari and Gnetum* .
V	**PALEOBOTANY:** Geological Scale; Radiocarbon dating; Contribution of Birbal Sahni to Paleobotany. Gondwana flora of India. Study of fossils in understanding evolution. Fossilization and fossil types. Economic importance of fossils – fossil fuels and industrial raw materials and uses. Study of organ genera: *Rhynia, Lepidocarpon, Cordaites* and *Lyginopteris.*

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

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

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination (Question paper)	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

Recommended Text:

1.Vashishta, P.C. Sinha, A.K and Anil Kumar. 2016. Botany for Degree students. Gymnosperms. S. Chand and Company Ltd., New Delhi.

2.Singh,V.,Pande,P.C andJain,D.K. 2021. A Text Book of Botany. Rastogi Publications, Meerut.

3.Bhatnagar, S.P and Alok Moitra. 2020. Gymnosperms, New Age International (P) Ltd., Publishers, Bengaluru.

4.Sharma, O.P. 2017. Pteridophyta, McGraw Hill Education, New York.

5.Vashishta.P.C.,A.K.Sinha and AnilKumar.2018.Botany for Degree students-Gymnosperms.S.

Chand and Company Ltd., NewDelhi.
6.Johri, R.M, Lata, S, Tyagi, K. 2005. A text book of Gymnosperms, Dominate pub and Distributer, New Delhi.

Reference books:

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

Web resources:

1. https://www.toppr.com/guides/biology/plant-kingdom/pteridophytes/
2. http://www.bsienvis.nic.in/Database/Pteridophytes-in-India_23432.aspx
3. https://books.google.co.in/books?hl=en&lr=&id=Pn7CAAAQBAJ&oi=fnd&pg=PA1&dq=Introduction+to+Gymnosperms&ots=sfYSzCL02&sig=ysX1KRvetV0bAza4Sq6RWau4XU8&redir_esc=y#v=onepage&q=Introduction%20to%20Gymnosperms&f=false
4. https://books.google.co.in/books/about/Botany_for_Degree_Gymnosperm_Multicolor.html?id=HTdFYFNxnWQC&redir_esc=y
5. https://books.google.co.in/books/about/Gymnosperms.html?id=4dvyNckni8wC
6. https://arboretum.harvard.edu/wp-content/uploads/2013-70-4-beyond-pine-cones-an-introduction-to-gymnosperms.pdf
7. https://www.palaeontologyonline.com/
8. https://books.google.co.in/books/about/Paleobotany.html?id=HzYUAQAAIAAJ
   https://trove.nla.gov.au/work/11471742?q&versionId=46695996

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	3	3
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-III LABORATORY COURSE-I: ALGAE, FUNGI, LICHENS, BRYOPHYTES, PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY

<table>
<tr><td>Title of the Course</td><td colspan="8">CORE-III LABORATORY COURSE-I: ALGAE, FUNGI, LICHENS, BRYOPHYTES, PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY</td></tr>
<tr><td>Paper Number</td><td colspan="8">CORE III</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td colspan="2" rowspan="2">P23CB3P</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2">Instructional Hours</td><td colspan="2">Lecture</td><td>Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">Per week</td><td colspan="2">4</td><td>--</td><td colspan="2">2</td><td>6</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="7">Students should be familiar with the fundamentals of algae, fungi, lichens, Bryophytes, Pteridophytes, Gymnospersms, Paleobotany and microbes in addition to essential laboratory techniques.</td></tr>
<tr><td colspan="2" rowspan="5">Learning Objectives</td><td colspan="7">1. To learn how to employ the use of instruments, technologies and methodologies related to thallophytes and non-flowering plant groups.</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td colspan="7">3. To comprehend the fundamental concepts and methods used to identify Bryophytes, Pteridophytes and Gymnosperms through morphological changes and evolution, anatomy and reproduction.</td></tr>
<tr><td colspan="7">4. To develop the technical abilities in staining, sectioning, Sterilizing and characterizing thallophytes, and other varieties of non-flowering plants.</td></tr>
<tr><td colspan="7">5. To compare the structural diversity of fossil and extant plant species.</td></tr>
</table>

EXPERIMENTS

Study of the Morphology & Anatomy of the vegetative and reproductive parts of the following:

I Algae:

a) Cyanophyceae - Nostoc, Oscillatoria

b) Chlorophyceae - Spirogyra,Caulerpa,Volvox, Chara.

c) Bacillariophyceae - Diatoms

d) Phaeophyceae - Sargassum, Ectocarpus, Laminaria.

e) Rhodophyceae - Gracilaria, Polysiphonia

II Fungi:

a) Myxomycetes - *Plasmodiophora*

b) Oomycetes - *Saprolegnia, Albugo*

c) Zygomycetes - *Rhizopus, Mucor*

d) Ascomycetes - *Aspergillus, Penicillium.*

e) Basidiomycetes - *Agaricus, Polyporus, Puccinia.*

f) Deuteromycetes - *Cercospora , Fusarium*

III Lichens: *Usnea*

IV Bryophytes:

a) Marchantiales - *Marchantia, Riccia.*

b) Jungermaniales - *Porella*

c) Anthocerotales - *Anthoceros*

d) Sphagnales - *Sphagnum*

e) Polytrichales - *Polytrichum*

V Pteridophytes:

a) Selaginellaceae - *Selaginella*

b) Equisetaceae - *Equisetum*

c) Marsileaceae - *Marsilea*

d) Gleicheniaceae - *Gleichenia*

e) Azollaceae - *Azolla*

VI Gymnosperms:

a) Cycadaceae -Cycas

b) *Araucariaceae* - *Araucaria*

c) Podocarpaceae - *Podocarpus*

d) Cupressaceae - *Cupressus*

e) Gnetaceae - *Gnetum*

VII Fossil slides observation:

a) Rhynia

b) Lepidocarpon

c) Sphenophyllum

d) Lyginopteris

e) Lagenostoma.

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

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	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

Recommended Text:

1. Kumar,H.D.1999. Introductory Phycology. Affiliated East-West Press, 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 andKrayesky,D. 2013.GeneralBotany laboratory Manual.AuthorHouse,Bloomington, USA.
2. Webster,JandWeber,R.2007.IntroductiontoFungi,3rdEd.CambridgeUniversityPress,Cambridge.
3. Sharma,O.P.2017. Bryophyta, Mac Millan India Ltd, NewDelhi.
4. Ashok, M. Bendre and Kumar. 2010. A text book of Practical Botany, Algae, Fungi, Lichen, Bryophyta, Pteridophyta, Gymnosperms and Palaeobotany. Revised edition. Published by Rakesh Kumar Rastogi publication.
5. Gangulee, H.C and A.K. Kar. 2013. College Botany. Vth Edition. S. Chand.

Web resources:

1. https://www.frontiersin.org/articles/10.3389/fmicb.2017.00923/full
2. https://microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175e.pdf
3. http://www.cuteri.eu/microbiologia/manuale_microbiologia_pratica.pdf
4. https://www.amazon.in/Manual-Practical-Bryophyta-Suresh-Kumar/dp/B0072GNFX4
5. https://www.amazon.in/Practical-Manual-Pteridophyta-Rajan-Sundara/dp/8126106883
6. https://www.google.co.in/books/edition/Gymnosperms/3YrT5E3Erm8C?hl=en&gbpv=1&dq=gymnosperms&printsec=frontcover
7. https://www.amazon.in/Paleobotany-Biology-Evolution-Fossil-Plants/dp/0123739721

Mapping with Programme Outcomes:

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

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

ELECTIVE I: MICROBIOLOGY, IMMUNOLOGY AND PLANT PATHOLOGY

Title of the Course	**MICROBIOLOGY, IMMUNOLOGY AND PLANT PATHOLOGY**						
Paper Number	**ELECTIVE I**						
Category	**ELECTIVE**	**Year**	**I**	**Credits**	**3**	**Course Code**	**P23DB01**
		Semester	**I**				

Instructional Hours Per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	5	**1**	**--**	**6**

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

UNIT	**CONTENTS**
I	**BACTERIA:** Types of microorganisms. General characteristic of bacteria -Outline classification of Bergey's manual of 9th edition. Bacterial growth – batch culture and continuous culture. Growth Curve. Determination of bacterial growth - Direct method: Haemocytometer, Viable plate count; Indirect method: Turbidity. Nutritional types. Reproduction - Fission and sporulation. Genetic recombination- Transformation, Transduction and Conjugation.
II	**VIRUSES:** General characters, Classification, Structure, Multiplication. Overview of Phycoviruses and Mycoviruses. Viruses of Eukaryotes - Plant viruses**.** Control of viral infections. Replication of DNA and RNA phages -Lytic and Lysogenic cycle. Viroids and prions and Mycoplasma a brief account.
	MICROBIOLOGY: Beneficial role of microbes **-** yoghurt, Cheese, Wine, & green tea. Spoilage of fruits, vegetables, meats, eggs and canned foods. Microbial toxins - Exotoxin,

III	Endotoxin & Mycotoxin. Food Preservation – temperature, drying, radiation and chemicals. Soil Microbiology: Importance of Microbial flora of soil. Interaction among soil microbes (positive and negative interactions) & with higher plants (rhizosphere & phyllosphere). Environmental Microbiology: Microbiology of water and air. Water borne diseases - chicken pox. Air borne diseases - Swine flu.. Microbial degradation of chemical pesticides and hydrocarbon.
IV	**IMMUNOLOGY:** Introduction; Immune System; Types of Immunity - Innate and Acquired.Immune Cells - Hematopoiesis, B and T lymphocytes - Maturation, NK cells. Antigen: Definition, Properties and types. Antibody -Structure, types and function. Antigen- Antibodyinteractions: definition, types- Precipitation, Agglutination, Complement fixation. Immune Response – Humoral and Cell Mediated. Vaccines –types and recombinant vaccines. Immunodiagnosis –Widal test, Enzyme-Linked Immunosorbent Assay (ELISA) and Immunoelectrophoresis
V	**PLANT PATHOLOGY:** Classification of plant diseases, Symptomology (important symptoms ofplant pathogens). Principles of plant infection –Inoculum, inoculum potential, Pathogenicity. Disease triangle. Causal agents of plant diseases - biotic causes and Abiotic causes. Mechanism of penetration- Disease development of pathogen (colonization) and dissemination of pathogens. Role of enzymes and toxins in disease development. Defence mechanism of host – structural and biochemical defences. Important diseases of crop plants in India - Little leaf of Brinjal,wheat rust,Bacterial leaf blight of rice and Red rust of sugarcane . Principles of disease management – Cultural practices, physical, chemical and biological methods. Plant quarantine and legislation.

Course outcomes: CO	**On completion of this course the student will be able to**	**Programme outcomes**
CO1	Recognize the general characteristics of microbes, plant defense and immune cells.	K1
CO2	Explain about the stages in disease development and various defense mechanisms in plants and humans.	K2
CO3	Elucidate concepts of microbial interactions with plant and humans.	K3
CO4	Analyze the importance of harmful and beneficial microbes and immune system	K4
CO5	Determine and interpret the detection of pathogens and appreciate their adaptive strategies.	K5 & K6

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination (Question paper)	Questionsrelatedtotheabovetopics,fromvariouscompetitive examinationsUPSC/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

Recommended Text:

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

Reference Books:

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

Web resources:

1. https://www.wileyindia.com/a-textbook-of-plant-pathology.html
2. https://www.britannica.com/science/plant-disease.
3. https://www.planetatural.com/pest-problem-solver/plant-disease/
4. https://www.elsevier.com/books/plant-pathology/agrios/978-0-08-047378-9
5. https://www.elsevier.com/life-sciences/immunology-and-microbiology/books
6. https://www.amazon.in/INTRODUCTION-IMMUNOLOGY-RAFIA-IMRAN-ebook/dp/B09B66SD3J

Mapping with Programme Outcomes:

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

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

ELECTIVE I: CONSERVATION OF NATURAL RESOURCES AND POLICIES

Title of the Course		**CONSERVATION OF NATURAL RESOURCES AND POLICIES**					
Paper Number		**ELECTIVE I**					
Category	**ELECTIVE**	**Year**	**I**	**Credits**	**3**	**Course Code**	**P23DB02**
		Semester	**I**				

Instructional Hours Per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	5	**1**	**--**	**6**

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.

UNIT	**CONTENTS**
I	**NATURAL RESOURCES:** Definition - Importance - Classification - Human physiological socio-economic and cultural development - Human Population Explosion - Natural Resource Degradation - Concept of conservation - Value system - Equitable resource use for sustainable life system.
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:** Soil, Complexity of soil nature, regional deposits, Land use and capability classification systems, Land use Planning models and their limitations. Impacts of natural and man-made activities on land characteristics and land use planning- Soil Erosion -Loss of Soil Nutrients - Restoration of Soil Fertility - Soil Conservation Methods and Strategies in India. Wet Land Conservation and Management - Ecological Importance of wet lands in India - Conservation Strategy and ecological Importance. Water Resources: Rivers and Lakes In India - Water Conservation and ground water level increase - Watershed Programme.

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:** Need for policies- Public Policy -Economic policies- Relationship between economic development and environment - Implementing Environmental Public Policy Strategies in pollution control - Constitutional provisions in India regarding environment - Public Awareness and Participation in Environmental Management - National Land Use Policy 1988 – Industrial Policy 1991.

Course outcomes: CO	**On completion of this course the student 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 & K6
CO3	Evaluate the management strategies of different natural resources	K3
CO4	Reflect upon the different national and international efforts in resource management and their conservation.	K4
CO5	State the various environmental policy passed to conserve the natural resources.	K5

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

Recommended Text:

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

Mapping with Programme Outcomes:

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 II: ECOLOGY, PHYTOGEOGRAPHY, CONSERVATION BIOLOGY &INTELLECTUAL PROPERTY RIGHTS

Title of the Course	**ECOLOGY, PHYTOGEOGRAPHY, CONSERVATION BIOLOGY & INTELLECTUAL PROPERTY RIGHTS**						
Paper Number	**ELECTIVE II**						
Category	**ELECTIVE**	**Year**	**I**	**Credits**	**3**	**Course Code**	**P23DB03**
		Semester	**II**				

Instructional Hours Per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	5	**1**	**--**	**6**

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	**ECOLOGICAL PRINCIPLES:** Introduction –Definitions. Diversity of plant life; growth form, life form. Basic concepts of population ecology– population dynamics – Regulation of population density. Basics concepts of community– characteristics,composition,structure,originanddevelopment– communitydynamics–trends of succession-Hydrosere
II	**ECOSYSTEMECOLOGY AND RESOURCEECOLOGY:** Introduction – kinds – major types – functional aspects of ecosystem: Food chain and food web, energy flow, laws of thermodynamics. Productivity–primary and secondary productivity –GPP&BPP. **Resource Ecology:** renewable and non-renewable energy sources. Soil: Formation, types and profile-erosion and conservation. 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 labeling.
III	**PHYTOGEOGRAPHY:** Phytogeographical Zones - Vegetation types of India and Tamil Nadu,

	Distribution: Continuous, Discontinuous and Endemism. Theories of discontinuous distribution: Continental drift, Age and area hypothesis. Geographical Information System (GIS)Principles of remote sensing and its applications.
IV	**BIODIVERSITY AND CONSERVATION ECOLOGY:** Definition, types of biodiversity – values of biodiversity – Hot spots – Threats to biodiversity: habitat loss. Poaching of wild life – Invasion of exotic species, man and wild life conflicts- endangered and endemic plant species of India, Red list categories of IUCN, Biotechnology assisted plant conservation-*insitu* and *exsitu* methods.
V	**INTELLECTUAL PROPERTY RIGHTS:** Intellectual Property Rights – Introduction, Kinds of Intellectual Property Rights- Patents, Trademarks, Copyrights, Trade Secrets. Need for intellectual property right, Advantages and Disadvantages of IPR. International Regime Relating to IPR – TRIPS, WIPO, WTO, GATTS. IPR in India genesis and development. Geographical Indication – introduction, types. Patent filing procedure for ordinary application.

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

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination Question paper)	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

Recommended Text:

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

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

Reference Books:

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

Web resources:

1. https://www.intechopen.com/chapters/56171
2. https://plato.stanford.edu/entries/biodiversity/
3. https://sciencing.com/four-types-biodiversity-8714.html.
4. https://www.iaea.org/topics/plant-biodiversity-and-genetic-resources
5. http://www.bsienvis.nic.in/Database/Status_of_Plant_Diversity_in_India_17566.aspx
6. https://www.youtube.com/watch?v=qtTLiQoYTyQ
7. https://www.youtube.com/watch?v=208B6BtX0Ps
8. https://www.youtube.com/watch?v=6p1TpVJYTds
9. https://www.amazon.in/Intellectual-Property-Rights-Vijay-Durafe-ebook/dp/B08N4VRQ86

Mapping with Programme Outcomes:

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

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

ELECTIVE II: ALGAL TECHNOLOGY

Title of the Course	**ALGAL TECHNOLOGY**						
Paper Number	**ELECTIVE II**						
Category	**ELECTIVE**	**Year**	**I**	**Credits**	**3**	**Course Code**	**P23DB04**
		Semester	**I**				

Instructional Hours Per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	5	**1**	**--**	**6**

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	**SCOPE OF ALGAL TECHNOLOGY :** Scope of algal technology - Commercial potential and utility of algae. Algae as sources for food, feed, pigments, Pharmaceuticals and neutraceuticals, fine chemicals, fuel, biofertilizers and hormones. Economic importance of algae in India.
II	**ALGAL PRODUCTS:** Industrial application of algae - fuel, algal lipids - transesterification to ester fuel - substitutes for petroleum derived fuel. Algal products - Spirulina mass cultivation and its applications. Mass cultivation of micro-algae as source of protein and as feed. Liquid seaweed fertilizers - method of preparation, applications and its advantages over inorganic fertilizers.
III	**ALGAL PRODUCTION AND UTILIZATION:** Algal production systems; Strain selection; Algal growth curve; Culture media; cultivation methods - small scale and Large-scale cultivation of algae. Harvesting and packing. Therapeutic uses - antioxidant, anti-ulcerogenic, antifungal, antibiotics, antitumor and antiviral compounds. Production of pigments and their utilization.
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 nanobiotechnology.

V	**ROLE OF ALGAE IN ENVIRONMENT MANAGEMENT** Role of algae in environmental health - Sewage treatment, treating industrial effluent, 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 centers in India and abroad and their importance.	
Course outcomes: 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& K3
CO2	Realization of the commercial potential of algal products.	K5
CO3	Analyze emerging areas of algal biotechnology for identifying therapeutic importance of algal products and their uses.	K2 & K4
CO4	Gain more information about algae genetics.	K4
CO5	Translate various algal technologies for the benefit of the ecosystem.	K3 & 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	

Recommended Text:

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. Aravali International, 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. 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.
6. 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, Band Yusuf, C. 2016.Algal biotechnology: Products and processes. 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

Mapping with Programme Outcomes:

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)

CORE-IV TAXONOMY OF ANGIOSPERMS AND ECONOMIC BOTANY

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">PLANT TAXONOMY OF ANGIOSPERMS AND ECONOMIC BOTANY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">CORE IV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2">P23CB4</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours Per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>5</td><td colspan="2">1</td><td>--</td><td colspan="2">6</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Prior knowledge on morphological, anatomical characteristics and uses of plants.</td></tr>
<tr><td colspan="2" rowspan="5">Learning Objectives</td><td colspan="6">1. To be familiar with the basic concepts and principles of plant systematics.</td></tr>
<tr><td colspan="6">2. To develop a suitable method for correct characterization and identification of plants.</td></tr>
<tr><td colspan="6">3. To understand the importance of taxonomic relationships in research of plant systematics.</td></tr>
<tr><td colspan="6">4. To provide information on various classification systems</td></tr>
<tr><td colspan="6">5. To know about the economic importance of plants.</td></tr>
<tr><td colspan="2">UNIT</td><td colspan="6">CONTENTS</td></tr>
<tr><td colspan="2">I</td><td colspan="6">TAXONOMY AND SYSTEMATICS:
Botanical exploration and contribution with special reference to India by William Roxburgh, J.D. Hooker, Robert Wright, Nathanial Wallich and Gamble, J.S. Principles of classification as proposed – Artificial – Linnaeus, Natural – Bentham and Hooker, Phylogenetic system -Hutchinson, Modern -APGIV. Botanical gardens and herbaria of world, preparation and maintenance of Herbarium, Botanical survey of India – its organization and role.</td></tr>
<tr><td colspan="2">II</td><td colspan="6">MODERN TRENDS IN TAXONOMY:
Modern trends in taxonomy, chemotaxonomy, numerical taxonomy, biosystemics. ICN binomial nomenclature, importance and principles. Typification, principles of priority,Nyms, effective and valid publication, author citation.Glossories and dictionaries, Taxonomic literature (Index Kewensis -IPNI)</td></tr>
<tr><td colspan="2">III</td><td colspan="6">SYSTEMATIC ANALYSIS OF PLANTS-I:
Polypetalae – Nympheaceae, Portulaceae, Rhamnaceae, Vitaceae, Sapindaceae, Combretaceae, Cucurbitaceae.</td></tr>
<tr><td colspan="2">IV</td><td colspan="6">SYSTEMATIC ANALYSIS OF PLANTS-II:
Gamopetalae - Asteraceae, Sapotaceae, Oleaceae, Boraginaceae, Bignoniaceae, Convolvulaceae, Acanthaceae, Verbenaceae.
Monochlamydeae – Nyctaginaceae, Casuarinaceae. Monocots – Orchidaceae, Amarylidaceae, Lilliaceae, Commelinaceae, Cyperaceae.</td></tr>
</table>

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

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

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

Recommended Text:

1. Pandey, B.P. 2013. Taxonomy of Angiosperms, S. Chand Publishing, New Delhi.
2. Sharma, O.P. 2017. Plant Taxonomy. (II Edition).The McGraw Hill Companies.
3. Singh, G. 2007. Plant systematics theory and practices. Oxford and IBH Publishing Co.
4. Jain, S.K and Rao R.R. 1993. A handbook of field and herbarium methods. Today and Tomorrow Publ.

5. Pandurangan, A.G., Vrinda, K.B and Mathew Dan. 2013. Frontiers in plant taxonomy. JNTBGRI, Thiruvananthapuram, Kerala.
6. Vardhana, R. 2009. Economic Botany. 1st ed. Sarup Book Publishers Pvt Ltd. New Delhi.
7. Subramaniam, N.S. 1997. Modern plant taxonomy. Vikas Publishing House, New Delhi.

Reference Books:

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

Web resources:

1.https://www.ipni.org/

2.http://www.theplantlist.org/

3.https://www.amazon.in/PLANT-TAXONOMY-Sharma/dp/0070141592

5.https://www.tropicos.org/home

6.http://apps.kew.org/herbcat/gotoHerbariumGrowthPage.do

7.https://www.absbooksindia.com/shop/science/botany/textbook-of-economic-botany

Mapping with Programme Outcomes:

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

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

CORE-V: PLANT ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS

Title of the Course	**PLANT ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS**						
Paper Number	**CORE V**						
Category	**Core**	**Year**	**I**	**Credits**	**5**	**Course Code**	**P23CB5**
		Semester	**II**				

Instructional Hours Per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	5	**1**	**--**	**6**

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

UNIT	**CONTENTS**
I	**CELL WALL:** Plant tissues: Meristems: Classifications: Theories of shoot and root apices. Vascular Cambium: Composition and organization. Xylem: Primary and secondary xylem - tracheary elements and vessels – vessel less dicots - xylem rays and axial parenchyma of angiosperm wood; Dendrochronology – grain, texture and figure in wood: ring porous and diffuse porous wood. Phloem: Ultra structure and ontogeny of xylem and phloem
II	**PERIDERM:** Structure, organization and activity of phellogen. Polyderm and Rhytiderm - wound periderm. Normal secondary thickening in Dicots; Anomalous secondary growth in Dicots. (Amaranthaceae, Aristolochiaceae, Bignoniaceae, Nyctaginaceae) and arborescent Monocots- Dracena. Ontogeny of leaf, Structure and types of Stomata. Nodal anatomy; Kranz anatomy and its significance.
III	**MICROSPORANGIUM AND MALE GAMETOPHYTE:** Structure and development of Anther; Ultrastructure and physiology of anther tapetum; Male gametophyte; Palynology: Morphology and ultra structure of pollen wall, pollen kitt, pollen analysis, pollen storage, pollen sterility and pollen physiology.

IV	**MEGASPORANGIUM AND FEMALE GAMETOPHYTE:** Structure and development of Megasporangium; Types of ovules, Endothelium, obturator and nucellus. Megasporogenesis: Female gametophyte: Structure, types, haustorialbehavior and Nutrition of embryo sacs. Fertilization: Double fertilization and triple fusion; Endosperm: Development of endosperm, types, physiological efficiency of endosperm haustoria and functions; Ruminate endosperm. Embryogeny: Development of monocot (Grass) and dicot (Crucifer) embryos.	
V	**POLYEMBRYONY:** Causes of Polyembryony, classification, induction and practical application. Apomixis and its significance. Seed and Fruit development and role of growth substances. Parthenocarpy and its importance.	
Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Learn the structures, functions and roles of apical *vs* lateral meristems in monocot and dicot plant growth.	K1& K2
CO2	Study the function and organization of woody stems derived from secondary growth in dicot and monocot plants.	K1&K4
CO3	Apply their idea on sectioning and dissection of plants to demonstrate various stages of plant development.	K2& K6
CO4	Understand the various concepts of plant development and reproduction.	K3& K6
CO5	Profitably manipulate the process of reproduction in plants with a professional and entrepreneurial mind set.	K5
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	

Recommended Text:

1. Bhojwani, S.S. Bhatnagar, S.P and Dantu, P.K. 2015. The Embryology of Angiosperms (6th revised and enlarged edition). Vikas Publishing House, New Delhi.
2. Maheshwari, P. 1963. Recent Advances in Embryology of Angiosperms. Intl. Soc. Plant Morphologists, New Delhi.
3. Sharma, P.C. 2017. Text Book of Plant Anatomy. Arjun Publishing House, New Delhi.

4. Pandey.S.N and Ajanta Chandha. 2006. Plant Anatomy and Embryology. Vikas Publishinf House Pvt. Ltd, New Delhi.
5. Narayanaswamy, S. 1994. Plant Cell and Tissue Culture. Tata McGraw Hill Ltd. New Delhi.

Reference Books:

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

Web resources:

1. https://www.ipni.org/
2. http://www.theplantlist.org/
3. https://faculty.etsu.edu/liuc/plant_anatomy_sites.htm
4. http://aryacollegeludhiana.in/E_BOOK/Botany/plant_anatomy.pdf
5. https://www.uou.ac.in/sites/default/files/slm/BSCBO-202.pdf
6. http://greenlab.cirad.fr/GLUVED/html/P1_Prelim/Bota/Bota_typo_014.html
7. https://www.askiitians.com/

Mapping with Programme Outcomes:

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

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

CORE-VI: LABORATORY COURSE - II: TAXONOMY OF ANGIOSPERMS, ECONOMIC BOTANY, PLANT ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS

<table>
<tr><td>Title of the Course</td><td colspan="8">LABORATORY COURSE - II:
TAXONOMY OF ANGIOSPERMS, ECONOMIC BOTANY, PLANT ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS</td></tr>
<tr><td>Paper Number</td><td colspan="8">CORE VI</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td colspan="2" rowspan="2">Course Code</td><td rowspan="2">P23CB6P</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2">Instructional Hours Per week</td><td>Lecture
2</td><td colspan="2">Tutorial
-</td><td>Lab Practice
4</td><td colspan="3">Total
6</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="7">Theoretical understanding of plant taxonomy, ecology and phytogeography, plant anatomy and embryology as well as basic laboratory skills for the relevant core course.</td></tr>
<tr><td colspan="2" rowspan="5">Learning Objectives</td><td colspan="7">1. Understand and develop skill sets in plant morphological, floral characteristics and artificial key preparation.</td></tr>
<tr><td colspan="7">2. Expedite skilled workers to carry out research in frontier areas of plant science.</td></tr>
<tr><td colspan="7">3. Classify meristems and identify their structures, functions and roles in monocot and dicot plants growth and secondary growth of woody plants</td></tr>
<tr><td colspan="7">4. Learn the importance of plant anatomy in plant production systems.</td></tr>
<tr><td colspan="7">5. Know about different vegetation sampling methods.</td></tr>
<tr><td>UNIT</td><td colspan="8">EXPERIMENTS</td></tr>
<tr><td>I</td><td colspan="8">TAXONOMY AND ECONOMIC BOTANY OF ANGIOSPERMS:
1. Preparation of artificial keys.
2. Description of a species, based on virtual herbarium and live specimens of the families mentioned in the theory.
3. Study the products of plants mentioned in the syllabus of economic botany with special reference to the morphology, botanical name and family.
4. Solving nomenclature problems.
Field trip:
A field trip at least 3-4 days to a floristically rich area to study plants in nature and field report submission of not less than 20 herbarium sheets representing the families studied.</td></tr>
<tr><td>II</td><td colspan="8">ANATOMY:
1. Study of shoot apex of Hydrilla
2. Observation of cambial types.
3. Sectioning and observation of nodal types.
4. Study of anomalous secondary growth of the following:
STEM- Nyctanthus, Bouerhhavia, Aristolochia, Bignonia, Piper petal and Mirabilis.</td></tr>
</table>

	ROOT: *Acyranthus* 5. Observation of stomatal types by epidermal peeling. 6. Maceration of wood and observation of the components of xylem. 7. Double staining technique to study the stem anomali.	
III	**EMBRYOLOGY:** 1. Observation of T.S. of anther. 2. Observation of ovule types. 3. Observation of mature embryo sacs. 4. Dissection and observation of embryos (globular and cordate embryos). 5. Study of pollen morphology 6. Study of in vitro pollen germination. 7. Observation of endosperm types.	
Course outcomes: to: CO	**On completion of this course, the students will be able**	**Programme outcomes**
CO1	To gain recent advances in plant morphological and floral characteristics.	K1
CO2	Understand about different floral characteristics and artificial key preparation which employed for plant identification and conservation.	K2
CO3	Recall or remember the information including basic and advanced in relation with plant anatomy and embryology.	K4 &K5
CO4	Apply their idea on sectioning and dissection of plants to demonstrate various stages of plant development.	K3
CO5	Know about different vegetation sampling methods.	K3

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination (Question paper)	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

Recommended Text:

1. Subramaniam, N.S. 1996. Laboratory Manual of Plant Taxonomy. Vikas Publishing House Pvt. Ltd., New Delhi.
2. Gokhale, S.B., Kokate, C.K. and Gokhale, A. 2016. Pharmacognosy of Traditional Drugs. NiraliPrakashan, 1st Edition. ISBN: 9351642062.
3. Joshi, S.G. 2018. Medicinal Plants. Oxford & IBH Publishing C., Pvt., Ltd., New Delhi. ISBN: 9788120414143.
4. Cutler, D.F., Botha, C.E.J., Stevenson, D.W., and William, D. 2008. Plant anatomy: an applied approach (No. QK641 C87). Oxford: Blackwell, UK.
5. Sundara, R. S. 2000. Practical manual of plant anatomy and embryology. Anmol Publ. PVT LTD, New Delhi.
6. Panshin, A.J and C. de Zeeuw.1980.Textbook of wood technology. Structure, identification and uses of the commercial woods of the United States and Canada. Fourth Edition. New York: McGraw-Hill Book Company.
7. Sharma, H.P. 2009. Plant Embryology: Classical and Experimental, Bombay Popular Prakashan, ISBN-8173199698, 9788173199691.

Reference books:

1. Aler Gingauz.2001. MedicinalChemistry.OxfordUniversityPress&WileyPublications.
2. MannJ.Davidson,R.SandJ.B.Hobbs,D.V.Banthorpe,J.B.Harborne.1994.*NaturalProducts*.Longman Scientificand TechnicalEssex.
3. Gopalan,C., B.V.RamasastriandS.C.Balasubramanian.1985.NutritiveValueofIndianFoods. NationalInstituteofNutrition,Hyderabad.
4. Harborne. J.B. 1998. Phytochemical methods. A guide to modern techniques of Plant Analysis, Chapman and Hall publication, London.
5. Traditionalplantmedicinesassourcesofnewdrugs.P.JHoughtoninPharmacognosy.Treaseand Evan's.16Ed.2009.
6. Sundara Rajan, S, 2003. Practical Manual of Plant Anatomy and Embryology 1st ed, Anmol Publications, ISBN-812610668.
7. Katherine Esau. 2006. Anatomy of Seed Plants. 2nd edition, John Wiley and Sons.

Web resources:

1. https://www.kobo.com/gr/en/ebook/phytochemistry-2
2. https://www.amazon.in/Textbook-Pharmacognosy-Phytochemistry-Kumar-Jayaveera-ebook/dp/B06XKSY76H
3. https://www.amazon.in/Computational-Phytochemistry-Satyajit-Dey-Sarker-ebook/dp/B07CV96NZJ
4. https://studyfrnd.com/pharmacognosy-and-phytochemistry-book/
5. https://www.worldcat.org/title/textbook-of-pharmacognosy-and-phytochemistry/oclc/802053616
6. https://www.worldcat.org/title/phytochemistry/oclc/621430002

Mapping with Programme Outcomes:

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

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

ELECTIVE-III: RESEARCH METHODOLOGY, COMPUTER APPLICATIONS & BIOINFORMATICS

Title of the Course	**RESEARCH METHODOLOGY, COMPUTER APPLICATIONS & BIOINFORMATICS**						
Paper Number	**ELECTIVE III**						
Category	**ELECTIVE**	**Year**	**I**	**Credits**	**3**	**Course Code**	**P23DB10**
		Semester	**II**				
Instructional Hours Per week		**Lecture**	**Tutorial**		**Lab Practice**		**Total**
		3	**2**		**--**		**5**
Pre-requisite		To impart expertise about analysis and research.					
Learning Objectives		1. To equip students to collect, analyze and evaluate data generated by their own inquiries in a scientific manner.					
		2. To provide an overview on modern equipments that they would help students gain confidence to instantly commence research careers and/or start entrepreneurial ventures.					
		3. To develop interdisciplinary skills in using computers in botany to learn about the biological database.					
		4. Students aware with the most recent technologies for sequencing and bioinformatics analysis and is able to apply them to the structural and functional genomics of plants.					
		5. Operate various software resources with advanced functions and its open office substitutes.					

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

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

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination Question paper)	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

Recommended Text:

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

Reference Books:

1. Jayaraman, J. 2000. Laboratory manual of Biochemistry, Wiley Eastern Limited, New Delhi 110 002.
2. Pevsner,J.2015.Bioinformaticsandfunctionalgenomics.Hoboken,NJ:Wiley-Blackwell.
3. Arthur Conklin W.M and Greg White, 2016. Principles of computer security. TMH. McGraw-Hill Education; 4 edition.
4. Irfan Ali Khan and Attiya Khanum (eds.). 2004. Introductory Bioinformatics. Ukaaz Publications, Hyderabad.

5. Arthur Conklin W.M., and Greg White. 2016. Principles of computer security. TMH., McGraw-Hill Education; 4th edition
6. Mishra Shanthi Bhusan. 2015. Handbook of Research Methodology - A Compendium for Scholars & Researchers, Ebooks2go Inc.
7. Narayana, P.S.D. Varalakshmi, T. Pullaiah. 2016. Research Methodology in Plant Science, Scientific Publishers, Jaipur, Rajasthan.

Web resources:

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

Mapping with Programme Outcomes:

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

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

ELECTIVE III: BIOPESTICIDE TECHNOLOGY

Title of the Course	**BIOPESTICIDE TECHNOLOGY**						
Paper Number	**ELECTIVE III(b)**						
Category	**ELECTIVE**	**Year**	**I**	**Credits**	**3**	**Course Code**	**P23DB11**
		Semester	**II**				

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

Pre-requisite	Prior knowledgeonimpactofchemicalpesticidesonenvironmentandbiopesticides.
Learning Objectives	1. To understand the value and applications of biopesticides.
	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 targets.

UNIT	**CONTENTS**
I	**INTRODUCTION:** Introduction of biopesticides. Biological control, History and concept of biopesticides. Importance, scope and potential of biopesticide. Advantages for the use of biopesticides.
II	**TYPES OF BIOPESTICIDES:** Classification of biopesticides, botanical pesticides and biorationales. Mass production technology of bio-pesticides. Major classes-Properties and uses of Bioinsecticides, biofungicides, biobactericides, bionematicides and bioherbicides. Importance of neem in organic agriculture.
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 biopesticides. Prospects and problems in commercialization and efficiacy of biopesticides. Commercial products of biopesticides.	
Course outcomes: 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 onlife.	K1& K2
CO2	Aware the significance of biopesticides and their beneficial role in controlling insect pests, diseases, nematodes and weeds.	K1&K4
CO3	Knowledge on identification of promising biopesticides and their mechanisms of action against insect pests, diseases, nematodes and weeds.	K2& K6
CO4	Learn the mass production and formulation technology of selected biopesticides.	K3& K6
CO5	Knowledge on product development for commercialization of biopesticides.	K5
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	

Recommended Text:

1. Johri,J.2020.RecentAdvancesinBiopesticides:BiotechnologicalApplications.NewIndiaPublishingAgency (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

Mapping with Programme Outcomes:

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

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

ELECTIVE-IV: NANOBIOTECHNOLOGY

<table>
<tr><td>Title of the Course</td><td colspan="7">NANOBIOTECHNOLOGY</td></tr>
<tr><td>Paper Number</td><td colspan="7">ELECTIVE IV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">ELECTIVE</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">P23DB12</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td rowspan="2">Instructional Hours Per week</td><td>Lecture</td><td colspan="3">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>3</td><td colspan="3">2</td><td colspan="2">--</td><td>5</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">To provide an insight into the principles of nanotechnolgoy in biological and medical research.</td></tr>
<tr><td rowspan="5">Learning Objectives</td><td colspan="7">1. To introduce the learners to the basic concepts in the emerging frontiers of nanotechnology.</td></tr>
<tr><td colspan="7">2. To give perspective to researchers and students who are interested in nanoscale physical and biological systems and their applications in medicine.</td></tr>
<tr><td colspan="7">3. To introduce the concepts in nanomaterials and their use with biocomponents to synthesize and interact with larger systems.</td></tr>
<tr><td colspan="7">4. To impart knowledge on the most recent molecular diagnostic and therapeutic tools used to treat various diseases.</td></tr>
<tr><td colspan="7">5. Incorporate sustainability in to account when you develop nanotechnology responsibly.</td></tr>
<tr><td>UNIT</td><td colspan="7">CONTENTS</td></tr>
<tr><td>I</td><td colspan="7">BASIC CONCEPTS IN NANOBIOLOGY:
History of Nanotechnology, Difference between Nanoscience and Nanotechnology, Green nanotechnology, Bottom up and top down approaches.</td></tr>
<tr><td>II</td><td colspan="7">UNIT II DIVERSITY IN NANOSYSTEMS:
Carbon based nanostructures - fullerences, nanotubes, nanoshells, buckyballs - biomolecules and nanoparticles, nanosensors, nanomaterials - Classification based on dimensionality quantum dots, wells and wires - metal based nano materials (gold, silver and oxides) - Nanocomposites- Nanopolymers – Nanoglasses-Nano ceramics.</td></tr>
<tr><td>III</td><td colspan="7">METHODS OF NANOBIOTECHNOLOGY:
Optical tools - Nanoforce and imaging - Surface methods -Mass spectrometry - Electrical Characterization and Dynamics of Transport - Microfludics: Concepts and applications to the Life Sciences.</td></tr>
<tr><td>IV</td><td colspan="7">NANOBIOTECHNOLOGY:
Nanodevices and nanomachines based on biological nanostructures - Protein and DNA nanoarrays, tissue engineering, and luminescent quantum dots for biological labeling.</td></tr>
<tr><td>V</td><td colspan="7">APPLICATIONS OF NANOBIOTECHNOLOGY:
Real Time PCR - Biosensors : From the glucose electrode to the Biochip -</td></tr>
</table>

	DNA Microarrays -Protein Microarrays - Cell Biochips - Lab on a chip - Polyelectrolyte multilayers - Biointegrating materials - Pharmaceutical applications of nanoparticles carriers.

Course outcomes: 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 converging to create the new area of bionanotechnology.	K1
CO2	Formulate procedures for the synthesis of nanoparticles which are of medical importance which could be used to treat specific diseases.	K2
CO3	Characterize the various types of nano particle synthesis and advocate 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 (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

Recommended Text:

1. Dupas, C, Houdy, P., Lahmani, M. 2007. Nanoscience: ―Nanotechnologies and Nanophysics‖, Springer-Verlag Berlin Heidelberg.
2. Sharon, M and Sharon, M. 2012. Bio-Nanotechnology- Concepts and Applications, CRC Press.
3. Atkinson, W.I. 2011. Nanotechnology. Jaico Book House, New Delhi.
4. Nalwa, H.S. 2005. Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology. American Scientific Publ.
5. Lindsay, S.M. 2011. Introduction to Nanoscience, Oxford universal Press, First Edition.
6. Jain K.K. 2006. Nanobiotechnology molecular diagnostics: Current techniques and application (Horizon Bioscience).Taylor & 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.

Reference Books:

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

Web resources:

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

Mapping with Programme Outcomes:

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

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

ELECTIVE-IV: APPLIED BIOINFORMATICS

Title of the Course		**APPLIED BIOINFORMATICS**					
Paper Number		**ELECTIVE IV**					
Category	**ELECTIVE**	**Year**	**I**	**Credits**	**3**	**Course Code**	**P23DB13**
		Semester	**II**				
Instructional Hours per week		**Lecture**		**Tutorial**	**Lab Practice**		**Total**
		3		**2**	**--**		**5**
Pre-requisite		Basic knowledge in molecular biology. Familiarity with operations of computers and MS office tools.					
Learning Objectives		1. To learn about the bioinformatics data bases, data banks, data form at and data retrieval from the online sources.					
		2.To explain the essential features of the inter disciplinary field of science for better understanding biological data.					
		3. To outline the types of biological databases.					
		4. To demonstrate different online bioinformatics tools.					
		5. To summarize the strong foundation for performing further research inbioinformatics.					

UNIT	CONTENTS
I	**BIOINFORMATICSANDINTERNET:** InternetBasics-FileTransferProtocol-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 Flat file- Submitting DNA Sequences to the Databases - DNA/RNA-Population, Phylogenetic, and Mutation Studies - Protein-Only Submissions - Consequences of DNA Model -EST/STS/GSS/HTG/SNP and Genome Centers - Contact points for submission of sequence data to DBJ/EMBL/Genbank.
III	**STRUCTURE DATABASES:** Introduction to Structures- Protein Data Bank (PDB) – Molecular Modeling Database at NCBI Structure File Formats - Visualizing Structural Information - DatabaseStructureViewers-AdvancedStructureModeling-StructureSimilarity Searching.
IV	**SEQUENCEALIGNMENTANDDATABASESEARCHING:** Introduction-Evolutionary Basis of Sequence Alignment- Modular Nature of Proteins-Optimal Alignment Methods- Substitution Scores and Gap Penalties-Database Similarity Searching-FASTA–BLAST (Blast P, Blast N, etc.,)- Position Specific Scoring Matrices, Spliced Alignments.

V	**PREDICTIVE METHODS:** Using Protein Sequences Protein Identity Based on Composition – Physical Properties Based on Sequence - Motifs and Patterns - Secondary Structure and Folding Classes –Specialized Structures or Features-Tertiary Structure.	
Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Familiarize with the tools of DNA sequence a alysis.	K1 & K2
CO2	Use and explain the application of bioinformatics.	K2 & K3
CO3	Master the aspects of protein-protein interaction, BLAST and PSI-BLAST.	K3 & K4
CO4	Describe the features of local and multiple alignments.	K3 & K4
CO5	Interpret the characteristics of phylogenetic methods and Bioinformatics applications.	K4 & K5
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	

Recommended Text:

1. Baxevanis,A.D.&Ouellette,B.F.2001.Bioinformatics:Apracticalguidetotheanalysisofgenesand proteins. NewYork: Wiley-Interscience.
2. Bourne,P.E.,&Gu,J.2009. Structural bioinformatics. Hoboken, NJ:Wiley- Liss.
3. Lesk,A.M.2002. Introduction to bioinformatics. Oxford: Oxford University Press.
4. Mount,D.W.2001.Bioinformatics: Sequenceandgenomeanalysis.ColdSpringHarbor,NY:ColdSpring HarborLaboratory Press.
5. Pevsner,J.2015.Bioinformaticsandfunctionalgenomics.Hoboken,NJ:Wiley-Blackwell.

Reference Books:

1. Campbell,A.MandHeyer,L.J.2003.Discoveringgenomics,proteomics,andbioinformatics.San Francisco: Benjamin Cummings.
2. Green,M.RandSambrook,J.2012.Molecularcloning:Alaboratorymanual.ColdSpringHarbor, NY: Cold Spring HarborLaboratory Press.
3. Liebler,D.C.2002.Introductiontoproteomics:Toolsforthenewbiology.Totowa,NJ:HumanaPress.
4. Old,R.W.,Primrose,S.B.,andTwyman,R.M.2001.Principlesofgenemanipulation:Anintroductionto geneticengineering. Oxford:Blackwell ScientificPublications.
5. 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. https://books.google.co.in/books/about/Applied_Bioinformatics.html?id=PXZZDwAAQBAJ&redir_esc=y

Mapping with Programme Outcomes:

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

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

SKILL ENHANCEMENT COURSE: AGRICULTURE AND FOOD MICROBIOLOGY

Title of the Course	**AGRICULTURE AND FOOD MICROBIOLOGY**						
Paper Number	**SKILL ENHANCEMENT-I**						
Category	**SKILL ENHANCEMENT**	**Year**	**I**	**Credits**	**2**	**Course Code**	**P23SEB1**
		Semester	**II**				

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

Pre-requisite	To understand the benefits of microbes in agriculture and food industry.
Learning Objectives	1. To provide comprehensive knowledge about plant – microbe interactions.
	2. To provide basic understanding about factors affecting growth of microbes
	3. To appreciate the role of microbes in food preservation.
	4. To understand about the benefits of microbes in agriculture and food industry.
	5. To gain knowledge about practices involved in food industry.

UNIT	**CONTENTS**
I	**ROLE OF MICROORGANISMS IN AGRICULTURE :** Role of symbiotic and free-living bacteria and cyanobacteria in agriculture, Mycorrhiza, Plant Growth Promoting Microorganims (PGPM) and Phosphate Solubilizing Microorganims (PSM).
II	**BIOCONTROL AND BIOFERTILIZATION:** Biocontrol of plant pathogens, pests and weeds, Restoration of waste and degraded lands, Biofertilizers: Types, technology for their production and application, vermi-compost.
III	**FOOD MICROBIOLOGY:** Intrinsic and extrinsic factors influencing growth of microorganisms in food, Microbes as source of food: Mushrooms, single cell protein.
IV	**FOOD MICROBIOLOGY:** Microbial spoilage of food and food products: Cereals, vegetables, prickles, fish and dairy products. Food poisoning and food intoxication. Food preservation processes. Microbes and fermented foods: Butter, cheese and bakery products.
V	**PREDICTIVE METHODS:** Using Protein Sequences Protein Identity Based on Composition – Physical Properties Based on Sequence - Motifs and Patterns - Secondary Structure and Folding Classes –Specialized Structures or Features-Tertiary Structure.

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

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination Question paper)	Questionsrelatedtotheabovetopics,fromvariouscompetitiveexaminations UPSC/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

Recommended Text:

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

Reference Books:

1. Adams, M.R. and Moss M. O. 2008. Food Microbiology, 3rd Edition, Royal Society of Chemistry, Cambridge, U.K.
2. Sylvia D.M. 2004. Principles and Applications of Soil Microbiology, 2nd Edition, Prentice Hall, USA.
3. Frazier, W.C. 1995. Food Microbiology, 4th Edition, Tata McGraw Hill Education, Noida, India.
4. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. 2001. Industrial Microbiology: An Introduction. 1st Edition, Blackwell Science, London, UK.
5. Das,S.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
5. https://www.amazon.in/Food-Microbiology-Martin-R-Adams-ebook/dp/B01D6B7V6A

Mapping with Programme Outcomes:

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

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

CORE VII-CELL AND MOLECULAR BIOLOGY

Title of the Course	**CELL AND MOLECULAR BIOLOGY**						
Paper Number	**CORE VIII**						
Category	**Core**	**Year**	**II**	**Credits**	**5**	**Course Code**	**P23CB7**
		Semester	**III**				
Instructional Hours Per week		**Lecture**	**Tutorial**		**Lab Practice**		**Total**
		5	**1**		**-**		**5**
Pre-requisite	To acquire knowledge on cell and expose the students a fundamental of the various techniques used in molecular studies.						
Learning Objectives	1. Enable to learn various cell structures and functions of prokaryotes and eukaryotes and understand the salient features and functions of cellular organelles.						
	2. To understand the cell division and it molecular mechanism so as to appreciate and manipulate normal and abnormal cell and tissue growth.						
	3. To enlighten people of past molecular biology developments.						
	4. To comprehend the molecular processes.						
	5. A thorough examination of DNA structure, replication process, transcription process and translation processes.						

UNIT	CONTENTS
I	Concept of prokaryote and Eukaryote. Structural organization of plant cell. Cell wall-Structure and functions, Plasma membrane; structure, models and functions, site for ATPase, ion carriers channels and pumps, receptors.
II	Chloroplast-structure and function, genome organization, gene expression, RNA editing, Mitochondria; structure, genome organization, biogenesis. Plant Vacuole - Tonoplast membrane, ATPases transporters as a storage organelle. Structure and function of other cell organelles- Golgi apparatus, lysosomes, endoplasmic reticulum and microbodies.
III	Nucleus: Structure and function, nuclear pore, Nucleosome organization, euchromatin and heterochromatin. Ribosome- Structure and functional significance. RNA and DNA Structure. A, B and Z Forms. Replication, transcription, translation in prokaryotes and eukaryotes. DNA damage and repair (Thymine dimer, photoreactivation, excision repair). Cell cycle and Apoptosis.
IV	DNA replication (prokaryotes and eukaryotes), enzymes involved in replication, DNA repair. DNA sequencing. Transcription, enzymes involved in transcription, post transcription changes, reverse transcription, Translation. overlapping genes.
V	DNA/gene manipulating enzymes: endonuclease, ligase, polymerase, phosphatase, transcriptase, transferase, topoisomerase. Gene cloning: cloning vectors,

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

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination Question paper)	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

Recommended Text:

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

Reference Books:

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

Web resources:

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

Mapping with Programme Outcomes:

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

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

CORE VIII- GENETICS, PLANT BREEDING & BIOSTATISTICS

Title of the Course	**GENETICS, PLANT BREEDING & BIOSTATISTICS**						
Paper Number	**CORE IX**						
Category	**Core**	**Year**	**II**	**Credits**	**5**	**Course Code**	**P23CB8**
		Semester	**III**				

Instructional Hours	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
Per week	**5**	**1**	**-**	**6**

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

UNIT	**CONTENTS**
I	Mendal's Law of inheritance. Gene interactions and modified dihybrid ratios. Quantitative inheritance. Sex determination in plants and theories of sex determination. Sex linked characters. Structure of Gene, Operon, inducible operon, Operator site, Promoter, Polycistronic mRNA, Regulator, Gene function and regulation in prokaryotes with reference to Lac operon and trp operon. Arabidopsis- gene regulation in flowering.
II	Recombination: Homologous and non-homologous recombination, site-specific recombination. Holiday model of recombination. Transposable genetic elements: Ac element, transposase, transposon, simple transposon, composite transposon, Is element. Transposons in *Zea mays*. Transposable elements in prokaryotes. UV induced mutation and its repair mechanism. Mismatch DNA repair mechanism. Mutation types- frame shift mutation, addition, deletion, substitution, transition and transversion. Xeroderma pigmentosum.
III	ABO blood group in humans. QTL mapping, Gene mapping methods**:** Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids. Extra chromosomal inheritance, maternal inheritance. Organelle genomes: Organization and functions of chloroplast and mitochondrial DNA.

IV	**PLANT BREEDING:** Objectives of plant breeding, characteristics improved by plant breeding, Genetic basis of breeding self and cross – pollinated crops. Pure line theory, pure line selection and mass selection, clonal selection methods. Hybridization, Genetics and physiological basis of heterosis.
V	**BIOSTATISTICS:** Measures of central tendency (Mean , Median , Mode) and dispersal (Mean deviation , standard deviation) , standard errors ANOVA (One way).probability distributions (Binomial, Poisson andnormal); sampling distribution; difference between parametric and non-parametric statistics; confidence interval; errors; levels of significance; regression and correlation; t-test;analysis of variance; x^2test.

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

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination Question paper)	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

RecommendedText:

1. Benjamin, A. Pierce. 2012. Genetics- A conceptual Approach. W.H. Freeman and Company, New York, England.
2. Stansfield, W.D. 1969. Theory and problems of Genetics. McGraw-Hill
3. Sinnott, E.W.Dunn, L.E and Dobzhansky, T. 1973. Principles of Genetics. McGraw-Hill.New York.
4. Chaudhari, H.K.1984. Elementary Principles of Plant Breeding. Oxford & IBH Publishing Company.
5. Brown, T.A. 1992. Genetics a Molecular Approach, 2nd Ed. Chapman and Hall.

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

Reference Books:

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

Web Resourses

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

Mapping with Programme Outcomes:

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

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

LABORATORY COURSE - III: CELL & MOLECULAR BIOLOGY, GENETICS, PLANT BREEDING AND BIOSTATISTICS

Title of the Course	**LABORATORY COURSE - III: CELL & MOLECULAR BIOLOGY, GENETICS, PLANT BREEDING AND BIOSTATISTICS**						
Paper Number							
Category	**Core**	**Year**	**II**	**Credits**	**4**	**Course Code**	**P23CB9P**
		Semester	**III**				

Instructional Hours Per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	2	**-**	**4**	**6**

Pre-requisite	Practicals 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	**EXPERIMENTS**
I	**CELL AND MOLECULAR BIOLOGY** 1. Identification of different stages of mitosis from suitable plant material. (Onion root tips, garlic root tips). 2. Identification of meiosis from suitable plant material. (Onion /Tradeschantia floral buds). 3. Study of cyclosis in cells of suitable plant material. 4. To study plant vacuole in cells of onion leaf peel. 5. Restriction digestion of DNA samples using restriction endonucleases (RE). 6. To study the structure and organization of plant cell in various tissues of various plants (incl. leaf, stem and roots).
II	**GENETICS** 1. Problem solving on dihybrid phenotypic, genotypic and test cross ratios. 2. Incomplete dominance in plants. 3. Interactions of factors and modified dihybrid ratios. 4. Multiple alleles in plants, blood group inheritance in human. 5. Sex linked inheritance in Drosophila and plants.

	6. Quantitative inheritance in plants. 7.Chromosome mapping from three point test cross data. .	
III	**PLANT BREEDING** 1. Techniques in plant hybridization.	
1V	**BIOSTATISTICS** Problems related to chi square ,correlation, regression and ANOVA	
Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Recall or remember the various aspects of cell biology, genetics, molecular biology, plant breeding and tissue culture.	K1
CO2	Understand various concepts of cell biology, genetics, plant breeding and tissue culture.	K2
CO3	Apply the theory knowledge gained into practical mode in order to acquire applied knowledge by day-to-day hands-on experiences.	K3
CO4	Analyze or interpret the results achieved in practical session in the context of existing theory and knowledge.	K4
CO5	Evaluate the theory and practical skills gained during the course.	K5 &K6
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination (Question paper)	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	

Recommended Text:

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

8. Shivakumar, S. 2002. Molecular analysis: Laboratory Manual. University press, Palkalai nagar, Madurai, India.

Reference Books:

1. Gardener, J, Simmons, H.J and Snustad, D.P. 2006. Principle of Genetics, John Wiley & Sons, New York.
2. De Robertis E.D.P. and De Robertis E.M.P. 2017. Cell and Molecular Biology (8thed.) (South Asian Edition), Lea and Febiger, Philadelphia, USA.
3. Jackson, S.A., Kianian, S.F., Hossain, K.G., and Walling, J. G. 2012. Practical laboratory exercises for plant molecular cytogenetics. In Plant Cytogenetics (pp. 323-333). Springer, New York, NY.
4. Glick, B.R and J.E. Thompson. 1993. Methods in Plant Molecular Biology and Biotechnology. CRC Press, Boca Raton, Florida.
5. Glover, D.M and B.D. Hames (Eds). 1995. DNA cloning 1: A Practical Approach; Core Techniques, 2nd edition PAS, IRL press at Oxford University Press, Oxford.
6. Gunning, B.E.S and M. W. Steer. 1996. Plant Cell Biology: Structure and function. Jones and Bartlett Publishers, Boston, Massachusetts.
7. Hackett, P.B. and J.A. Fuchs, J.W. Messing. 1988. An Introduction to Recombinant DNA Techniques: Basic Experiments in Gene Manipulation. The Benjamin/ Cummings Publishing Co., Inc Menlo Park, California. 8. Hall, RD. (Ed).1999. Plant Cell Culture Protocols. Humana Press, New Jersey.
8. Harris, N and K.J. Oparka. 1994. Plant cell Biology: A Practical Approach. IRL Press, At Oxford University Press, Oxford, UK.
9. Gelvin, S.B., Schilperoort, R.A. (Eds.). 2000. Plant Molecualr Biology Manual.
10. Henry, RJ. 1997. Practical applications of plant molecular biology, Chapman & Hall, London.
11. Krebs, J.E., Goldstein E.S. and Kilpatrick S.T. 2017. Lewin's GENES XII (12thed.). Jones & Bartlett Learning.

Web sources:

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

Mapping with Programme Outcomes:

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

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

CORE X- INDUSTRY MODULE - INDUSTRIAL BOTANY

Title of the Course		**INDUSTRIAL BOTANY**					
Paper Number		**Core X**					
Category	**Industry**	**Year**	**II**	**Credits**	**3**	**Course Code**	**P23CB10**
		Semester	**III**				

Instructional Hours Per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	1	**-**	**4**	**5**

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

UNIT	**CONTENTS**
I	**ALGAE IN INDUSTRIES:** Fertilizer industry-Seaweeds, pharmaceutical industry – antibiotics, agar, carageenin, alginin, diatomate earth, mineral industry, fodder industry
II	**FUNGI IN INDUSTRIES:** Beneficial use of yeast, Fermentation of alcohol, preparations of enzyme, organic acid preparation, cheese production, protein manufacture, vitamins, fats.
III	**PLANT PRODUCTS:** Fibres and Fibre-Yielding Plants, wood and cork, tannins and dyes, rubber, fatty oils and Vegetable fats, sugars and starches, pulp and paper, gums and resins.biobricks.
IV	**BACTERIA IN INDUSTRIES:** Food industry, dairy products, bioleaching, biogas production**,** bioremediation
V	**PLANT TISSUE CULTURE :** Tissue culture: Micropropagation, synthetic seeds, cell culture.

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Understand the basics of algae in industrial applications.	K1
CO2	Demonstrate and to recollect the uses in fungi in industries.	K2
CO3	Explain bacterial role in industries.	K3

CO4	Compare and contrast the use of plants in industries.	K4
CO5	Discuss and develop skills for working in industries specializing in biomolecules.	K5 & K6

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

Recommended Text:

1. 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. Introductory Phycology.Affiliated East-West Press, Delhi.
11. Das,SandSaha,R.2020. Microbiology Practical Manual.CBS Publishers and Distributors (P) Ltd.,

New Delhi, India.
12. Willie, J and Sherwood, L. 2016. Prescott's Microbiology McGraw-Hill Education; 10th Edition, ISBN: 978-1259281594
13. Reinert, J. Bajaj. T.P.S. 1977. Applied and Fundamental Aspects of Plant cell, tissue and organ Culture. Springer – Verlaug.

Web resources:

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

Mapping with Programme Outcomes:

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

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

ELECTIVE V: RECOMBINANT DNA TECHNOLOGY AND INDUSTRIAL APPLICATIONS

Title of the Course	**RECOMBINANT DNA TECHNOLOGY AND INDUSTRIAL APPLICATIONS**						
Paper Number	**ELECTIVE V**						
Category	**ELECTIVE**	**Year**	**II**	**Credits**	**3**	**Course Code**	**P23DB18**
		Semester	**III**				

Instructional Hours Per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	4	**1**	**-**	**5**

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**
I	Recombinant DNA (DNA insertion in to Plasmid). Transformation. Direct and indirect gene transfer. Detection of recombinant molecule, production of gene products from cloned genes, **a**ntibiotics, enzymes, anticancer drugs, interferons.
II	Production of vitamins: B12 (bacteria –*Paracoccusdenitrificans*, Propionibacteriumshermanii, E.Coli) Vitamin-C(*Saccharomyces cerevisiae* and *Zygosaccharomyces bailii* yeast and Gluconobacteroxydans bacteria.)
III	Human Deoxyribonuclease I, Human Tissue Plasminogen Activator, β-Glucocerebrosidase, L-Asparaginase, Deoxycytidine kinase, Acid sphingomyelinase.Penicillins, aminoglycosides, tetracyclines from fungi and bacteria.
IV	Recombinant hormones**:** insulin (somatotrophin).vaccines Hepatitis B human Interferons Interferon..
V	rDNA technology**-** milk production in cattle, cheese ripening. Fungal α-amylase silk production in sericulture. Uses in agriculture Bt-cotton, BT-brinjal, golden rice.

Course outcomes: 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)	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

Recommended Text:

1. Neal Stewart, Jr. 2008. Plant Biotechnology and Genetics: Principles, Techniques and Applications. JohnWiley&sons Inc.
2. Smith. J.K. 1996. Biotechnology – 3 rd Ed. Cambridge Univ. Press, Cambridge.
3. Khan. I.A. and A. Khanum .2004. Fundamentals of Biotechnology – Forensic Science Genetic Engineering. Ukaaz publication, Hyderabad.
4.Mba, C., Afza, R., Bado, S., and Jain, S.M. 2010. Plant Cell Culture: Essential Methods, John Wiley & Sons, UK.
5.Abdin, M.Z., Kiran, U., Kamaluddin, M., Ali, A. (Eds.). 2017. Plant Biotechnology: Principles and Applications, Springer publishers.

Reference books:

1. Watson, J.D. *et al.* 2003. Molecular Biology of the Gene. Fourth Edition. The Benjamin Cummings Pub. Co.
2. Lewin, B. 2003. Genes VIII. Oxford University Press.
3. Friefelder,D. 2005. Molecular Biology. Second Edition. NarosaPub.House.
4. Sobtir.C. and Gobe. 1991. Eukaryotic chromosomes. Narosa Publishinghouse.
5. Smith-Keary, P. 1991. Molecular Genetics. Macmillan Pub. Co. Ltd. London.

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=false

Mapping with Programme Outcomes:

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)

ELECTIVE V - SILVICULTURE AND COMMERCIAL LANDSCAPING

Title of the Course	**SILVICULTURE AND COMMERCIAL LANDSCAPING**						
Paper Number	**ELECTIVE V**						
Category	**ELECTIVE**	**Year**	**I**	**Credits**	**3**	**Course Code**	**P23DB19**
		Semester	**III**				

Instructional Hours Per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	4	**1**	**--**	**5**

Pre-requisite	Students should know about the fundamental concepts of gardening and landscaping.
Learning Objectives	1. To understand the basic concepts of horticulture.
	2.To learn the various methods of plant propagation.
	3.To know the art of fruit crop and vegetable crop cultivation.
	4.To know about the fundamental concepts of gardening and landscaping.
	5.To provide an overview of various gardening styles and its scope in recreation and bio-aesthetic planning.

UNIT	**CONTENTS**
I	Basics of Horticulture: Importance and scope of Horticulture - Divisions of Horticulture – Climate, soil and nutritional needs – Manures and fertilizers – Organic manures – Inorganic fertilizers – Biofertilizers – Methods of applications of manures and fertilizers - Water irrigation – Surface irrigation – Sub irrigation – Special irrigation methods – Plant protection and pest control for horticulture crops.
II	Plant propagation: Natural method: Propagation through seeds and specialized vegetative structures - Artificial methods: Cutting: types (root, stem, leaf cuttings), advantages and disadvantages - Layering: types (simple, compound, tip, trench, mound, air-layering) advantages and disadvantages - Grafting: types (inarching, side, splice, whip/tongue, veneer, cleft, bark, epicotyl, top-working) advantages and disadvantages - Budding: Types (T-budding, shield, patch, and ring budding) advantages and disadvantages - Stock – scion relationships – Micropropagation.
III	Fruit crops: Training and pruning methods for fruit plants – Induction of flowering, flower thinning - fruit setting and fruit development – Seedlessness in horticultural fruits – Importance of plant growth regulators in fruit crops – Cultivation and harvesting methods of important fruit crops; Mango, Sapota, Pomegranate, Grapes and Guava.

IV	Flower and vegetable crops: Floriculture – Cultivation of commercial flower crops – Rose, Jasmine, Chrysanthemum, Crossandra, Anthurium and Gerberas – Cut flowers – Vase life period – Packages for export of cut flowers - Flower decoration – Dry and wet decoration - State Integrated Board of Studies – Botany PG 32 Classification of vegetables – Cultivation of important vegetables - Tomato, Potato, Onion, Cabbage and Snake guard – Layout for a model kitchen garden.
V	Landscape designing: Principles and methods of landscape designing – Types of garden – Garden components – Shrubs and shrubberies, ornamental hedges, edges, flower beds, borders and carpet beds – Climbers and creepers – Foliage plants - Succulents and cacti – Ornamental palms – Orchids - Topiary and trophy - Rockeries and arches – Lawn making and maintenance – Water garden - Layout for college garden - Indoor gardening – Hanging baskets - Bonsai plants – Training and pruning - Terrace garden - Cultivation of tree species – Eucalyptus and teak.

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	To understand the importance and divisions of horticulture.	K1
CO2	Demonstrate the art of floriculture and landscape gardening.	K2
CO3	Explain plant propagation and fruit crop cultivation.	K3
CO4	Compare and contrast the vegetable cultivation and kitchen gardening.	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

Recommended Text:

1. Edmond, J.B. 1977. Fundamentals of Horticulture. Tata McGraw Hill Publishers Co. Ltd., New Delhi.
2. Kumar, N. 2017. Introduction to Horticulture, Midtech Publisher.
3. Manibushan Rao, K. 1991. Textbook of Horticulture. Macmillan Publishing Co., New York.
4. Rao, K.M. 2000. Text book of Horticulture. Macmillan India Ltd, New Delhi.
5. George, A. 2002. Horticulture Principles and Practices. 2nd Edition. Pearson Education, Delhi.
6. Bohra, M.P.S. and Arora, 2017. Introduction to Horticulture, 2 nd Edition.
7. Singh, J. 2018. Fundamentals of Horticulture. Kalyani Publishers.
8. Acquaah, J. 2009. Horticulture – principles and practices, 4th edition, PHI learning Pvt. Ltd.
9. Rao Manibhushan K. 1991. Textbook of horticulture. MaC Millan India Ltd.
10. Gangulee H. C. and Kar A. K. 2004. College Botany Vol II, New Central Book Agency
11. Sharma V. K. 1999. Encyclopaedia of Practical Horticulture, Vol I –IV, Deep And Deep Publ. Pvt. Ltd.

Reference books:

1. Edment Senn Andrews. 1994. Fundamentals of Horticulture.Tata. McGraw Hill Publishing Co., Ltd., Delhi.
2. Adams, 2005. Principles of Horticulture. IVth Ed. Elsevier India Pv. Ltd
3. Antje Rugullis. 2008. 1001 Garden Plants and Flowers. Parragon Publishers.
4. Berry, F. and Kress, J. 1991. Heliconia: An Identification Guide . Smithsonian Books.
5. Butts, E. and Stensson, K. 2012.Sheridan Nurseries: One hundred years of People,Plans, and Plants. Dundurn Group Ltd.
6. Russell, T. 2012. Nature Guide: Trees: The world in your hands(Nature Guides).

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

Mapping with Programme Outcomes:

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 – GARDENING

Title of the Course	**GARDENING**						
Paper Number	**SKILL ENGHANCEMENT II- NME (SEC2)**						
Category	**SKILL ENGHANCEMENT**	**Year**	**II**	**Credits**	**2**	**Course Code**	**P23SEB2**
		Semester	**III**				

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

Pre-requisite	Students should know about the fundamental concepts of gardening.
Learning Objectives	1.To understand the basic concepts of gardening
	2.To learn the various methods of plant propagation.
	3.To know the art of fruit crop and vegetable crop cultivation.
	4.To create awareness about kitchen gardening .
	5.To provide an overview of various gardening styles

UNIT	**CONTENTS**
I	Basics of Horticulture: Importance and scope of Horticulture - Divisions of Horticulture – Climate, soil and nutritional needs – Manures and fertilizers – Organic manures – Inorganic fertilizers – Biofertilizers – Methods of applications of manures and fertilizers - Water irrigation – Surface irrigation – Sub irrigation – Special irrigation methods – Plant protection and pest control for horticulture crops.
II	Plant propagation: Natural method: Propagation through seeds and specialized vegetative structures - Artificial methods: Cutting: types (root, stem, leaf cuttings), advantages and disadvantages - Layering: types (simple, compound, tip, trench, mound, air-layering) advantages and disadvantages - Grafting: types (inarching, side, splice, whip/tongue, veneer, cleft, bark, epicotyl, top-working) advantages and disadvantages - Budding: Types (T-budding, shield, patch, and ring budding) advantages and disadvantages - Stock – scion relationships – Micropropagation.
III	Fruit crops: Training and pruning methods for fruit plants – Induction of flowering, flower thinning - fruit setting and fruit development – Seedlessness in horticultural fruits – Importance of plant growth regulators in fruit crops – Cultivation and harvesting methods of important fruit crops; Mango, Sapota, Pomegranate, Grapes and Guava.

IV	Flower and vegetable crops: Floriculture – Cultivation of commercial flower crops – Rose, Jasmine, Chrysanthemum, Crossandra, Anthurium and Gerberas – Cut flowers – Vase life period – Packages for export of cut flowers - Flower decoration – Dry and wet decoration - State Integrated Board of Studies – Botany PG 32 Classification of vegetables – Cultivation of important vegetables - Tomato, Potato, Onion, Cabbage and Snake guard – Layout for a model kitchen garden.
V	Landscape designing: Principles and methods of landscape designing – Types of garden – Garden components – Shrubs and shrubberies, ornamental hedges, edges, flower beds, borders and carpet beds – Climbers and creepers – Foliage plants - Succulents and cacti – Ornamental palms – Orchids - Topiary and trophy - Rockeries and arches – Lawn making and maintenance – Water garden - Layout for college garden - Indoor gardening – Hanging baskets - Bonsai plants – Training and pruning - Terrace garden - Cultivation of tree species – Eucalyptus and teak.

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	To understand the importance and concepts of gardening .	K1
CO2	Demonstrate the art of ornamental gardening.	K2
CO3	Explain plant propagation and fruit crop cultivation.	K3
CO4	Compare and contrast the vegetable cultivation and kitchen gardening.	K4
CO5	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

Recommended Text:

1. Manibhushan Rao K. (1991) Text book of Horticulture. University of Madras, Madras.
2. Kumar Dr. N. (2010) Introduction to Horticulture. New Delhi.
3. Rao, K.M. 2000. Text book of Horticulture. Macmillan India Ltd, New Delhi.

4. George, A. 2002. Horticulture Principles and Practices. 2nd Edition. Pearson Education, Delhi.
5. Bohra, M.P.S. and Arora, 2017. Introduction to Horticulture, 2 nd Edition.
6. Singh, J. 2018. Fundamentals of Horticulture. Kalyani Publishers.
7.Acquaah, J. 2009. Horticulture – principles and practices, 4th edition, PHI learning Pvt. Ltd.
8.Rao Manibhushan K. 1991. Textbook of horticulture. MaC Millan India Ltd.
9.Gangulee H. C. and Kar A. K. 2004. College Botany Vol II, New Central Book Agency
10.Sharma V. K. 1999. Encyclopaedia of Practical Horticulture, Vol I –IV, Deep And Deep Publ. Pvt. Ltd.

Reference books:

1. Edment Senn Andrews. 1994. Fundamentals of Horticulture.Tata. McGraw Hill Publishing Co., Ltd., Delhi.
2. Adams, 2005. Principles of Horticulture. IVth Ed. Elsevier India Pv. Ltd
3. Antje Rugullis. 2008. 1001 Garden Plants and Flowers. Parragon Publishers.
4. Berry, F. and Kress, J. 1991. Heliconia: An Identification Guide . Smithsonian Books.
5. Butts, E. and Stensson, K. 2012.Sheridan Nurseries: One hundred years of People,Plans, and Plants. Dundurn Group Ltd.
6. Russell, T. 2012. Nature Guide: Trees: The world in your hands(Nature Guides).

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

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	4	4	4	4	3	3	4	4	4
CO2	3	4	4	4	4	3	3	4	4	4
CO3	3	4	4	4	4	3	3	4	4	4
CO4	3	4	4	4	4	3	4	4	4	4
CO5	3	4	4	4	4	3	4	4	4	4

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

INTERNSHIP/INDUSTRIAL ACTIVITY

Title of the Course	**INTERNSHIP/INDUSTRIAL ACTIVITY**						
Paper Number							
Category		**Year**	I	**Credits**	2	**Course Code**	
		Semester	II				
Instructional Hours Per 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	
C1	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..	
C2	To comprehend how theoretical ideas are applied in many sectors and industries.	
C3	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.	
C4	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.	
C5	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**	**No. of Hours**
I	**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 labeled 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	**CONTENTS OF THE REPORT** 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 outcomes: 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 planning and carrying out tests.	K2
CO3	Collect data and educate yourself on how to analy results of your scientific studies.	K3 & K5
CO4	This in-the-moment industrial exposure helps them become more knowledgeable and skilled in the latest technology.	K4
CO5	Improving communication skills and coming up with creative are crucial components of training that help someone become an entrepreneur.	K5 & K6

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination Question paper)	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

Recommended Text:

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.

Mapping with Programme Outcomes:

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

CORE XI -PLANT PHYSIOLOGY AND PLANT METABOLISM

Title of the Course	**PLANT PHYSIOLOGY AND PLANT METABOLISM**						
Paper Number	**CORE XI**						
Category	**Core**	**Year**	**II**	**Credits**	**5**	**Course Code**	**P23CB11**
		Semester	**IV**				
Instructional Hours Per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		5	**1**		**-**	**6**	
Pre-requisite	Basic knowledge on physiological processes in plants.						
Learning Objectives	1.To acquire knowledge on the functional aspects of plants.						
	2.To understand the biophysical and biochemical processes of plants.						
	3.To study the metabolism of plants.						
	4.To learn the plant growth regulations.						
	5.To know the adaptive mechanisms of plants in adverse environmental conditions.						

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

IV	Growth and development – Phases of plant growth – growth types- Growth regulators- Auxins, gibberellins, cytokinins, abscisic acid, ethylene, brassinosteroids. Photoperiodism – Classification of plants and mechanism of flowering – Phytochrome and their action on flowering – Vernalization- Mechanism and its practical application, biological rhythms and movements. Seed dormancy .
V	Plant senescence –Types and Mechanism of senescence- Abscission: Morphological and biochemical changes – Significance. Fruit ripening- Biochemical, Physiological changes and control of fruit ripening. Plant response to environmental stress: Biotic and Abiotic stress – Water, temperature, light and salinity- Adaptive mechanism to various stresses (avoidance, escape, tolerance)–stress responsive proteins – anti-oxidative mechanism.

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Relate understand properties and importance of water in biological system, nutrients and its translocation.	K1
CO2	Demonstrate the importance of light in plant growth and the harvest of energy.	K2
CO3	Explain the energy requirement and nitrogen metabolism.	K3
CO4	Compare the various growth regulators that influence plant growth.	K4
CO5	Discuss the senescence and plant response to environmental stress.	K5 & K6

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

Recommended Text:

1. Gauch, H.G.1972. Inorganic Plant Nutrition. Hutchinson & Dowd. New York.
2. Govindji. 1982. Photosynthesis. AP. New York.
3. Jacob, W.P. 1979. Plant Hormones and Plant Development. Cambridge University Press. Cambrigde
4. Khan, A.A. 1982. The Physiology and Biochemistry of Seed development, Dormancy and Germination. Elesiver. Amsterdam.
5. Salisbury, F. B.C.W. Ross.1991. Plant Physiology. Wassworth Pub. Co. Belmont.
6. Ting, I.P. 1982. Plant Physiology. Addison Wesley Pb. Philippines.
7. Sage, R and R.K. Monson (eds). 1999. The Biology of C4 Plants AP New York.
8. Postgate, J. 1987. Nitrogen Fixation. 2nd Edition Cassel, London.

9. Lincoln Taiz, Eduardo Zeiger, Ian Max Moller and Angus Murphy. 2015. Plant Physiology. 6th Ed., Sinauer Associates.
10. Stacey, G.R.H. Burris and Evans, H.J. 1992. Biological Nitrogen Fixation. Chapman and Hall, New York
11. Mann, J. 1987. Secondary Metabolism Clarendron Press, Oxford.
12. Jain, V.K. 2017. Plant Physiology, S.Chand & Company Ltd. New Delhi.
13. Lincoln, T, Eduardo, Z, Ian Max, M, and Angus, M. 2018. Fundamentals of Plant Physiology. Sinauer Associates Inc., US.
14. Pandey, N.S and Pandey, P. 2016. Textbook of Plant Physiology. Daya Publishing House, New Delhi.
15. Taiz, L. Zeiger, E., Moller, I.M and Murphy, A. 2015. Plant Physiology and Development 6th Edition. Sinauer Associates, Sunderland, CT.
16. Guowei Li Veronique Santoni ChristopheMaurel. 2014. Plant aquaporins: Roles in plant physiology. Biochimica et Biophysica Acta (BBA) - General Subjects Volume 1840, Issue 5, Pages 1574-1582.

Reference Books:

1. Bidwell, R.G.S. 1974. Plant Physiology, Macmillan Publisher, Boston.
2. Devlin, R.M. 1996. Plant Physiology, PWS publisher, Boston.
3. Jain, V.K. 2017. Fundamentals of Plant Physiology. Chand & Company Ltd., New Delhi.
4. Gontia. 2016. A textbook of Plant Physiology. Satish Serial publishing House, New Delhi.
5. Leopold, A.C, 1994. Plant Growth and Development, McGraw Hill, New York.
6. Lincoln Taiz et al., 2014. Plant Physiology and Development. Sinauver Associates Inc. Publishers, Sunderland, Massachusetts.
7. Moore, T.C. 1989. Biochemistry and Physiology of Plant Hormones (2nd Edition). SpringerVerlag, New York, USA.
8. Noggle, R.G and Fritz, G.J. 2010. Introductory Plant Physiology, PHI Learning Pvt Ltd, New Delhi.
9. Park S. Nobel. 2005. Physicochemical and Environmental Plant Physiology. Elsevier Academic Press, New York.
10. Panda, S.K, 2005. Advances in Stress Physiology of Plants. Scientific Publishers India, Jodhpur.
11. Salisbury, F.B and Cleon Ross, 2007. Plant Physiology, Wadsworth Publishing Company, Belimont.
12. Shinha. R.K. 2007. Modern Plant Physiology. Ane Books India, New Delhi.
13. William G. Hopkins, 1999. Introduction to Plant Physiology, John Wiley and sons, INC, New York.
14. Heldt, H.W. 2005. Plant Biochemistry, 3rd Edition. Elsevier Academic Press.

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
8. 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 XII: BIOCHEMISTRY & APPLIED BIOTECHNOLOGY

Title of the Course	**BIOCHEMISTRY & APPLIED BIOTECHNOLOGY**						
Paper Number	**CORE XII**						
Category	**Core**	**Year**	**II**	**Credits**	**5**	**Course Code**	**P23CB12**
		Semester	**IV**				

Instructional Hours Per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	5	**1**	**-**	**6**

Pre-requisite	Basic knowledge on primary and secondary plant metabolites and enzymes. 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 biomolecules.
	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**
I	Chemical bonds - ionic bond, covalent bond, coordinate covalent bond, hydrogen bond, hydrogen ion concentration (pH), buffers. Thermodynamics principle, Laws of Thermodynamics -free energy concept, redox potential, dissociation and association constant, activation energy, binding energy.
II	Classification of carbohydrates; Structure and properties of monosaccharides, Oligosaccharides, Polysaccharides - Glycoproteins. Protein and Amino acids: Structure, Classification and properties; Peptides - Structure: Primary, secondary**,** tertiary and quaternary structures. Classification of Lipids: Structure and properties of fatty acids, phospholipids, glycolipids, lipoproteins, cholesterol - structure and functions.
III	Enzymes- Classification and nomenclature chemical nature of enzymes - factors affecting enzyme action - Michaelis - Menton constant, Lineweaver Burk plot, Enzyme inhibition, co enzymes- mechanism of enzyme action, isoenzymes. Secondary Metabolites: Structure, classification and properties of alkaloids, steroids, terpenoids, flavonoids. Glycosides - their chemical nature and role.
IV	Transgenic plants - pest resistance, herbicidal resistance, Disease resistant, abiotic and biotic stress tolerant, in improving crop yield, food quality- Golden rice, Edible vaccines, virus induced gene silencing. Cytoplasmic male sterility and fertility restoration, terminator Seed technology, antisense technology for Delayed

	fruit ripening, Plants as factories for useful products and pharmaceuticals.
V	Screening of Biotransformants - 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.

Course outcomes: 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 biomolecules.	K2
CO3	Explain the role of enzymes in plants.	K3
CO4	Compare and contrast the methods of transgenic plants production and natural plants.	K4
CO5	Discuss and develop skills for effective utilization of microbial/plant enzymes and their role in biological cells	K5 &K6

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

Recommended Text:

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

Reference Books

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

Web sources:

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

Mapping with Programme Outcomes:

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

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

PROJECT: GROUP PROJECT

Title of the Course	**PROJECT: GROUP PROJECT**						
Paper Number							
Category	**Skill Enhancement**	**Year**	**II**	**Credits**	**7**	**Course Code**	**P23BPW**
		Semester	**IV**				

Instructional Hours Per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	2	**-**	**8**	**10**

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

UNIT	**CONTENTS**
I	1. Each student will be allotted a Project Guide from the faculty of the department concerned by lot method. 2. The topic of the dissertation shall be assigned to the candidate before the beginning of third semester. 3. After the completion of the project work, the student has to submit four copies of dissertation with report carrying his/her project report for evaluation by examiners. After evaluation, one copy is to be retained in the College Library. 4. Project work will be evaluated by both the external and the internal (Project Guide)examiners for the maximum of 100marks in total on the scale of the maximum of 50marksforthe internal and the external each. Viva-vocewillbeconductedbythepanelcomprising,ExternalexaminerandInternal Examiner for the maximum of 100 marks in total on the scale of the maximum of 50marksforthe internal and the external each.
II	All the candidates of M.Sc (Botany) are required to undergo a major project and submit the following: 1. Dissertation/Thesis based on the work done by the student. 2. Soft copy of the project on CD/DVD. **PROJECT EVALUATION GUIDELINES:** **The project is evaluated on the basis of following heads:** For Viva-Voce maximum is 60 marks which will be conducted by both the internal and external examiners during end semester university practical examinations.

	Internal: 40 marks I Review – Selection of the field of study, topic and literature collection - 15 marks II Review – Research design and data collection - 10 marks III Review – Analysis and conclusion, preparation of rough draft - 15 marks **External:** 60 marks Thesis/ Dissertation - 30 marks Presentation - 15 marks Viva-voce - 15 marks	
III	**Suggested areas of work:** Algae, fungi, microbiology, biocontrol agents, plant tissue culture, plant physiology, phytochemistry, biochemistry, anatomy, plant taxonomy, Ethnobotany, ecology, sustainable agriculture, herbal formulations, cytogenetics, molecular biology, biotechnology, bioinformatics, nanotechnology and applied botany.	
IV	**Methodology:** **Each project should contain the following details:** 1. Brief introduction on the topic 2. Review of Literature 3. Materials and Methods 4. Results and Discussion – evidences in the form of figures, tables and photographs. 5. Summary 6. Bibliography	
Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	For students in those pertinent core areas, the project is preparing them to become professionals after graduation.	K1
CO2	Compile data and familiarize yourself with techniques for planning and carrying out tests.	K2
CO3	Collect data and educate yourself on how to evaluate the analyzed results of your scientific studies.	K3 & K5
CO4	In-the-moment industrial exposure helps them become more knowledgeble and skilled in the latest technology.	K4
CO5 .	Improving communication skills and coming up with creative ideas are crucial components of training that help someone become an entrepreneur.	K5 & K6
Extended Professional Component (is a part of internal component only, Not to be included in the External	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved	

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

Recommended Texts:

1. Wilson,KandJ.Walker(Eds).1994.PrinciplesandTechniquesofPracticalBiochemistry(4th Edition)CambridgeUniversityPress,Cambridge.
2. Bendre,A.MandAshokKumar.2009.AtextbookofpracticalBotany.Vol.I&II.RastogiPublication.Meerut.9thEdition.
3. ManjuBala,SunitaGupta,Gupta,N.K.2012.PracticalsinPlantPhysiologyandBiochemistry.Scientific Publisher.
4. 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
5. https://kau.in/document/laboratory-manual-biochemistry

Mapping with Programme Outcomes:

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

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

ELECTIVE VI -ORGANIC FARMING

Title of the Course	**ORGANIC FARMING**						
Paper Number	**ELECTIVE VI**						
Category	**ELECTIVE**	**Year**	**II**	**Credits**	**3**	**Course Code**	**P23DB23**
		Semester	**IV**				

Instructional Hours Per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	4	**1**	**-**	**5**

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

UNIT	**CONTENTS**
I	**AGRONOMY:** Organic farming- concept, characteristics, significance, organic ecosystem, scope of organic farming in India - Principles and types of organic farming. Choice of crops & varieties in organic farming - Initiative by Govt/NGOs/Other organizations for promotion of organic farming Operational structure of NPOP (National Programme for Organic Production).Organic production methods for cereals, vegetables and fruit crops
II	**SOIL SCIENCE:** Organic farming for sustainable agriculture; Manures and preparation methods - compost, methods of composting - Green manuring, vermicompost and biofertilizer (Rhizobium). Harmful effect of non-judicious chemical fertilization - Organic farming practices for improving soil health
III	**FUNDAMENTAL OF ORGANIC FARM MANAGEMENT:** Land management in organic farming - Water management in organic farming. Preventive and cultural methods for insects and pest control - Identification of different fungal and bacterial biocontrol agents. Indigenous technical knowledge for insects-pest, disease - Weed and nutrient management in organic farming
IV	**POST HARVEST MANAGEMENT:** Processing, labeling of organic produce - Storage and transport of organic produce.
V	**ORGANIC QUALITY CONTROL STANDARDS:** Certification- types, process & procedure and agencies. Quality aspect and grading - Packaging and handling. Economic considerations and viability of organic products - Export of organic product and marketing

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

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

Recommended Text:

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

Reference books:

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

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

Mapping with Programme Outcomes:

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

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

ELECTIVE VI : FORESTRY AND WOOD TECHNOLOGY

Title of the Course	**FORESTRY AND WOOD TECHNOLOGY**						
Paper Number	**ELECTIVE**						
Category	**Elective**	**Year**	**II**	**Credits**	**3**	**Course Code**	**P23DB24**
		Semester	**IV**				

Instructional Hours Per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	4	**1**	**-**	**5**

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**
I	**Introduction and scope of Forest Botany:** Merits of combining traditional Botany and Forestry practices. General introduction to forests, natural and manmade. Types of forests tropical, temperate, evergreen, semi evergreen, deciduous, monoculture, multipurpose, social and industrial. Forest and climate - Forest and Biodiversity - Forest and gene conservation - Forest and ecosystem - Forest and civilization. Geographical history of the forest vegetation - natural vs. artificial. Special emphasizes on social forestry, Industrial forestry and Multi-purpose forestry. Preservation of natural forestry - Pollution control.
II	**Forest genetics**: Forest physiology, forest ecology – strong interrelationships. Macro-dynamic ecosystem reserves, hydrological cycles, balance. Identification of timber plants based on vegetative features. Seedlings, leaves, bark branching pattern architectural models of trees. Major and minor forest products, use and misuse of forests by man, direct and indirect forest wealth, forest policies, forest protection through peoples committee.
III	**Silviculture:** Concept and scope of study, forest in general form, composition, classification of world forests and Indian forests. Classification based on its quality density, tolerance, crown; water cycles of forest. Photosynthetic processes in forest: nitrogen and mineral nutrition in forests.

IV	**Seed dynamics in forest:** Seed production, dissemination, germination, establishment and mortality, growth of trees in general terms - height, diameter, volume, growth of stands - gross increment, net increment, stand reaction to varies types of cuttings.
V	**Measurement:** Definition, direct measurements, direct and indirect estimate, and prediction. Measurement of diameter - rules and methods, measurement of height - different rules, methods, instruments, total height and merchantable length. Measurement of volume - common units, different methods and procedures of volume measurements. Measurement of age: direct estimate, averages, standard error, and sampling, General concept of indirect estimate based on one or more independent variables. Forestry for social and national development. Progress to be achieved in social forestry, industrial forestry and multiple forestry. Forest Laws- Indian Forest Act, 1927; Forest conservation Act. Wild Life Protection Act, 1972.

Course outcomes: 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

Recommended Text:

1. Manikandan, K and S. Prabhu. 2013. Indian forestry, a breakthrough approach to forest service. Jain Bros.
2. Roger Sands. 2013. Forestry in a global context, CAB international.
3. Balakathiresan.S.1986.EssentialsofForestManagement.NatrajPublishers,Dehradun.
4. Agarwala,V.P.1990.ForestsinIndia,EnvironmentalandProtectionFrontiers.Oxford & IBH

PublishingCo.New Delhi.
5. Chundawat, B.S. and Gautham, S.K. 1996. Text book of Agro forestry. Oxford and IBH publisher, New Delhi.
6. Singhi, G.B. 1987. Forest Ecology of India, Publisher: Rawat.
7. Ramprakash. 1986. Forest management. IBD Publishers, Debra Dun.
8. Tiwari, K.M. 1983. Social forestry in India. Nataraj Publishers, Dehra Dun.
9. WWF. 2007. Timber identification manual. TRAFFIC, New Delhi.
10. Dhiman, A.K. 2003. Sacred plants and their medicinal uses. Daya publishing house, New Delhi.
11. Mehta, T. 1981. A handbook of forest utilization. Periodical Expert Book Agency, New Delhi.
12. Nair, N.C and Henry, A.N. 1983. Flora of Tamilnadu, India. Series: 1, Analysis, Vol.1. BSI, Coimbatore, India.

Reference Books:

1. Donald L. Grebner. Jacek P. Siry and Pete Bettinger. 2012. Introduction to forestry and Natural resources Academic press
2. West, P.W. 2015. Tree and forest measurement, Springer international publishing Switzerland.
3. Kollmann, F.F.P and Cote, W.A. 1988. Wood science and Technology. Vol. I & II Springer Verlag, New York.
4. Agarwala,V.P.1990.ForestsinIndia,EnvironmentalandProtectionFrontiers.OxfordIBHPublishing Co.,New Delhi.
5. Rao, K.R. and Juneja, K.B.S. 1992. Field identification of 50 important timbers of India. ICFRE Publi. Dehradun 123 p.
6. Avery, T.E. 1967. Forest Measurements. Mc Grand Hill Book Company, New York.
7. Manikandan K, Prabhu S. 2018. Indian Forestry A Breakthrough Approach To Forest Services, Jain Brothers.
8. Pathak, P.S, Ram Newaj. 2012. Agro forestry: Potentials and Opportunities. India Agrobios.
9. Powell, Baden B.H. 2004. Manual of Forest Law. New Delhi: Biotech.
10. Uthappa, A.R. 2015. Sangram Bhanudas Chavan, Competitive Forestry, New Vishal Publications, 1st ed.
11. Chaturvedi, A.N. and Khanna, L.S. 2015. Hand Book of Forestry (5th Edition).
12. Frederick Franklin Moon, 2018. The Book of Forestry. Repro Books.
13. Parthiban, K.T. 2018. Introduction to Forestry & Agroforestry.

Web resources:

1. http://wwwwds.worldbank.org/external/default/WDServer/WDSP/IB/2006/10/19/000112742_20 06 1019150049/Rendered/PDF/367890Loggerheads0Report.pdf.
2. https://www.britannica.com/science/forestry
3. https://en.wikipedia.org/wiki/Forestry.
4. https://www.biologydiscussion.com/forest/essay-forest-importance.major-products-and-its-conservation/25119
5. https://academic.oop.com
6. https://www.sciencedirect.com/topics/agriculture-and-biological-science-forest-product.

Mapping with Programme Outcomes:

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

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

SKILL ENHANCEMENT : PROFESSIONAL COMPETENCY SKILL ENHANCEMENT

Title of the Course	**BOTANY FOR COMPETETIVE EXAMINATIONS**						
Paper Number	**SEC III**						
Category	**Skill Enhancement**	**Year**	**II**	**Credits**	**2**	**Course Code**	**P23SEB3**
		Semester	**IV**				

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

Pre-requisite	To understand the concept of skill enhancement.
Learning Objectives	1. To study the biodiversity by describing and explaining the morphology and reproductive processes of algae, fungi, Lichens bryophytes .
	2.To provide comprehensive knowledge about microbes and its effect on man and environment.
	3. To study and understand the phylogeny, Paleontology and distinctive characteristics of fossil records of Pteridophytes and Gymnosperms.
	4.Learn the importance of plant anatomy in plant production systems
	5.To gain knowledge about the various cell structures and functions of prokaryotes and eukaryotes and to understand the laws of inheritance, genetic basis of loci and alleles and their linkage.

UNIT	**CONTENTS**
I	. **Viruses** - A general account of viruses- nature, origin, purification symptomatology methods, transmission and control measures of viruses - Vector relationships, multiplication, Bacterial viruses, algal viruses and mycoviruses. **Bacteria**-General account of bacteria with reference to cell morphology, appendages, envelops nutrition, growth and reproduction, structure and replication of nucleic acids in Bacterial plasmids and gene manipulation, classification as per Bergey Manual (1973) economic importance of bacteria. **Algae-** general characteristics; criteria for algal classification; Round's system of classification; general characters, structure and reproduction of various groups of algae. Economic importance of algae with special emphasis on algal blooms, indicators of pollution, algae as alternate source of energy **Fungi** -Classification (Alexopoulos and Mims 1979). A systematic study of the range of structure, reproduction, life cycles, phylogeny and affinities of the main classes of fungi; Economic importance of fungi **Lichens** - A general account of lichens - Structure, nutrition; reproduction, classification and economic importance of lichens.

II	**Plant Pathology** - A general account of plant disease due to fungi, bacteria and viruses with special reference to India Host microbe interaction, principles of disease control, (physical, chemical and biological methods). **Microbiology**-Soil microbiology-Soil microbes N_2 fixation and Bio-geochemical cycles-Food and Water microbiology-Microbial flora of fresh and spoiled foods-Industrial microbiology-Industrial applications of microbes for the manufacture of Alcohols, SCP organic acids.
III	**Bryophytes:**Bryophytes: general characteristics; Proskaeur's (1957) system of classification; structure and reproduction of various groups of bryophytes..Evolution of sporophyte; apogamy and apospory; alternation of generation; economic importance of bryophytes. **Pteridophytes**: Classification (Sporne 1976) - Distribution of extinct and extant forms - comparative study of morphology and anatomy of sporophytes-Structure and development of gametophytes of the major groups (Psilopsida, Lycopsida, Sphenopsida and Pteropsida). **Gymnosperms**: Classification (Sporne 1977) - Distribution of extinct and extant forms - Comparative study of morphology and reproduction of major groups – Cycadopsida, Coniferopsida and Gnetopsida evolution of male and female gametophytes, Economic importance of gymnosperms. **Paleobotany** Geological time scale, Techniques of fossil study, Types of fossils and different methods of fossilization. Radio carbon dating, study of fossil forms in algae, bryophytes, pteriodophytes and Gymnosperms.
IV	**Taxonomy:** History and classification-Artificial system-Linnaeus, Natural system-Jessieu De Candolle, Bentham and Hooker, Phylogenetic system-Engler and Prantl. Bessey Hutchinson Recent Trends in systematics-Cytotaxonomy, Chemotaxonomy, Numerical taxonomy. International Code of Botanical Nomenclature, Herbarium techniques. **Embryology:** Microsporogenesis and structure of microsporangium – Male gametophte. Mega sporogenesis and structure of megasporangium – Female gametophyte. Present concept of fertlization, Endosperm types – Endosperm haustoria. **Anatomy:** Meristems – General account, classification, various concepts of apical organization of shoot and root apices. Procambium, Cambium and their relationship. Development of Secondary vascular tissues. Simple tissues, Complex tissues – Xylem & Phloem. Wood anatomy – variations in wood structure – tyloses – Heartwood and sapwood – growth rings.
	Plant Physiology: Water relations of plants – Mechanism of absorption of water – passive and active – apoplast symplast concept. Stomatal mechanism and Transpiration – Ascent of Sap. Photosynthesis –. Photosynthetic pigments and pigment systems.

V	Respiration – Glycolysis, Krebs cycle, Electron Transport phytochromes – role and mode of action. **Biochemistry**: Chemistry of carbohydrates – classification – structure and function, lipids – classification, occurrence. Proteins – structure, properties and classification of Nucleic acids – chemistry of Nucleic acids – structure and properties, different types of RNA, their origin, properties and functions. Enzymes – Properties, mode of action, nomenclature and classification – factors affecting enzyme activity. **Cell Biology:** Prokaryotes and Eukaryotes. Ultra structure and molecular organization of cell-cell wall, plasma membrane, Endoplasmic reticulum, Mitrochondria, Lysosomes Cell division – Mitosis, meiosis and their significance Chromosome – morphology, fine structure, Types – giant chromosome. **Genetics**: Mendelian and Non-mendelian inheritance – linkage and crossing over. Mutation – Mutagenic agents – structural and chemical basis of mutations in plants cytoplasmic inheritance, Male sterility in plants – Sex determination in plants – sex linked inheritance. Replication of DNA – Methods and models in DNA repair mechanism – Enzymes – split genes –Jumping and mobile genes – concepts of gene – Cistron, Muton and Recon.

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Relate to the structural organizations of algae, fungi, lichens	K1
CO2	Elucidate concepts of microbial interactions with plant and humans.	K2
CO3	Learn the morphological/anatomical organization, life history of major types of Bryophytes, Pteridophytes, Gymnosperms & Paleobotany	K3
CO4	Understand the various concepts of plant development and reproduction. And the characteristic features of the families	K4
CO5	Compare and contrast the physiological functions and Metabolism .	K5 & K6

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)

Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

1.Kumar, H.D.1999. Introductory Phycology. Affiliated East-West Press, Delhi

2.Sharma, O.P. 2011. Fungi and Allied Microorganisms, Mc Graw Hill, ISBN:9780070700383, 0070700389

3.Pandey, P.B. 2014. College Botany-1: Including Algae, Fungi, Lichens, Bacteria, Viruses, Plant Pathology, Industrial Microbiology and Bryophyta. Chand Publishing, New Delhi

4.Vashishta, P.C. Sinha, A.K and Anil Kumar. 2016. Botany for Degree students. Gymnosperms. S. Chand and Company Ltd., New Delhi

5.Bhatnagar, S.P and Alok Moitra. 2020. Gymnosperms, New Age International (P) Ltd., Publishers, Bengaluru.

6.Bhojwani, S.S. Bhatnagar, S.P and Dantu, P.K. 2015. The Embryology of Angiosperms (6th revised and enlarged edition). Vikas Publishing House, New Delhi
.

7.Maheshwari, P. 1963. Recent Advances in Embryology of Angiosperms. Intl. Soc. Plant Morphologists, New Delhi.

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

9.Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments.6th edition. John Wiley& Sons.

Reference books:

1.Sundaralingam, V. 1991. Marine algae. Bishen Singh and Mahendra Pal Singh Publishers, Dehradun.

2.Edwardlee,R. 2018. Phycology, 5thEd., Cambridge UniversityPress, London.

3.Nash, T.H. 2008. Lichen Biology, Cambridge University press.

4.Parihar, N.S. 2019. An Introduction to Embryophyta Pteridophytes. 5th Edition, Surjeet Publication, Delhi.

5.Pandey, S.N and Trivedi, P.S. 2015. A Text Book of Botany Vol. II- 12 th edition (Paper back), Vikas Publishing

6. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.

7. Gupta. P.K. 2000. Cell and Molecular Biology, Rastogi Pub. Meerut.

8.Rastogi. 1996. Cell and molecular biology. New age international publishers.

9.Elliott, W.H. and Ellioff. 1997. Biochemistry and molecular biology. Oxford.

10.. Freifelder D., 1987. Molecular Biology. Narosa publishing house.

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.nature.com/scitable/topic/cell-biology 7.https://plato.stanford.edu/entries/molecular-biology/ 8.https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/bioinformatics 9.https://.britannica.com/technology/biotechnolog/

Mapping with Programme Outcomes:

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

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