MANONMANIAM SUNDARANAR UNIVERSITY
TIRUNELVELI – 12

MODIFIED AND CORRECTED SYLLABUS

M.SC BOTANY

FROM THE ACADEMIC YEAR 2026 – 2027

Contents

1. Preamble
2. Structure of Course
3. Learning and Teaching Activities
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Introduction:

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.

VISION

Developing students with sound knowledge in Botany and Plant Biotechnology to effectively utilize and manage biological resources for sustainable development.

MISSION

Disseminating knowledge and imparting skills to enhance employability, foster innovation in research and promote entrepreneurship in the fields of Botany and Plant Biotechnology.

About the programme

The M.Sc. – Botany programme includes a wide diversity of courses covering all aspects of Plant Sciences. In addition to unique combinations of basic, advanced and applied courses (as Core and Discipline-Specific Elective papers), the programme also has a strong interdisciplinary component. Emphasis is on experiential learning through hands-on laboratory exercises, field trips and projects. Current thrust areas of teaching provide students with substantial exposure and skills in plant biology. The disciplines include plant structure, growth and development, systematics, physiology, biochemistry, molecular biology, recombinant DNA technology, genomics and proteomics, pathology, ecology and environment, genetics and plant breeding, evolutionary biology, bioinformatics, biostatistics and transgenic technology on a variety of taxa ranging from algae, fungi and other microbes, bryophytes and vascular plants (ferns, gymnosperms and angiosperms including crop plants) at the cellular, community and ecosystem levels.

Objectives of the Programme

This programme has the following broad objectives:

- To inculcate the concepts of Botany
- To provide the knowledge and skills required by a postgraduate in Botany
- To fill the gap between academia and industry with regard to demand and supply.

Duration

The minimum duration of the programme is two years, which is divided into four semesters.

Eligibility Criteria

Graduation with B.Sc. Botany degree from any recognized University /Institution

Medium of Instruction

The programme is available in English.

Teaching-learning process

The programme allows using of varied pedagogical methods and techniques.

A. **Theory** 1. Lecture 2. Tutorial 3. Seminars 4. Assignment 5. Tests /assessments based on problem-solving. 6. Group discussions

B. **Practical**: 1. Laboratory-based practical components and experiments. 2. Field-based learning

C. **Project/ dissertation**: 1. Research problem discussion. 2. Technology-enabled learning. 3. Internship or summer training.

Written Examination: Theory Paper (Bloom's Taxonomy based)

Question paper Model

1. **Testing Pattern (25 +75)**
   Internal - 25 marks
   External - 75 marks

2. **Internal Assessment**
   Internal – 25 marks

Theory Course:

For theory courses there shall be three tests conducted by the faculty concerned and the average of the best two can be taken as the Continuous Internal Assessment (CIA) for a maximum of 15 marks. The duration of each test shall be one/one and a half hour.

Continuous Internal Assessment	15 marks
Seminar	5 marks
Assignment	5 marks

For theory Papers:

Part A 15 X 1 = 15 Marks - Answer all questions (No choice)
Part B 5 X 4 = 20 Marks - Choosing either (a) or (b)
Part C 5 X 8 = 40 Marks - Choosing either (a) or (b)
Total = 75 marks

Laboratory Courses:

Internal - 50 marks
External - 50 marks

Practical examinations: External Examinations shall be conducted at the end of every semester. There is no practical examination for elective papers. The external evaluation of

practical examination shall be conducted by two examiners appointed by the University. The duration of each test shall be 3 hours.

For Laboratory Courses, there shall be Continuous Internal Assessment Test and Record.

One test in Laboratory part, attendance and class participation. The CIA for a maximum of 50 marks. The duration of test shall be 3 hours.

Records: A duly certified record of practical exams should be submitted during the external examination. The entire experiments mentioned in the practical syllabus are expected to be done and recorded. The criteria to be observed in the valuation of records are fixed and are appended below: a. Content should cover the entire practical works mentioned under individual courses. b. Neatness and scientific accuracy. c. Timely submission of record.

Methods of Evaluation of Practical (The existing pattern will be followed)		
Internal	Continuous Internal Assessment Test	50 Marks
	Attendance and Class Participation	
External	End Semester Examination	50 Marks

Components of Internal Practical Assessment (CIA)

1. Regular submission of Record -10 marks
2. Attendance more than 90 % for practical sessions- 5 marks, 80-89 %- 4 marks, 70-79 %- 3 marks.
3. Submission of observation note book- 10 marks
4. Internal practical examination-25 marks

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

Programme outcomes (POS)

Programme: M.Sc. Botany:	**Duration: 2 years**
Programme outcomes (PO)	
The M.Sc. Botany program is designed to achieve the following objectives	
PO 1	To impart knowledge on the fundamental, advanced and emerging concepts in Botany.
PO 2	To provide up-to-date theoretical knowledge on various forms of plants, their interactions with biotic and abiotic entities in the ecosystem and relevant practical skills.
PO 3	To comprehend and interpret various facts of Botany including the importance and judicious utilization of plant sources.
PO 4	To promote proficiency in designing research problems, review of literature, laboratory experiments, data analyses and preparation of reports with professional ethics.
PO 5	To understand the principles and applications of various traditional and modern

	techniques used in Botany.
PO 6	To disseminate knowledge on the design and execution of experiments in Botany with emphasis on the operation of relevant sophisticated instruments.
PO 7	To impart knowledge on the economic importance of plant/microbial resources and their products and to promote entrepreneurship skill. To enable the students to take up various qualifying examinations concerning Botany and to face the challenges in career opportunities

Programme Specific Outcomes (PSOs):

PSO1	The student completing the course is able to identify various life forms of plants. Students gain knowledge on morphological and anatomical features of algae, fungi, bryophytes, pteridophytes, gymnosperms and angiosperms. Students are able to demonstrate the acquisition of knowledge of facts, concepts, principles and theories.
PSO2	Deeper knowledge and understanding of the learning areas and its under lying principles and theories.
PSO3	Students should be able to demonstrate the acquisition of theoretical and technical knowledge in multidisciplinary contexts
PSO4	The student completing the course is trained in various analytical techniques of plant biology. Students can execute experiments related to basic studies.
PSO5	The graduates should be able to demonstrate the ability to critically evaluate the essential theories, policies, and practices by following a scientific approach to knowledge development.
PSO6	The student is capable of executing short research projects incorporating various tools and techniques in any of the basic specializations of Plant Sciences under supervision.
PSO7	Acquire academic excellence in plant sciences to pursue higher studies, research and employability. To create effective entrepreneurs by enhancing their critical thinking, problem solving and decision makes skill that will facilitate startups and high potential organizations.

Template for P.G. Programmes – Botany 2026 – 2027

Semester–I	Credit	Hours	Semester-II	Credit	Hours	Semester-III	Credit	Hours	Semester–IV	Credit	Hours
1.1 Core-I	4	5	2.1 Core - VI	4	5	3.1. Core-XI	4	5	4.1 Core-XVI	4	5
1.2 Core-II	4	5	2.2 Core - VII	4	5	3.2 Core-XII	4	5	4.2 Core-XVII	4	5
1.3 Core III	4	5	2.3 Core – VIII	4	5	3.3 Core –XIII	4	5	4.3 Core XVIII	4	5
1.4 Core IV - Laboratory Course - 1	1	2	2.4 Core IX - Laboratory Course - 3	1	2	3.4 Core XIV Laboratory course- 5	1	2	4.4 Core XIX– Laboratory course-7	1	2
1.5 Core V – Laboratory Course - 2	2	4	2.5 Core X - Laboratory Course - 4	2	4	3.5 Core XV Laboratory course- 6	2	4	4.5 Core XX– Laboratory course-8	2	4
1.6 Discipline Centric Elective - I	4	5	2.6 Discipline Centric Elective – II	4	5	3.6 Discipline Centric Elective – III	4	5	4.6. Core - XXI Project with Viva Voce	4	4
1.7 SEC I	3	4	2.7 SEC -II	3	4	3.7 SEC-III	3	4	4.7 Generic Centric Elective – VI	4	5
						3.8 Internship / Industrial Visit / Research Knowledge Updating activity	2	-			
	22	**30**		**22**	**30**		**24**	**30**		**23**	**30**
									Total Credit Points	**91**	

Credit Distribution for PG Programmes - Semester wise papers – Botany - 2026 – 2027

Course Name M.Sc. Botany		Hours Per week		Credits
		Lecture Hours per week	Tutorial hours per week	
SEMESTER 1				
CORE	**Core I** Plant Diversity - I: Algae, Fungi, Lichens and Bryophytes	3	2	4
	Core II Plant Diversity - II: Pteridophytes, Gymnosperms and Paleobotany	3	2	4
	Core III Microbiology, Immunology and Plant Pathology	3	2	4
	Core IV Laboratory course- 1: Covering Core Paper - I	1	1	1
	Core V Laboratory course- 2: Covering Core Paper – II and III	2	2	2
Elective (Generic Discipline-Centric)	**ECI:** (any One from the following) A. Applied Phycology and Applied Mycology B. Horticulture and Plant Breeding	3	2	4
Skill Enhancement (SE1)	**SE1:** Applied Microbiology	3	1	3
Extended hours may be utilized for Library/Self supportive learning/Group discussion/Affinity/Psychometric activities/Fine arts/Extension activities				
Total			**30**	**22**
SEMESTER 2				
CORE	**Core VI** Taxonomy of Angiosperms	3	2	4
	Core VII Plant Anatomy and Embryology of Angiosperms	3	2	4

	Core VIII Plant Biotechnology and Genetic Engineering	3	2	4
	Core IX Laboratory course 3: Covering Core Paper VI	1	1	1
	Core X Laboratory course 4: Covering Core Papers VII and VIII	2	2	2
Elective (Generic Discipline-Centric)	**EC2:** (any one from the following) A. Biodiversity, Evolution and Economic Botany B. Agriculture Botany and Forestry	3	2	4
Skill Enhancement (SE2)	**SE2** Applied Biotechnology and Nanobiotechnology	3	1	3
		Total	**30**	**22**
SEMESTER 3				
CORE	**Core XI** – Cell and Molecular Biology	3	2	4
	Core XII - Genetics and Biostatistics	3	2	4
	Core XIII – Biochemistry and Biophysics	3	2	4
	Core XIV - Laboratory course - 5 covering Core Paper XI	2	2	1
	Core XV- Laboratory course - 6 covering Core Papers XII and XIII	1	1	2
Elective (Generic Discipline-Centric)	**EC3:** (any one from the following) A. Pharmacognosy and Phytochemistry B. Plant Genomics	3	2	4
Skill Enhancement (SE3)	**SE3** Bioanalytical Techniques	3	1	3
Internship/Industrial Activity (Carried out at the end of III Semester– 30 hours)				2
Total			**30**	**24**

SEMESTER 4				
CORE	**Core XVI** Plant Physiology and Plant metabolism	3	2	4
	Core XVII Ecology and Phytogeography	3	2	4
	Core XVIII Research Methodology and Bioinformatics	3	2	4
	Core XIX– Laboratory course – 7 Covering Core Paper XVI	1	1	1
	Core XX–Laboratory course- 8 Covering core papers XVII and XVIII	2	2	2
Project	**Core – XXI** Project with Viva Voce	2	2	4
Elective VI (Generic Discipline - Centric)	**EC4** (One from the following) A. Gene Cloning and Gene Therapy B. Applied Ecology and Remote Sensing	3	2	4
	Total		30	23
	Total credit			91

Programme Specific Outcomes (PSOs)

Title of the Paper	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
Core I Plant Diversity - I: Algae, Fungi, Lichens and Bryophytes	3	2	1	-	-	2	3
Core II Plant Diversity - II: Pteridophytes, Gymnosperms and Paleobotany	3	2	1	-	-	2	3
Core III Microbiology, Immunology and Plant Pathology	2	3	2	1	2	1	-
Core IV Laboratory course- 1	3	3	2	1	-	2	1
Core V Laboratory course- 2:	3	3	2	1	-	2	1
EC1: A. Applied Phycology and Applied Mycology	2	3	2	-	-	2	2
EC1: B. Horticulture and Plant Breeding	2	3	2	-	-	2	2
SE1: Applied Microbiology	2	2	3	1	1	3	1
Core VI Taxonomy of Angiosperms	3	2	3	2	1	2	1
Core VII Plant Anatomy and Embryology of Angiosperms	3	2	2	2	1	2	2

Core VIII Plant Biotechnology and Genetic Engineering	3	2	3	2	-	-	1
Core IX Laboratory course 3:	3	3	2	1	-	2	1
Core X Laboratory course 4:	3	3	2	1	-	2	1
EC2: A. Biodiversity, Evolution and Economic Botany	3	2	3	2	-	-	1
EC2: B. Agriculture Botany and Forestry	2	2	2	-	-	1	1
SE2 Applied Biotechnology and Nanobiotechnology	3	1	3	1	1	-	1
Core XI Cell and Molecular Biology	3	2	3	2	-	-	1
Core XII Genetics and Biostatistics	3	2	1	3	-	1	1
Core XIII – Biochemistry and Biophysics	3	2	2	1	-	-	1
Core XIV Laboratory course - 5	3	3	2	1	-	2	1
Core XV Laboratory course **-** 6	3	3	2	1	-	2	1
EC3: A. Pharmacognosy and Phytochemistry	2	2	3	2	-	-	1
EC3: B. Plant Genomics	2	3	2	2	-	1	1
SE3: Bioanalytical Techniques	3	2	2	2	1	2	1
Core XVI Plant Physiology and Plant metabolism	3	2	1	2	-	2	1
Core XVII Ecology and Phytogeography	3	1	2	2	-	2	1
Core XVIII Research Methodology and Bioinformatics	3	2	1	2	-	1	2
Core XIX Laboratory course – **7**	3	3	2	1	-	2	1
Core XX Laboratory course- 8	3	3	2	1	1	2	1
Core XXI Project with Viva Voce	3	3	2	2	-	1	2
EC4: A. Gene Cloning and Gene Therapy	3	3	2	2	-	-	-
EC4: B. Applied Ecology and Remote Sensing	2	2	2	2	-	-	1

0 – No correlation 1 – Low 2- Medium 3 – High

M.Sc. BOTANY CURRICULUM

I YEAR – I SEMESTER

CORE I

Title of the Course		**PLANT DIVERSITY – I: ALGAE, FUNGI, LICHENS AND BRYOPHYTES**					
Paper Number		**CORE I**					
Category	Core	**Year**	I	**Credits**	4	**Course Code**	
		Semester	I				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		3	2	--	5		
Pre-requisite		Students should be familiar with the basics of algae, fungi, lichens and Bryophytes.					
Learning Objectives		1. To learn about the classification, distinguishing traits, geographic distribution, and reproductive cycle of algae, fungi, lichens, and bryophytes. 2. To gain knowledge about the ecological and economic importance of algae, fungi, lichens and bryophytes. 3. To spark interest in the evolutionary roots of plant development. 4. To study the biodiversity by describing and explaining the morphology and reproductive processes of algae, fungi, bryophytes and microorganisms. 5. To connect the link between algae with their terrestrial counterpart bryophytes through morphological characters and variations of gametophytes and sporophytes and their evolutionary significance.					

UNIT	CONTENTS
I	**ALGAE:** Contributions of Indian Phycologist (M.O.P Iyengar, T.V. Desikachary, V. Krishnamurthy and V.S. Sundaralingam), Classification of algae by F.E. Fritsch (1935-45). Salient features of major classes: Cyanophyceae, Chlorophyceae, Xanthophyceae, Chrysophyceae, Cryptophyceae, Dinophyceae, Chloromonadineae, Euglenophyceae, Charophyceae, Bacillariophyceae, Phaeophyceae and Rhodophyceae. Range of thallus organization, diverse habitats of algae, cell structure, pigmentation, reproduction (vegetative, asexual and sexual) and life cycle patterns, origin and evolution of sex in algae. Fossil algae. Structure, reproduction and life cycles of the following genera: *Oscillatoria*, *Oedogonium*, *Chara, Padina* and *Gracilaria.*
	FUNGI: Habit, types of mycelium, structure of fungal cell, reproduction, fruiting bodies and life cycle patterns. Mode of nutrition in fungi. Contributions of Indian Mycologist (C.V. Subramanian), Classification of Fungi by Alexopoulos and Mims (1979).

II	General characters of major classes: Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina. Heterothallism in fungi, sexuality in fungi, Parasexuality. Structure, reproduction and life cycles of the following genera: *Phytophthora, Rhizopus, Xylaria, Polyporus* and *Albugo.*
III	**LICHENS:** Classification (Hale, 1969). Habit and habitat, Types – based on growth forms (Crustose, Foliose, Fruticose, Leprose, Squamulose, Filamentous), based on nature of the fungal component (Ascolichens, Basidiolichens, Deuterolichens), Based on thallus structure (Heteromerous, Homoiomerous). Vegetative structures associated with the lichen thallus. Structure and reproduction in lichens.
IV	**BRYOPHYTES:** Habitat, structure of gametophyte and sporophyte, reproduction - vegetative and sexual, alternation of generations. Classification of Bryophytes by Watson (1971). General account of structure and development of gametophyte, sporophyte of Marchantiales, Jungermanniales, Anthocerotales, Sphagnales, Funariales and Polytrichales. Structure, reproduction and life histories of the following genera: *Targionia, Lunularia, Porella* and *Polytrichum.* Spore dispersal mechanisms in bryophytes, spore germination patterns in bryophytes. Affinities of Bryophytes with algae and pteridophytes. Progressive and retrogressive evolution of lichens. Fossil Bryophytes.
V	**ECONOMIC IMPORTANCE:** Algae - Agricultural importance - food and fodder - space travel - medicine - single cell protein - Industrial products (Agar-Agar, Carrageenan, Laminarin, Alginic acid, Diatomite, Iodine and biofuel) - indicator of industrial wastes - sewage disposal. Fungi – Economic importance in food, single cell protein, Mycorrhizae, biological research, biopesticides, industries and medicine. Lichen –economic importance and as indicator of pollution. Bryophytes – Ecological and economic importance – industry, horticulture and medicine.

Course Outcomes

CO	Course outcomes – on completion of this course, the students will be able to	Programme outcomes
CO 1	Relate to the structural organizations of algae, fungi, lichens and bryophytes	K1
CO 2	Demonstrate both the theoretical and practical knowledge in understanding the diversity of basic life forms and their importance	K2
CO 3	Explain life cycle patterns in algae, fungi, lichens and Bryophytes	K3
CO 4	Compare and contrast the mode of reproduction in diverse groups of basic plant forms.	K4

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.
8. Fritsch, F.E. 1945. The structure and reproduction of the algae. Vikas publishing Co. ISBN: 0-521-77051-3.

Reference Books

1. Sundaralingam, V. 1991. Marine algae. Bishen Singh and Mahendra Pal Singh Publishers, Dehradun.
2. Edwardlee, R. 2018. Phycology, 5th Ed., Cambridge University Press, London.
3. Nash, T.H. 2008. Lichen Biology, Cambridge University press.
4. Johri, R.M., Lata, S. and Tyagi, K. 2012. A Textbook of Bryophyta. Dominant Publishers & Distributors Pvt., Ltd., New Delhi. ISBN: 9789384207335.
5. Alexopoulos, C.J. and Mims, M. 2007. Introductory Mycology. 4th Edition, Wiley Publishers, ISBN: 9780471522294
6. Cavers, F.1971. The interrelationship of Bryophytes. Dawsons Pallwall. ISBN -0-521-66794-1
7. Chopra, R.N.2001. Biology of Bryophytes. Narosa publishers. ISBN: 81-224-343- 9
8. Lee, R. E. 2009. Phycology. Cambridge University Press. ISBN: 978-0521-14144-42.
9. Rashid, A. 1982. An introduction to Pteridophyta. Vikas publishing Co. (repr. ed). ISBN: 81- 259-0709-2

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	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	1	1	0	0	3	3	3	1	2	1	1
CO2	3	2	2	1	2	1	1	3	3	1	1	1	2	0
CO3	3	2	1	1	0	1	0	3	2	1	2	1	0	2
CO4	3	2	0	1	1	1	2	3	3	1	1	2	1	1

0 – No correlation 1 – Low 2- Medium 3 – High

CORE 2

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

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

Pre-requisite	Students should know about the fundaments of Pteridophytes, Gymnosperms and fossil records.
Learning Objectives	1. To investigate the classification, distinctive traits, distribution and reproduction and life history of the various classes and major types of Pteridophytes and Gymnosperms. 2. To identify and characterize diversity of lower vascular plants in order to comprehend the dynamics of diversity to realize the importance of diversity. 3. To research the classification, phylogeny and economic importance of Pteridophytes and Gymnosperms. 4. To study and understand the phylogeny and Paleontology of Pteridophyte sand 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 (K.R. Sporne, 1966). Origin and evolution of Pteridophytes; Telome concept; stelar evolution; heterospory and origin of seed habit; soral evolution in ferns, eusporangiate and leptosporangiate forms. General characters of Psilopsida, Lycopsida, Sphenopsida and Pteropsida. Economic importance of Pteridophytes.
II	**PTERIDOPHYTES:** Structure, anatomy, reproduction and life cycles of the following genera: *Isoetes, Equisetum, Ophioglossum, Pteris, Marselia* and *Azolla.*
III	**GYMNOSPERMS:** General characteristics and classification (K.R. Sporne, 1965). A general account of distribution of Gymnosperms. Affinities of gymnosperms with ferns and angiosperms. General characters of Cycadopsida, Coniferopsida and Gnetopsida. Economic importance of Gymnosperms.
IV	**GYMNOSPERMS:** Structure, anatomy, reproduction and life cycles of the following genera: *Cycas*, *Cupressus, Araucaria, Podocarpus and Gnetum*

V	**PALEOBOTANY:** Geological Scale; Radiocarbon dating; Contribution of Birbal Sahni to Paleobotany. Gondwana flora of India. Fossilization and fossil types. Living fossils. Economic importance of fossils – fossil fuels and industrial raw materials and uses. Fossil algae and fossil bryophytes. Study of organ genera: *Rhynia, Lepidocarpon, Calamites, Cordaites* and *Lyginopteris.*

Recommended texts

1. Sundar Rajan S. 1999. Introduction to Pteridophyta. New Age International Publishers, New Delhi.
2. Sporne, K.R. 1962. The morphology of Pteridophytes. Hutchinson Univ. Library, London.
3. Chandra S. and Srivastava, M. 2003. Pteridology in the New Millennium. Khuwar Acad. Publishers.
4. Vashishta. P.C., A.K. Sinha and Anil Kumar. 2018. Botany for Degree students - Gymnosperms. S. Chand and Company Ltd., New Delhi
5. Bhatnagar S.P and Moitra A. 2000. Gymnosperms. New Age International Ltd.
6. Arnold A.C. 2005. An Introduction to Paleobotany. Agrobios (India). Jodhpur.

References

1. Ranker T.A. and Haufler C.H. 2008. Biology and Evolution of Ferns and Lycophytes. Cambridge University Press.
2. Sharma, O.P. 2017. Pteridophytes, MacMillan India Ltd. Delhi.
3. Sporne, K.R. 1965. The morphology of Gymnosperms. Hutchinson Univ. Library, London
4. Sharma O.P. and S. Dixit. 2002. Gymnosperms. Pragati Prakashan
5. Karl, J.N. 1981. Paleobotany, Paleoecology & Evolution. Praeger Publishing, New Delhi 3.
6. Meyen, S.V. 1987. Fundamentals of Paleobotany. Chapman and Hall, New York.
7. Stewart W.N. and Rothwell G.W. 2005. Paleobotany and the Evolution of Plants. 2nd Ed., Cambridge University Press.
8. Glime, J. M. & Saxena, D.1991. Uses of Bryophytes. Today and Tomorrows Printers & Publishers.
9. Surange K. R. 1966. Indian Fossil Pteridophytes. Bot. Monograph, CSIR.

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PS6	PS7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	1	1	0	0	3	3	3	1	2	1	1
CO2	3	3	2	1	2	1	1	3	3	1	1	2	2	2
CO3	3	3	1	1	0	1	1	3	2	1	2	1	2	2
CO4	3	2	0	1	1	2	2	3	3	1	1	2	1	1

0 – No correlation 1 – Low 2- Medium 3 – High

CORE 3

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">MICROBIOLOGY, IMMUNOLOGY AND PLANT PATHOLOGY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">CORE III</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">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</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>3</td><td colspan="2">2</td><td>--</td><td colspan="2">5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">1. The goal of the course is to provide students with basic understanding of microbiology, immunology, plant pathology and the etiology of specific plant diseases.</td></tr>
<tr><td colspan="2">Learning Objectives</td><td colspan="6">2. To provide comprehensive knowledge about microbes and its effect on man and environment.</td></tr>
<tr><td colspan="2"></td><td colspan="6">3. To provide comparative analysis of major groups of microbes.</td></tr>
<tr><td colspan="2"></td><td colspan="6">4. To study the principles of immune system, immunizing agents like antibodies and vaccines and gene therapy methods.</td></tr>
<tr><td colspan="2"></td><td colspan="6">5. To enhance the knowledge and skills needed for self-employment using the microbial derived products.</td></tr>
<tr><td colspan="2"></td><td colspan="6">6. To appreciate the role of immune system in conferring disease resistance.</td></tr>
<tr><td>UNIT</td><td colspan="7">CONTENTS</td></tr>
<tr><td>I</td><td colspan="7">BACTERIA:
Types of microorganisms - Extremophiles. Contribution of Leuwenhoek, Louis Pasteur, Robert Koch, Edward Jenner. Bacteria - cell structure, size, shape, flagella, pili, cell membrane, cell wall, cell organelles, plasmid. Bacterial classification (outline) - Bergey’s manual of systemic Bacteriology. Microbial locomotion, Chemotaxis. Bacterial growth - Growth Curve - batch culture and continuous culture. Nutritional classification of bacteria. Reproduction - Fission and sporulation. Genetic recombination- Transformation, Transduction and Conjugation.</td></tr>
<tr><td>II</td><td colspan="7">VIRUSES:
General characters, International Committee for Taxonomy of Viruses (ICTV) classification of viruses, Overview of Phycoviruses and Mycoviruses. Structure of TMV. Viruses of Eukaryotes – Animal & Plant viruses. Oncogenic viruses. Bacteriophages - classification, replication of DNA and RNA phages -Lytic and Lysogenic cycle. Virusoids, viroids and prions. Mycoplasma: Structure and classification.</td></tr>
<tr><td>III</td><td colspan="7">IMMUNOLOGY:
Introduction; Immune System; Types of Immunity - Innate and Acquired. Immune Cells - Hematopoiesis, B and T lymphocytes - Maturation, NK cells. Introduction to inflammation, Adaptive immune system, Innate Immune system. Antigen: Definition, Properties and types. Antibody – Structure, types and function. Generation of antibody</td></tr>
</table>

	diversity. Antigen - Antibody interactions: definition, types- Precipitation, Agglutination, Complement fixation. Immune Response – Humoral and Cell Mediated. Immunodiagnosis –Blood Grouping, Widal test, Enzyme-Linked Immunosorbent Assay (ELISA), Immunoelectrophoresis and Immunodiffusion.
IV	**PLANT PATHOLOGY:** Classification of plant diseases, Symptomology (important symptoms of plant pathogens). Principles of plant infection –Inoculum, inoculum potential, Pathogenicity. Disease triangle. Host parasite interaction. Causal agents of plant diseases - biotic and Abiotic causes, Elicitors. Mechanism of plant disease development. Role of enzymes and toxins in disease development. Defence mechanism of host – structural and biochemical defences - oxidative burst; Phenolics, Phytoalexins, RJ proteins – R proteins- functions. PR-proteins –classes of PR-proteins, their role in plants defence.
V	**PLANT PATHOLOGY:** Epidemiology – disease forecasting. Cultural, physical, biological, chemical, and botanicals methods of plant disease control. Integrated Pest Management system. Study of the following diseases with reference to their incidents – symptom and control measures – fungal (Cercospora leaf spot of Brinjal) – bacterial (Bacterial leaf blight - paddy) – mycoplasmal (phyllody of *Sesamum*) – viral (Yellow vein mosaic disease - Bhendi) – nematode (Root knot of potato). Post harvest diseases – Vegetables (Tomato and Carrot), Fruits (Citrus and Apple). Plant Growth Promoter Rhizobacteria (PGPR) - mechanisms of action and applications.

Course Outcomes

CO	**Course outcomes – on completion of this course, the students will be able to**	**Programme outcomes**
CO 1	Understand the basic concept of plant pathology and comprehend the disease cycle and various host and pathogen interactions	K1
CO 2	Identify the common plant diseases and pathogens, isolate the pathogen and suggest control measures.	K2
CO 3	Gain knowledge of microbes and their importance, application in day-to-day life.	K3
CO 4	Summarize the characteristics of different types of microorganisms, and the methods used to classify them. Describe structure, reproduction and importance of bacteria and virus	K4
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. 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. Sullia SB and Shantharam S 2001. General Microbiology. Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.
5. Dube, H.C. 2010. A text Book of Fungi, Bacteria and Viruses, 3rd Edition, Agrobios India, ISBN: 8188826383.
6. Vaman Rao, C. 2006. Immunology. 2nd Edition. Narosa Publisher.
7. Kenneth, M. 2017. Janeway's Immunobiology. 9th Edition. Garland Publisher.
8. Rao AS 1999. Introduction to Microbiology. Prentice Hall of India Pvt. Ltd., Delhi.
9. Prescott *et al.* 2003.Microbiology. McGraw Hill Education, New York.
10. Willey, J M., Sherwood, L.M. and Woolverton, C.J. 2017. Prescott's Microbiology, 10th Edition, McGraw-Hill, USA
11. Vos, P., Garrity, G., Jones, D., Krieg, N.R., Ludwig, W., Rainey, F.A., Schleifer, K.-H. and Whitman, W.B. (eds., 2009). Bergey's Manual of Systematic Bacteriology, 2nd ed., vol. 3, Springer-Verlag, New York, NY.
12. Kavanagh, K. 2017. Fungi, Biology and Applications 3rd edition. Wiley.

Reference Books

1. Agrios, A.G. 2007. Plant Pathology, Elsevier. ISBN: 9780120445653.
2. Jeffery, C., Pommerville. 2014. Alcamos Fundamentals 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.
9. Singh, R. S. 2017. Introduction To Principles Of Plant Pathology 5th edition. Medtech.

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	PS6	PS7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	3	1	1	1	0	3	3	3	1	2	1	1
CO2	3	3	1	1	2	0	1	3	3	1	2	1	2	2
CO3	3	2	1	1	0	1	1	3	2	1	2	1	0	2
CO4	3	2	0	1	1	2	2	3	3	1	2	1	1	1

0 – No correlation 1 – Low 2- Medium 3 – High

CORE IV

Title of the Course	**LABORATORY COURSE - 1 COVERING CORE PAPER I**						
Paper Number	**CORE IV**						
Category	**Core**	**Year**	**I**	**Credits**	**1**	**Course Code**	
		Semester	**I**				
Instructional Hours Per week	**Lecture**	**Tutorial**			**Lab Practice**		**Total**
	-	--			**2**		**1**
Pre-requisite	Students should be familiar with the fundamentals of algae, fungi, lichens, Bryophytes, in addition to essential laboratory techniques.						
Learning Objectives	1. To learn how to employ the use of instruments, technologies and methodologies related to thallophytes plant groups.						
	2. To enhance information on the identification of each taxonomical group by developing the skill-based detection of the morphology and microstructure of algae, and fungi.						
	3. To comprehend the fundamental concepts and methods used to identify Bryophytes, through morphological changes and evolution, anatomy and reproduction.						
	4. To develop the technical abilities in staining, sectioning, sterilizing, and characterizing. thallophytes, and other varieties of non-flowering plants.						
	5. To compare the structural diversity of fossil and extant plant species.						

UNIT	EXPERIMENTS
I	**ALGAE** Study/ microscopic observation of vegetative, anatomical and reproductive structures of the genera mentioned in the theory, using temporary or permanent slides/ specimens/ mounts. Field visit to study freshwater and marine water algal habitats and submission of five herbarium sheets Preparation of culture media and culture of green algae/ blue green algae in the laboratory (Demonstration) Identification of microalgae (green / blue green) in the given algal mixtures.
II	**FUNGI** Study of morphological and reproductive structures of the following living forms: *Puccinia, Phytophthora, Rhizopus, Albugo, Polyporus* and *Colletotrichum* Isolation and identification of fungi from soil.
III	**LICHENS** Study of morphological and reproductive structures of the genera *Parmelia/ Usnea.*

IV	**BRYOPHYTES** External morphology and internal anatomy of the vegetative and reproductive organs of the following living forms: *Bryum, Fissidens, Frullania, Porella* and *Polytrichum*.
V	**Spotters –Economic importance** (Photograph/slide/habit) Algae - *Gelidium, Spirulina, Chlorella*, Diatoms, *Nostoc*. Fungi – Yeast, *Agaricus, Penicillum*. Lichen – *Parmelia*. Bryophyte – *Sphagnum*. Identification of scientists photographs mentioned in the syllabus Habit and reproductive parts of genera mentioned in the syllabus

Course Outcomes

CO	Course outcomes – on completion of this course, the students will be able to	Programme outcomes
CO 1	Recall and applying the basic keys to distinguish at species level Identification of important algae and fungi through its structural organizations	K1 & K4
CO 2	Inculcate scientific skills to study the specimens of non-vascular cryptogams in laboratory.	K2
CO 3	Develop practical skills to identify, classify and distinguish non-vascular cryptogams.	K3
CO 4	Formulate techniques to isolate and culture of alga and fungi as well as to understand the diversity of plant forms	K5
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)	
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill	

Recommended texts

1. Kumar, H.D. 1999. Introductory Phycology. Affiliated East-West Press, Delhi.
2. Bendre, A. M. 2010. A Text Book of Practical Botany – 1. Rastogi Publications, Meerut, India.
3. Dugan, Frank. 2006. The Identification of Fungi: An Illustrated Introduction With key, Glossary and Guide to Literature. The American Phytopathological Society.
4. Edwardlee, R. 2018. Phycology, 5th Edition, Cambridge University Press, London.
5. Fritsch F.E. 1935. The Structure & Reproduction of Algae. Cambridge University Press Cambridge, U.K. Vol. I, Vol. II.
6. Smith, G. M. 1978. Manual of Phycology. The Ronald Press Company.
7. Krishnamurthy, V. 1998. Algae of India and Neighboring Countries. 1. Chlorophycota. Oxford & IBH publishing Co. Pvt. Ltd.

Reference Books

1. Chmielewski, J.G and Krayesky, D. 2013.General Botany laboratory Manual. Author House, Bloomington, USA.
2. Webster, J and Weber, R. 2007. Introduction to Fungi, 3rd Ed. Cambridge University Press, Cambridge.
3. Sharma, O.P.2017. Bryophyta, MacMillan India Ltd, New Delhi.
4. Ashok, M. Bendre and Kumar. 2010. A text book of Practical Botany, Algae, Fungi, Lichen, Bryophyta, Pteridophyta, Gymnosperms and Palaeobotany. Revised edition. Published by Rakesh Kumar Rastogi publication.
5. Gangulee, H.C and A.K. Kar. 2013. College Botany. Vth Edition. S. Chand
6. Chopra, R.N. and Kumar, P.K. 2005. Biology of Bryophytes, eds. New age International publisher.
7. Irvine, D. E. & D. M. John. 1984. Systematics of the Green Algae. Academic Press.

Web resources

1. https://www.frontiersin.org/articles/10.3389/fmicb.2017.00923/full
2. https://microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175e.pdf
3. http://ngc.digitallibrary.co.in/bitstream/123456789/190/1/A%20Textbook%20of%20Practical%20Botany%20Vol.%201.pdf
4. https://assets.vmou.ac.in/MBO10.pdf
5. https://uou.ac.in/sites/default/files/slm/BSCBO-104.pdf

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PS6	PS7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	1	2	1	1	3	2	3	3	2	3	3	3	3
CO2	3	3	2	1	1	1	1	2	2	1	2	2	1	2
CO3	3	1	2	1	1	1	1	3	2	1	3	1	3	2
CO4	3	2	3	1	0	1	0	3	3	1	3	3	1	1

0 – No correlation 1 – Low 2- Medium 3 – High

CORE V

Title of the Course	CORE-V LABORATORY COURSE - 2 COVERING THEORY PAPER II and PAPER III						
Paper Number	**CORE V**						
Category	Core	**Year**	I	**Credits**	2	**Course Code**	
		Semester	I				

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

Pre-requisite	Students should be familiar with the fundamentals of Pteridophytes, Gymnospersms, Paleobotany in addition to essential laboratory techniques.
Learning Objectives	1. To learn how to employ the use of instruments, technologies and methodologies related non-flowering plant groups.
	2. To enhance information on the identification of each taxonomical group by developing the skill-based detection of the morphology and microstructure of algae, and fungi.
	3. To gain knowledge on processes of fossilization in ancient eras
	4. Students will learn about the principle, working and applications of commonly used instruments in microbiology.
	5. Students will gain knowledge about the different types of microorganisms and their significance.

UNIT	**EXPERIMENTS**
I	**PTERIDOPHYTES** External morphology and internal anatomy of the vegetative and reproductive organs of the following living forms: *Isoetes, Equisetum, Marselia, Pteris* and *Azolla*. *Fossil slides observation: Rhynia, Lepidocarpon, Calamites.*
II	**GYMNOSPERMS** External morphology and internal anatomy of the vegetative and reproductive organs of the following living forms: *Cycas, Cupressus, Araucaria, Podocarpus, Gnetum* and *Ephedra*. Fossil slides observation*: Cordaites* and *Lyginopteris*
III	**MICROBIOLOGY** Preparation of culture media, agar slant - agar plate. Isolation of microbes by streak and pour plate method. Isolation of soil, water microbes by serial dilution techniques. Isolation of fungi from soil and water Isolation and identification *Rhizobium* from root nodules Gram staining of Bacteria Demonstration of bacterial mobility (Hanging drop method).

IV	**PLANT PATHOLOGY** Observe, identify and record the etiology of leaf spot of Brinjal, Bacterial leaf blight of paddy, phyllody of *Sesamum*, Yellow vein mosaic disease of Bhendi. Identification of Post harvest disease – Vegetables (Tomato and Carrot), Fruits (Citrus and Apple). Record the diseased crop plants in the field, prepare and submit five herbarium sheets
V	**SPOTTERS** (Photographs/Model) Bacterial cell. TMV, Bacteriophage, Bacterial growth curve, Transduction and Conjugation. Antigen - Antibody interactions Habit and reproductive parts of genera mentioned in the syllabus

Course Outcomes

CO	**Course outcomes – on completion of this course, the students will be able to**	**Programme outcomes**
CO 1	Demonstrate conceptual understanding of pteridophytes and gymnosperms, their origin, evolution, and economic importance.	K1 & K4
CO 2	Develop skills to identify pteridophytes and gymnosperms based on morphological and anatomical features.	K2
CO 3	Identify and analyze the reproductive structures of Pteridophytes and Gymnosperms	K3
CO 4	The students will learn about the classification, salient features of fossil groups of Pteridophytes and Gymnosperms.	K5
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)	
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill	

Recommended Texts

1. Sharma, O.P. 2012. Pteridophyta, Tata McGraw-Hills Ltd,NewDelhi.
2. Sharma O.P and S, Dixit.2002.Gymnosperms.PragatiPrakashan.
3. Johri, R.M, Lata, S, Tyagi, K. 2005. A text book of Gymnosperms, Dominate pub and Distributer, New Delhi.
4. Das, S and Saha, R. 2020. Microbiology Practical Manual. CBS Publishers and

Distributors (P) Ltd., New Delhi, India.
5. Sharma K 2005. Manual of Microbiology Tools and Techniques**.** Ane Book, New Delhi, India.
6. Aneja KR 2003. Experiments in Microbiology, Plant pathology and Biotechnology. New Age International publishers, New Delhi.
7. Reddy SM and Ram Reddy S 2000. Microbiology a Laboratory Manual. BSC Publishers and Distributors, Hyderabad.
8. Rangaswamy G 1962. Plant disease in India. Asia Publishing House, Bombay.
9. Das, S. and Saha, R. 2020. Microbiology Practical Manual. CBS Publishers and Distributors (P) Ltd., New Delhi, India
10. Beddome R.H. 1863-1865. Ferns of South India. Reprint (1970). Today & Tommorrow's Publ., New Delhi.
11. Dyer A.F. 1979. The experimental biology of ferns. Academic Press, London.
12. Andrews Jr., H. N. 1961. Studies in Paleobotany. John Wiley, New York
13. Scott, D. H. 1909. Studies in Fossil Botany, 2nd edn. Vol 1 A and C Black, London

Reference Books

1. Chmielewski, J.G and Krayesky, D. 2013. General Botany laboratory Manual. Author House, Bloomington, USA.
2. 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.
3. Gangulee, H.C and A.K. Kar. 2013. College Botany. Vth Edition. S. Chand.
4. Beck, J. V. et al. 1968. Laboratory Manual for General Microbiology. Burgess Pub. Co.

Web resources

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

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PS6	PS7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	1	2	1	1	3	2	3	3	2	3	3	3	3
CO2	3	3	2	1	1	1	1	2	2	1	2	2	1	2
CO3	3	1	2	1	1	1	1	3	2	1	3	1	3	2
CO4	3	2	3	1	0	1	0	3	3	1	3	3	1	1

0 – No correlation 1 – Low 2- Medium 3 – High

ELECTIVE I - A

Title of the Course		APPLIED PHYCOLOGY AND MYCOLOGY					
Paper Number		ELECTIVE I (A)					
Category	Elective	Year	I	Credits	4	Course Code	WBOE11
		Semester	I				
Instructional Hours per week		Lecture	Tutorial		Lab Practice	Total	
		3	2		--	5	
Pre-requisite		1. Students will understand the industrial applications of algae and fungi, including their use in food, pharmaceuticals, and biotechnology.					
Learning Objectives		2. Students will acquire detailed knowledge about the mycorrhizal associations					
		3. To understand the concept of fermentation					
		4. To enable students differentiate between edible and poisonous mushrooms.					
		5. To make students understand the basics and develop interest in mushroom cultivation techniques					
		6. Students will be able to conduct research, analyze data, and apply scientific methods to solve problems related to phycology and mycology					

UNIT	CONTENTS
I	**Cyanobacteria** -as biofertilizer, mass production of micro-algae (Laboratory culture, Trough method, Pit method, Field production, Raceway ponds) and field application. Media for cyanobacterial culture (BG-11 medium, Allen and Arnon's medium). Seaweed Liquid fertilizers - method of preparation, applications and its advantages over inorganic fertilizers. Biofuel production from algae, carbon dioxide sequestration with algae. Photobioreactors for production of microalgae.
II	**Bioactive compounds from Cyanobacteria**, Sea weed polysaccharides like Agar, carrageenin, Laminarin and alginates, diatomite, funori. Food supplements from algae. Seaweed farming methods - harvesting and post-harvest handling of sea weed – Cultivation of *Kappaphycus*. *Spirulina* -mass cultivation and its applications. Extraction of Agar agar from *Gracilaria.*
III	**Mass production of Fungi**- Production of Arbuscular Mycorrhizal (AM) fungi. Fungi as Bio-control agent - Mycoinsecticides, Mycoherbicide, Mycofungicides. Mass production of *Trichoderma.* Mycoprotein production of cheese, yeast. Mycotoxins - Food Toxins, Ergot Toxins. Fungal diseases of humans and domestic animals.

IV	**Fermentation Technology**- Definition, types of fermentation – submerged and solid state fermentation. Modes of fermentation – Batch, continuous and fed-batch. Parts of fermenter and their function, Types of fermenters – continuous stirred-tank fermenter, Bubble column fermenter, Airlift fermenter. Fungi and production of alcoholic beverages: wine, beer; fungal enzymes of commercial importance – production of zymase, Invertase; industrial production of ethanol, citric acid, penicillin, ergot alkaloids; Fungi in Biological research - *Neurospora*.
V	**Mushrooms:** Differences between edible and poisonous mushrooms, Spawn production: culture media preparation, Preparation of mother spawn, production of planting spawn, storage/transportation of spawn, Criteria for selection of good quality spawn. Cultivation of button, milky mushroom and oyster mushrooms. Diseases of Mushrooms and their management. Medicinal value of mushrooms, nutraceuticals and dietary supplements. Mushroom recipes.

Course Outcomes

CO	Course outcomes – on completion of this course, the students will be able to	Programme outcomes
CO 1	Learn various economic importance of Algae and fungi	K1
CO 2	Knowledge on biofertilizer application in agriculture and organic farming. Skill developed on biofertilizer production technology	K5, K6
CO 3	Demonstrate a knowledge and understanding of basic fermentations processes, design of various fermenters and their types and economics of fermentation.	K3
CO 4	Assess various methods of isolation and cultivation of algae.	K4
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. Edwardlee, R. 2018. Phycology, 5th Ed., Cambridge University Press, London.
2. Kumar, H.D. 1999. Introductory Phycology. Affiliated East-West Press, Delhi.
3. Lee, R.E. 2008. Phycology, Cambridge University Press, Cambridge. 4th Ed.
4. Purkayastha RP, Chandra A (1985) Manual of Indian edible Mushrooms. Today and Tomorrows Printers and Publishers, New Delhi.
5. Sahoo,D. 2000).Farming the ocean: seaweeds cultivation and utilization. Aravali International, New Delhi.
6. Pathak VN, Yadav N. 1998. Mushroom Production and Processing Technology. Agrobios, Jodhpur
7. Webster, J. And Weber, R. (2007). Introduction to Fungi, Cambridge University Press.

8. Sethi, I.K. andWalia, S.K. (2011).Textbook of Fungi and Their Allies, Macmillan Publishers India Ltd.

Reference Books

1. Sharma, O.P. 2011. Fungi and Allied Microorganisms, McGraw Hill.
2. Lee, R.E. (2018). Phycology, Fifth Edition. Cambridge University Press, Cambridge
3. Sahoo, D. and Seckbech, J. (Eds) 2015. The Algae World. Springer, Dordrecht.
4. Van Den Hoek, C., Mann, D.G. and Jhans, H.M. (1995). Algae: An Introduction to Phycology. Cambridge University Press, Cambridge.
5. Venkataraman, G. S. 1972. Algal Biofertilizers and Rice Cultivation. Today and Tomorrow's publishers.
6. Venkataraman, G. S., Goyal, S. K., Kaushik B. D., and Roychaudhary, P. 1974. Algae form and function. Today and Tomorrow's printers. .
7. Tripathi DP 2005. Mushroom Cultivation. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
8. Pandey RK, Ghosh SK 1996. A Hand Book on Mushroom Cultivation. Emkey Publications.
9. Pathak VN, Yadav N, Gaur M 2000. Mushroom Production and Processing Technology. Vedams E books Pvt. Ltd., New Delhi.

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PS6	PS7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	2	2	1	2	3	2	2	1	2	2	1	2
CO3	3	3	2	2	1	3	2	3	2	1	1	1	3	2
CO4	3	2	1	3	2	3	3	3	3	1	1	1	1	3

0 – No correlation 1 – Low 2- Medium 3 – High

ELECTIVE – I B

Title of the Course	**HORTICULTURE AND PLANT BREEDING**						
Paper Number	**ELECTIVE I (B)**						
Category	**Elective**	**Year**	**I**	**Credits**	**4**	**Course Code**	
		Semester	**I**				

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

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

UNIT	**CONTENTS**
I	**Horticulture:** Divisions of Horticulture. Horticultural zones of India. Garden: Types – Formal & Informal Garden – English, Japanese, Spanish, Mogul, Persian garden. Principles of Ornamental Gardening. Components of Ornamental Gardens: arboretum, foliage trees, herbs, climbers and annuals, shrubbery, fernery, palmatum, cacti and succulents, pergolas, hedges, edges, flower beds, arches, carpet beds, lawn and topiary. Plants used in interior spaces. Special types of gardens, vertical garden, roof garden, bog garden, sunken garden, rock garden, clock garden and water garden. Famous gardens of India.
II	**Propagation Methods**: Sexual (seeds) and asexual reproduction (cuttings, layering, grafting, and budding). Propagation through specialized underground structures. Propagation facilities: Mist chamber, greenhouses, glasshouses, cold frames, polyhouses, phytotrons nursery. Garden Implements – Digger, Pruning shears, Garden Rake.
III	**Commercial floriculture**: importance and scope. Commercial flower crops in Tamil Nadu. Production and packaging of cut flowers; Methods to prolong vase life. Flower arrangement: principles, different styles. Commercial cultivation of orchids. Vegetable gardens, kitchen garden, truck garden, vegetable forcing, market gardens.

	Different steps in planning and layout establishment and management of orchards, hexagonal and contour systems of planting – their merits and demerits.
IV	**Plant Breeding**: Objectives of plant breeding; Centres of origin: Different centres and their significance. Plant introduction: primary and secondary, plant introduction agencies. Procedure of plant introduction –quarantine- cataloguing- evaluation – multiplication - distribution – acclimatization, merits and demerits. Selection: pureline selection, mass selection, pedigree selection, clonal selection, bulk method of selection, merits and demerits, achievements of each type. Backcross method of breeding.
V	**Hybridization:** objectives, types and procedure of hybridization. Genetic basis of inbreeding depression, heterosis. Mutation breeding and Polyploidy in crop improvement. QTL mapping and Marker assisted selection for crop improvement. Antisense technology and Somolonal variation in crop improvement. Germplasm conservation- *in situ* seed banks, shoot tip banks, cell and organ banks, DNA banks. Germplasm evaluation- cataloguing- multiplication and distribution.

Course Outcomes

CO	**Course outcomes – on completion of this course, the students will be able to**	**Programme outcomes**
CO 1	Get knowledge on concepts, tools and techniques related to Plant Breeding and Horticulture	K1
CO 2	Gain knowledge on importance of ornamental plants and their diversity. Demonstrate advanced technologies like training, pruning etc.	K2
CO 3	Acquire knowledge on Plant Breeding techniques and Germplasm conservation	K3
CO 4	Practice production technology of cut flowers, loose flowers and principle of growing commercial flowers. Become eligible to manage a commercial floriculture unit	K4
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. Sharma, J.R. 1994. Principles and practices of Plant Breeding, TATA McGraw Hill.
2. Ram J. Singh. 2002. Plant Cytogenetics, 2nd edition, CRC Press.
3. Stoskopf, NC. 1999. Plant breeding: Theory and Practice. Scientific Publishers.
4. Mahabal Ram, 2014, Plant Breeding Methods, PHI Publishers.

5. Jain, H.K. and Kharkwal, M.C. 2004. Plant breeding: Mendelian to molecular approaches. Narosa Publishing house, New Delhi.
6. Kumar, N. 1990. Introduction to Horticulture. Rajyalakshmi publications, Nagarcoil, Tamilnadu.
7. Jitendra Singh, 2002. Basic Horticulture. Kalyani Publishers, Hyderabad.

Reference Books:

1. Prasad and Kumar, 2014. Principles of Horticulture 2nd Edn. Agrobios (India).
2. Edmond, J.B, Sen, T.L, Andrews, F.S and Halfacre R.G., 1963. Fundamentals of Horticulture. Tata Mc Graw Hill Publishing Co., New Delhi.
3. Denisen E.L. 1957. Principles of Horticulture. Macmillan Publishing Co., New York.
4. Chadha, K.L.(ICAR), 2002,2001. Hand book of Horticulture. ICAR, New Delhi
5. Peter, K.V. 2009. Basics Horticulture. New India Publishing Agency
6. Kausal Kumar Misra and Rajesh Kumar, 2014. Fundamentals of Horticulture. Biotech Books.
7. Jitendra Singh, 2011. Basic Horticulture. Kalyani Publications, New Delhi.
8. Chopra VL. 2004. Plant Breeding. Oxford & IBH.
9. Gupta SK. 2005. Practical Plant Breeding. Agribios.
10. Pohlman JM and Bothakur DN. 1972. Breeding Asian Field Crops. Oxford & IBH.
11. Roy D. 2003. Plant Breeding, Analysis and Exploitation of Variation. Narosa Publ. House.
12. Simmonds NW. 1990. Principles of Crop Improvement. English Language Book Society.
13. Singh BD. 2022. Plant Breeding: Principles and Methods. Kalyani Publishers.

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PS6	PS7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	2	2	3	1	1	3	2	2	2	3	1	1
CO2	3	2	1	2	3	1	1	3	2	1	2	3	1	1
CO3	3	2	2	1	1	1	3	3	2	2	1	1	1	3
CO4	3	2	1	1	2	3	3	3	2	1	1	2	3	3

0 – No correlation 1 – Low 2- Medium 3 – High

SKILL ENHANCEMENT COURSE

Title of the Course	**APPLIED MICROBIOLOGY**						
Paper Number	**SKILL ENHANCEMENT COURSE I**						
Category	**SEC -1**	**Year**	**I**	**Credits**	**3**	**Course Code**	
		Semester	**I**				
Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**			
	3	**1**	**--**	**4**			
Pre-requisite	Students should know basics of diversity of Microorganisms						
Learning Objectives	1. Gain knowledge of microbes and their importance, application in day-to-day life with special reference to environmental sustainability and industry.						
	2. Exhibit knowledge and understanding the use of microbes in production of human consumption.						
	3. Learn methods of microbial extraction of metals from minerals. Concept of enzymology, concept of biogas and industrial waste management.						
	4. Record the Microbes and Microbial diversity in Food						
	5. Study on the disease causing microorganisms						
UNIT	**CONTENTS**						
I	**Microbes in Soil and Agriculture**: Microorganisms of rhizosphere and phyllosphere. Biofertilizers - types of biofertilizers – Isolation, identification, mass multiplication, field application of *Rhizobium* and *Azospirillum*. *Azotobacter*: Classification and important characteristics. Biopesticides - mode of action of *Bacillus thuringenesis*. Solid waste management - Composting, vermicomposting, silage.						
II	**Microbes in degradation and mining**: Biodegradable and non-biodegradable pollutants. Bioremediation- types and microbes involved. Biodegradation-hydrocarbons, pesticides, herbicides and other important compounds. Genetically engineered microbes in biodegradation. Bioleaching and its significance copper, uranium, other metals. Sewage/waste water treatment - Primary, secondary (aerobic and anaerobic) and tertiary methods – Disinfection. Biogas production.						
III	**Microbes in food**: Principle of food preservation- asepsis, high temperature, low temperature, cryopreservation, drying, chemical preservatives and radiations. Food spoilage- cereals and cereal products, sugar and sugar products, fruits, vegetables, meat, fish and sea foods, milk and milk products. Dairy Microbiology: Micro flora						

	of milk. Sources of milk contamination. Preservation and spoilage of milk and milk products.
IV	**Microbes for industrial exploitation**: Microbial production of organic acids (Acetic acid, Lactic acid), Amino acids (L - Glutamic acid), Antibiotics (Streptomycin, Tetracyclin), enzymes (Amylases, Proteases), vitamins (B12, Riboflavin). Bacteria in Fiber Retting, for Curing of Tea and Tobacco, preparation of Serums and Vaccines.
V	**Medical Microbiology** Microorganisms and human diseases: Bacterial diseases: principle of infection and communicable diseases. Causal organism and symptoms of air borne diseases, Water borne diseases, Sexually Transmitted diseases, Contact diseases, Insect borne diseases, Protozoan diseases. Chemotherapeutic agents and Chemotherapy, Antibiotics classification and their mode of action: inhibition of Cell-wall synthesis, Damage to cytoplasmic membrane, Inhibition of Nucleic acid and Protein synthesis, Inhibition of specific enzyme systems. Mechanism of resistance to Antibiotics.

Course Outcomes

CO	**Course outcomes – on completion of this course, the students will be able to**	**Programme outcomes**
CO 1	Understand the significance and activities of microorganisms in various food and role of intrinsic and extrinsic factors on microbial growth in foods leading to spoilage, and understand the principles underlying the preservation methods	K1
CO 2	Study the different types of microorganisms in milk and their activities - fermented dairy products and spoilage and their applications as probiotics	K2
CO 3	Demonstrate a knowledge and understanding of microbiological assays of growth promoting and growth inhibiting substances.	K3
CO 4	Recognize the biochemical and genetic basis for antibiotic resistance and ways of controlling spread of antibiotic resistance.	K4
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. Dubey, R. C. and Maheswari, D. K. 2013. A Textbook of Microbiology, S. Chand & Comp. ISBN 81-219-2620-3
2. Pelczar, H.J. E.C.S. Chan and N.R. Kreig. 1996. Microbiology concepts and applications. McGraw Hill Inc. ISBN 0-07-049234-4

3. Kaursethi I and Surinder KW 2011. Text Book of Fungi and their Allies. Macmillan publishers, New Delhi, India
4. Y. H. Hui, E. Özgül Evranuz, (2015), Handbook of Plant-Based Handbook of Fermented Food and Beverage Technology, 2nd Edition, CRC Press, New York, USA.
5. Subbarao N.S. (1995), Biofertilizers in Agriculture and Forestry, 3rd edition, Oxfordand IBH publishing Co. Pvt. Ltd, New Delhi.
6. Rangaswami G and D.G. Bagyaraj, (2002), Agricultural Microbiology, 2nd edition. Prentice Hall of India, New Delhi.
7. Claudio Nicolini, (2009). Nanobiotechnology & Nanobiosciences. Pan Stanford Publishing Pvt. Ltd, ISBN 13: 9789814241380.

Reference Books

1. Atlas, M R. 1997. Principles of Microbiology. Wm. C. Brown Publishers. ISBN 0-8151-0889-3
2. Hull, R. 2004. Plant Virology.4th Edn. Academic Press., ISBN 0-12-361160-1
3. Madigan M.T. and Martinko, J. M. 2006. Biology of Microorganisms, 11th ed., Pearson Prentice. 9780132017848 and 0132017849
4. Perry, J. J. and Stanley, J. T. 1997. Microbiology Dynamics and Diversity. Saunders College Publishing. ISBN 0-03-053893-9
5. Prescott, M. J., Harley, J. P. and Klein, D. A. 2008. Microbiology, 7th ed. WCB McGraw Hill. ISBN 978 007-126 727 4
6. Stanier, R.Y. 1987. General Microbiology. 5th Ed. McMillan Education Ltd. ISBN 0-333-41768-2
7. Talaro, K. P. and Talaro, A. 2002. Foundations in Microbiology. McGraw Hill Publ. ISBN 0-07-232042-7
8. David Reisner, E. (2009) Bionanotechnology- Global Prospects, Taylor &Francis Group, LLC, ISBN 9780429129575.
9. Hari Singh Nalwa (2006). Handbook of Nanostructural Biomaterials and their applications in Nanobiotechnology. 1st Ed. American Scientific Publishers, 13-978-1-4398-0876.
10. Mirkin C.A. and C.M. Niemeyer, (2007). Nanobiotechnology- II, More Concepts and Applications, WILEY-VCH, Verlag Gmb H &C o, ISBN: 978-3-527-31673-1.

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PS6	PS7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	2	2	1	1	1	3	2	2	2	3	1	1
CO2	3	2	2	2	0	2	2	3	2	1	2	3	0	1
CO3	3	2	2	2	1	2	0	3	2	2	2	1	2	0
CO4	3	2	1	1	2	1	1	3	2	2	2	2	1	1

0 – No correlation 1 – Low 2- Medium 3 – High

Semester II

CORE VI

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">TAXONOMY OF ANGIOSPERMS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">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 rowspan="2">Course Code</td><td rowspan="2"></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 colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>3</td><td colspan="2">2</td><td colspan="2">-</td><td>5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="7">Prior knowledge on morphological, anatomical characteristics and uses of plants.</td></tr>
<tr><td colspan="2" rowspan="5">Learning Objectives</td><td colspan="7">1. To be familiar with the basic concepts and principles of plant systematics.</td></tr>
<tr><td colspan="7">2. To develop a suitable method for correct characterization and identification of plants.</td></tr>
<tr><td colspan="7">3. To understand the importance of taxonomic relationships in research of plant systematics.</td></tr>
<tr><td colspan="7">4. To provide information on various classification systems</td></tr>
<tr><td colspan="7">5. To understand the principles, articles and recommendations of International Code of Nomenclature and apply the rules and regulations formulated by the botanical congress while naming the plant species.</td></tr>
<tr><td>UNIT</td><td colspan="8">CONTENTS</td></tr>
<tr><td>I</td><td colspan="8">Botanical exploration and contributions- with special reference to India by William Roxburgh, J. D. Hooker, Robert Wright, Nathanial Wallich and Gamble, J. S. Origin of Angiosperms. Principles of classification as proposed – Artificial – Linnaeus, Natural – Bentham and Hooker, Phylogenetic system - Hutchinson, Modern –APG IV classification (major clades). Herbarium techniques - virtual herbarium; major herbaria of the world and India, functions of Herbaria. Taxonomic keys; indented (yolked) and bracketed keys. Online data bases: IPNI – Index Kewensis and The Plant List.</td></tr>
<tr><td>II</td><td colspan="8">Phylogenetic systematics: Terms and concepts (homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly, synapomorphy, apomorphy). Phylogenetic Tree - Definition, types, construction steps and methods, uses. Cladistics and biosystematics. Cluster analysis. Taxonomic evidences - from Morphology, Chemotaxonomy, Numerical Taxonomy, Embryology, Palynology. Literature (Floras, Manuals, Icones, Monographs, Revisions). Botanical survey of India – its organization and major contributions. Major Botanical gardens in India.</td></tr>
<tr><td>III</td><td colspan="8">History of Botanical codes – Botanical Congress – ICBN to ICN (Shenzhen code 2018). Principles of ICN, rules and the recommendations of the ICBN, typification, principles</td></tr>
</table>

	of priority, effective and valid publication, author citation. Nomenclature of hybrids and cultivated plants. Detail study of the following families: Nympheaceae, Tiliaceae, Portulacaceae, Zygophyllaceae, Rhamnaceae,
IV	**Detail study of the following families**: Sapindaceae, Combretaceae Apiaceae. Asteraceae, Sapotaceae, Oleaceae, Boraginaceae, Scrophulariaceae, Bignoniaceae, Convolvulaceae.
V	**Detail study of the following families**: Acanthaceae, Verbenaceae. Nyctaginaceae, Piperaceae, Polygonaceae. Orchidaceae, Araceae, Lilliaceae, Commelinaceae, Cyperaceae.

Course Outcomes

CO	Course outcomes – on completion of this course, the students will be able to	Programme outcomes
CO 1	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
CO 2	Explain the principles of taxonomy. Summarize the taxonomic hierarchy. Define Binomial nomenclature. Group Activity – Construct key preparation	K1, K2 K5, K6
CO 3	Explain the various types of classification. Construction of floral formula and floral diagram. Illustrate and explain the characteristic features and list out the Economic importance of the families.	K1, K2 K3, K4
CO 4	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
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. 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
4. https://www.tropicos.org/home
5. http://apps.kew.org/herbcat/gotoHerbariumGrowthPage.do
6. https://www.absbooksindia.com/shop/science/botany/textbook-of-economic-botany

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PS6	PS7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2	3	2	1	1	3	3	2	3	2	1	1
CO2	2	1	2	3	1	2	2	2	1	2	3	1	0	2
CO3	2	3	1	2	1	2	2	2	3	1	2	0	2	0
CO4	1	2	1	0	2	1	3	1	2	1	1	2	1	3

0 – No correlation 1 – Low 2- Medium 3 – High

CORE VII

Title of the Course		PLANT ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS					
Paper Number		CORE VII					
Category	Core	Year	I	Credits	4	Course Code	
		Semester	II				
Instructional Hours Per week		Lecture	Tutorial		Lab Practice		Total
		3	2		--		5
Pre-requisite		1. To acquire knowledge on the anatomical structure and reproductive phase of angiosperms.					
Learning Objectives		2. Learn the importance of plant anatomy in plant production systems.					
		3. Classify meristems and identify their structures, functions and roles in monocot and dicot plants growth and secondary growth of woody plants.					
		4. Understand the mechanism underling the shift from vegetative to reproductive phase.					
		5. Trace the development of male and female gametophyte.					
		6. Understand the recent advances in palynology.					

UNIT	CONTENTS
I	**Anatomy:** **Cell structure and its components.** Structure of cell wall - cell wall thickening - growth of cell wall. Plasmodesmata- types of pits; Meristems: Classifications, theories of shoot and root apices; Organization of root apical meristem (RAM) and shoot apical meristem (SAM); Quiescent center. Vascular Cambium: structure - types - functions. Types of vascular bundles. Floral vasculature. Xylem and phloem: Ontogeny, types and structure of components, transfer cells. Secretary tissue and Epidermal tissue system. Ergastic substances.
II	**Structural organization** - Phellogen. Polyderm and Rhytiderm – wound periderm-activities. Normal secondary thickening in Dicots; Anomalous secondary growth in Dicots (Aristolochiaceae, Bignoniaceae, Piperaceae). Primary thickening in palms; Ontogeny of leaf; Structure and types of Stomata; Types of trichomes; Major nodal types. Wood – physical and mechanical properties of wood: Defects in wood; reaction wood; ring porous and diffuse porous wood, Sapwood and Heartwood, Tyloses. Dendrochronology. Commercial woods of South India.
III	**Embryology:** **ABC Model of Flower Organization**: Structure and development of Anther - **Microsporogenesis,** ultrastructure and physiology of anther tapetum; Syncytium formation. Ultrastructure and development of pollen wall, pollen kitt, pollen tube

	structure and growth, NPC classification, pollen analysis, pollen storage, pollen sterility. Nemec phenomenon.
IV	**Megasporogenesis**. Development of Embryo Sac – Monosporic, Bisporic, Tetrasporic. Structure and development of Megasporangium; Types of ovules, tenuinucelate and crassinucleate, Endothelium, obturator, aril, perisperm, hypostase and epistase. Haustorial behavior of Embryo Sac. Types of Pollination - Pollination mechanisms, Pollen - Stigma Interaction. Fertilization: Double fertilization and triple fusion; Incompatibility types - genetic basis of self incompatibility.
V	**Endosperm**: Development of endosperm, types, physiological efficiency of endosperm haustoria and functions. Embryogenesis: Development of monocot (Grass) and dicot (Crucifer) embryos. Seed and Fruit development. Polyembryony, classification, induction and practical application. Apomixis and its significance. Parthenocarpy and its importance.

Course outcomes

CO	Course outcomes – 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	Collaborative learning and communication skills through practical sessions, teamwork, group discussions and home assignments.	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. 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 Publishing 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.
5. Crang, R., Lyons-Sobaski, S and Wise, R. 2018. Plant Anatomy: A Concept-Based Approach to the Structure of Seed Plants. Springer International Publishing.
6. Cutler, D. F., Botha, T and Stevenson, D.W. 2008. Plant Anatomy: An Applied Approach. Blackwell Publishing, Malden, USA.
7. 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	PS6	PS7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	2	2	3	3	3	2	1	2	1	2	2
CO2	3	3	1	3	1	2	2	2	2	1	2	2	1	2
CO3	3	2	2	0	1	1	2	3	2	3	1	0	2	2
CO4	3	1	0	1	0	2	3	3	3	1	2	3	2	0

0 – No correlation 1 – Low 2- Medium 3 – High

CORE VIII

Title of the Course		**PLANT BIOTECHNOLOGY AND GENETIC ENGINEERING**					
Paper Number		**CORE VIII**					
Category	**Core**	**Year**	**I**	**Credits**	**4**	**Course Code**	
		Semester	**II**				
Instructional Hours Per week		**Lecture**	**Tutorial**		**Lab Practice**		**Total**
		3	**2**		**-**		**5**
Pre-requisite		Prior basic knowledge on plant tissue culture and Genetic Engineering					
Learning Objectives		1. To discuss the principle of Plant Tissue Culture					
		2. To understand the importance of Plant Tissue Culture and its applications					
		3. To impart hands-on training on various aspects of Tissue Culture. Initiate tissue culture and establish their lab.					
		4. Execute/ accomplish micropropagation through bud culture, organogenesis and somatic embryogenesis.					
		5. To familiarise students with fundamentals of DNA recombinant technology and advanced aspects of genetic engineering.					

UNIT	CONTENTS
I	**Plant Tissue Culture**: History, Totipotency, differentiation, dedifferentiation and redifferentiation. Nutrient media: Composition of commonly used nutrient culture media – role of growth regulators. Micropropagation – steps of micropropagation - explants selection, culture establishment, shoot multiplication, rooting and hardening and acclimatization. Callus culture - Organogenesis. Cell suspension culture - protocol, types, growth measurement, viability test, synchronization, applications.
II	**Somatic embryogenesis** – induction of embryogeny *in vitro*, indirect and direct somatic embryogenesis, production of artificial seeds. Somatic hybridization and its impact on plant breeding. Protoplast culture and regeneration of plants, isolation, merits and demerits. Somaclonal variations and isolation of useful mutants; mechanisms and applications in genotype improvement. Cybrids and their application. Anther and pollen culture – production of haploids. *In vitro* fertilization. Embryo and endosperm culture. Embryo rescue. Meristem tip culture.
III	***In-vitro* strategies for conservation of germplasm**. Cryopreservation of plant cell and tissue cultures and establishment of gene bank. Biotransformation by immobilized cells - by hairy root culture - by free cells. Plant cell Immobilization - types and methods - applications. Hairy root culture, elicitation – types of elicitors. Development of genetically modified plants through *Agrobacterium* and CMV mediated gene transfer and direct gene transfer using PEG.

IV	**Genetic Engineering** - definition, Cloning vectors– pBR322, pUC18, plasmids, phages and cosmids, Transposons, primary vectors and plant binary vectors for transformation. Expression vectors: Characteristics of expression vectors, cloning with fusion tags: His tags, GST tags, CBD and MBD tags. DNA manipulating enzymes: Restriction enzymes - types, Terminal transferases, Alkaline phosphatases, Polynucleotide kinase, Methylases, polymerases - types, ligases. Methods of gene transfer – transformation, transfection, electroporation, liposome mediated gene transfer, particle gun method and microinjection, Ti and Ri plasmid mediated transfer. Identification of recombinants - selectable markers, Reporter genes (GUS assay, luciferase) and Promoters used in plant vectors. VIGS – Virus Inducing Gene Silencing
V	**Genomic DNA Library**: Genomic DNA fragmentation, size fractionation. cDNA Library: RNA isolation, cDNA synthesis and cloning. Screening strategies of DNA libraries: Functional screening, probe-based screening and immunoscreening. Plant genetic engineering using recombinant DNA techniques: Genetic engineering for abiotic stress, crop improvement(CRISPR/Cas technique); Strategies for Marker Gene Removal from Transgenic plants; Transgene silencing, Strategies to avoid gene silencing and improve gene expression in transgenic plants, Description and uses of antisense RNA, ribozymes in plants.

Course Outcomes

Course outcomes	On completion of this course, the students will be able to:	Programme outcomes
CO1	Recall the principles and culture techniques of cells, callus, organs, pollen, anthers, embryos and protoplasts..	K1
CO2	Understand the techniques used in plant growth and regeneration under *in vitro* conditions.	K2
CO3	Apply the role plant tissue culture techniques in the production some secondary metabolites and planting stock in horticulture.	K3
CO4	Analyze the conditions that are suitable for direct and indirect plant regeneration. Create idea to seek for suitable job in relevant industries/research centers or to become a potential entrepreneur based on knowledge achieved during the course.	K4
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. Narayanaswamy, S. 1999. Plant cell and tissue culture. 8th edn. Tata McGraw Hill Publ. ISBN 0074602772.
2. Bhojwani, S.S and Razdan, M.K. 2004. Plant Tissue Culture, Read Elsevier India Pvt. Ltd. ISBN 818147 3256.
3. Trigiano, R.N and D.J. Gray (eds.). 2000. Plant tissue culture concepts and laboratory exercises. CRC Press. (Textbook). 2nd Edition.

4. Kyte, M and Kleyn, J. 1996. Plant from test tubes. Timber Press. Auge, R. et al., 1995. In vitro culture and its applications in horticulture. Science Publishers, Inc.
5. Auge, R. 1995. In vitro culture and its applications in horticulture. Science Publishers, Inc.
6. Gamborg, O.L. and G.C. Phillips (eds). 1995. Plant cell, tissue and organ culture. Springer Lab Manual.
7. Khasim, S.M. 2002. Botanical Microtechnique: Principles and Practice, Capital Publishing Company, New Delhi.
8. Srivastava, P.S. 1998. Plant Tissue Culture and Molecular Biology. N.R. Book Distributors, New Delhi.
9. Vinay Sharma and Afroz Alam. 2019. Plant Tissue Culture. Wiley.
10. Pullaiah, E., Rao, T., M.V. Subba, Sreedev. 2017. Plant Tissue Culture: Theory and Practicals. Scientific Publishers.
11. Chawla, H.S. 2009. Introduction to plant biotechnology, 3rd edition, Oxford and IBH publishing, New Delhi.
12. Gupta, S.D and Ibaraki, Y. 2006. Plant tissue culture engineering (Vol. 6). Springer Science & Business Media, Germany.
13. Razdan, M.K. 2015. Introduction to Plant Tissue Culture, 3rd edition. Oxford and IBH publishing, New Delhi.
14. Robert, N. Trigiano and Dennis, J and Gray (Eds.). 2011. Plant Tissue Culture, Development, and Biotechnology, CRC Press, Taylor & Francis Group.
15. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 1991.
16. Desmond S. T. Nicholl 2008 An Introduction to Genetic Engineering, United States of America by Cambridge University Press, New York.
17. Ashok Aggarwal, C.M. Govil, Jitender Sharma 2017, Plant Biotechnology and Genetic Engineering, PHI Learning Pvt. Ltd. Rimjhim House, 111, Patparganj Industrial Estate, Delhi - 110 092, India.

Reference Books

1. Bhojwani, S. S and Dantu, P.K. 2013. Plant tissue culture: an introductory text (Vol. 318). New Delhi, India: Springer.
2. Vasil, I.K. and Thorpe, T.A. 1994. Plant Cell and Tissue Culture, Kluwer Academic Press, The Netherlands.
3. Loyola-Vargas, V.M. Ochoa-Alejo, N. 2016. Somatic embryogenesis: Fundamental aspects and applications, Springer international publishing, Switzerland.
4. Elhiti, M., Stasolla, C and Wang, A. 2013. Molecular regulation of plant somatic embryogenesis. In Vitro Cellular & Developmental Biology-Plant, 49(6), 631-642
5. Collins, H.A. and Edwards, S. 1998. Plant Cell Culture, Bios Scientific Publishers, Oxford, UK.
6. Rihan, H.Z., Kareem, F., El-Mahrouk, M.E., and Fuller, M.P. 2017. Artificial seeds (principle, aspects and applications). Agronomy, 7(4), 7.
7. Anis Mohammad and Ahmad Naseem. 2016. Plant Tissue Culture: Propagation, Conservation and Crop Improvement, Springer. Singapore**.**
8. Abdin, M.Z., Kiran, U., Kamaluddin, M., Ali, A. (Eds.). 2017. Plant Biotechnology: Principles and Applications, Springer publishers.

9. Fett-Neto, Arthur Germano (Ed.). 2016. Biotechnology of Plant Secondary Metabolism: Methods and Protocols, Springer publishers.
10. Trigiano, R. N., and Gray, D. J. 2011. Plant tissue culture, development, and biotechnology. CRC Press, US.
11. Kartha, K.K. 1985. Cryopreservation of Plant Cells and Organs. CRC Press, Boca Raton, Florida, USA.
12. Primrose S.B., R.M. Twyman and R.W. Old; 2001. Principles of Gene Manipulation. 6th Edition, S.B. University Press.
13. Brown TA, 2006. Genomes, 3rd ed. Garland Science.
14. Primrose S, Twyman R, 2006. Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell.
15. Glick BR, Pasternak JJ, 1998. Molecular Biotechnology, 3rd Edition, ASM Press.

Web sources

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

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PS6	PS7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	1	2	2	3	2	2	2	2	1	1	2	1	2
CO3	3	2	2	1	1	3	2	3	2	1	1	1	2	2
CO4	3	2	3	0	2	3	3	3	3	1	1	1	2	2

0 – No correlation 1 – Low 2- Medium 3 – High

CORE IX

Title of the Course		**LABORATORY COURSE – 3 COVERING CORE PAPER VI**					
Paper Number		**CORE IX**					
Category	**Core**	**Year**	**I**	**Credits**	**1**	**Course Code**	
		Semester	**II**				
Instructional Hours Per week		**Lecture**	**Tutorial**	**Lab Practice**		**Total**	
		-	**-**	**2**		**2**	
Pre-requisite		Theoretical understanding of plant taxonomy, as well as basic laboratory skills for the relevant core course.					
Learning Objectives		1. Conceptual understanding of the aims and objectives of plant taxonomy, ICN classification and role of herbaria.					
		2. Elaborate the history and features of artificial, natural, and phylogenetic classification systems, particularly those proposed by Linnaeus, Bentham & Hooker, and APG IV.					
		3. Demonstrate an understanding of the principles of botanical nomenclature and the application of the International Code of Botanical Nomenclature (ICBN).					
		4. Enhance skill in the adopting methods and specific techniques suitable for identification of locally available different groups of plants					
		5. Identify the diagnostic characters, economic significance, and distribution of major plant families					
UNIT	**EXPERIMENTS**						
I	Preparation of dichotomous key						
II	Description of a species, live specimens of the families mentioned in the theory.						
III	Study the products of families mentioned in the syllabus – Botanical name, family, Morphology of useful part and its uses.						
IV	Workout nomenclatural problems regarding priority and author citations. Identification of Binomial using flora (J.S. Gamble).						
V	Identification of common plants in the families mentioned in the theory Construction of plant phylogenetic trees with various phylogenetic methods (Neibour Joining, Maximum Likelihood etc) (Demonstration)						
Field trip: A field trip at least 2-3 days to a floristically rich area to study plants in nature and field report submission of not less than 10 herbarium sheets representing the families studied.							

Course Outcomes

CO	Course outcomes – on completion of this course, the students will be able to	Programme outcomes
CO 1	To gain recent advances in plant morphological and floral characteristics.	K1
CO 2	Understand about different floral characteristics and artificial key preparation which employed for plant identification and conservation.	K2
CO 3	Enhance skill in the adopting methods and specific techniques suitable for identification of locally available different groups of plants.	K4 & K5
CO 4	Familiarize immense knowledge on economic importance of higher plants. Gain hands on experience on herbarium preparation techniques.	K3
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)	
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill	

Recommended texts

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.

Reference Books

1. Aler Gingauz.2001. Medicinal Chemistry. Oxford University Press & Wiley Publications.
2. Mann J. Davidson, R. Sand J.B. Hobbs, D.V. Banthorpe, J.B .Harborne. 1994. *Natural Products*.Longman Scientific and Technical Essex.
3. Gopalan,C., B.V. Ramasastriand S.C. Balasubramanian. 1985. Nutritive Value of Indian Foods. National Institute of Nutrition, Hyderabad.
4. Harborne. J.B. 1998. Phytochemical methods. A guide to modern techniques of Plant Analysis, Chapman and Hall publication, London.
5. Traditional plant medicines as sources of new drugs. P. J Houghtonin Pharmacognosy. Trease and Evan's.16Ed.2009.

Web resources

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

5. https://www.worldcat.org/title/phytochemistry/oclc/621430002

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PS6	PS7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	1	2	1	2	1	1	2	1	2	1	2	1	1
CO2	2	3	2	1	1	0	2	2	3	2	1	1	2	2
CO3	2	3	0	1	1	1	1	2	1	2	1	1	1	1
CO4	1	2	3	1	2	0	0	1	2	1	1	2	1	1

0 – No correlation 1 – Low 2- Medium 3 – High

CORE X

Title of the Course		LABORATORY COURSE – 4 COVERING CORE PAPERS VII AND VIII					
Paper Number		CORE X					
Category	Core	Year	I	Credits	2	Course Code	
		Semester	II				
Instructional Hours Per week		Lecture	Tutorial	Lab Practice	Total		
		-	-	2 + 2	4		
Pre-requisite		Theoretical understanding of plant anatomy and embryology as well as basic laboratory skills for the relevant core course.					
Learning Objectives		1. Classify meristems and identify their structures, functions and roles in monocot and dicot plants growth and secondary growth of woody plants					
		2. Expedite skilled workers to carry out research in frontier areas of plant science.					
		3. Learn the importance of plant anatomy in plant production systems.					
		4. It provides a proper procedure for in vitro plant multiplication usable for agricultural practices and germplasm conservation.					
		5. the knowledge regarding sterilization methods, explant and media selection and hardening together with the familiarization about worldwide applications of plant tissue culture for the wellbeing of society					
UNIT	**EXPERIMENTS**						
I	**ANATOMY** 1. Sectioning and observation of cambial types. 2. Sectioning and observation of nodal types. 3. Study of anomalous secondary growth of the following *Nyctanthus, Tinospora, Dracaena, Piper* and *Mirabilis*. 4. Observation of stomatal types by epidermal peeling. 5. Maceration of wood and observation of the components of xylem. 6. Double staining technique to study the stem anomali.						
II	**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.
III	**PLANT BIOTECHNOLOGY** 1. Sterilization techniques in plant tissue culture 2. Preparation of MS Medium 3. Isolate embryos of *Cicer aertinum* and perform *in vitro* culture 4. Isolate and inoculate anthers for haploid production.
IV	**PLANT BIOTECHNOLOGY** 1. Meristem and axillary bud culture on suitable tissue culture medium using potato. 2. Callus induction and callus culture. 3. Artificial seed production 4. Demonstrate various steps of cell suspension culture technique.
V	**PLANT BIOTECHNOLOGY** 1. DNA amplification by PCR 2. Preparation of fresh competent cells of *E. coli.* 3. Demonstrate transformation of *E. coli* and screening of transformants (Blue / white screening)

Course Outcomes

CO	**Course outcomes – on completion of this course, the students will be able to**	**Programme outcomes**
CO 1	Develop a conceptual understanding of plant anatomy, organization of shoot and root apex and angiosperm evolution.	K1 & K2
CO 2	Analyse the anatomical composition of different parts of plants and their relationships.	K1 & K4
CO 3	Develop skills of section cutting and preparation of slides	K2 & K6
CO 4	Enhance collaborative learning and communication skills through practical sessions, teamwork, group discussions and home assignments.	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. 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.
2. Sundara, R. S. 2000. Practical manual of plant anatomy and embryology. Anmol Publ. PVT LTD, New Delhi.

3. 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.
4. Sharma, H.P. 2009. Plant Embryology: Classical and Experimental, Bombay Popular Prakashan, ISBN-8173199698, 9788173199691
5. Archana, Rani, 2015. Practical Plant Biotechnology and Genetics, New India Publishing Agency New Delhi
6. Ashwani Kumar Ed. 2006. Plant Biotechnology and Its Applications in Tissue Culture, I K International Publishing House New Delhi.
7. Gilmartin, Philip M Ed 2002. Molecular Plant Biology: A Practical Approach, Oxford Univresity Press Oxford.

Reference Books

1. Traditional plant medicines as sources of new drugs. P. J Hought on in Pharmacognosy. Trease and Evan's.16 Ed.2 009.
2. Sundara Rajan, S, 2003. Practical Manual of Plant Anatomy and Embryology 1st ed, Anmol Publications, ISBN-812610668.
3. Katherine Esau. 2006. Anatomy of Seed Plants. 2nd edition, John Wiley and Sons.
4. Smith, R.H. 2012. Plant tissue culture: techniques and experiments. Academic Press, UK.
5. Sambrook J, D.W. Russel; 2001. Molecular Cloning: A Laboratory Manual, Vols 1- 3, CSHL.
6. Loyola-Vargas, V.M and Vázquez-Flota, F. 2006. Plant cell culture protocols (Vol. 318). USA: Humana Press, New Jersey.
7. Pullaiah, T. 2009. Plant Tissue Culture: Theory and Practicals, Scientific Publishers Journals Dept.Timir Baran Jha and Biswajit Ghosh. 2016. Plant Tissue Culture: Basic and Applied, Platinum Publishers; 2nd Edn.
8. Hall, R.D. (Ed.). 1999. Plant Tissue Culture: Techniques and Experiments, Academic Press, New York.
9. Rober, H. Smith. 2013. Plant Tissue Culture: Techniques and Experiments, Academic Press, Elsevier.

Web resources

1. https://studyfrnd.com/pharmacognosy-and-phytochemistry-book/
2. https://www.youtube.com/watch?v=Inm5oE1U8qw
3. https://www.youtube.com/watch?v=GlCOQijkIKc
4. https://www.jove.com/science-education/11090/basic-plant-anatomy-roots-stems-and-leaves

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PS6	PS7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	1	2	1	2	1	1	2	1	2	1	2	1	1
CO2	2	3	2	1	1	0	2	2	3	2	1	1	2	2
CO3	2	3	0	1	1	1	1	2	1	2	1	1	1	1

CO4	1	2	3	1	2	0	0	1	2	1	1	2	1	1

0 – No correlation 1 – Low 2- Medium 3 – High

ELECTIVE 2 A

Title of the Course		**BIODIVERSITY, EVOLUTION AND ECONOMIC BOTANY**						
Paper Number		**Elective 2(A)**						
Category	**Core**	**Year**	**I**	**Credits**	**4**	**Course Code**		
		Semester	**II**					
Instructional Hours Per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**			
		3	-	**2**	**5**			
Pre-requisite		Theoretical understanding of Biodiversity, Evolution and Economic Botany for the relevant elective course.						
Learning Objectives		1. To address various critical issues in conserving the biodiversity with special reference to economically important plants and the plants listed in RED data.						
		2. Disseminate knowledge on conservation of biodiversity and protection of environment						
		3. To study biodiversity management and conservation.						
		4. To enhance the knowledge of the students and equip them in evaluate and protecting invaluable components of nature and interactions with the environment.						
		5. To understand the concept of evolution. It provides a comprehensive account of evidences to support concept of evolution and different theories for exploring the mechanism of evolution.						

UNIT	
I	**Biodiversity:** Definition, Levels of Biodiversity - species, genetic and ecosystem diversity. Value of Biodiversity. Components of Biodiversity – Alpha, Beta and Gamma Biodiversity. Patterns of Biodiversity - Latitudinal gradients, Species-Area relationships. Threats and loss of biodiversity; Causes for extinction: habitat loss, desertification, pollution, industrialization, hunting, invasive species. The theory of island biogeography; Edge effect, Biodiversity Boom, Ecotones.
II	**Biodiversity conservation strategies** - *In situ* and *ex situ* conservation. Biodiversity hot spots - Criteria for determining hot spots – hot spots of India, Keystone species, megadiversity countries, Biosphere reserves in India, National Parks and Wildlife Sanctuaries in Tamil Nadu. Biodiversity restoration - Principles, degradation, tools and methods, restoration and ecosystem functioning. IUCN species conservation status categories: critically endangered, endangered, vulnerable, near threatened and endemic species. Red Data Books. Convention on Biological Diversity, National Biodiversity Authority, State Biodiversity Board, People Biodiversity Register, WCMC, CITES. Impact of Climate Change on biodiversity.

III	**Evolution** - Origin and history of life on earth, the evidences for evolution. History of Evolutionary thought - Darwinism, Lamarckism, Neo-Darwinism and de Vries theory of mutation. Heritability, Variation, Natural Selection, Fitness and Adaptation, Types of Selection (Stabilizing, Directional and Disruptive). Interaction - Coevolution (Co-adaptations, arms race, Red Queen hypothesis, co-speciation), prey-predator interactions (crypsis, mimicry). Macroevolution - Adaptive radiation, species concepts, and speciation, biogeography and convergence.
IV	**Economic Botany**: Scientific names, family, brief morphological description, economically important parts and uses of Cereals (Rice, Wheat), Millets (Pearl Millet and Minor Millets), Pulses (Pigeon pea, Chickpea) Oilseeds: Mustard, Sunflower, Oil Palm), Fibres (Cotton, Silk Cotton, Jute), Sugars (Sugarcane, Sugarbeet), Fodders and green manure crops, Plantation crops (Coconut, Cocoa, Tea), Root and Tuber Crops (Sweet Potato, Tapioca), fruits: (Papaya, Citrus, Grapes), Vegetables (Tomato, Brinjal, Gourds).
V	**Economic Botany:** Scientific names, family, brief morphological description, economically important parts and uses of Fumigatories and masticatories (Tobacco, Betelvine, Areacanut), Medicinal and Aromatic Plants (Belladonna, Cinchona, Nux-vomica), Narcotics (Cannabis, Opium), Dye, Tannin, Gum and Resin yielding plants. Non-traditional economic plants (Jojoba, Agave, broom grass), Rubber (Para-rubber, Assam rubber), Spices (Ajwain, Cumin, Fenugreek), Timber (Teak, Mahogany). Processing of Tea and coffee. Extraction of sandalwood oil. Collection and processing of natural rubber (*Havea*). Paper making process from wood.

Course Outcomes

CO	**Course outcomes – on completion of this course, the students will be able to**	**Programme outcomes**
CO 1	Understand the concept and scope of biodiversity. Identify the causes and implications of loss of biodiversity.	K1 & K2
CO 2	Familiarize immense knowledge on economic importance of higher plants. Utilize various strategies for the conservation of biodiversity.	K1 & K4
CO 3	Understand core concepts of Economic Botany and realise the commercial and industrial aspects of certain economically important plants.	K2 & K6
CO 4	Cite the scientific evidence for biodiversity change in the modern era and detail the contemporary causes of diversity loss	K3 & K6
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)	
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill	

Text Books

1. Bergstrom, C. T. and L. A. Dugatkin. 2012. Evolution,Second MEDIA Edition. W.W. Norton & Company, International Student Edition, pp-756.
2. Jobling, M., E. Hollox, M. Hurles, T.Kivisild and C. T.Tyler Smith. 2014. Human Evolutionary Genetics. Second Edition. Garland Sciences, London, pp-650.
3. Veer Bala Rostogi, 2018. Organic Evolution (Evolutionary Biology), Thirteenth Edition Vinoth Kumar Jain, Scientific International (Pvt.) Ltd, New Delhi, pp-590.
4. Nehra, Sampat Ed., 2007. Economic Botany, Pointer Publishers Jaipur.
5. Saxena, Rupali 2014. Economic Botany of Angiosperms, Anmol Publications New Delhi.
6. Krishna Murthy K V 2003. Text Book of Biodiversity, CRC Press
7. Singh MP, 2021. Plant Biodiversity and Taxonomy, Daya Publiahing house,
8. Patil D A. 2024 Biodiversity and Plant resources, Agrobios India.
9. Singh, Pandey and Jain 2017. Economic Botany, Rastogi Publication, Meerut.

Reference Books

1. Strickberger. M. W. 2000. Evolution. Third Edition, Jones Bartlett Publishers, pp-722.
2. Hall B. K. and B. Hallgrimsson. 2014. Strickberger's Evolution. Fifth Edition, Bartlett Learning, An Ascend Learning Company, pp-642.
3. Barton, N.H., D. Briggs, J.A. EisenDavid,D.B. Goldstein and N.H. Patel. 2007. Evolution. Cold Spring Harbor Laboratory Press, pp-833.
4. Sober, E. 1984. The Nature of Selection, Evolutionary Theory in Philosophical Focus. Cambridge, MA: MIT Press
5. Joshi PC, 2020. Ecology and Biodiversity, Todays and Tomorrows printers and Publishers, Karol Bagh, Delhi-110005.
6. Kaliwal B. B. 2017. A New Horizons in Biodiversity, Todays and Tomorrows printers and Publishers, Karol Bagh, Delhi-110005.
7. Sobti RC 2022. Biodiversity Threats and Conservation, CRC Press
8. Pratima Vishwakarma 2024 A Textbook of Botany - Plant Biodiversity -2 Discount Group of Publication
9. Pulliah T 2018 Biodiversity in India, Daya Publishing house
10. Pandey B P. 2015. Economic Botany. S. Chand and Co.
11. Kochhar S.L. 2016. Economic Botany in the Tropics. A comprehensive study.
12. Miglani S, 2016. A Textbook of Economic Botany. ABS Books.
13. Verma V, 2009. Textbook of Economic Botany. ANE Books.
14. B. Baruah 2017. Economic Botany, Kalyani Publishers, New Delhi.

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PS6	PS7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	1	2	2	2	2	3	3	1	2	2	2	2
CO2	3	2	2	1	3	2	1	2	2	1	1	2	2	1
CO3	2	1	2	1	1	3	1	2	1	2	1	1	0	1

CO4	2	2	3	2	2	3	2	2	2	3	2	2	3	2

0 – No correlation 1 – Low 2- Medium 3 – High

ELECTIVE 2 B

Title of the Course		**AGRICULTURAL BOTANY AND FORESTRY**					
Paper Number		**Elective 2 (B)**					
Category	**Core**	**Year**	**I**	**Credits**	**4**	**Course Code**	
		Semester	**II**				
Instructional Hours Per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		3	-	**2**	**5**		
Pre-requisite		Basic knowledge on Agriculture and Forestry gained during undergraduate course.					
Learning Objectives		To address various critical issues in conserving the biodiversity with special reference to economically important plants and the plants listed in RED data.					
		Disseminate knowledge on conservation of biodiversity and protection of environment					
		To study biodiversity management and conservation.					
		To enhance the knowledge of the students and equip them in evaluate and protecting invaluable components of nature and interactions with the environment.					
		To understand the concept of evolution. It provides a comprehensive account of evidences to support concept of evolution and different theories for exploring the mechanism of evolution.					
UNIT							
I		**Agroclimatic zones of India.** Cropping system in India – Kharif, Rabi, and Zaid. Soil profile - physical and chemical properties of soil - soil biota - classification of Indian soils - soil erosion - causes and effects - acid and sodic soils. Types of Farming in India. Concepts of multiple cropping, multistorey, relay and inter-cropping. Water, its properties and role in plants. Irrigation - Classification of soil water - methods of irrigation.					
II		**Agricultural implements and Machineries and their usage.** Tillage- Primary and Secondary tillage - Conventional tillage - Minimum tillage – Stubble mulch tillage. Weed and their management- Harmful effects of weeds- Classification of weeds – Propagation and Dissemination of weed, Methods of weed control- Mechanical, Cultural, Chemical, Biological. Integrated weed management. Herbicide – Classification - Mode of action.					
III		**Organic farming** - Definition, Principles, Benefits and its Scope in India - Eco-friendly pest management. Organic manures: Bulky - FYM- Green manures- Sheep and Goat Manure - Compost- Various methods of composting- Vermicompost- Coir pith compost. Concentrated organic manures- Oil cakes- Fish meal- Meat meal- bone meal.					

	Production of liquid organic manures- vermiwash- jeevamritham, beejamrit, panchagavya.
IV	**Forestry**: Definition, importance of Forests, Types of Forest in India and Tamil Nadu. Classification of forests - High forests, coppice forests, virgin forest and second growth forests, pure and mixed forests. Forests at different altitudes. Plants adaptations in different habitats. Branching pattern - architectural models of trees. Silviculture – definition, pollarding, lopping, thinning, pruning. Silviculture of some of the economically important species in India - *Azadirachta indica, Tectona grandis, Swietenia mahagoni*, and *Dalbergia sisso*.
V	**Major and minor forest products**. Forest degradation – Causes and mitigation measures, Biological invasion, Forest fires –Types and causes. Afforestation, Reforestration, Agroforestry - farm forestry, social forestry. Applications of Remote Sensing and GIS in forestry and forest resource management. Forest Laws - Indian Forest Act, 1927, Wild Life Protection Act, 1972, Forest (conservation) rules 2022.

Course Outcomes

CO	**Course outcomes – on completion of this course, the students will be able to**	**Programme outcomes**
CO 1	Acquire knowledge about farming in India, soil type and cropping systems	K1 & K2
CO 2	Gain knowledge about tillage technologies involved in agriculture	K1 & K4
CO 3	To acquaint the students about general principles of tree breeding with examples of important trees.	K2 & K6
CO 4	Students can acquire knowledge about organic farming and their advantages. Basic knowledge on problem soils and their management, learn on crop production in problem soils and their reclamation.	K3 & K6
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)	
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill	

Text Books

1. Kanwar, J.S. (1985) Theory and Practice of Soil Fertility. ICAR Pub.
2. Pierzinsky GM, Sims TJ & Vance JF. 2002. Soils and Environmental Quality. 2nd Ed. CRC Press.
3. Tisdale SL, Nelson SL, Beaton JD & Havlin JL. 1999. Soil Fertility and Fertilizers. 5th Ed. Prentice Hall of India.
4. Troeh FR & Thompson LM. 2005. Soils and Soil Fertility. Blackwell.
5. Chand, S. (2008). Integrated Nutrient Management for Sustainable Crop Production and Soil Health, International Book Distributing Co., Lucknow, UP

6. Indian Society of Soil Science 2002. Fundamentals of Soil Science. ISSS, New Delhi.

7. Sehgal J. 2002. Introductory Pedology: Concepts and Applications. New Delhi.

8. Das. P.C. 2003 Manures and Fertilizers, Kalyani Publishers

9. SubbaRao, N.S. 2004 Soil Microbiology Oxford & IBH.

10. Magdoff F & Weil RR 2004. Soil Organic Matter in Sustainable Agriculture. CRC Press.

Reference Books

1. A.M. Michael, 1987. Irrigation – Theory and Practice, Vikas Publishing House Pvt. Ltd., New Delhi
2. S.S. Parihar and B.S. Sandhu, 1978. Irrigation of field crops – Principles and Practices, ICAR, New Delhi
3. Lenka, 1999. Irrigation and Drainage. Kalyani Publishers, New Delhi.
4. G.H. Sankara Reddy and T. Yellamanda Reddy. 1995. Efficient use of irrigation water. Kalyani Publishers, New Delhi.
5. Gupta, O. P. 1998. Modern Weed Management. Agro Botanica Bikaner, India.
6. Subramanian, S. A. Mohammed Ali and R. Jayakumar. 1991. All about Weed Control. Kalyani Publishers, New Delhi.
7. Dutta M and Saini GC. 2009. Advances in Forestry Research in India, Vol. XXX.
8. Champion, H, G and Seth, S.K. 1968. Forest types of India, a revised survey of forest types of India, GOI Press, New Delhi, 404p.
9. Grebner, D.L., Bettinger, P and Siry, J.P. 2012. Introduction to Forestry and Natural Resources. Academic Press. 508p (Google eBook).
10. Khanna, L.S. 1989. Principles and Practice of Silviculture. Khanna Bandhu, New Delhi, 473p.
11. Ashok Kumar (2001). Botany in Forestry and Environment. Kumar Media (P) Ltd. Gandhinagar, Gujarat.
12. Bor N. L. (1990). Manual of Indian Forest Botany. Periodical Expert Book Agency. New Delhi.
13. Awasthi, L.P. 2021. Biopesticides in Organic Farming: Recent Advances. CRC Press, Florida, USA.
14. Gangwar B.,Gopakumar, V. 2016 Organic Farming :Technologies and Strategies, Today & Tomorrow's Printers and Publishers, New Delhi.
15. Gangwar B. 2017 Towards Organic Agriculture, Today & Tomorrow's Printers and Publishers, New Delhi.

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PS6	PS7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	1	1	2	2	1	3	3	3	3	3	2	1
CO2	2	2	2	1	1	0	1	2	2	2	2	2	1	1
CO3	2	1	2	3	1	1	1	1	2	1	1	1	1	1
CO4	3	2	3	3	2	1	1	3	3	1	1	1	1	1

0 – No correlation 1 – Low 2- Medium 3 – High

SKILL ENHANCEMENT COURSE - 2

Title of the Course		**APPLIED BIOTECHNOLOGY AND NANOBIOTEHCNOLOGY**					
Paper Number		**SKILL ENHANCEMENT COURSE 2**					
Category	**Core**	**Year**	**I**	**Credits**	**3**	**Course Code**	
		Semester	**II**				
Instructional Hours Per week		**Lecture**	**Tutorial**	**Lab Practice**		**Total**	
		3	1	-		**4**	
Pre-requisite		Students should be familiar with the basic and applied knowledge on biotechnology					
Learning Objectives		To provide a basic overview of Transgenic plants.					
		To introduce the concepts in nanomaterials and their use with biocomponents to synthesize and interact with larger systems.					
		To impart knowledge on the most recent RNA Interference molecular diagnosis to treat various diseases.					
		To enhance the knowledge on Transgenic animals.					
		To critically analyze the DNA finger printing techniques					

UNIT	
I	**Categories of Genetically Engineered Plants** – Transgenics, Cisgenics, Intragenics, Genome and Promoter Edited Plants. Mechanism of insect resistance in Bt crops - post-harvest shelf-life improvement in Flavor Savr, Zeneca Tomato Paste - virus resistance in Rainbow Papaya, Transgenic Squash - transgenic biofortification in Golden rice. Transgenic plants for abiotic stress tolerance: drought, salinity, and temperature resistance.
II	**Transgenic technology for developing male sterile lines** - Barnase–Barstar System. Transgenic protein enhancement – Star Link corn. Molecular basis of herbicide tolerance in Roundup Ready soybean. Seed Production Technology (SPT) system in hybrid seed production. Molecular diagnosis RNA Interference (RNAi) for Nematode Resistance. Challenges in commercializing transgenic plants. Bioinsecticides (thuricides), Biofertilizer (phosphate solubilising microorganisms).
III	**Human insulin production by genetic engineering**. Production of Growth Factors – Somatotropin, Somatostatin. Production of monoclonal antibody, Hepatitis B Vaccine and Blood Clotting Factors. Production of biopolymer - Xanthan Gum. Genetically

	Engineered Microorganism - Super bug - Steps in the construction of Super bug. Bioremediation methods - *In situ* and *ex situ* bioremediation. DNA Microarrays – Protein Microarrays – Cell Biochips.
IV	**Transgenic animals** - Transgenic Mice, fish and cow. Knock-out and Knock-in Technology. DNA diagnostics of genetic and Chromosomal disorders. DNA fingerprinting- common techniques and applications. Gene therapy – types - somatic virus germline gene therapy, mechanism of gene therapy, Immunotherapy. Microbial production of therapeutic compounds (β-lactum), Peptide antibiotics (Quinolinones), Biotransformation of steroids, Vit.B-12 and riboflavin fermentation. Microbial production of bioplastics (PHB, PHA).
V	**Nanobiotechnology**: Meaning, characteristics of Nanomaterials: shapes and sizes of nanomaterials, determination of nanostructures by SEM, TEM, XRD, EDAX. Different kinds of nanomaterials. Nanobiosensing: Definition of biosensors, main components of biosensors, different types of biosensors, applications of biosensors. Nanomedicine: Nanoparticle within a biological environment, nanoparticles for therapy- drug delivery, gene delivery, protein delivery, photothermal and photodynamic therapy. Nanomaterials for tissue engineering and prosthetics. Nanoparticles based bioimaging.

Course Outcomes

CO	**Course outcomes – on completion of this course, the students will be able to**	**Programme outcomes**
CO 1	Acquire knowledge about Transgenic plants	K1 & K2
CO 2	Discuss and develop skills for hybrid seed production and molecular farming.	K1 & K4
CO 3	Students can acquire knowledge Nanobiotechnology and their advantages.	K2 & K6
CO 4	Enhance collaborative learning and communication skills through practical sessions, teamwork, group discussions and home assignments.	K3 & 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. Rehm, H. J and G. Reed, Biotechnology-*A multi- Volume Comprehensive Treatise*, 2nd Ed, Vol 3, Wiley-VCH, 1993
2. Moo-Young, M. 2004. *Comprehensive Biotechnology,* Vol. 2, Pergamon Press,
3. Dicosmo, F and M. Missawa, 1996. *Plant Cell Culture Secondary Metabolism: Towards Industrial Application*. CRC LLC.
4. Frazier, W.C. and Weshoff, D.C. (2015). Food Microbiology (5th edition) McgrawHill.
5. Das, H.K. 2010. Textbook of Biotechnology (4th edition). Wiley India Pvt. Ltd. New Delhi
6. Gamborg, O.L and G.C. Phillips (eds). 1995. Plants, genes and agriculture. Jones and Bartlett Publishers.
7. Kreuzer, H and A. Massey. 1996. Recombinant DNA and biotechnology. A guide for teachers. ASM Press.
8. Kumar, Pradeep. 2018. Advances in Microbial Biotechnology: Current Trends and Future Prospects. 10.1201/9781351248914.
9. Thieman. 2014. Introduction to Biotechnology 3rd Edition. Pearson Education India.
10. Khan. I.A. and A. Khanum .2004. Fundamentals of Biotechnology – Forensic Science Genetic Engineering. Ukaaz publication, Hyderabad.

Reference Books

1. Gupta. P.K., 1998. Elements of Biotechnology. Rastogi publications, Meerut.
2. Gupta, S.D and Ibaraki, Y. 2006. Plant tissue culture engineering (Vol. 6). Springer Science & Business Media, Germany.
3. Halford, N. 2015. Plant Biotechnology: Current and Future Applications of Genetically Modified crops, John Wiley and Sons.
4. Kumar, Pradeep. 2018. Advances in Microbial Biotechnology: Current Trends and Future Prospects. 10.1201/9781351248914.
5. Chawla, H.S. 2009. Introduction to Biotechnology, 2nd edn. Oxford IBH, ISBN:978-81-204-1732-8.
6. Halford, N. 2015. Plant Biotechnology: Current and Future Applications of Genetically Modified Crops, John Wiley and Sons.
7. Kumar, H.D. 2007. Molecular Biology and Biotechnology, Vikas Publishing House, New Delhi.
8. Glick, B.R and J.E. Thompson. 1993. Methods in Plant Molecular Biology and Biotechnology. CRC Press, Boca Raton, Florida.

Web Resources

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	PS6	PS7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	3	2	2	1	1	3	3	3	2	1	2	2
CO2	2	2	2	3	1	1	2	2	1	1	2	1	2	2
CO3	1	3	1	1	1	1	2	1	1	3	1	1	3	2
CO4	3	2	1	2	2	1	1	3	3	1	2	1	2	3

0 – No correlation 1 – Low 2- Medium 3 – High