Annamalai University

(Accredited with 'A+' Grade by NAAC)

Faculty of Science

DEPARTMENT OF BOTANY

M.Sc. BOTANY

ProgrammeCode:SBOT21

Regulations, Curriculum and Syllabus
2023-2024

1. Preamble
2. StructureofCourse
3. LearningandTeachingActivities
4. AssessmentActivities
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1. Preamble

Taxonomy forms three learning domains: the cognitive (knowledge), affective(attitude), andpsychomotor(skill). Thisclassificationenablestoestimatethelearningcapabilitiesofstudents.

Briefly, it is aimed to restructure the curriculum as student-oriented, skill-based, and institution-industry-interactioncurriculumwiththevariouscourses under**"Outcome Based Education with Problem Based Courses, Project Based Courses, and Industry Aligned Programmes"**having revised Bloom's Taxonomy for evaluating students skills.

Introduction: PO &PSO

Programme Outcome, Programme Specific Outcome and Course Outcome

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

Programme Outcomes:

PO1: Disciplinary Knowledge: Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form part of Post graduate programmes of study.

PO2: Critical Thinking: Capability to apply analytic thought to a body of knowledge; analyze and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development.

PO3: Problem Solving: Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one’s earning to real-life situations.

PO4: Analytical & Scientific Reasoning: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data

from a variety of sources; draw valid conclusions and support them with evidence and examples and addressing opposing viewpoints.

PO5: Research related skills: Ability to analyze, interpret and draw conclusions from quantitative / qualitative data; and critically evaluate ideas, evidence, and experiences from an open-minded and reasoned research perspective; develop sense of inquiry and capability for asking relevant questions / problem arising / synthesizing / articulating / ability to recognize cause and effect relationships / define problems. Formulate hypothesis, Test / analyze / Interpret the results and derive conclusions.

PO6: Self-directed & Lifelong Learning: Ability to work independently, identify and manage a project. Ability to acquire knowledge and skills, including "learning how to learn", through self-placed and self-directed learning aimed at personal development, meeting economic, social and cultural objectives.

Programme Specific Outcomes:

PSO1: Acquire good knowledge and understanding, to solve specific theoretical & applied problems in different areas of the specific discipline of study.

PSO2: Understand, formulate, develop arguments logically to address issues arising in social sciences, business and other context /fields.

PSO3: To prepare the students who will demonstrate respectful engagement with other's ideas, behaviors, beliefs and apply diverse frames of references to decisions and actions. To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations. To encourage practices grounded in research that comply with employment laws, leading the organization towards growth and development.

Mapping of Course Learning Outcomes (CLOs) with Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)can be carried out accordingly, assigning the appropriate level in the grids.

DEPARTMENT OF BOTANY

M.Sc. BOTANY

Programme Code: SBOT21

Post-Graduate Curriculum Design

Semester–I	C	Semester-II	C	Semester-III	C	Semester–IV	C
1.1. Core-I Plant Diversity-I Algae, Fungi, Lichens and Bryophytes	5	2.1. Core-IV Taxonomy of Angiosperms and Economic Botany	5	3.1. Core-VII Cell and Molecular Biology	5	4.1.Core-XI Plant Physiology and Plant metabolism	5
1.2 . Core-II Plant Diversity - II: Pteridophytes, Gymnosperms and Paleobotany	5	2.2. Core-V Plant Anatomy and Embryology of angiosperms	5	3.2. Core - VIII Genetics, Plant Breeding & Biostatistics	5	4.2 Core – XII Laboratory course-IV: Covering Core Paper XI	5
1.3. Core – III Laboratory course- I: Covering Core Papers - I and II	4	2.3. Core VI Laboratory course- II: Covering Core Papers IV and V	4	3.3. Core – IX Ecology, Phytogeography, Conservation Biology and Intellectual Property rights	5	4.3. Project with Viva-Voce	7
1.4. Elective (Generic Discipline Centric) – I Horticulture / Algal Technology	3	2.4. Elective (Generic Discipline Centric) – III Nano -biotechnology / Applied bioinformatics	3	3.4. Core - X Laboratory course- III Covering Core Papers VII , VIII and IX)	4	4.4. Elective (Generic Discipline Centric)– VI Organic farming / Forestry and Wood Technology	3
1.5. Elective (Generic Discipline Centric) – II Mushroom cultivation / Microbiology, immunology and plant pathology	3	2.5. Elective (Generic Discipline Centric) – IV Research methodology, Computer applications & Bioinformatics / Medicinal Botany	3	3.5. Elective (Generic Discipline Centric)– V Applied Plant cell & Tissue culture / Silviculture and Commercial Landscaping	3	4.5. Skill Enhancement Course SEC 3: Botany for Advanced Studies / Professional Competency Skill	2
		2.6. Skill Enhancement Course SEC 2: Agricultural Food Microbiology	2	3.6. Skill Enhancement Course SEC 3: Term Paper Seminar Presentation	2	4.6 Extension Activity	1
				3.7. Internship / Industry Module: Industrial Botany/ Nursery and Gardening	2		
	20		**22**		**26**		**23**
						Total Credit Points	**91**

Annamalai University

Department of Botany

M.Sc. Botany (Two Year) Programme

Programme Code: SBOT21

Curricula and Scheme of Examination

(For students admitted from the academic year 2023-2024)

Course Code	Course Title	Hours/ Week			C	Marks		
		L	T	P		CIA	ESE	Total
Semester-I								
23BOTC101	Core 1: Plant Diversity-I Algae, Fungi, Lichens and Bryophytes	5	2	0	5	25	75	100
23BOTC102	Core 2: Plant Diversity - II: Pteridophytes, Gymnosperms and Paleobotany	5	2	0	5	25	75	100
23BOTC103	Core 3: Laboratory Course- I: Covering Core Papers - 1 and 2	0	0	5	4	40	60	100
23BOTE104/ 23BOTE105	Horticulture / Algal Technology	3	2	0	3	25	75	100
23BOTE106/ 23BOTE107	Mushroom Cultivation / Microbiology, Immunology and Plant Pathology	3	3	0	3	25	75	100
		30			20			
Semester-II								
23BOTC201	Core 4: Taxonomy of Angiosperms and Economic Botany	5	2	0	5	25	75	100
23BOTC202	Core 5: Plant Anatomy and Embryology of angiosperms	5	2	0	5	25	75	100
23BOTC203	Core 6: Laboratory Course-II: Covering Core Papers 4 and 5	0	0	5	4	40	60	100
23BOTE204/ 23BOTE205	Nano biotechnology / Applied bioinformatics	3	1	0	3	25	75	100
23BOTE206/ 23BOTE207	Research Methodology, Computer Applications & Bioinformatics / Medicinal Botany	3	1	0	3	25	75	100
23BOTS208	Agricultural Food Microbiology	3	0	0	2	25	75	100
		30			22			
Semester-III								
23BOTC301	Core 7: Cell and Molecular Biology	4	1	0	5	25	75	100
23BOTC302	Core 8: Genetics, Plant Breeding & Biostatistics	4	1	0	5	25	75	100
23BOTC303	Core 9: Ecology, Phytogeography, Conservation Biology and Intellectual Property Rights	4	1	0	5	25	75	100
23BOTC304	Core 10: Laboratory Course-III: Covering Core Papers 7, 8 and 9.	0	0	5	4	40	60	100

23BOTE305/ 23BOTE306	Applied Plant Cell & Tissue culture / Silviculture and Commercial Landscaping	3	2	0	3	25	75	100
23BOTE307	SEC – Term Paper Seminar Presentation	2	1	0	2	25	75	100
23BOTA308 23BOTA309 23BOTA310	Internship Industry Module: Industrial Botany/ Nursery and Gardening	2	0	0	2	25	75	100
		30			26			
Semester – IV								
23BOTC401	Core 11: Plant Physiology and Plant metabolism	5	2	0	5	25	75	100
23BOTC402	Core 12: Laboratory Course-IV: Covering Core Papers XI	0	0	5	5	25	75	100
23BOTC403	Project with Viva-voce	0	0	5	7	25	75	100
23BOTE404 23BOTE405	Organic farming / Forestry and Wood Technology	3	2	0	3	40	60	100
23BOTS406	SEC: Botany for Advanced Studies / Professional Competency Skill	2	2	0	2	25	75	100
23BOTA407	Extension activities	2	2	0	1	25	75	100
		30			23			
	Total Credits	**120**			**91**			

L- Lectures; P- Practical; T – Tutorial; C- Credits; CIA- Continuous Internal Assessment; ESE- End-Semester Examination

COURSE	NO's.	CREDITS
Core Papers	**12**	**57**
Elective (Generic Discipline Centric)	**6**	**18**
Skill Enhancement Course/Professional Competency Skill	**3**	**6**
Project	**1**	**7**
Internship/Industrial activity	**1**	**2**
Extension Activity	**1**	**1**
TOTAL CREDITS	**24**	**91**

Programme:	**M.Sc.Botany**
Duration:	**2years**
ProgrammeOutcomes(PO)	
TheM.Sc. Botanyprogramis designedtoachievethefollowingobjectives	
PO1	Toimpartknowledgeonthefundamental,advancedandemergingconceptsinBotany.
PO2	Toprovideuptodate theoreticalknowledgeonvariousformsofplants,theirinteractions with biotic and abiotic entities in the ecosystem and relevant practicalskills.
PO3	TocomprehendandinterpretvariousfacetsofBotanyincludingtheimportanceandjudiciousutilization ofplant sources.
PO4	To address various criticalissuesinconservingthebiodiversitywithspecialreferencetoeconomically important plants and theplants listed in REDdata.
PO5	Tounderstandtheprinciplesandapplicationsofvarioustraditionalandmoderntechniques used in Botany.
PO6	Todisseminateknowledgeonthedesignandexecutionofexperimentsin Botanywithemphasis on the operation ofrelevantsophisticated instruments.
PO7	Toimpartknowledgeontheeconomicimportanceofplant/microbialresourcesandtheirproducts and to promoteentrepreneurship skill.
PO8	To promote proficiency in designing the research problems, review of literature,laboratory experiments, data analyses and preparation of reports with professionalethics.
PO9	Tomotivatethestudentstotakeupinnovativeandcutting-edgeresearchinfrontierareasof Botany and related biology subjects.
PO10	Toenablethestudentstotakeupvariousqualifyingexaminationsconcerning Botanyandtofacethe challenges in career opportunities.

Program Specific Outcomes(PSO)	
OnsuccessfulcompletionoftheM.Sc.Botanyprogram,thestudentsare expectedto	
PSO1	Familiarizewiththefundamental,advancedand emergingconceptsinBotany.
PSO2	Understandtheroleofplantsandtheirinteractionswithotherorganismsinvariousecosystems.
PSO3	Identify the potency of plant resources in contemporary research and visualize futurethrustareas in Botany.
PSO4	Designscientificexperimentsindependentlyandtogenerateusefulinformationtoaddress various issues in Botany.
PSO5	Acquirebasicknowledgeonprinciplesandapplicationsoflaboratoryinstrumentsandadequateskills to handlethem.
PSO6	Chooseandapplyappropriatetools,techniques,resources,etc.toperformvariousexperiments in Botany.
PSO7	Carryoutscientificexperimentsindependentlyorincollaborationwithinter-disciplinaryor multidisciplinary approaches.
PSO8	Disseminateknowledgeonconservationofbiodiversityandprotectionofenvironment.
PSO9	Awarenessonthesustainableutilizationofplant/microbialresourcesfollowingthebioethicalnorms.
PSO10	Demonstrateproficiencyincommunicatingwithvariousstakeholderslikestudents,teachers,scientists and society.

(For the students admitted during the academic year 2023–2024 onwards)

Semester	23BOTC101: Core 1: Plant Diversity-I: Algae, Fungi, Lichens and Bryophytes	L	T	P	C
I		5	2	0	5

Learning Objective (LO):

LO1	To learn about the classification, distinguishing traits, geographic distribution, and reproductive cycle of algae, fungi, lichens, and bryophytes
LO2	To gain knowledge about the ecological and economic importance of algae, fungi, lichens and bryophytes
LO3	To spark interest in the evolutionary roots of plant development
LO4	To study the biodiversity by describing and explaining the morphology and reproductive processes of algae, fungi, bryophytes and microorganisms
LO5	Toexposethebeneficialandharmfulviewpoint

Course Outcomes (CO)

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

Unit – 1

ALGAE:

General account of algology, Contributions of Indian Phycologist (T.V.Desikachary, V.Krishnamurthy and V.S.Sundaralingam), Classification of algae by F.E.Fritsch (1935-45) & Silva (1982). Salient features of major classes: Cyanophyceae, Chlorophyceae, Xanthophyceae, Chrysophyceae, Cryptophyceae, Dinophyceae, Chloromonadineae, Euglenophyceae, Charophyceae, Bacillariophyceae, Phaeophyceae and Rhodophyceae. Range of thallus organization, algae of diverse habitats, reproduction (vegetative, asexual and sexual) and life cycles. Phylogeny and inter-relationships of algae, origin and evolution of sex in algae.

Structure, reproduction and life histories of the following genera: *Oscillatoria*, *Scytonema*, *Ulva*, *Codium*, *Diatoms*, *Dictyota*and *Gelidium.*

Unit – 2

FUNGI:

General Characteristics, occurrence and distribution. Mode of nutrition in fungi. Contributions of Indian Mycologists (C.V.Subramanian), Classification of Fungi by Alexopoulos and Mims (1979) & Recent trends in the classification of fungi - Phylogeny and inter-relationships of major groups of fungi. General characters of major classes: Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina.

Heterothallism in fungi, sexuality in fungi, Para sexuality, sex hormones in fungi.

Structure, reproduction and life histories of the following genera: *Plasmodiophora, Phytophthora, Rhizopus, Taphrina, Polyporus* and *Colletotrichum.*

Unit – 3

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

BRYOPHYTES:

Unit – 4

General characters and Classification of Bryophytes by Watson (1971). Distribution, Structural variations and evolution of gametophytes and sporophytes in Bryopsida, Anthoceropsida and Mosses. General characters of major groups - Marchantiales, Jungermaniales, Anthocerotales, Sphagnales, Funariales and Polytrichales. Reproduction - Vegetative and sexual, spore dispersal mechanisms in bryophytes, spore germination patterns in bryophytes.

Structure, reproduction and life histories of the following genera: *Targionia, Lunularia, Porella* and *Polytrichum.*

Unit – 5

ECONOMIC IMPORTANCE:

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

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. KevinK. 2018. Fungi biology and Application, 3rd Edition, Wiley Blackwell.
5. Pandey, P.B. 2014. College Botany-1: Including Algae, Fungi, Lichens, Bacteria, Viruses, Plant Pathology, Industrial Microbiology and Bryophyta. Chand Publishing, New Delhi.
6. Singh, Pandey and Jain. 2020. A text book of Botany, 5th Edition, Rastogi Publication, Meerut.
7. Sharma, O.P. 2014. Bryophyta, Mcgraw Hill, ISBN: 9781259062872, 1259062872

Reference Books:

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

Web resources:

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

Outcome Mapping:

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

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

Semester	23BOTC102: Core 2: Plant Diversity - II: Pteridophytes, Gymnosperms and Paleobotany	L	T	P	C
I		5	2	0	5

Learning Objective (LO):

LO1	Toinvestigatetheclassification,distinctive traits,distributionandreproductionandlifehistoryofthevariousclassesand majortypes ofPteridophytesand Gymnosperms
LO2	To identify and characterize diversity of lower vascular plants in order to comprehend the dynamics of diversity to realize the importance of diversity
LO3	To research the classification, phylogeny and economic importance of Pteridophytes and Gymnosperms
LO4	TostudyandunderstandthephylogenyandPaleontologyofPteridophytesand Gymnosperms
LO5	To learn about the conceptoffossilsandprocessoffossilization;distinctive characteristics offossilrecords of Pteridophytes and Gymnosperms

Course Outcomes (CO)

COs	On completion of this course the student will be able to	POs
CO1	Recallonclassification,recenttrendsinphylogeneticrelationship,generalchar acters ofPteridophytesand Gymnosperms.	K1 &K3
CO2	Learnthemorphological/anatomicalorganization,lifehistory of majortypes ofPteridophytesand Gymnosperms	K3 & K4
CO3	ComprehendtheeconomicimportanceofPteridophytes, Gymnosperms, and fossils.	K3 & K5
CO4	UnderstandingtheevolutionaryrelationshipofPteridophytesand Gymnosperms.	K2
CO5	Awarenessonfossiltypes,fossilizationandfossilrecordsof Pteridophytesand Gymnosperms.	K1 & K3
K1-Remember; **K2**-Understand; **K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** –Create.		

Unit – 1

PTERIDOPHYTES:

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

Unit – 2

PTERIDOPHYTES:

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

Unit – 3

GYMNOSPERMS:

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

Unit – 4

GYMNOSPERMS:

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

Unit – 5

PALAEOBOTANY:

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

RecommendedText:

1. Vashishta, P.C.Sinha, A.K and Anil Kumar. 2016. Botany for Degree students. Gymnosperms. S. Chand and Company Ltd., New Delhi.
2. Singh,V.,Pande,P.C andJain,D.K. 2021. ATextBookofBotany.RastogiPublications,Meerut.
3. Bhatnagar, S.P and AlokMoitra. 2020. Gymnosperms, New Age International (P) Ltd., Publishers, Bengaluru.
4. Sharma, O.P. 2017. Pteridophyta, McGraw Hill Education, New York.
5. Vashishta.P.C.,A.K.SinhaandAnilKumar.2018.BotanyforDegreestudents-Gymnosperms.S. Chand and Company Ltd., NewDelhi.
6. Johri, R.M, Lata, S, Tyagi, K. 2005. A text book of Gymnosperms, Dominate pub and Distributer, New Delhi.

Reference books:

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

Web resources:

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

OutcomeMapping:

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

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

Semester	23BOTP103:Core 3: Laboratory Course- I: Covering Core Papers - 1 and 2	L	T	P	C
I		0	0	5	4

Learning Objective (LO):

LO1	To learn how to employ the use of instruments, technologies and methodologies related to thallophytes and non-flowering plant groups.
LO2	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
LO3	To comprehend the fundamental concepts and methods used to identify Bryophytes, Pteridophytes and Gymnosperms through morphological changes and evolution, anatomy and reproduction
LO4	To develop the technical abilities in staining, sectioning, sterilizing, and characterizing.

	thallophytes, and other varieties of non-flowering plants
LO5	To compare the structural diversity of fossil and extant plant species

Course Outcomes (CO)

COs	On completion of this course the student will be able to	POs
CO1	Recallandapplyingthebasickeystodistinguishatspecieslevelidentificationofi mportantalgaeandfungithrough itsstructural organizations.	K1& K4
CO2	Demonstrate practical skills in Thallophytes, Pteridophytes and Gymnosperms.	K2
CO3	Describe the structure of algae, fungi, lichens, Bryophytes, Pteridophytes and Gymnosperms.	K3
CO4	Determine the importance of structural diversity in the evolution of plant forms.	K5
CO5	Formulate techniques to isolate and culture of alga and fungi as well as to understand the diversity of plant forms.	K5 & K6
K1-Remember; **K2**-Understand; **K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** –Create.		

EXPERIMENTS

ALGAE

Study of algae in the field and laboratory of the genera included in theory.

External morphology and internal anatomy of the vegetative and reproductive structures of the following living forms: *Oscillatoria*, *Scytonema*, *Ulva*, *Codium*, *Diatoms*, *Dictyota*and*Gelidium*(depending onavailability of the specimen).

To record the local algal flora–Study of their morphology and structure.

Identification of algae to species level (at least One).

Preparation of culture media and culture of green algae and blue green algae in the laboratory (Demonstration).

FUNGI

Study of morphological and reproductive structures ofthefollowinglivingforms: *Plasmodiophora*, *Phytophthora*, *Rhizopus*, *Taphrina*, *Polyporus* and *Colletotrichum* (depending onavailability of thespecimen).

Isolation and identification of fungi from soil, air, and Baiting method.

Preparation of culture media.

Cultivationofmushroomin the laboratory (Demonstration).

LICHENS

Study of morphological and reproductive structures of the genera *Parmelia.*

BRYOPHYTES

External morphology and internal anatomy of the vegetative and reproductive organs of thefollowinglivingforms: *Targionia*, *Lunularia*, *Porella* and *Polytrichum*(depending onavailability of thespecimen).

PTERIDOPHYTES

External morphology and internal anatomy of the vegetative and reproductive organs of thefollowinglivingforms: *Isoetes, Equisetum Angiopteris, Osmunda, Pteris* and *Azolla* (depending onavailability of thespecimen).

Fossilslidesobservation:Rhynia, Lepidocarpon, Calamites.

GYMNOSPERMS

External morphology and internal anatomy of the vegetative and reproductive organs of thefollowinglivingforms:*Thuja,Cupressus, Araucaria, Podocarpus, Gnetum*and *Ephedra* (depending onavailability of thespecimen).

Fossilslidesobservation*: Cordaites*and *Lyginopteris.*

Outcome Mapping :

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

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

Semester	23BOTE104:HORTICULTURE	L	T	P	C
I		3	2	0	3

Learning Objective (LO):

LO1	Know about the brief history, divisions, classification and structure of horticultural plants.
LO2	Acquire knowledge on plant growth processes and stages of plant growth.
LO3	Understand the plant growth environment in relation to soil, nutrients, fertilizers, and bio inoculants.
LO4	Study the sexual and vegetative propagation methods including propagation through specialized vegetative structures
LO5	Develop practical skills in micro propagation techniques and soil-less production of horticultural crops

Course Outcomes (CO)

COs	On completion of this course the student will be able to	POs
CO1	Identify and categorize various horticultural plants and the conditions that	K1

	affect their growth and productivity.	
CO2	Explain the various structures and growth processes of horticultural plants.	K2
CO3	Demonstrate the propagation, growth, and maintenance of plants in horticulture systems.	K3
CO4	Correlate the soil characteristics and fertility to good plant growth.	K4
CO5	Utilize the role plant tissue culture techniques in the production of quality planting stock in horticulture.	K5
CO6	Apply horticultural skills and knowledge to explore career opportunities in horticulture industry.	K6
K1-Remember; **K2**-Understand; **K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** –Create.		

Unit – 1:

INTRODUCTION TO HORTICULTURE

Definition; Brief History, Divisions of Horticulture, Classification of horticultural plants, Structure of Horticultural Plants –Cell and Tissue systems, Anatomy of stem root and leaf, Morphological structures, Plant growth processes-A brief account of Photosynthesis, Respiration, Transpiration and Translocation, Stages of plant growth.

Unit – 2:

FACTORS AFFECTING PLANT GROWTH

Plant Growth Environment: Abiotic factors, Soil –Profile structure, Primary and Secondary nutrients and their functions, Organic matter, Fertilizers –organic, Inorganic and Potting Media, Bio inoculants, Methods of fertilizer application, Directing Plant growth-Training -Pruning and thinning.

Unit – 3:

PLANT PROPAGATION

Plant propagation: Seeds –Advantages, Viability, Mechanism of Dormancy and Dormancy Breaking: Methods of Direct and Indirect Seedling Production in Nurseries and Transplantation; Propagation through specialized underground structures –Corm, Tuber, Sucker, Bulb, Bulbil, Rhizome; Vegetative Propagation –Cutting, Layering, Grafting and Budding.

Unit – 4:

MICROPROPAGATION TECHNIQUES

Stages, multiplication by shoot tip, Nodal culture and Callus culture-Application and Limitations, Somatic embryogenesis, Synthetic seeds –Preparation and Potential uses of artificial seeds, Embryo Rescue, Soil-less Production of Horticultural crops –Hydroponics, sand culture, gravel culture.

Unit – 5:

AESTHETICS OF HORTICULTURE

Design: Elements and Principles of Design, Flower Arrangement, Terrarium Culture, Bonsai, Growing Plants Indoors, Turf Production, Landscaping-Principles, Types of Parks, Xeriscaping. Postharvest handling of Horticultural Products –Harvesting, Storage, Processing, Elements of Marketing. Robotics in Horticulture.

RecommendedText:

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

Reference Books:

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

Web resources:

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

Outcome Mapping :

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

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

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

Semester	23BOTE105:ALGAL TECHNOLOGY	L	T	P	C
I		3	2	0	3

Learning Objective (LO):

LO1	To provide a basic overview of algae cultivation techniques and resource potentials.
LO2	To educate people about the widespread commercial uses of algae.
LO3	To educate people about the therapeutic usesof algae.
LO4	Toenrichthecurrentknowledgeof how algae are used inbasicresearchandtechnologicalapplications.
LO5	To spread awareness of the value of algae biotechnology and its applications in diverse industries.

Course Outcomes (CO)

COs	On completion of this course the student will be able to	POs
CO1	Understand the applied facet of botany and acquire a complete knowledge about the cultivation methods in algae.	K1& K3
CO2	Realization of the commercial potential of algal products.	K5
CO3	Analyze emerging areas of algal biotechnology for identifying therapeutic importance of algal products and their uses.	K2 & K4
CO4	Gain more information about algae genetics.	K4
CO5	Translate various algal technologies for the benefit of the ecosystem.	K3 & K6
K1-Remember; **K2**-Understand; **K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** –Create.		

Unit – 1:

SCOPE OF ALGAL TECHNOLOGY

Scope of algal technology – Commercial potential and utility of algae. Algae as sources for food, feed, pigments, Pharmaceuticals and neutraceuticals, fine chemicals, fuel, biofertilizers and hormones. Economic importance of algae in India.

Unit – 2:

ALGAL PRODUCTS

Industrial application of algae - fuel, algal lipids - transesterification to ester fuel - substitutes for petroleum derived fuel. Algal products - Spirulina mass cultivation and its applications. Mass cultivation of micro-algae as source of protein and as feed. Liquid seaweed fertilizers - method of preparation, applications and its advantages over inorganic fertilizers.

Unit – 3:

ALGAL PRODUCTION AND UTILIZATION

Algal production systems; Strain selection; Algal growth curve; Culture media; cultivation methods – small scale and Large-scale cultivation of algae. Harvesting and packing. Therapeutic uses - antioxidant, anti-ulcerogenic, antifungal, antibiotics, antitumor and antiviral compounds. Production of pigments and their utilization.

Unit – 4:

IMMOBILIZATION AND RDNA TECHNOLOGY IN ALGAE

Algal immobilization and its applications - culturing for metabolite production and natural compounds. Methods of immobilization - alginate beads-extraction of compounds. Recombinant DNA technology in algae - Transformation systems in algae. Isolation of protoplasts, regeneration of fusion of macro algae. Role of algae in nanobiotechnology.

Unit – 5:

ROLE OF ALGAE IN ENVIRONMENT MANAGEMENT

Role of algae in environmental health - Sewage treatment, treating industrial effluent, Phytoremediation- heavy metal removal, algae as indicators in assessing water quality and pollution; Saprobic index; Monitoring, assessment, restoration and management of coastal and marine ecosystem environment. Algal culture collection centers in India and abroad and their importance.

RecommendedText:

1. Trivedi, P.C. 2001. Algal Biotechnology. Point publisher, Jaipur. India.
2. Bold, H.C and Wynne, M.J. 1978. Introduction to the Algae: Structure and Function. Prantice Hall of IndiaNew Delhi.
3. Sahoo, D. 2000. Farming the ocean: seaweed cultivation and utilization. AravaliInternational, New Delhi.
4. Bast, F. 2014. An Illustrated Review on Cultivation and Life History of Agronomically Important Sea plants. In Seaweed: Mineral Composition, Nutritional and Antioxidant Benefits and Agricultural Uses, Eds. VitorHugoPomin, 39-70. Nova Publishers, New York. ISBN: 978-1-63117-571-8**.**

5. Rapouso, M.F.J., Morais, R.M.S.C., Morais, A.M.M.B. 2013. Bioactivity and applications of sulphated polysaccharides from marine microalgae. Marine Drugs, 11, 233-252.
6. Bajpai, Rakesh, K., Prokop,Ales,Zappi,Mark,E.2014.AlgalBiorefineriesVolume1:

Reference Books:

1. Kumar H.D and H.N. Singh.1982. A text Book on Algae. Affiliated East- West Press Pvt. Ltd
2. Suganya, T and Renganathan, S. 2015. Biodiesel production using algal technology. Academic Press. ISBN: 0128009713.
3. Bajpai, RakeshK., Prokop, Ales, Zappi, MarkE. 2014. Algal Biorefineries Volume 1: Cultivation of Cells and Products. Springer. ISBN: 9400774931.
4. Hojnacka, K., Wieczorek, P.P., Schroeder, G., Michalak, I. (Eds.). 2018. Algae Biomass: Characteristics and Applications. Developments in Applied Phycology.
5. Aziz, Farhad and Rasheed, Rezan. 2019. A Course Book of Algae. Publisher: University of Sulaimani. ISBN: 978-9922-20-391-1.
6. Dinabandhu, S and Kaushik. B.D. 2012. Algal Biotechnology and Environment. I.K. International, New Delhi.
7. Trivedi, P.C. 2001. Algal Biotechnology. Point publisher, Jaipur. India.
8. Becker. E.W. 1994. Micro algae Biotechnology and Microbiology. CambridgeUniversity press.
9. Borowitzka, M.A. and borowizka, L.J. 1996. Microalgal Biotechnology. CambridgeUniversity Press, Cambridge,
10. Bast, F. 2014. Seaweeds: Ancestors of land plants with rich diversity. Resonance, 19(2) 1032-1043 *ISSN*: 0971-8044.
11. Faizal, Band Yusuf, C. 2016.Algal biotechnology: Products and processes. Springer.
12. Gouveia, L. 2011. Microalgae as a feedstock for biofuels. Springer Briefs in Microbiology, London.

Web resources:

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

OutcomeMapping:

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

CO3	3	2	3	2	2	3	1	1	1	1
CO4	3	3	3	3	3	3	3	2	3	2
CO5	3	2	3	3	3	3	3	1	3	1

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

Semester	23BOTE106:MUSHROOM CULTIVATION	L	T	P	C
I		3	3	0	3

Learning Objective (LO):

LO1	Toteachtheidentificationofmushrooms.
LO2	Todifferentiatetheediblemushrooms withtoxicand hallucinatingfungi.
LO3	Tostudythecultivation techniqueofmushrooms
LO4	Tolearntheeconomicimportanceofmushroominvariousfields.
LO5	Tostudy howto establishmushroom cultivation asbusiness enterprise.
LO6	Toteachtheidentificationofmushrooms.

Course Outcomes (CO)

COs	On completion of this course the student will be able to	POs
CO1	Knowledgeonidentificationofedibleandtoxicmushroomsbelongingto Ascomycotaand Basidiomycota.	K1,K3
CO2	Outlinethenutraceutical propertiesof ediblemushrooms.	K2,K4
CO3	Knowledgeon cultivationtechniques ofedible and medicinal mushrooms.	K3,K6
CO4	Understandtheharvestand post-harvesttechniquesofmushroomcrops.	K4
CO5	Knowledgeonthe productionand marketingstrategies formushrooms.	K5
K1-Remember; **K2**-Understand; **K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** –Create.		

Unit – 1:

INTRODUCTION:

Mushroom,EdibleMushroom,commercialproduction,medicinalvalueofmushrooms,nutraceuticals and dietary supplements

Unit – 2:

MORPHOLOGICAL AND MICROSCOPICAL IDENTIFICATION OF EDIBLE AND POISONOUS MUSHROOMS:

Keysforidentificationofediblemushrooms:*Agaricusbisporus,Pleurotussajorcaju,Volvariellavolvcea*and*Calocybeindica.*Keyforidentifyinghallucinogenicmushroom(*Psilocybe*sp.)MedicinalMushroom –*Cordyceps,Ganoderma lucidum*and*Lentinusedodes.*

Unit – 3 :

CULTIVATION:

Substratesterilization,bedpreparation,croppingroomandmaintenance,raising of pure culture and spawn preparation, factors effecting button mushroom production(Temp,pH, airandwatermanagement, competitor mouldsand otherdisease).

Unit – 4 :

POST-HARVESTMANAGEMENT:

Harvest,storage,qualityassuranceofmushrooms.Pestmanagement.

Unit – 5:

Worldproductionediblemushroom,Legalandregulatoryissuesofintroducingthemedicinalmushrooms in different countries. Developing small scale industry and Government schemes.MushroomResearch Centres–Internationaland National levels

RecommendedText:

1. Cheung,P.C.K.2008. Mushroomsasfunctionalfood.AJohnWiley&Sons, Inc.,Publication.
2. Dijksterhuis, J. and Samson, R.A. 2007. Food Mycology: A multifaceted approach in fungiandfood. CRC press, Newyork.
3. Hall.,R.I.,Stepheson,S.L.,Buchanan,P.K.,Yun,W.andCole,A.L.J.2003.Edibleandpoisonous mushrooms of theworld. TimberPress,Portland, Cambridge.
4. Ting,S.andMiles,P.G.2004.Mushrooms:Cultivation,nutritionalvalue,medicinaleffectandnutritional environmental impact. CRC press, Newyork.
5. Verma, 2013. Mushroom: edible and medicinal: cultivation conservation, strain improvement with their marketing.DayaPublishingHouse.

Referencebooks:

1. Tiwari.,SC.,PandeyK. 2018.Mushroomcultivation.Mittalpublisher,NewDelhi.
2. Philips,G.,Miles,Chang,S-T. 2004.Mushrooms:Cultivation, nutritionalvalue, medicinaleffectand environmentaleffect. 2nd ed. CRCPress.
3. Diego,C.Z.,Pando-Gimenez,A.2017.Edibleandmedicinalmushrooms:TechnologyandApplication.Wiley-Blackwell publishers.
4. NitaBahl. 2002. Handbook on Mushroom 4th edition Vijayprimlani for oxford & IBH publishing co., Pvt., Ltd., New Delhi. Dr.C. SebastianRajesekaranReader in Botany BishopHeberCollege, Trichy – 17.
5. Suman. 2005. Mushroom Cultivation Processing and Uses, M/s. IBD Publishers and Distributors, New Delhi.

Web resources:

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

Outcome Mapping:

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

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

Semester	23BOTE107:MICROBIOLOGY, IMMUNOLOGY AND PLANT PATHOLOGY	L	T	P	C
I		3	3	0	3

Learning Objective (LO):

LO1	To provide comprehensive knowledge about microbes and its effect on man and environment.
LO2	To provide comparative analysis of major groups of microbes.
LO3	To study the principles of immune system, immunizing agents like antibodies and vaccines and gene therapy methods.
LO4	To enhance the knowledge and skills needed for self-employment using the microbial derived products.
LO5	To appreciate the role of immune system in conferring disease resistance.

Course Outcomes (CO)

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

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

Unit – 1:

BACTERIA:

Types of microorganisms. General characteristic of bacteria – Outline classification of Bergey's manual of 9th edition. Classification of bacteria based on Morphological, cultural, physiological and molecular characteristics. Bacterial growth – batch culture and continuous culture. Growth Curve. Factors affecting growth. Determination of bacterial growth – Direct method: Haemocytometer, Viable plate count; Indirect method: Turbidity. Nutritional types.

Reproduction - Fission and sporulation. Genetic recombination- Transformation, Transduction and Conjugation. Isolation and cultivation of bacteria. Maintenance of bacterial culture.

Unit – 2:

VIRUSES:

General characters, Classification, Structure, Multiplication. Overview of Phycoviruses and Mycoviruses. Viruses of Eukaryotes – Animal & Plant viruses. Cultivation of viruses – in embryonated egg and in plants. Control of viral infections. Bacteriophages- classification, replication of DNA and RNAphages -Lytic and Lysogenic cycle. Viroids and prions. Mycoplasma: Structure and classification.

Unit – 3:

FOOD MICROBIOLOGY:

Beneficial role of microbes – yoghurt, Olives, Cheese, Bread, Wine, Tempeh, Miso & Fermented green tea. Spoilage of fruits, vegetables, meats, poultry, eggs, bakery products, dairy products and canned foods. Microbial toxins - Exotoxin, Endotoxin & Mycotoxin. Action of Enterotoxin, Cytotoxin& Neurotoxin. Food Preservation – temperature, drying, radiation and chemicals. Soil Microbiology: Importance of Microbial flora of soil and factors affecting the microbial community in soil. Interaction among soil microbes (positive and negative interactions) & with higher plants (rhizosphere &phyllosphere). Microorganisms in organic matter decomposition. Environmental Microbiology: Microbiology of water and air. Water borne diseases - diphtheria, chicken pox. Air borne diseases - Swine flu and Measles. Microbial degradation of chemical pesticides and hydrocarbon

Unit – 4:

IMMUNOLOGY:

Introduction; Immune System; Types of Immunity - Innate and Acquired.Immune Cells - Hematopoiesis, B and T lymphocytes - Maturation, NK cells. Introduction to inflammation, Adaptive immune system, Innate Immune system. Antigen: Definition, Properties and types. Antibody – Structure, types and function. Generation of antibody diversity.Antigen - Antibody interactions: definition, types- Precipitation, Agglutination, Complement fixation. Immune Response – Humoral and Cell Mediated. Vaccines – history, types and recombinant vaccines. Immunodiagnosis –Blood Grouping, Widal test, Enzyme-Linked Immunosorbent Assay (ELISA), Immunoelectrophoresis and Immunodiffusion.

Unit – 5:

PLANT PATHOLOGY:

History and significance of plant pathology. Classification of plant diseases, Symptomology (important symptoms ofplant pathogens). Principles of plant infection –Inoculum, inoculum potential, Pathogenicity. Disease triangle. Host parasite interrelationship and interaction. Causal agents of plant diseases - biotic causes (fungi, bacteria virus, mycoplasma, nematodes, parasitic algae, angiospermic parasites - Abiotic causes (Physiological, deficiency of nutrients & minerals and pollution).Mechanism of penetration- Disease development of pathogen (colonization) and dissemination of pathogens. Role of enzymes and toxins in disease development. Defence mechanism of host – structural and biochemical defences. Important diseases of crop plants in India - Sheath blight of rice, Late blight of potato, Little leaf of Brinjal and Red rust of tea.

Principles of disease management – Cultural practices, physical, chemical and biological methods, disease controlled by immunization. Biocontrol - merits and demerits;

Plant quarantine and legislation. Integrated Pest Management system. Diagnostic technique to detect pest/pathogen infection - Immunofluorescence (IF).

1. Tissue culture

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

Outcome Mapping:

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

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

Semester	23BOTC201:Core 4: Taxonomy of Angiosperms and Economic Botany	L	T	P	C
II		5	2	0	5

Learning Objective (LO):

LO1	To be familiar with the basic concepts and principles of plant systematics.
LO2	To develop a suitable method for correct characterization and identification of plants.
LO3	To understand the importance of taxonomic relationships in research of plant systematics.
LO4	To provide information on various classification systems
LO5	To know about the economic importance of plants.

Course Outcomes (CO)

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

Unit – 1:

TAXONOMY AND SYSTEMATICS

Botanical exploration and contribution with special reference to India by William Roxburgh, J.D. Hooker, Robert Wright, Nathanial Wallich and Gamble, J.S. Principles of classification as proposed – Artificial – Linnaeus, Natural – Bentham and Hooker, Phylogenetic system - Hutchinson, Modern – Takhtajan. Botanical gardens and herbaria of world, preparation and maintenance of Herbarium, Botanical survey of India – its organization and role.

Unit – 2:

MODERN TRENDS IN TAXONOMY

Modern trends in taxonomy, chemotaxonomy, numerical taxonomy, biosystemics. ICBN uninominal systems- genesis binomial nomenclature, importance and principle. Important articles, typification, principles of priority, effective and valid publication, author citation, recommendations and amendments of code. Glossaries and dictionaries, Taxonomic literature (Index Kewensis)

Unit – 3:

SYSTEMATIC ANALYSIS OF PLANTS-I

Polypetalae – Nympheaceae, Sterculiaceae, Portulaceae, Rhamnaceae, Vitaceae, Sapindaceae, Combretaceae, Turneraceae.

Unit – 4:

SYSTEMATIC ANALYSIS OF PLANTS-II

Gamopetalae – Sapotaceae, Oleaceae, Boraginaceae, Scrophulariaceae, Bignoniaceae, Convolvulaceae, Acanthaceae, Verbenaceae.

Monochlamydeae – Nyctaginaceae, Aristolochiaceae, Casuarinaceae. Monocots – Orchidaceae, Amarylidaceae, Lilliaceae, Commelinaceae, Cyperaceae.

Unit – 5:

ECONOMIC BOTANY

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

RecommendedText:

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 MathewDan. 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 AnnieRegland. 2004. Taxonomy of Angiosperms systematic Botany, Economic Botany, Botany &Ethnobotany.
3. Anonymous, 2004. Cultivation of Selected Medicinal Plants. National MedicinalPlants Board, Govt. of India, New Delhi.
4. Vallabh. 2000. Practical Pharmacognosy, Kolkata. New Delhi.
5. AcharyaVipulRao. 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 IndiaNew Delhi.
8. MohamadAli. 2009. Pharmacognosy and Phytochemistry. CBS Publications& Distribution, New Delhi, Volume.1.
9. Lewis, W.H and M.P.F. ElwinLewis. 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

OutcomeMapping:

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

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

Semester	23BOTC202:Core 5: Plant Anatomy and Embryology of Angiosperms	L	T	P	C
II		5	2	0	5

Learning Objective (LO):

LO1	Learn the importance of plant anatomy in plant production systems.
LO2	Classify meristems and identify their structures, functions and roles in monocot and dicot plants growth and secondary growth of woody plants.
LO3	Understand the mechanism underling the shift from vegetative to reproductive phase.
LO4	Trace the development of male and female gametophyte.
LO5	Understand the recent advances in palynology.

Course Outcomes (CO)

COs	On completion of this course the student will be able to	POs
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 fromsecondary growth in dicot and monocot plants.	K1&K4
CO3	Apply their idea on sectioning and dissection of plants to demonstrate various stages of plant development.	K2& K6
CO4	Understand the various concepts of plant development and reproduction.	K3& K6

CO5	Profitably manipulate the process of reproduction in plants with a professional and entrepreneurial mindset.	K5
K1-Remember; **K2**-Understand; **K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** –Create.		

Unit – 1:

CELL WALL:

Morphological and physico-chemical changes; Plasmodesmata- types of pits – growth of cell wall – formation of intercellular spaces; Meristems: Classifications: Theories of shoot and root apices, Cytological zonation in shoot apex. Vascular Cambium: Composition and organization – multiplicative and additive divisions. Xylem: Primary and secondary xylem – tracheary elements and vessels – vesselless dicots – xylem rays and axial parenchyma of angiosperm wood; Dendrochronology – grain, texture and figure in wood; reaction wood; ring porous and diffuse porous wood. Phloem: Ultra structure and ontogeny of sieve tube elements and companion cell. Evolution of tracheary elements.

Unit – 2:

PERIDERM:

Structure, organization and activity of phellogen. Polyderm and Rhytiderm – wound periderm. Normal secondary thickening in Dicots; Anomalous secondary growth in Dicots (Amaranthaceae, Aristolochiaceae, Bignoniaceae, Piperaceae, Nyctaginaceae) and arborescent Monocots. Primary thickening in palms; Ontogeny of leaf, Structure and types of Stomata; Leaf abscission; Major nodal types; Kranz anatomy and its significance. Microtechnique: Principle of killing and fixation, dehydration and rehydration of botanical specimens. Stains: Principle of double staining (fast-green and light green) of free hand sections; Protocol for serial sectioning of paraffin wax impregnated specimens; Mounting and mounting media.

Unit – 3:

MICROSPORANGIUM AND MALE GAMETOPHYTE:

Structure and development of Anther; Ultrastructure and physiology of anther tapetum; Male gametophyte; Palynology: Morphology and ultrastructure of pollen wall, pollen kitt, pollen analysis, pollen storage, pollen sterility and pollen physiology.

Unit – 4:

MEGASPORANGIUM AND FEMALE GAMETOPHYTE:

Structure and development of Megasporangium; Types of ovules, Endothelium, obturator and nucellus. Megasporogenesis: Female gametophyte: Structure, types, haustorialbehavior and Nutrition of embryo sacs. Fertilization: Double fertilization and triple fusion; Endosperm: Development of endosperm, types, physiological efficiency of endosperm haustoria and functions; Ruminate endosperm. Embryogeny: Development of monocot (Grass) and dicot (Crucifer) embryos.

Unit – 5:
POLYEMBRYONY:

Causes of Polyembryony, classification, induction and practical application. Apomixis and its significance. Seed and Fruit development and role of growth substances. Parthenocarpy and its importance.

RecommendedText:

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 AjantaChandha. 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 HanumanthaRao, 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/

OutcomeMapping:

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

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

Semester 23BOTC203: Core 6: Laboratory Course-II: Covering L T P C

II	**Core Papers 4 and 5**	**0**	**0**	**5**	**4**

Learning Objective (LO):

LO1	Understand and develop skill sets in plant morphological, floral characteristics and artificial key preparation.
LO2	Expedite skilled workers to carry out research in frontier areas of plant science.
LO3	Classify meristems and identify their structures, functions and roles in monocot and dicot plants growth and secondary growth of woody plants
LO4	Learn the importance of plant anatomy in plant production systems.
LO5	Know about different vegetation sampling methods.

Course Outcomes (CO)

COs	**On completion of this course the student will be able to**	**POs**
CO1	To gain recent advances in plant morphological and floral characteristics.	K1
CO2	Understand about different floral characteristics and artificial key preparation which employed for plant identification and conservation.	K2
CO3	Recall or remember the information including basic and advanced in relation with plant anatomy and embryology.	K4 &K5
CO4	Apply their idea on sectioning and dissection of plants to demonstrate various stages of plant development.	K3
CO5	Know about different vegetation sampling methods.	K3
K1-Remember; **K2**-Understand; **K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** –Create.		

TAXONOMY AND ECONOMIC BOTANY OF ANGIOSPERMS

Preparation of artificial keys.

Description of a species, based on virtual herbarium and live specimens of the families mentioned in the theory.

Study the products of plants mentioned in the syllabus of economic botany with special reference to the morphology, botanical name and family.

Solving nomenclature problems.

Field trip:

A field trip at least 3-4 days to a floristically rich area to study plants in nature and field report submission of not less than 20 herbarium sheets representing the families studied.

ANATOMY

1. Study of shoot apex of *Hydrilla*
2. Observation of cambial types.
3. Sectioning and observation of nodal types.
4. Study of anomalous secondary growth of the following:

STEM-*Nyctanthus*, *Bouerhhavia*, *Aristolochia*, *Bignonia*, *Piper* petal and *Mirabilis*. ROOT: *Acyranthus*

5. Observation of stomatal types by epidermal peeling.
6. Maceration of wood and observation of the components of xylem.

7. Double staining technique to study the stem anomali.

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.

OutcomeMapping:

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

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

Semester	23BOTE204: NANO BIOTECHNOLOGY	L	T	P	C
II		3	1	0	3

Learning Objective (LO):

LO1	To introduce the learners to the basic concepts in the emerging frontiers of nanotechnology.
LO2	To give perspective to researchers and students who are interested in nanoscale physical and biological systems and their applications in medicine.
LO3	To introduce the concepts in nanomaterials and their use with biocomponents to synthesize and interact with larger systems.
LO4	To impart knowledge on the most recent molecular diagnostic and therapeutic tools used to treat various diseases.
LO5	Incorporate sustainability in to account when you develop nanotechnology responsibly.

Course Outcomes (CO)

COs	On completion of this course the student will be able to	POs
CO1	Recall the essential features of biology and nanotechnology that are converging to create the new area of bionanotechnology.	K1

CO2	Formulate procedures for the synthesis of nanoparticles which are of medical importance which could be used to treat specific diseases.	K2
CO3	Characterize the various types of nano particle synthesis and advocate promotes the use of nano materials and anno composites.	K3
CO4	Analyze and apply the important of nanoparticles in plant diversity.	K4
CO5	Construct various types of nanomaterial for application and evaluate the impact on environment.	K5 & K6
K1-Remember; **K2**-Understand; **K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** –Create.		

Unit – 1 :

BASIC CONCEPTS IN NANOBIOLOGY

History of Nanotechnology, Difference between Nanoscience and Nanotechnology, Green nanotechnology, Bottom up and top down approaches.

Unit – 2:

DIVERSITY IN NANOSYSTEMS

Carbon based nanostructures - fullerences, nanotubes, nanoshells, buckyballs – biomolecules and nanoparticles, nanosensors, nanomaterials - Classification based on dimensionality quantum dots, wells and wires – metal based nano materials (gold, silver and oxides) - Nanocomposites- Nanopolymers – Nanoglasses–Nano ceramics.

Unit – 3:

METHODS OF NANOBIOTECHNOLOGY

Optical tools – Nanoforce and imaging – Surface methods – Mass spectrometry – Electrical Characterization and Dynamics of Transport – Microfludics: Concepts and applications to the Life Sciences.

Unit – 4:

NANOBIOTECHNOLOGY

Nanodevices and nanomachines based on biological nanostructures - Protein and DNA nanoarrays, tissue engineering, and luminescent quantum dots for biological labeling.

Unit – 5:

APPLICATIONS OF NANOBIOTECHNOLOGY

Real Time PCR – Biosensors : From the glucose electrode to the Biochip – DNA Microarrays Protein Microarrays – Cell Biochips – Lab on a chip – Polyelectrolyte multilayers – Biointegrating materials – Pharmaceutical applications of nanoparticles carriers.

RecommendedText:

1. Dupas, C, Houdy, P., Lahmani, M. 2007. Nanoscience: ―Nanotechnologies and Nanophysics‖, Springer-Verlag Berlin Heidelberg.
2. Sharon, M and Sharon, M. 2012. Bio-Nanotechnology- Concepts and Applications, CRC Press.
3. Atkinson, W.I. 2011. Nanotechnology. Jaico Book House, New Delhi.
4. Nalwa, H.S. 2005. Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology. American Scientific Publ.
5. Lindsay, S.M. 2011. Introduction to Nanoscience, Oxford universal Press, First Edition.
6. Jain K.K. 2006. Nanobiotechnology molecular diagnostics: Current techniques and application (Horizon Bioscience).Taylor &Francis1st edition.

7. Pradeep, T. 2012. Textbook of Nanoscience and Nanotechnology, McGraw Hill Education(India)Private Limited.
8. XiuMeiWang,MuruganRamalingam,XiangdongKongandLingyunZhao.2017.Nanobiomaterials: Classification, Fabrication and Biomedical Applications, Wiley-VCHVerlagGmbH & Co. KGaA.

ReferenceBooks:

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

Web resources:

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

OutcomeMapping:

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

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

Semester	23BOTE205: APPLIED BIOINFORMATICS	L	T	P	C
II		3	1	0	3

Learning Objective (LO):

LO 1	Basicknowledgeinmolecularbiology.FamiliaritywithoperationsofcomputersandMS officetools.
LO 2	Tolearnaboutthebioinformaticsdatabases,databanks,dataformatanddataretrievalfromtheonli nesources.
LO 3	Toexplaintheessentialfeaturesoftheinterdisciplinaryfieldofscience forbetterunderstandingbiologicaldata.
LO 4	Tooutlinethetypes ofbiologicaldatabases.
LO 5	Todemonstratedifferent onlinebioinformaticstools.
LO 6	Tosummarizethestrong foundationforperformingfurtherresearch inbioinformatics.

Course Outcomes (CO)

COs	On completion of this course the student will be able to	POs
CO1	FamiliarizewiththetoolsofDNAsequence analysis.	K1 & K2
CO2	Useandexplainthe applicationofbioinformatics.	K2 & K3
CO3	Mastertheaspectsofprotein-proteininteraction,BLASTandPSI-BLAST.	K3 & K4
CO4	Describethefeatures oflocaland multiplealignments.	K3 & K4
CO5	Interpretthecharacteristicsofphylogeneticmethodsandbioinformaticsapplicat ions.	K4 & K5
K1-Remember; **K2**-Understand; **K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** –Create.		

Unit – 1:

BIOINFORMATICSANDINTERNET:

InternetBasics-FileTransferProtocol-TheWorldWideWeb-InternetResources–databases–types-Applications-NCBI DataModel-SEQ-Ids–Biosequences-Biosequencesets–Sequence annotation–Sequencedescription.

Unit – 2:

GENBANK SEQUENCE DATABASE:

Introduction- Primary And Secondary Databases - Format Vs.Content-GenbankFlatfile-SubmittingDNASequencestotheDatabases - DNA/RNA-Population,Phylogenetic, and Mutation Studies - Protein-Only Submissions - Consequences of DNA Model -EST/STS/GSS/HTG/SNP and Genome Centers -Contact points for submission of sequence data toDBJ/EMBL/Genbank.

Unit – 3:

STRUCTURE DATABASES:

Introduction to Structures- Protein Data Bank (PDB) - MolecularModeling Database at NCBI Structure File Formats - Visualizing Structural Information -DatabaseStructureViewers - AdvancedStructureModeling-StructureSimilarity Searching.

Unit – 4:

SEQUENCEALIGNMENTANDDATABASESEARCHING:

Introduction-EvolutionaryBasisofSequenceAlignment-ModularNatureofProteins-OptimalAlignmentMethods-SubstitutionScoresandGap Penalties-DatabaseSimilaritySearching-FASTA–BLAST(BlastP,BlastN,etc.,)-PositionSpecificScoringMatrices, Spliced Alignments.

Unit – 5:

PREDICTIVE METHODS:

Using Protein Sequences Protein Identity Based on Composition - PhysicalProperties Based on Sequence - Motifs and Patterns - Secondary Structure and Folding Classes - SpecializedStructures orFeatures-Tertiary Structure.

RecommendedText:

1. Baxevanis,A.D.&Ouellette,B.F.2001.Bioinformatics:Apracticalguidetotheanalysisofgenesa nd proteins. NewYork: Wiley-Interscience.
2. Bourne,P.E.,& Gu,J.2009. Structuralbioinformatics.Hoboken, NJ:Wiley-Liss.
3. Lesk,A.M.2002. Introductiontobioinformatics.Oxford: OxfordUniversityPress.
4. Mount,D.W.2001.Bioinformatics:Sequenceandgenomeanalysis.ColdSpringHarbor,NY:Col dSpringHarborLaboratory Press.
5. Pevsner,J.2015.Bioinformaticsandfunctionalgenomics.Hoboken,NJ:Wiley-Blackwell.

ReferenceBooks:

1. Campbell,A.MandHeyer,L.J.2003.Discoveringgenomics,proteomics,andbioinformatics.San Francisco: BenjaminCummings.
2. Green,M.RandSambrook,J.2012.Molecularcloning:Alaboratorymanual.ColdSpringHarbor, NY: ColdSpringHarborLaboratory Press.
3. Liebler,D.C.2002.Introductiontoproteomics:Toolsforthenewbiology.Totowa,NJ:HumanaPr ess.
4. Old,R.W.,Primrose,S.B.,andTwyman,R.M.2001.Principlesofgenemanipulation:Anintroduct ionto geneticengineering. Oxford:Blackwell ScientificPublications.
5. Primrose,S.B.,Twyman,R.M.,Primrose,S.B.,andPrimrose,S.B.2006.Principlesofgene manipulationandgenomics.Malden,MA:BlackwellPub.

Web resources:

1. Bioinformatics:Algorithms&ApplicationsbyProf.M.MichaelGromihaIIT-Madras.https://nptel.ac.in/courses/102/106/102106065/#.
2. ChristopherBurge,DavidGifford,andErnestFraenkel. *7.91*.JFoundationsofComputationalandSystems*Biology*. Spring2014.MassachusettsInstituteofTechnology:MITOpenCourseWare,https://ocw.mit.edu.

3. https://link.springer.com/book/10.1007/978-3-540-72800-9.
4. https://www.amazon.in/Applied-Bioinformatics-Paul-Maria-Selzerebook/dp/B001AUOYY2
5. https://books.google.co.in/books/about/Applied_Bioinformatics.html?id=PXZZDwAAQBAJ&redir_esc=y.

OutcomeMapping:

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

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

Semester	23BOTE206: RESEARCH METHODOLOGY, COMPUTER APPLICATIONS & BIOINFORMATICS	L	T	P	C
II		3	1	0	3

Learning Objective (LO):

LO1	To impart expertise about analysis and research.
LO2	To equip students to collect, analyze and evaluate data generated by their own inquiries in a scientific manner.
LO3	To provide an overview on modern equipments that they would help students gain confidence to instantly commence research careers and/or start entrepreneurial ventures.
LO4	To develop interdisciplinary skills in using computers in botany to learn about the biological database.
LO5	Students aware with the most recent technologies for sequencing and bioinformatics analysis and is able to apply them to the structural and functional genomics of plants.
LO6	Operate various software resources with advanced functions and its open office substitutes.

Course Outcomes (CO)

COs	On completion of this course the student will be able to	POs
CO1	Realize the need of centrifuges and chromatography and their uses in research	K1 &K2
CO2	Learn the principles and applications of electrophoresis.	K2 &K3
CO3	Construct the phylogenetic trees for similar characteristic feature ofplant genomes and study *de novo* drug design through synthetic biology.	K5 &K6

CO4	Understand the concept of pairwise alignment of DNA sequences using algorithms.	K3 &K4
CO5	Interpretthefeatures oflocaland multiplealignments.	K4 &K5
K1-Remember; **K2**-Understand; **K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** –Create.		

Unit – 1:

Literature collection and citation: bibliography - bibliometrics (scientometrics): definition-laws - citations and bibliography - *biblioscape - plagiarism- project proposal writing - dissertation writing – paper presentation (oral/poster) - E-learning tools- monograph - introduction and writing-Standard operating procedure (SOP) – introduction and preparation - Research Institutions - National and International.

Unit – 2:

Basic principles and applications of pH meter, UV-visible spectrophotometer, centrifuge, lyophilizer, chromatography- TLC, Gas chromatography with mass spectrum (GC/MS), and HPLC-Scanning electron microscopy-Agarose gel Electrophoresis - Polyacrylamide GelElectrophoresis –Polymerase chain reaction

Unit – 3:

Introduction to computers and Bioinformatics. Types of hardware and software operating systems. Fundamentals of networking, operation of networks, telnet, ftp, www, Internet. Biological Research on the web: Using search engines, finding scientific articles.

Unit – 4:

Public biological databases, searching biological databases. Use of nucleic acid and protein data banks.

Unit – 5:

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

RecommendedText:

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

Reference Books:

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

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

Web resources:

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

OutcomeMapping:

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

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

Semester	23BOTE207: MEDICINAL BOTANY	L	T	P	C
II		3	1	0	3

Learning Objective (LO):

LO1	To understand the uses and effects of medicinal plants and herbal supplements.
LO2	To gain knowledge about the historical and modern uses of plants in medicine.
LO3	To gain insights into the perspectives of ethnobotanical research.
LO4	To know the various methods of harvesting, drying and storage of medicinal herbs.
LO5	To create new strategies to enhance growth and quality check of medicinal herbs.

Course Outcomes (CO)

COs	On completion of this course the student will be able to	POs

CO1	Recognize plants and relate to their medicinal uses	K1
CO2	Explain about the phytochemistry, pharmacognosy and bioprospecting of medicinal plant extracts.	K2
CO3	Apply techniques for conservation and propagation of medicinal plants.	K3
CO4	Analyze and decipher the significance of various methods of harvesting, drying and storage of medicinal herbs.	K4
CO5	Develop new strategies to enhance growth and quality check of medicinal herbs considering the practical issues pertinent to India.	K5 & K6
K1-Remember; **K2**-Understand; **K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** –Create.		

Unit – 1:

HISTORY AND TRADITIONAL SYSTEMS OF MEDICINE:

Historical Perspectives – European, African, American, Southeast Asian Practices. Scope and Importance of Medicinal Plants; Traditional systems of medicine - Definition and Scope. Classical health traditions - Naturopathy, Siddha, Ayurveda, Homeopathy, Unani and MateriaMedica. Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in Ayurvedic treatments, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umoor-e-tabiya, tumors treatments/ therapy, polyherbal formulations.

Unit – 2:

PHYTOCHEMISTRY AND PHARMACOGNOSY:

Phytochemistry, important phytoconstituents, their plant sources, medicinal properties. Histochemistry – definition, principles, staining methods. Biological stains – bright field dyes and flurochromes, detection and localization of phytochemicals. Raw drugs, authenticity, study through physical, microscopic and analytical methods. Different types of formulations. Adulteration and Admixtures.

Unit – 3:

ACTIVE PRINCIPLE &DRUG DISCOVERY:

Brief description of selected plants, Active principles, biochemical properties and medicinal uses of Guggul (*Commiphora*) for hypercholesterolemia, *Boswellia*for inflammatory disorders, Arjuna (*Terminalia arjuna*) for cardio protection, turmeric (*Curcuma longa*) for wound healing, antioxidant and anticancer properties, Kutaki (*Picrorhizakurroa*) for hepatoprotection, Opium Poppy for analgesic and antitussive, *Salix* for analgesic, *Cinchona* and *Artemisia* for Malaria, *Rauwolfia*as tranquilizer, *Belladona* as anticholinergic, *Digitalis* as cardiotonic, *Podophyllum* as antitumor, *Stevia rebaudiana*for antidiabetic, *Catharanthus roseus* for anticancer. Bioprospecting, drug discovery from plants with reference to diabetes and cancer. Product development and quality control.

Unit – 4:

CONSERVATION AND AUGMENTATION:

Significance of Cultivation, management, policies for conservation and sustainable use of medicinal plants. Conservation of endemic and endangered medicinal plants, Red list criteria; *In situ* conservation: Biosphere reserves, sacred groves, National Parks; *Ex situ* conservation: Botanic Gardens, Ethno medicinal plant Gardens. Propagation of Medicinal Plants: seeds, cuttings, layering, grafting and budding.

Unit – 5:

ETHNO BOTANY AND FOLK MEDICINE:

Concepts and definition of Ethno botany and folk medicines. A brief history of ethnobotanical studies – globally & locally. Methods to study ethno botany; Applications of Ethno botany: Folk medicines of ethno botany, ethno medicine, ethno ecology, ethnic communities of India. Understanding the traditions of tribes in Tamil Nadu – Irulas and Kanis. Repository of Ethnobotanical data – Archeology, inventories, folklore and literature. Traditional Knowledge Sharing - Prior information consent, interviews, questionnaires and knowledge partners.Plants associated with culture, social, religious and medicinal purposes.Commercial use of traditional knowledge – ethics, IPR, biopiracy, equitable benefit sharing models.

RecommendedText:

1. AYUSH (www.indianmedicine.nic.in). 2014. *About the systems—An overview of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy.* New Delhi: Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (AYUSH), Ministry and Family Welfare, Government of India.
2. Bhat, S.V., Nagasampagi, B.A., & Meenakshi, S. 2009. Natural Products – Chemistry and Applications. Narosa Publishing House, India Ltd.
3. CSIR- Central Institute of Medicinal and Aromatic Plants, Lucknow. 2016. *AushGyanya*: Handbook of Medicinal and Aromatic Plant Cultivation.
4. Kapoor, L.D. 2001. Handbook of Ayurvedic medicinal plants. Boca Raton, FL: CRC Press.
5. Saroya, A.S. 2017. Ethno botany. ICAR publication.
6. Sharma, R. 2003. Medicinal Plants of India-An Encyclopedia. Delhi: Daya Publishing House.
7. Sharma, R. 2013. Agro Techniques of Medicinal Plants. Daya Publishing House, Delhi.
8. Thakur, R.S., H. S. Puri, and Husain, A. 1989. *Major medicinal plants of India*. Central Institute of Medicinal and Aromatic Plants, Lucknow, India.

Reference Books:

1. Akerele, O., Heywood, V and Synge, H. 1991. The Conservation of Medicinal Plants. CambridgeUniversity Press.
2. Evans, W.C. 2009. Trease and Evans Pharmacognosy, 16th edn. Philadelphia, PA: Elsevier Saunders Ltd.
3. Jain, S.K. and Jain, Vartika. (eds.). 2017. Methods and Approaches in Ethnobotany: Concepts, Practices and Prospects. Deep Publications, Delhi
4. Amruth. 1996. The Medicinal plants Magazine (All volumes) Medicinal plant Conservatory Society, Bangalore.
5. Bhattacharjee, S.K. 2004. Hand Book of Medicinal plants. Pointer Publishers, Jaipur.
6. Handa, S.S and V.K.Kapoor. 1993. Pharmacognosy. VallabhPrakashan, New Delhi.

Web resources:

1. https://www.amazon.in/Medical-Botany-Plants-Affecting-Health/dp/0471628824

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

OutcomeMapping:

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

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

Semester	23BOTS208:Agriculture and Food Microbiology	L	T	P	C
II		3	0	0	2

Learning Objective (LO):

LO1	To provide comprehensive knowledge about plant – microbe interactions.
LO2	To provide basic understanding about factors affecting growth of microbes
LO3	To appreciate the role of microbes in food preservation.
LO4	To understand about the benefits of microbes in agriculture and food industry.
LO5	To gain knowledge about practices involved in food industry.

Course Outcomes (CO)

COs	On completion of this course the student will be able to	POs
CO1	Recognize the general characteristics of microbes and factors affecting its growth	K1
CO2	Explain the significance of microbes in increasing soil fertility	K2
CO3	Elucidate concepts of microbial interactions with plant and food.	K3
CO4	Analyze the impact of harmful microbes in agriculture and food Industry.	K4
CO5	Determine and appreciate the role of microbes in food preservation and as biocontrol.	K5 &K6
K1-Remember; **K2**-Understand; **K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** –Create.		

Unit – 1:

ROLE OF MICROORGANISMS IN AGRICULTURE

Role of symbiotic and free-living bacteria and cyanobacteria in agriculture., Mycorrhiza, Plant Growth Promoting Microorganims (PGPM) and Phosphate Solubilizing Microorganims (PSM).

Unit – 2:

BIOCONTROL AND BIOFERTILIZATION

Biocontrol of plant pathogens, pests and weeds, Restoration of waste and degraded lands,Biofertilizers: Types, technology for their production and application, vermi-compost.

Unit – 3:

FOOD MICROBIOLOGY

Intrinsic and extrinsic factors influencing growth of microorganisms in food, Microbes as source of food: Mushrooms, single cell protein.

Unit – 4:

FOOD MICROBIOLOGY

Microbial spoilage of food and food products: Cereals, vegetables, prickles, fish and dairy products. Food poisoning and food intoxication. Food preservation processes. Microbes and fermented foods: Butter, cheese and bakery products.

Unit – 5:

PREDICTIVE METHODS:

Using Protein Sequences Protein Identity Based on Composition - PhysicalProperties Based on Sequence - Motifs and Patterns - Secondary Structure and Folding Classes - SpecializedStructures orFeatures-Tertiary Structure.

RecommendedText:

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

Reference Books:

1. Adams, M.R. and Moss M.O. 2008. Food Microbiology, 3rd Edition, Royal Society of Chemistry, Cambridge, U.K.
2. Sylvia D.M. 2004. Principles and Applications of Soil Microbiology, 2nd Edition, Prentice Hall, USA.
3. Frazier, W.C. 1995. Food Microbiology, 4th Edition, Tata McGraw Hill Education, Noida, India.
4. WaitesM.J., MorganN.L., RockeyJ.S. and Higton G. 2001. Industrial Microbiology: An Introduction. 1st Edition, Blackwell Science, London, UK.

5. Das,S.andSaha,R.2020.MicrobiologyPracticalManual.CBSPublishersandDistributors(P) Ltd., New Delhi,India.

Web resources:

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

Outcome Mapping:

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

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

Semester	23BOTC301: Core 07: CELLAND MOLECULAR BIOLOGY	L	T	P	C
III		4	1	0	5

Learning Objective (LO):

LO1	To acquire knowledge on cell and expose the students a fundamental of the various techniques used in molecular studies.
LO2	Enable to learn various cell structures and functions of prokaryotes and eukaryotes and understand the salient features and functions of cellular organelles.
LO3	To understand the cell division and it molecular mechanism so as to appreciate and manipulate normal and abnormal cell and tissue growth.
LO4	To enlighten people of past molecular biology developments.
LO5	To comprehend the molecular processes.

Course Outcomes (CO)

COs	On completion of this course the student will be able to	POs
CO1	Recall a plant cell structure and explain its function.	K1
CO2	Illustrate and explain the structure of various cell organelles.	K2
CO3	Explain the structure and functional significance of nucleic acid.	K3
CO4	Compare and contrast the DNA replication (prokaryotes and eukaryotes), enzymes involved in replication, DNA repair	K4
CO5	Discuss and develop skills for DNA/gene manipulating and the enzymes involved.	K5 &K6
K1-Remember; **K2**-Understand; **K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** –Create.		

Unit – 1:

The dynamic cells, Concept of prokaryote and Eukaryote. Structural organization of plant cell, specialized plant cell types chemical foundation. Cell wall- Structure and functions, Plasma membrane; structure, models and functions, site for ATPase, ion carriers channels and pumps, receptors. Plasmodesmata and its role in movement of molecule.

Unit – 2:

Chloroplast-structure and function, genome organization, gene expression, RNA editing, Mitochondria; structure, genome organization, biogenesis. Plant Vacuole - Tonoplast membrane, ATPases transporters as a storage organelle. Structure and function of other cell organelles- Golgi apparatus, lysosomes, endoplasmic reticulum and microbodies.

Unit – 3:

Nucleus: Structure and function, nuclear pore, Nucleosome organization, euchromatin and heterochromatin. Ribosome- Structure and functional significance. RNA and DNA Structure. A, B and Z Forms. Replication, transcription, translation in prokaryotes and eukaryotes. DNA damage and repair (Thymine dimer, photoreactivation, excision repair). Cell cycle and Apoptosis; Control mechanisms, role of cyclin dependent kinases. Retinoblastoma and E2F proteins, cytokinesis and cell plate formation, mechanisms of programmed cell death.

Unit – 4:

DNA replication (prokaryotes and eukaryotes), enzymes involved in replication, DNA repair. DNA sequencing. Transcription, enzymes involved in transcription, post transcription changes, reverse transcription, Translation. overlapping genes.

Unit – 5:

DNA/gene manipulating enzymes: endonuclease, ligase, polymerase, phosphatase, transcriptase, transferase, topoisomerase. Gene cloning: cloning vectors, molecular cloning and DNA libraries. Molecular genetic elements, insertion elements, transposons. Recombinant DNA. Direct and indirect gene transfer. Detection of recombinant molecule, production of gene products from cloned genes. Genome library, cDNA library.

RecommendedText:

1. Roy, S.C and Kumar, K.D.C. 1977. Cell Biology, New Central Book Agency, Calcutta.
2. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments.6th edition. John Wiley & Sons.
3. Aminul, I. 2011. Text Book of Cell Biology. Books and Allied (P) Ltd, Kolkata, India.

4. GeoffreyM.Cooper.2019.TheCell:AMolecularApproach, OxfordUniversityPress.
5. Turner, P.C., Mclenann, A.G., Bates, A.D. and White, M.R.H. 2001. Instant notes on molecular biology.
6. Watson, J.D, Baker T.A., BellS.P., GannA., Levine M., LosickR. 2014. Molecular Biology of the Gene (7th edition), Pearson Press.
7. SnustadPeter, D. MichaelJ.Simmons. 2015. Principles of Genetics, John Wiley Sons.
8. Clark, D. 2010. Molecular Biology. Academic Press Publication.
9. DavidFreifelder. 2008. Essentials of Molecular Biology. Narosa Publishing house. New Delhi.
10. GeoffreyM.Cooper and RobertE.Hausman. 2015. The Cell: A Molecular Approach. 7 thedn. Sinauer Associates is an imprint of Oxford University Press.

Reference Books:

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

Web resources:

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

OutcomeMapping:

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

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

Semester	23BOTC302: CORE 8: GENETICS, PLANT BREEDING & BIOSTATISTICS	L	T	P	C
III		4	1	0	5

Learning Objective (LO):

LO1	The students will be able to have conceptual understanding of laws of inheritance, genetic basis of loci and alleles and their linkage.
LO2	Develop critical understanding of chemical basis of genes and their interactions at population and evolutionary levels.
LO3	Familiarize with genetic basis of heterosis.
LO4	Reflect upon the role of various non-conventional methods used in crop improvement.
LO5	Solve problems quantitatively using appropriate arithmetical, algebraic, or statistical methods

Course Outcomes (CO)

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

Unit – 1:

Mendal's Law of inheritance. Gene interactions and modified dihybrid ratios. Quantitative inheritance. Sex determination in plants and theories of sex determination. Sex linked characters. Structure of Gene ,Operon , inducible operon , Operator site, Promoter, Polycistronic m RNA, Regulator, regulator constitutive,Regulator super repressor, repressor, super repressor, inducer. Gene function and regulation in prokaryotes with reference to Lac operon and trp operon. Producer gene , structural gene and integrator gene. Gene Regulation eukaryotes –Britten and Davidson model, Arabidopsis- gene regulation in flowering.

Unit – 2:

Recombination: Homologous and non-homologous recombination, site-specific recombination. Holiday model of recombination. Transposable genetic elements: Ac element, transposase, transposon, simple transposon, composite transposon, Is element. Transposons in *Zea mays*. Transposable elements in prokaryotes. UV induced mutation and its repair mechanism.

Mismatch DNA repair mechanism. Mutation types- frame shift mutation, addition, deletion, substitution, transition and transversion. Xeroderma pigmentosum.

Unit – 3:

ABO blood group in humans. QTL mapping, Gene mapping methods**:** Linkage maps, tetrad analysis, mapping with molecular markers ,mapping by using somatic cell hybrids. Extra chromosomal inheritance, maternal inheritance. Organelle genomes : Organization and functions of chloroplast and mitochondrial DNA.

Unit – 4:

PLANT BREEDING:

Objectives of plant breeding, characteristics improved by plant breeding, Genetic basis of breeding self and cross – pollinated crops. Pure line theory, pure line selection and mass selection, clonal selection methods. Hybridization ,Genetics and physiological basis of heterosis.

Unit – 5:

BIOSTATISTICS:

Measures of central tendency (Mean , Median , Mode) and dispersal (Mean deviation , standard deviation) , standard errors ANOVA (One way).probability distributions (Binomial, Poisson andnormal); sampling distribution; difference between parametric and non-parametric statistics; confidence interval; errors; levels of significance; regression and correlation; t-test; analysis of variance; X2 test;; basic introduction to Multivariate statistics, etc.

RecommendedText:

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

Reference Books:

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

Web Resourses:

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

OutcomeMapping:

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

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

Semester	23BOTC303:Core 9: Ecology, Phytogeography, Conservation Biology& Intellectual Property Rights	L	T	P	C
III		4	1	0	5

Learning Objective (LO):

LO1	To analyze and comprehend the fundamental ideas of plant ecology as a scientific study of environment.
LO2	To study the plant communities and plant succession stages.
LO3	To be aware of the causes, impacts and control measures of pollution.
LO4	To study biodiversity management and conservation.
LO5	To enhance the knowledge of the students and equip them in evaluate and protecting invaluable components of nature and interactions with the environment.

Course Outcomes (CO)

COs	On completion of this course the student will be able to	POs
CO1	Understandthescopeandimportanceofpopulationecology,plant communitiesandecosystemecology.	K1& K2
CO2	Understand the applied aspect of environmental botany.	K1&K4
CO3	Students will spot the sources and pollution and seek remedies to mitigate and rectify them.	K2& K6
CO4	Identify different plant communities, categorize plant biomes and identify threatened, endangered plant species and create awareness program in protection of biodiversity.	K3& K6
CO5	Analyze insight into the vegetation types, species interaction and their importance and the factors influencing the environmental conditions.	K5
K1-Remember; **K2**-Understand; **K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** –Create.		

Unit – 1:

ECOLOGICAL PRINCIPLES:

Introduction – History, scope, concepts. Diversity of plant life; growth form, life form. Basicconcepts of population ecology– population dynamics – Regulation of populationdensity.Basicsconceptsofcommunity– characteristics,composition,structure,originanddevelopment–communitydynamics– trendsofsuccession.

Unit – 2:

ECOSYSTEM ECOLOGY AND RESOURCE ECOLOGY:

Introduction – kinds – major types – functional aspects of ecosystem: Foodchainandfoodweb,energyflow,lawsofthermodynamics.Productivity–primaryandsecondary productivity –GPP&BPP.

Resource Ecology: Energy resources; renewable and non-renewable.

Soil: Formation, types and profile-erosionandconservation,Waterresources–conservationandmanagement.

EnvironmentDeterioration: Climatechange - Greenhouseeffectandglobalwarming,ozonedepletionandacidrain.Wastemanagement-Solidande-waste,recyclingofwastes. Eco-restoration/remediationecological foot prints - carbon foot print - ecolabeling - environmental auditing.

Unit – 3:

PHYTOGEOGRAPHY:

Phytogeographical Zones - Vegetation types of India and Tamil Nadu, Distribution: Continuous,DiscontinuousandEndemism.Theoriesofdiscontinuous distribution: Continentaldrift,Ageandareahypothesis. Geographical Information System (GIS)Principles of remote sensing and its applications.

Unit – 4:

BIODIVERSITY AND CONSERVATION ECOLOGY:

Definition, types of biodiversity – values of biodiversity – Hot spots – Threats tobiodiversity: habitat loss. Poaching of wild life – Invasion of exotic species, man and wild lifeconflicts-endangeredandendemicplantspeciesofIndia, Red list categories of IUCN, Biotechnologyassistedplantconservation-*insitu*and*exsitu*methods.

Unit – 5:

INTELLECTUAL PROPERTY RIGHTS:

Intellectual Property Rights – Introduction, Kinds of Intellectual Property Rights- Patents, Trademarks, Copyrights, Trade Secrets. Need for intellectual property right, Advantages and Disadvantages of IPR. International Regime Relating to IPR – TRIPS, WIPO, WTO, GATTS. IPR in India genesis and development. Geographical Indication – introduction, types. Patent filing procedure for ordinary application.

RecommendedText:

1. Sharma, P.D. 2017. Ecology and Environment-Rastogi Publication, Meerut.
2. PushpaDahiya and ManishaAhlawat. 2013. Environmental Science-A New Approach, NarosaPub. House, New Delhi.pp.2.1-2.60.
3. EugeneOdum, 2017. Fundamentals of Ecology 5th Ed.Cengage, Bengaluru.
4. SharmaP.D. 2019. Plant ecology and phytogeography, Rastogi Publications, Meerut.
5. NeerajNachiketa. 2018 Environmental & Ecology A Dynamic approach. 2nd Edition GKP Access Publishing.
6. Chandra, A.M and Ghosh, S.K. 2010. Remote sensing and Geographical Information System, Narosa Publishing House Pvt. Ltd. New Delhi.

Reference Books:

1. Keddy, P.A. 2017. Plant Ecology: Origins, processes, consequences. 2nd ed. Cambridge
2. University Press. ISBN. 978-1107114234.
3. Krishnamurthy, K.V. 2004. An Advanced Text Book of Biodiversity- Principles and
4. Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi.
5. Ahuja, V.K. 2017. Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.
6. Nithyananda, K.V. 2019. Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
7. VenkataramanM. 2015. An introduction to Intellectual property rights. Create space

Independent Pub.North Charleston, USA.
8. Kormondy, E.J. 2017. Concepts of Ecology. Prentice Hall, U.S.A. 4th edition.
9. Gillson, L. 2015. Biodiversity Conservation and Environmental Change, OxfordUniversity Press, Oxford.

Web resources:

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

OutcomeMapping:

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

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

Semester	23BOTP304: Core10: Laboratory Course - III Covering Core Papers 7,8 and 9	L	T	P	C
III		0	0	5	4

Learning Objective (LO):

LO1	Extract bimolecule of diverse nature from different sources so that they will be able to assess the metabolic profile of their source material.
LO2	Recognize the role that water plays in several physiological processes in plants.
LO3	Understand the principles of plant breeding to apply crop improvement programmes
LO4	Understandecology and phytogeography
LO5	To enhance the knowledge of the students and equip them in evaluate and protecting invaluable components of nature and interactions with the environment

Course Outcomes (CO)

Cos	On completion of this course the student will be able to	POs
CO1	Recall or remember the various aspects of cell biology, genetics, molecular biology, plant breeding and tissue culture.	K1
CO2	Understand various concepts of cell biology, genetics, plant breeding and tissue culture.	K2
CO3	Understand the fundamentals of water and its relation to plants.	K1 & K3
CO4	Understandtheroleofpigmentinphotosyntheticmechanismandrelatedeventsof plants.	K4
CO5	Evaluate the theory and practical skills gained during the course and create idea to seek for suitable job in relevant industries.	K5 & K6
K1-Remember; **K2**-Understand; **K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** –Create.		

CELLAND MOLECULAR BIOLOGY

1. Identification of different stages of mitosis from suitable plant material. (Onion root tips, garlic root tips).
2. Identification of meiosis from suitable plant material. (Onion /Tradeschantia floral buds).
3. Isolation of cell organelles : Mitochondria, Chloroplast, Nucleus, Lysosomes and there assay by succinate dehydrogenase activity (Mitochondria), acid phosphatase activity (Lysosome), acetocarmine staining (Nucleus) and microscopic observation (Chloroplast)
4. Study of mitotic index from suitable plant material.
5. Study of cyclosis in cells of suitable plant material.
6. To study plant vacuole in cells of onion leaf peel.
7. Restriction digestion of DNA samples using restriction endonucleases (RE).
8. To study the structure and organization of plant cell in various tissues of various plants (incl. leaf, stem and roots).

GENETICS

1. Problem solving on dihybrid phenotypic, genotypic and test cross ratios.
2. Incomplete dominance in plants.
3. Interactions of factors and modified dihybrid ratios.
4. Multiple alleles in plants, blood group inheritance in human.
5. Sex linked inheritance in Drosophila and plants.
6. Quantitative inheritance in plants.
7. Tetrad analysis in Neurospora.
8. Complementation analysis to find out complementation groups in viruses.
9. Chromosome mapping from three point test cross data. Calculation of chiasmatic interference.
10. Calculate gene and genotypic frequency by Hardy-Weinberg equation.

PLANT BREEDING

1. Techniques in plant hybridization.

ECOLOGY

1. Determination of the quantitative characters of a plant community by random quadrat method (abundance, density, dominance, species diversity, frequency) in grazing land, forests.
2. Estimation of above ground and below ground biomass in a grazing land employing minimum size of quadrat.
3. To determine soil moisture, porosity and water holding capacity of soil collected from varying depth at different locations.
4. Determination of pH of soil and water by universal indicator (or) pH meter.
5. Determination of dissolvedoxygen.
6. Estimation of carbonate.
7. Estimation of bicarbonate.

PHYTOGEOGRAPHY, CONSERVATION BIOLOGY & INTELLECTUAL PROPERTY RIGHTS

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

Outcome Mapping:

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

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

Semester	23BOTE305: Applied Plant Cell & Tissue Culture	L	T	P	C
III		3	2	0	3

Learning Objective (LO):

LO1	To comprehend the basic principles and methodologies of plant tissue culture.
LO2	To acquire knowledge on *in vitro* cultivation techniques to develop protocols targeted towards commercialization.
LO3	To gain understanding of the various techniques of tissue culture for secondary metabolites production. .
LO4	To recognize the worth of traditional germplasm and receive training in preserving and enhancing crop varieties to meet consumer demand and global legal policies.
LO5	To impart practical information on plant tissue culture in order to produce labour suitable for the demands of the industry and research facilities

Course Outcomes (CO)

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

Unit – 1:

BASIC PLANT TISSUE CULTURE:

Totipotency and concepts of plant tissue culture – Laboratory organization – Design of different laboratories and management - Aseptic techniques - Plant culture media – Inorganic nutrients – Macronutrients – Micronutrients - Carbon and energy sources – Organic supplements – Growth regulators – Solidifying agent – MS medium and B5 medium – Explant preparation - Methods of sterilization – Transfer and incubation of culture – Transplantation area.

Unit – 2:

MICROPROPAGATION:

Micropropagation – Stages of micropropagation - Multiplication by axillary and apical shoots – Multiplication by adventitious shoots – Multiplication through callus culture – Organogenesis and somatic embryogenesis – Multiplication and Rooting - Hardening - Factors effecting micropropagation – Technical problems in micropropagation - Practical applications of micropropagation – Somaclonal&gametoclonal variation – synthetic seed technology - Shoot tip/Meristem culture for virus free plants.

Unit – 3:

CELLAND PROTOPLAST CULTURES AND HAPLOID PRODUCTION:

Single cell and cell suspension culture – Applications - Production of haploids - Anther culture and pollen culture – Induction of haploids from un-pollinated ovaries and ovules – Role of haploids in Plant breeding - Protoplast culture: Protoplast isolation, purification – regeneration – culturing. Protoplast fusion techniques – somatic hybridization and cybridization - Applications of protoplast culture and hybridization.

Unit – 4:

METABOLIC ENGINEERING:

Application of cell culture systems in metabolic engineering - advantages of cell, tissue and organ culture as a source of secondary metabolites - Hairy root culture - Screening of high yielding cell lines - Procedures for extraction of high value industrial products – Alkaloids, food additives and insecticides in *in vitro* system.

Unit – 5:

CRYOPRESERVATION AND BIOREACTORS:

Germplasm storage and conservation – Methods of in vitro conservation – Cryopreservation and steps involved in cryopreservation of plant materials - Types of bioreactors (Stirred tank and airlift) and their uses - Industrial scaling – Upstream and downstream processing - Manipulation in production profile by biotic and abiotic elicitation – Biotransformation – Food vaccines, bioplastics, plantibodies, plantigens - Applications of tissue culture in agriculture, Horticulture and forestry.

RecommendedText:

1. Narayanaswamy, S. 1999. Plant cell and tissue culture. 8th edn.Tata McGraw Hill Publ. ISBN 0074602772.
2. Bhojwani, S.S andRazdan, 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 AfrozAlam. 2019. Plant Tissue Culture. Wiley.
10. Pullaiah, E., Rao, T., M.V. Subba, Sreedev. 2017. Plant Tissue Culture: Theory and Practicals. Scientific Publishers.
11. Chawla, H.S. 2009. Introduction to plant biotechnology, 3rd edition, Oxford and IBH publishing, New Delhi.
12. Gupta, S.D and Ibaraki, Y. 2006. Plant tissue culture engineering (Vol. 6). Springer Science & Business Media, Germany.
13. Razdan, M.K. 2015. Introduction to Plant Tissue Culture, 3rd edition.Oxford and IBH publishing, New Delhi.

14. Rober, H.Smith. 2013. Plant Tissue Culture: Techniques and Experiments, Academic Press, Elsevier.
15. Robert, N.Trigiano and Dennis, J and Gray (Eds.). 2011. Plant Tissue Culture, Development, and Biotechnology, CRC Press, Taylor& Francis Group.

Reference Books:

1. Bhojwani, S. S and Dantu, P.K. 2013. Plant tissue culture: an introductory text (Vol. 318). New Delhi, India: Springer.
2. Vasil, I.K. and Thorpe, T.A. 1994. Plant Cell and Tissue Culture, Kluwer Academic Press, The Netherlands.
3. Loyola-Vargas, V.M. Ochoa-Alejo, N. 2016. Somatic embryogenesis: Fundamental aspects and applications, Springer international publishing, Switzerland.
4. Elhiti, M., Stasolla, C and Wang, A. 2013. Molecular regulation of plant somatic embryogenesis. In Vitro Cellular & Developmental Biology-Plant, 49(6), 631-642
5. Collins, H.A. and Edwards, S. 1998. Plant Cell Culture, Bios Scientific Publishers, Oxford, UK.
6. Hall, R.D. (Ed.). 1999. Plant Tissue Culture: Techniques and Experiments, AcademicPress, New York.
7. Kartha, K.K. 1985. Cyropreservation of plant cells and organs. CRC Press, Boca Raton, Florida.
8. Rihan, H.Z., Kareem, F., El-Mahrouk, M.E., and Fuller, M.P. 2017. Artificial seeds (principle, aspects and applications). Agronomy, 7(4), 7.
9. Pullaiah, T. 2009. Plant Tissue Culture: Theory and Practicals, Scientific Publishers Journals Dept.Timir Baran Jha and BiswajitGhosh. 2016. Plant Tissue Culture: Basic and Applied, Platinum Publishers; 2nd Edn.
10. Anis Mohammad and AhmadNaseem. 2016. Plant Tissue Culture: Propagation, Conservation and Crop Improvement, Springer. Singapore**.**
11. Loyola-Vargas, V.M and Vázquez-Flota, F. 2006. Plant cell culture protocols (Vol. 318). USA: Humana Press, New Jersey.
12. Mba, C., Afza, R., Bado, S., and Jain, S.M. 2010. Plant Cell Culture: Essential Methods, John Wiley & Sons, UK.
13. Abdin, M.Z., Kiran, U., Kamaluddin, M., Ali, A. (Eds.). 2017. Plant Biotechnology: Principles and Applications, Springer publishers.
14. Fett-Neto, ArthurGermano (Ed.). 2016. Biotechnology of Plant Secondary Metabolism:Methods and Protocols, Springer publishers.
15. Smith, R.H.2012. Plant tissue culture: techniques and experiments. Academic Press, UK.
16. Trigiano, R.N., and Gray, D. J. 2011. Plant tissue culture, development, and biotechnology. CRCPress, US.
17. Kartha, K.K. 1985. Cryopreservation of Plant Cells and Organs. CRC Press, Boca Raton, Florida, USA.

Web Resources:

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

Outcome Mapping:

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

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

Semester	23BOTE306:Silviculture and Commercial Landscaping	L	T	P	C
III		3	2	0	3

Learning Objective (LO):

LO1	To understand the basic concepts of horticulture.
LO2	To learn the various methods of plant propagation.
LO3	To know the art of fruit crop and vegetable crop cultivation.
LO4	To know about the fundamental concepts of gardening and landscaping.
LO5	To provide an overview of various gardening styles and its scope in recreation and bio-aesthetic planning.

Course Outcomes (CO)

Cos	On completion of this course the student will be able to	POs
CO1	To understand the importance and divisions of horticulture.	K1
CO2	Demonstrate the art of floriculture and landscape gardening.	K2
CO3	Explain plant propagation and fruit crop cultivation.	K3
CO4	Compare and contrast the vegetable cultivation and kitchen gardening.	K4
CO5	Discuss and develop skills for effective understanding onlandscaping and components of gardens.	K5 &K6
K1-Remember; **K2**-Understand; **K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** –Create.		

Unit – 1:

Basics of Horticulture: Importance and scope of Horticulture - Divisions of Horticulture – Climate, soil and nutritional needs – Manures and fertilizers – Organic manures – Inorganic fertilizers – Biofertilizers – Methods of applications of manures and fertilizers - Water irrigation – Surface irrigation – Sub irrigation – Special irrigation methods – Plant protection and pest control for horticulture crops.

Unit – 2:

Plant propagation: Natural method: Propagation through seeds and specialized vegetative structures - Artificial methods: Cutting: types (root, stem, leaf cuttings), advantages and disadvantages - Layering: types (simple, compound, tip, trench, mound, air-layering) advantages and disadvantages - Grafting: types (inarching, side, splice, whip/tongue, veneer, cleft, bark, epicotyl, top-working) advantages and disadvantages - Budding: Types (T-budding, shield, patch, and ring budding) advantages and disadvantages - Stock – scion relationships – Micropropagation.

Unit – 3:

Fruit crops: Training and pruning methods for fruit plants – Induction of flowering, flower thinning - fruit setting and fruit development – Seedlessness in horticultural fruits – Importance of plant growth regulators in fruit crops – Cultivation and harvesting methods of important fruit crops; Mango, Sapota, Pomegranate, Grapes and Guava.

Unit – 4:

Flower and vegetable crops: Floriculture – Cultivation of commercial flower crops – Rose, Jasmine, Chrysanthemum, Crossandra, Anthurium and Gerberas – Cut flowers – Vase life period – Packages for export of cut flowers - Flower decoration – Dry and wet decoration - State Integrated Board of Studies – Botany PG 32 Classification of vegetables – Cultivation of important vegetables - Tomato, Potato, Onion, Cabbage and Snake guard – Layout for a model kitchen garden.

Unit – 5:

Landscape designing: Principles and methods of landscape designing – Types of garden – Garden components – Shrubs and shrubberies, ornamental hedges, edges, flower beds, borders and carpet beds – Climbers and creepers – Foliage plants - Succulents and cacti – Ornamental palms – Orchids - Topiary and trophy - Rockeries and arches – Lawn making and maintenance – Water garden - Layout for college garden - Indoor gardening – Hanging baskets - Bonsai plants – Training and pruning - Terrace garden - Cultivation of tree species – Eucalyptus and teak.

RecommendedText:

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

Reference books:

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

Web Resources:

1. https://courses.opened.uoguelph.ca/contentManagement.do?method=load&code=CM000019
2. www.teachervision.com/gardening
3. https://pace.oregonstate.edu/catalog/master-gardener-series-oregon-master-gardener-program
4. https://www.amazon.in/Gardening-Landscape-Design-and-Botanical-Garden/s?rh=n%3A1318122031%2Cp_27%3Aand+Botanical+Garden
5. https://www.overdrive.com/subjects/gardening
6. https://www.scribd.com/book/530538456/Opportunities-in-Landscape-Architecture-Botanical-Gardens-and-Arboreta-Careers

Outcome Mapping:

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

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

Semester	23BOTS307: SEC – TERM SEMINAR PRESENTATION	L	T	P	C
III		2	1	0	2

Semester	23BOTI308: INTERNSHIP	L	T	P	C
III		2	0	0	2

Learning Objective (LO):

LO1	The main goal of the internship programme is to give students exposure to industry and help them comprehend current management techniques by having them work for at least fifteen days in an industry/institution over the summer..
LO2	To comprehend how theoretical ideas are applied in many sectors and industries.
LO3	To create a foundation for industry-integrated education, as well as to give students better practical knowledge and hands-on experience, improve their leadership qualities, and sharpen

	their problem-solving and management skills.
LO4	The internship must focus on practice. The college will require the students to visit the offices of the research lab/industry/institution it has a memorandum of understanding (MOU) with in order to receive on-the-job training in the many different areas of those businesses' operations.
LO5	Internships provide students with practical experience in a variety of fields, including manufacturing, productivity, development, and quality analysis. These experiences prepare students for competitive hiring processes in reputable MNC industries.

Course Outcomes (CO)

Cos	On completion of this course the student will be able to	POs
CO1	For students in those pertinent core areas, the internship is preparing them to become professionals after graduation.	K1
CO2	Compile data and familiarize yourself with techniques for planning andcarrying out tests.	K2
CO3	Collect data and educate yourself on how to analyze results of your scientific studies.	K3&K5
CO4	This in-the-moment industrial exposure helps them become more knowledgeable and skilled in the latest technology.	K4
CO5	Improving communication skills and coming up with creative ideas are crucial components of training that help someone become an entrepreneur.	K5 & K6
K1-Remember; **K2**-Understand; **K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** –Create.		

Guidelines for Internship Programme:

1. To give students the opportunity to spend at least fifteen days on their own during the III Semester vacation in order to acquire exposure to research labs, industry, and respected institutions and comprehend contemporary research procedures.
2. Individual instruction is provided for the internship. The internship programme must be completed in order to receive a credential.
3. Students are required to indentify a research labs/industry/recognized institution for their Internship Programme Coordinator in consultation with and approval of their faculty guide. The choice of the research labs/industry/recognized institution should be intimated to the Internship coordinator before commencement of the Internship. Simultaneously, students should also have identified a guide within the research labs/industry/recognized institution (industry guide) under whose supervision and guidance they would carry out their Internship Program.
4. Students are expected to learn about the history of the research labs, industry, and recognized institution during their time. They must also learn about its founders or shareholders, the nature of business, organizational structure, reporting relationships, and how the various management functions (such as finance, HR, marketing, sales, and operations) operate. This list is merely illustrative and not comprehensive. Students should collect and gather as much as possible of written materials, published data, and related matter.

5. Before leaving the research labs/industry/recognized institution, obtain the Internship Programme completion certificate on the letterhead of a research lab/industry/, or an accredited institution.
6. Maintain Internship Programme record with details on activities and personal learning during their project period.
7. The department head and the coordinator of the internship programme form a committee to ensure that the internship is followed.
8. At least two copies of the report must be prepared by the intern at the conclusion of the internship program—one for submission to the college and one copy for the student. If the organization, the guide, or both request additional copies, more copies may be made. The sources from which the information was gathered should be made crystal apparent in the report. Every page needs to have a number, which should be centred at the bottom of the page. All tables, figures, and appendices must be appropriately labeled and consecutively numbered or lettered. The report must be printed, bound (ideally with soft binding), and contain at least 25 pages.
9. The internship training report should be submitted to the department within a month from the date of commencement of fourth semester.
10. However, such submission shall not be accepted after the end of third semester Examinations.

Evaluation of the Internship:

i. The internship program will be assessed by the assigned Internship Programme Coordinator from the host institute.
ii. Evaluation will be done by the Internship Programme Coordinator of the host institute and through seminar presentation/viva-voce.
iii. The presentation should be specific, clear and well analyzed, and indicate the specific sources of information.
iv. According to the statement of the draft the evaluation of the interns will be done as per the sincerity and research output of the students. In addition the evaluation will also be assessed according to the activity of the log book, format of presentation, quality of the report made by the interns, uniqueness, skill sets and evaluation report of the internship coordinator.

College Guide Manual – Summer Internship Program

1. The Internship Programme Coordinator should give proper procedures to the intern before and after the Internship.
2. The Internship Programme Coordinator should interact with the research labs/industry/recognized institution at least once before completion of the internship.
3. The weekly report submitted by the student should be reviewed and reported to the Internship Programme coordinator.

Internal: 100 marks

Internship Programme
Completion certificate - 30 marks
Internship report - 30 marks
Presentation - 20 marks
Viva-Voce - 20 marks

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Outcome Mapping:

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

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

Semester	23BOTI309: INDUSTRIAL BOTANY	L	T	P	C
III		2	0	0	2

Learning Objective (LO):

LO1	The course will equip students to either obtain employment in the field or start their own business there, depending on the needs of the industry.
LO2	To learn the applied aspects of industrial application of algae, fungi, bacteria, plants, molecular biology and recombination technology.
LO3	The student would be competent to work in industries.
LO4	To educate people about the widespread commercial uses of fungi.
LO5	To know about the economic importance of plants.
LO6	To acquire knowledge on *in vitro* cultivation techniques to develop protocols targeted towards commercialization.

Course Outcomes (CO)

COs	On completion of this course the student will be able to	POs
CO1	Understand the basics of algae in industrial applications.	K1
CO2	Demonstrate and to recollect the uses in fungi in industries.	K2
CO3	Explain bacterial role in industries.	K3
CO4	Compare and contrast the use of plants in industries.	K4
CO5	Discuss and develop skills for working in industries specializing in biomolecules.	K5 &K6
K1-Remember; **K2**-Understand; **K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** –Create.		

Unit – 1:

ALGAE IN INDUSTRIES:

Fertilizer industry-Seaweeds, pharmaceutical industry – antibiotics, agar, carageenin, alginin, diatomate earth, mineral industry, fodder industry

Unit – 2:

FUNGI IN INDUSTRIES:

Beneficial use of yeast, Fermentation of alcohol, preparations of enzyme, organic acid preparation, cheese production, protein manufacture, vitamins, fats.

Unit – 3:

PLANT PRODUCTS:

Fibres and Fibre-Yielding Plants, wood and cork, tannins and dyes, rubber, fatty oils and Vegetable fats, sugars and starches, pulp and paper, gums and resins.

Unit – 4:

BACTERIA IN INDUSTRY:

Food industry, dairy products, bioleaching, biogas production**,** bioremediation

Unit – 5:

RECOMBINANT PLANTS:

Tissue culture: Micropropagation, somatic seeds, cell culture

RecommendedText:

1. Trivedi, P.C. 2001. Algal Biotechnology. Point publisher, Jaipur. India.

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

Reference books:

1. Becker. E.W. 1994. Micro algae Biotechnology and Microbiology.CambridgeUniversitypress.
2. Borowitzka, M.A. and borowizka, L.J. 1996. Microalgal Biotechnology. CambridgeUniversity Press, Cambridge,
3. Sahoo, D. 2000. Farming the ocean: seaweed cultivation and utilization. AravaliInternational,New Delhi.
4. MahendraRai. 2009. Advances in Fungal Biotechnology. I.K. International Publishing House, New Delhi.
5. Street,H.E.1978. EssayinPlant Taxonomy,AcademicPress, London,UK.
6. AlexanderN.Glazer and HiroshiNikaido. 1994. Microbial Biotechnology.
7. Pandey, B.P. 2005. College Botany I: Including Algae, Fungi, Lichens, Bacteria, Viruses, Plant Pathology, Industrial Microbiology and Bryophyta. S Chand & Company.
8. Chichister, U.K.J. 1999. Cultivation and Processing of Medicinal Plants, Wiley & Sons
9. WilliamCharlesEvans.1989. Pharmacognosy, 14th ed. Harcourt Brace & Company.
10. Kumar,H.D.1999. IntroductoryPhycology.Affiliated East-WestPress,Delhi.
11. Das,SandSaha,R.2020.MicrobiologyPracticalManual.CBSPublishersandDistributors(P) Ltd., New Delhi,India.
12. Willie, J and Sherwood, L. 2016. Prescott's Microbiology McGraw-Hill Education; 10th Edition, ISBN: 978-1259281594
13. Reinert, J.Bajaj. T.P.S. 1977. Applied and Fundamental Aspects of Plant cell, tissue and organ Culture. Springer – Verlaug.

Web Resources:

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

Outcome Mapping:

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

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

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

Semester	23BOTI310:Nursery and Gardening	L	T	P	C
III		2	0	0	2

Learning Objective (LO):

LO1	To recognize the importance of nursery and gardening
LO2	To gain an understanding of nursery management.
LO3	To develop skills necessary to manage a wholesale nursery.
LO4	To acquire knowledge regarding theory and practice of rising plants.
LO5	To develop an interest to become an entrepreneur.

Course Outcomes (CO)

COs	On completion of this course the student will be able to	POs
CO1	Recognize the basic process required for growing and maintaining plants in nurseries	K1
CO2	Explain the different methods of plant propagation and various gardening styles	K2
CO3	Apply techniques for effective hardening of plants and computer applications for creative gardening.	K3&K6
CO4	Compare and contrast cultivation of different vegetables and growth of plants in nursery and gardening.	K4
CO5	Develop new strategies to enhance growth and quality of nursery plants.	K5 &K6
K1-Remember; **K2**-Understand; **K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** –Create.		

Unit – 1:

NURSERY:

Definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants.

Unit – 2:

SEED:

Structure and types - Seed dormancy; causes and methods of breaking dormancy - Seed storage: Seed banks, factors affecting seed viability, genetic erosion - Seed production technology - seed testing and certification.

Unit – 3:

VEGETATIVE PROPAGATION:

Air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings - Hardening of plants - green house - mist chamber, shed root, shade house and glasshouse.

Unit – 4:

GARDENING:

definition, objectives and scope - different types of gardening - landscape and home gardening - parks and its components - plant materials and design - computer applications in landscaping.

Unit – 5:

GARDENING OPERATIONS:

Soil laying, manuring, watering, management of pests and diseases and harvesting. Sowing/raising of seeds and seedlings: Transplanting of seedlings - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes, and carrots - Storage and marketing procedures.

RecommendedText:

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

Reference Books:

1. N.L.Patel, S.L.Chawla, T.R.Ahlawat: Commercial Horticulture‖, 2016, ASPEECollege of Horticulture, Navsari Agricultural University, Navsari 396 450, Gujarat,
2. Prasad S & Kumar U. 2005. Greenhouse Management for Horticultural Crops. 2nd Ed.Agrobios.
3. GeorgeAcquaah, 2002, Horticulture-principles and practices. Prentice-Half of Indiapvt. Ltd., New Delhi.
4. Abraham, A and Vatsala, P. 1981. Introduction to Orchids. Trop.Bot.Garden, Trivandrum.

5. Hartman, H.T and Kester, D.E. 1989. Plant propagation. Printice Hall Ltd., New Delhi.

Web resources:

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

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

Outcome Mapping:

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

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

Semester – IV

Semester	23BOTC401: Core 11: PLANT PHYSIOLOGY AND PLANT METABOLISM	L	T	P	C
IV		5	2	0	5

Learning Objective (LO):

LO1	Basic knowledge on physiological processes in plants.
LO2	To acquire knowledge on the functional aspects of plants.
LO3	To understand the biophysical and biochemical processes of plants.
LO4	To study the metabolism of plants.
LO5	To learn the plant growth regulations.
LO6	To know the adaptive mechanisms of plants in adverse environmental conditions.

Course Outcomes (CO)

COs	On completion of this course the student will be able to	POs

CO1	Relate understand properties and importance of water in biological system, nutrients and its translocation.	K1
CO2	Demonstrate the importance of light in plant growth and the harvest of energy.	K2
CO3	Explain the energy requirement and nitrogen metabolism.	K3
CO4	Compare the various growth regulators that influence plant growth.	K4
CO5	Discuss the senescence and plant response to environmental stress.	K5 &K6
K1-Remember; **K2**-Understand; **K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** –Create.		

Unit – 1:

Water Relations: Physical and chemical properties of water –Components of water potential - Plasmolysis - water absorption by roots – Apoplast and Symplast concept - water transport through the xylem — Transpiration and evapotranspiration- stomatal structure and function – mechanism of stomatal opening and closing – mineral nutrition – essential nutrients – macro and micro nutrients – deficiencies and plant disorders – absorption of solutes – translocation of solutes – pathways and mechanisms. phloem loading and unloading - translocation of photosynthates – source- sink relationship – partitioning of assimilates and harvest index

Unit – 2:

Photosynthesis: The physical nature of light – the absorption and fate of light energy – absorption and action spectra- photoreceptors- Ultrastructure and biochemical compartmentation of Chloroplast; Photosynthetic Electron Transport and Photophosphorylation (cyclic and noncyclic): Photosystems and reaction centres - Light Harvesting complexes - Photosystem I & II and Oxidation of Water; Carbon metabolism: C3, C4 and CAM pathways and their distinguishing features - photorespiration and its significance. Biochemistry and Molecular Biology of RUBISCO.

Unit – 3:

An overview of plant respiration – Glycolysis – TCA cycle– Electron Transport – oxidative phosphorylation and ATP synthesis – Chemiosmotic Theory - Pentose Phosphate Pathway– Respiration and its significance in crop improvement. Cyanide resistant respiration; Nitrogen fixation (Biological - symbiotic and non-symbiotic), Physiology and Biochemistry of nitrogen fixation State Integrated Board of Studies – Botany PG 40.

Unit – 4:

Growth and development – Phases of plant growth – growth types- Growth substances - Auxins, gibberellins, cytokinins, abscisic acid, ethylene, brassinosteroids - physiological effect and mechanism of action in agricultural and horticultural crops –Photoperiodism – Classification of plants and mechanism of flowering – Phytochrome and their action on flowering – Vernalization- Mechanism and its practical application, biological rhythms and movements. Seed dormancy and causes and Seed germination and their biochemical changes.

Unit – 5:

Plant senescence –Types and Mechanism of senescence- Abscission: Morphological and biochemical changes – Significance. Fruit ripening- Biochemical, Physiological changes and

control of fruit ripening. Plant response to environmental stress: Biotic and Abiotic stress – Water, temperature, light and salinity- Adaptive mechanism to various stresses (avoidance, escape, tolerance)–stress responsive proteins – anti-oxidative mechanism.

RecommendedText:

1. Gauch, H.G.1972. Inorganic Plant Nutrition. Hutchinson & Dowd. New York.
2. Govindji. 1982. Photosynthesis. AP. New York.
3. Jacob,W.P. 1979. Plant Hormones and Plant Development. CambridgeUniversity Press. Cambrigde
4. Khan, A.A. 1982. The Physiology and Biochemistry of Seed development, Dormancy and Germination. Elesiver. Amsterdam.
5. Salisbury, F. B.C.W. Ross.1991. Plant Physiology. WassworthPub. Co. Belmont.
6. Ting,I.P. 1982.Plant Physiology. AddisonWesley Pb. Philippines.
7. Sage, R and R.K.Monson (eds). 1999. The Biology of C4 Plants AP New York.
8. Postgate, J. 1987. Nitrogen Fixation. 2nd Edition Cassel, London.
9. Lincoln Taiz, EduardoZeiger, IanMaxMoller and AngusMurphy. 2015. Plant Physiology. 6th Ed., Sinauer Associates.
10. Stacey, G.R.H.Burris and Evans, H.J. 1992. Biological Nitrogen Fixation. Chapman and Hall, New York
11. Mann, J. 1987. Secondary Metabolism Clarendron Press, Oxford.
12. Jain, V.K. 2017. Plant Physiology, S.Chand& Company Ltd. New Delhi.
13. Lincoln, T, Eduardo, Z, IanMax, M, and Angus, M. 2018. Fundamentals of Plant Physiology. Sinauer Associates Inc., US.
14. Pandey, N.S and Pandey, P. 2016. Textbook of Plant Physiology. Daya Publishing House, New Delhi.
15. Taiz, L.Zeiger, E., Moller, I.M and Murphy, A. 2015. Plant Physiology and Development 6th Edition. Sinauer Associates, Sunderland, CT.
16. GuoweiLi Veronique SantoniChristopheMaurel. 2014. Plant aquaporins: Roles in plant physiology. Biochimica et Biophysica Acta (BBA) - General Subjects Volume 1840, Issue 5, Pages 1574-1582.

Reference Books:

1. Bidwell, R.G.S. 1974. Plant Physiology, Macmillan Publisher, Boston.
2. Devlin, R.M. 1996. Plant Physiology, PWS publisher, Boston.
3. Jain, V.K. 2017. Fundamentals of Plant Physiology. Chand & Company Ltd., New Delhi.
4. Gontia. 2016. A textbook of Plant Physiology. Satish Serial publishing House, New Delhi.
5. Leopold, A.C, 1994. Plant Growth and Development, McGraw Hill, New York.
6. Lincoln Taiz et al., 2014. Plant Physiology and Development. Sinauver Associates Inc. Publishers, Sunderland, Massachusetts.
7. Moore, T.C. 1989. Biochemistry and Physiology of Plant Hormones (2nd Edition). SpringerVerlag, New York, USA.
8. Noggle, R.G and Fritz, G.J. 2010. Introductory Plant Physiology, PHI Learning Pvt Ltd, New Delhi.
9. Park S.Nobel. 2005. Physicochemical and Environmental Plant Physiology. Elsevier Academic Press, New York.
10. Panda, S.K, 2005. Advances in Stress Physiology of Plants. Scientific Publishers India, Jodhpur.

11. Salisbury, F.B and CleonRoss, 2007. Plant Physiology, Wadsworth Publishing Company, Belimont.
12. Shinha. R.K. 2007. Modern Plant Physiology. Ane Books India, New Delhi.
13. WilliamG.Hopkins, 1999. Introduction to Plant Physiology, JohnWiley and sons, INC, New York.
14. Heldt, H.W. 2005. Plant Biochemistry, 3rd Edition. Elsevier Academic Press.

Web resources:

1. https://www.sciencedirect.com/topics/agriculture-and0biological-sciences/plant-physiology.
2. https://learn.careers360.com/biology/plant-physiology-chapter/
3. https://www.biologydiscussion.com/plants/plant-physiology/top-6-processes-of-plant- physiology/24154.
4. https://apan.net/meetings/apan45/files/17/17-01-01-01.pdf
5. https://basicbiology.net/plants/physiology
6. https://learn.careers360.com/biology/plant-physiology-chapter/4
7. https://swayam.gov.in/nd2_cec20_bt01/preview
8. https://www.nature.com/subjects/plant-physiology

Outcome Mapping:

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

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

Semester		L	T	P	C
IV	23BOTP402: Core 12: Laboratory Course – IV Covering Core Paper XI	0	0	5	5

Learning Objective (LO):

LO1	Observe the different stages of mitosis and chromosome behaviour and organization during various stages and to learn staining techniques of various plant tissues.
LO2	Explain the principles of linkage, crossing over and the hereditary mechanisms.
LO3	Expose the students to gain recent advances in molecular biology.

LO4 Understand the principles of plant breeding to apply crop improvement programmes

Course Outcomes (CO)

COs	On completion of this course the student will be able to	POs
CO1	Recall or remember the various aspects of cell biology, genetics, molecular biology, plant breeding and tissue culture.	K1
CO2	Understand various concepts of cell biology, genetics, plant breeding and tissue culture.	K2
CO3	Apply the theory knowledge gained into practical mode in order to acquire applied knowledge by day-to-day hands-on experiences.	K3
CO4	Analyze or interpret the results achieved in practical session in thecontext ofexisting theory and knowledge.	K4
CO5	Evaluate the theory and practical skills gained during the course.	K5 &K6
K1-Remember; **K2**-Understand; **K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** –Create.		

PLANT PHYSIOLOGY

1. Determination of osmotic potential by plasmolytic method.
2. Determination of water potential using gravimetric method.
3. Determination of water potential using dye method (Chardakov's method).
4. Effect of Monochromatic light on apparent photosynthesis.
5. Effect of CO_2 concentration on apparent photosynthesis.
6. Effect of temperature on protoplasmic membrane.
7. Separation of chloroplast pigments using paper chromatographic technique.
8. Estimation of chlorophyll content using Arnon's method.
9. Determination of rate of photosynthesis using O_2 electrode.
10. Experiment to study the rate of Hill activity of isolated chloroplast by dye-reduction.

Outcome Mapping:

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

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

Semester	23BOTD403: Project with Viva-voce	L	T	P	C

IV				0	0	5	7

Learning Objective (LO):

LO1	To recognize the concept of research and its various forms in the context of botany.
LO2	To improve abilities relating to scientific experiments.
LO3	To become proficient in data collection and the documentation of scientific findings.
LO4	To prepare students for entry-level positions or professional training programmes in any field of Botany.
LO5	Compare the various reporting and writing styles used in science.

Course Outcomes (CO)

COs	On completion of this course the student will be able to	POs
CO1	For students in those pertinent core areas, the project is preparing them to become professionals after graduation.	K1
CO2	Compile data and familiarize yourself with techniques for planning and carrying out tests.	K2
CO3	Collect data and educate yourself on how to evaluate the analyzed results of your scientific studies.	K3 & K5
CO4	In-the-moment industrial exposure helps them become more knowledgeble and skilled in the latest technology.	K4
CO5	Improving communication skills and coming up with creative ideas are crucial components of training that help someone become an entrepreneur.	K5 & K6
K1-Remember; **K2**-Understand; **K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** –Create.		

1. EachstudentwillbeallottedaProjectGuidefromthefacultyofthe departmentconcerned by lot method.
2. The topic of the dissertation shall be assigned to the candidate before the beginning of third semester.
3. Afterthecompletionoftheprojectwork,thestudenthastosubmitfourcopiesof dissertation withreportcarryinghis/herprojectreport for evaluation by examiners. After evaluation, one copy is to be retained in the College Library.
4. Projectworkwillbeevaluated by boththeexternalandtheinternal(ProjectGuide)examiners for the maximum of 100marks in total on the scale of the maximum of 50marksforthe internal andthe externaleach.
5. Viva-vocewillbeconductedbythepanelcomprising,ExternalexaminerandInternal Examiner for the maximum of 100 marks in total on the scale of the maximum of 50marksforthe internal andthe externaleach.

All the candidates of M.Sc (Botany) are required to undergo a major project and submit the following:

1. Dissertation/Thesis based on the work done by the student.
2. Soft copy of the project on CD/DVD.

PROJECT EVALUATION GUIDELINES:

The project is evaluated on the basis of following heads:

For Viva-Voce maximum is 60 marks which will be conducted by both the internal and external examiners during end semester university practical examinations.

Internal: 40 marks

I Review – Selection of the field of study,

topic and literature collection - 15 marks

II Review – Research design and data collection - 10 marks

III Review – Analysis and conclusion, preparation of rough draft - 15 marks

External: 60 marks

Thesis/ Dissertation - 30 marks

Presentation - 15 marks

Viva-voce - 15 marks

Suggested areas of work:

Algae, fungi, microbiology, biocontrol agents, plant tissue culture, plant physiology, phytochemistry, biochemistry, anatomy, plant taxonomy, Ethnobotany, ecology, sustainable agriculture, herbal formulations, cytogenetics, molecular biology, biotechnology, bioinformatics, nanotechnology and applied botany.

Methodology:

Each project should contain the following details:

1. Brief introduction on the topic
2. Review of Literature
3. Materials and Methods
4. Results and Discussion – evidences in the form of figures, tables and photographs.
5. Summary
6. Bibliography

Recommended Texts:

1. Wilson,KandJ.Walker(Eds).1994.PrinciplesandTechniquesofPracticalBiochemistry(4th Edition)CambridgeUniversityPress,Cambridge.
2. Bendre,A.MandAshokKumar.2009.AtextbookofpracticalBotany.Vol.I&II.RastogiPublication.Meerut.9thEdition.
3. ManjuBala,SunitaGupta,Gupta,N.K.2012.PracticalsinPlantPhysiologyandBiochemistry.ScientificPublisher.
4. Wilson,KandJ.Walker.2005.PrinciplesandTechniquesofPracticalBiochemistry,5thEdition. CambridgeUniversitypress,NewYork.
5. RodneyBoyer.2000.ModernExperimentalBiochemistry, 3rdEdition.PublishedbyAddisonWesleyLongman. Singapore.

Reference Books:

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

2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. 1995. Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.
3. Ruzin, S.E. 1999. Plant microtechnique and microscopy. OxfordUniversityPress, New York, U.S.A.
4. Wilson and Goulding. 1987. Principles of biochemical techniques, Oxford University Press.
5. Mukherji, S. and Ghosh, A.K. 2005. Plant Physiology. First Central Edition, New Central Book Agency (P) Ltd., Kolkata.
6. Taiz, L and Zeiger, E. 2010. Plant Physiology. 5th Edition. Sinauer Associates, USA.
7. Heldt, H.W and Piechulla, B. 2010. Plant Biochemistry, 4th Edition. Academic Press, NY.
8. Wilson, K and Walker, J. 2010. Principles and Techniques of Biochemistry and Molecular Biology, Seventh edition, Cambridge University Press, USA.

Web resources:

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

Outcome Mapping:

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

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

Semester	23BOTE404: ORGANIC FARMING	L	T	P	C
IV		3	2	0	3

Learning Objective (LO):

LO1	To study various aspects of organic farming.
LO2	To understand the relevance of organic farming, its advantages and short comings against conventional high input agriculture.
LO3	To know the importance of organic farming in the present scenario and its impact on environment and soil health.

LO4	Awareness on the importance of organic farming in the present scenario and its impact on environment and soil health.
LO5	Expose the students to about quality aspect and grading.

Course Outcomes (CO)

COs	On completion of this course the student will be able to	POs
CO1	Knowledge on various aspects of organic farming.	K1
CO2	Understand the relevance of organic farming, its advantages.	K2
CO3	Explain the short comings against conventional high input agriculture.	K3
CO4	Compare the packaging methods of harvest.	K4
CO5	Discuss and develop skills for post harvest management.	K5 &K6
K1-Remember; **K2**-Understand; **K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** –Create.		

Unit – 1:

AGRONOMY:

Organic farming- concept, characteristics, significance, organic ecosystem, scope of organic farming in India - Principles and types of organic farming. Choice of crops & varieties in organic farming - Initiative by Govt/NGOs/Other organizations for promotion of organic farming Operational structure of NPOP (National Programme for Organic Production) - Concept of dryland agronomy Organic nutrient resources & their fortification, restriction to nutrient use in organic farming - Organic production methods for cereals, vegetables and fruit crops.

Unit – 2:

SOIL SCIENCE:

Organic farming for sustainable agriculture; Manures- compost, methods of composting - Green manuring, vermicompost and biofertilizer

Harmful effect of non-judicious chemical fertilization - Organic farming practices for improving soil health. Quality parameters of organic manures and specifications - Soil fertility in organic farming systems. Manure preparation methodology - Soil improvement

Unit – 3:

FUNDAMENTAL OF ORGANIC FARM MANAGEMENT:

Land management in organic farming - Water management in organic farming. Organic insect disease management - Organic pest disease management. Preventive and cultural methods for insects and pest control - Identification of different fungal and bacterial biocontrol agents. Indigenous technical knowledge for insects-pest, disease - Weed and nutrient management in organic farming.

Unit – 4:

POST HARVEST MANAGEMENT:

Processing, labeling of organic produce - Storage and transport of organic produce.

Unit – 5:

ORGANIC QUALITY CONTROL STANDARDS:

Certification- types, process & procedure and agencies. Quality aspect and grading - Packaging and handling. Economic considerations and viability of organic products - Export of organic product and marketing.

RecommendedText:

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

Reference Books:

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

Web Resourses:

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

OutcomeMapping:

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

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

Semester	23BOTE405: Forestry and Wood Technology	L	T	P	C
IV		3	2	0	3

Learning Objective (LO):

LO1	To study various aspects of Forest Botany.
LO2	To understand the importance and different forests and plants species.
LO3	To know the ecological significance of forests.
LO4	To enable the students to information on forests laws.
LO5	To raise student awareness of the need to create a sustainable way of living and the current Global issues with forestry caused by human interference.

Course Outcomes (CO)

COs	On completion of this course the student will be able to	POs
CO1	Knowledge on various aspects of Forest Botany	K1
CO2	Understand the importance and of different forests.	K2
CO3	Analyze the ecological significance of forests	K3
CO4	To understand the dynamics of the forest.	K4
CO5	Understanding on various Indian forests laws and acts.	K5 &K6
K1-Remember; **K2**-Understand; **K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** –Create.		

Unit – 1:

Introduction and scope of Forest Botany - Merits of combining traditional Botany and Forestry practices. General introduction to forests, natural and manmade. Types of forests tropical, temperate, evergreen, semi evergreen, deciduous, monoculture, multipurpose, social and industrial. Forest and climate - Forest and Biodiversity - Forest and gene conservation - Forest and ecosystem - Forest and civilization. Geographical history of the forest vegetation - natural vs. artificial. Special emphasizes on social forestry, Industrial forestry and Multi-purpose forestry. Preservation of natural forestry - Pollution control.

Unit – 2:

Forest genetics, Forest physiology, forest ecology – strong interrelationships. Macro-dynamic ecosystem reserves, hydrological cycles, balance. Identification of timber plants based on vegetative features. Seedlings, leaves, bark branching pattern architectural models of trees. Major and minor forest products, use and misuse of forests by man, direct and indirect forest wealth, forest policies, forest protection through peoples committee.

Unit – 3:

Silviculture: concept and scope of study, forest in general form, composition, classification of world forests and Indian forests. Classification based on its quality density, tolerance, crown; water cycles of forest. Photosynthetic processes in forest: nitrogen and mineral nutrition in forests.

Unit – 4:

Seed dynamics in forest: seed production, dissemination, germination, establishment and mortality, growth of trees in general terms – height, diameter, volume, growth of stands – gross increment, net increment, stand reaction to varies types of cuttings.

Unit – 5:

Measurement: definition, direct measurements, direct and indirect estimate, and prediction. Measurement of diameter – rules and methods, measurement of height – different rules, methods, instruments, total height and merchantable length. Measurement of volume – common units, different methods and procedures of volume measurements. Measurement of age: direct estimate, averages, standard error, and sampling, General concept of indirect estimate based on one or more independent variables. Forestry for social and national development. Progress to be achieved in social forestry, industrial forestry and multiple forestry. Forest Laws- Indian Forest Act, 1927; Forest conservation Act. Wild Life Protection Act, 1972.

RecommendedText:

1. Manikandan, K and S.Prabhu. 2013. Indian forestry, a breakthrough approach to forest service. Jain Bros.
2. Roger Sands. 2013. Forestry in a global context, CAB international.
3. Balakathiresan.S.1986.EssentialsofForestManagement.NatrajPublishers,Dehradun.
4. Agarwala,V.P.1990.ForestsinIndia,EnvironmentalandProtectionFrontiers.Oxford & IBH PublishingCo.New Delhi.
5. Chundawat, B.S. and Gautham, S.K. 1996. Text book of Agro forestry. Oxford and IBH publisher, New Delhi.
6. Singhi, G.B. 1987. Forest Ecology of India, Publisher: Rawat.
7. Ramprakash. 1986. Forest management. IBD Publishers, DebraDun.
8. Tiwari, K.M. 1983. Social forestry in India. Nataraj Publishers, Dehra Dun.
9. WWF. 2007. Timber identification manual. TRAFFIC, New Delhi.
10. Dhiman, A.K. 2003. Sacred plants and their medicinal uses. Daya publishing house, New Delhi.
11. Mehta, T. 1981. A handbook of forest utilization. Periodical Expert Book Agency, New Delhi.
12. Nair, N.C and Henry, A.N. 1983. Flora of Tamilnadu, India. Series: 1, Analysis, Vol.1. BSI, Coimbatore, India.

Reference Books:

1. DonaldL.Grebner. JacekP.Siry and PeteBettinger. 2012. Introduction to forestry and Natural resources Academic press
2. West, P.W. 2015. Tree and forest measurement, Springer international publishing Switzerland.
3. Kollmann, F.F.P and Cote, W.A. 1988. Wood science and Technology. Vol. I & II Springer Verlag, New York.
4. Agarwala,V.P.1990.ForestsinIndia,EnvironmentalandProtectionFrontiers.OxfordIBHPublishingCo.,New Delhi.
5. Rao, K.R. and Juneja, K.B.S. 1992. Field identification of 50 important timbers of India. ICFRE Publi. Dehradun 123 p.
6. Avery, T.E. 1967. Forest Measurements. Mc Grand Hill Book Company, New York.
7. ManikandanK, PrabhuS. 2018. Indian Forestry A Breakthrough Approach To Forest Services, Jain Brothers.
8. Pathak, P.S, Ram Newaj. 2012. Agro forestry: Potentials and Opportunities. IndiaAgrobios.
9. Powell, Baden B.H. 2004. Manual of Forest Law. New Delhi: Biotech.
10. Uthappa, A.R. 2015. SangramBhanudasChavan, Competitive Forestry, New Vishal Publications, 1st ed.

11. Chaturvedi, A.N. and Khanna, L.S. 2015. Hand Book of Forestry (5th Edition).
12. FrederickFranklinMoon, 2018. The Book of Forestry. Repro Books.
13. Parthiban, K.T. 2018. Introduction to Forestry & Agroforestry.

Web Resourses:

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

OutcomeMapping:

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

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

Semester	23BOTS406 : BOTANY FOR ADVANCED STUDIES/ PROFESSIONAL COMPETENCY SKILL	L	T	P	C
IV		2	2	0	2

Learning Objective (LO):

LO1	To be familiar with the basic concepts and principles of plant systematics.
LO2	Learn the importance of plant anatomy in plant production systems.
LO3	To expose the students a fundamental of the various techniques used in molecular studies.
LO4	To learn about the physiological processes that underlie plant metabolism.
LO5	To know the energy production and its utilization in plants.
LO6	To acquire knowledge on *in vitro* cultivation techniques to develop protocols targeted towards commercialization.

Course Outcomes (CO)

COs	On completion of this course the student will be able to	POs
CO1	Understand of the basic principles of systematics, including	K1,K2&K5

	identification, nomenclature, classification, and the inference of evolutionary patterns from data	
CO2	Learn the structures, functions and roles of apical *vs* lateral meristems in monocot and dicot plant growth.	K1,K3&K5
CO3	Understand the organization of nuclear genome	K3&K5
CO4	Understand the various steps involved in the basic functioning of plant growth and the nutritive value of food.	K2,K3&K5
CO5	Gain awareness about the various process involved in the energy production in plants and metabolic pathways.	K1,K5&K6
K1-Remember; **K2**-Understand; **K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** –Create.		

Unit – 1:

MOLECULAR GENETICS

Molecular Biology of gene expression: Brief overview of the Central Dogma and Teminism. Transcription in prokaryotes and eukaryotes. Types and structure of RNA polymerase, Different types of RNA, Regulatory sequences and transcription factors involved. Mechanism: Initiation, elongation and termination. Split genes and RNA splicing in eukaryotes. Translation in prokaryotes and eukaryotes. Salient features, exceptions, tRNA-suppressor mutations. Mechanism of translation: Chain initiation, elongation and termination, proteins involved, factors affecting translation accuracy. Molecular mechanism of mutation, cancer biology, human cytogentics

Molecular mechanism of Gene Regulation: Regulation in prokaryotes, Regulation in Eukaryotes, Epigenetic mechanisms: methylation and transcriptional inactivation, cosuppression through transcriptional silencing, genome imprinting. RNA processing->alternative splicing, RNA stability, RNA interference. Translational regulation: Gene amplification, mating type interconversion.

Genomics: Structural genomics, Genetic and physical mapping (RFLP), microsatellite maps, cyotogenetic maps, physical maps, positional cloning, chromosome walks and jumps, Genome sequencing, genome databases, human genome sequencing project. Functional genomics. transcriptome, proteome and metabolome, Microarrays and gene-chips. Comparative genomics. Functional and evolutionary relationships prokaryotes, organelles and eukaryotes, orthologues and paralogues. Metabolomics: Identification and quantification of cellular metabolites in biological samples. Pharmacogenomics and drug designing.

Unit – 2:

ADVANCED TRENDS IN SYSTEMATICS

(i) Basic concepts of:

a. Morphology - History, general morphology, types of data, methods of gathering data,
b. Anatomy - History, general anatomy, types of data, methods of gathering data,
c. Embryology – History, types of data, methods of gathering data;
d. Palynology: History, general palynological characters, types of data, methods of gathering data;
e. Cytology and Cytogenetics: History, general cytological and cytogenetic characters, types of data, methods of gathering data;

f. Ecology, History, general ecology, types of data, methods of gathering data
(At least two examples from each section should be studied to substantiate the taxonomic significance)

(ii) Chemotaxonomy:

a. History, general chemical and chemotaxonomic characters, types of data, methods of gathering data.
b. Identification of the major classes of the pharmaceutically important secondary metabolites from natural sources 8 (phenolics, steroids, terpenoids glycosides and alkaloids).
c. Applications: Phytochemicals in cosmetics, aromatherapy, disease prevention, biotechnology in the production of phytochemicals. Phytochemical databases

(iii) **Molecular trends in Biosystematics**

a. Molecules and genomes in plant systematics, techniques used in molecular taxonomy, molecular systematics in crop evolution
b. Serology in relation to plant taxonomy- Methods, role of serology in taxonomy.
c. Cladistics and Phenetics (iv) Molecular trends in Reproductive Biology: (i) Apomixis – Types, cytogenetic basis and induction of apomixes, applications.

(iv)Biochemistry and genetics of incompatibility, methods to overcome incompatibility, pollen viability tests, molecular basis of incompatibility

Sterility – Male sterility, CMS, GMS, CGMS, temperature sensitive and photosensitive malesterility, transgenic male sterility, female sterility and zygotic sterility.

Unit – III

PLANT PHYSIOLOGY

Modern concepts Photosynthesis – Environmental and agricultural relevance; Respiration – Biochemical control of respiration. Photomorphogenesis Phytochrome genes and their expression, control of photo-morphogenic responses. Dose-response relations in photomorphogenesis, light induced chloroplast differentiation, effect of photoreceptors.

Biological clock: Circadian rhythms, rhythm responses to environment, clock mechanism. Photoperiodism General principles , florigen concept

Plant growth and development Patterns of growth and differentiation; Gene expression and mutations regulating meristem function, embryogenesis, seedling, root, leaf and flower development. Homeotic genes, ABCD model in Arabidopsis flower, hormonal control of plant tissue development, effect of auxins on root and root formation, gibberellin promoted growth of plants, ethylene and triple response mutants, brassinosteroids and photomorphogenesis.

Unit – IV

PLANT PHYSIOLOGY

Enzymes: General account: Importance and properties of enzymes in biological sciences, the classification and nomenclature of enzymes with examples, Mechanism of enzyme action role of enzyme in chemical action, various factors affecting the enzyme activity. Molecular genetics in plant physiology, Environmental plant physiology, Stress physiology .

Unit – V

ECONOMC BOTANY

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

RecommendedText:

1. Sharma, O.P. 2017. Plant Taxonomy. (II Edition).The McGraw Hill Companies.
2. Maheshwari, P. 1963. Recent Advances in Embryology of Angiosperms. Intl. Soc. Plant Morphologists, New Delhi.
3. Sharma, P.C. 2017. Text Book of Plant Anatomy. Arjun Publishing House, New Delhi.
4. Jain, V.K. 2017. Plant Physiology, S.Chand& Company Ltd. New Delhi.
5. Lincoln, T, Eduardo, Z, IanMax, M, and Angus, M. 2018. Fundamentals of Plant Physiology. Sinauer Associates Inc., US.
6. Becker, W.M., KleinsmithL.J.&HardinJ. 2005. The World of the Cell (6th edition). Benjamin/Cummings Pub. Co.New York.
7. Brooker, R.J. 1999. Genetics Analysis and Principles. Addison Wesley Longman Inc., New York.
8. Bruce, A. et. al. 2002. Molecular Biology of the Cell. Garland Publishing. New York.

Reference books:

1. Mabberley, J.D. 2014. Mebberley's Plant-Book: A portable dictionary of plants, their classification and uses, 3rd ed. Cambridge University Press, Cambridge, U.K. 1021pp.
2. Pandey.B.P. 1999. Economic Botany. S. Chand Limited, New Delhi.
3. Bhojwani, S.S. and Soh, W.Y. 2013. Current trends in the embryology of angiosperms. Springer Science & Business Media, Germany.
4. Cutler, D. F., Botha, T and Stevenson, D.W. 2008. Plant Anatomy: An Applied Approach. Blackwell Publishing, Malden, USA.
5. Steward, F.C. 2012. Plant Physiology Academic Press, US.
6. Hopkins, W.G and Huner, N.P. 2009. Introduction to Plant Physiology (4th ed.). John Wiley & Sons. U.S.A.
7. Noggle G.R and G.J.Fritz. 2002. Introductory Plant Physiology. Prentice Hall of India, New Delhi.
8. AnthonyJ . F. G .2000. An Introduction to Genetic Analysis. W. H. Freeman &Co. New York.
9. Hartl, .D.L & Jones E. W. 2000. Genetic analysis of Genes and Genomes Jones and Bartlett Pub, Boston.
10. Klug .S.W. &Cummings, M.R. 2003. Concepts of Genetics . Pearson Education Pvt. Ltd., Singapore. Kreezer et al . 2001. Recombinant DNA and Biotechnology. American Society for Cell Biology, New York.
11. LodishHarvey. 1999. Molecular Cell Biology. W.H. Freeman &Co. New York.
12. Russell, P.J. 2005. Genetics: A Molecular Approach (2nd edition). Pearson/Benjamin Cumming, San Francisco.
13. Snustad, D. P. &SimmonsM.J. 2003.Principles of Genetics. John Hailey & Sons Inc. U.S.A.

Web Resources:

1. http:// www.ornl.gov.
2. http:// ash. gene. ncl. ac .nk..
3. http://tor. cshl. org. http:www. gdb. org.

4. http: //www. neg r. org.
5. http: // www. genetics. wustl. edu.
6. http: // genome. imb- jena. dc

Outcome Mapping:

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

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

Semester	23BOTX407 : Extension Activities	L	T	P	C
IV		2	2	0	1

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