M.Sc., BOTANY PROGRAMME
SCHEME OF EXAMINATION

Sem.	Course Code	Course Title	Nature of the course	C	L	P	E	CFA	ESE	Total Marks
I	24BOTP0101	Plant diversity I (Algae, Fungi, Lichens and Bryophytes)	Major	4	4	-	3	40	60	100
	24BOTP0102	Plant diversity II (Pteridophytes, Gymnosperms and Paleobotany)	Major	4	4	-	3	40	60	100
	24BOTP0103	Environmental Biology	Major	4	4	-	3	40	60	100
	24BOTP0104	Cell and Molecular Biology	Major	4	4	-	3	40	60	100
	24BOTP0105	Practical -1: Plant diversity I & II	Major	2	-	4	3	60	40	100
	24BOTP0106	Practical -2: Environmental Biology & Cell and Molecular Biology	Major	2	-	4	3	60	40	100
	24GTPP0001	Gandhi in Everyday Life	-	2	2	-	-	50	-	50
			Total	**22**	**18**	**8**				
II	24BOTP0207	Bioinstrumentation and Research Methods	Major	4	4	-	3	40	60	100
	24BOTP0208	Plant Physiology, Biophysics and Biochemistry	Major	4	4	-	3	40	60	100
	24BOTP0209	Anatomy and Embryology of Angiosperms	Major	4	4	-	3	40	60	100
	24BOTP0210	Advanced Biostatistics	Major	4	4	-	3	40	60	100
	24BOTP0211	Practical -3: Bioinstrumentation and Research Methods, Plant Physiology, Biophysics & Biochemistry, Anatomy and Embryology of Angiosperms	Major	2	-	4	3	60	40	100
	--	Elective: Generic	Generic	3	3	-	3	40	60	100
	24ENGP00C1	Communication and Soft Skills	Soft Skills	2	2	-	-	50	-	50
	24BOTP0212	Summer Internship/ Mini Project (15 to 30 days during II -Semester Break)	Major	1	--	-	-	50	-	50
			Total	**24**	**21**	**4**				
III	24BOTP0313	Genetics and Genomics	Major	4	4	-	3	40	60	100
	24BOTP0314	Angiosperms Systematics and Economic Botany	Major	4	4	-	3	40	60	100
	24BOTP0315	Plant ecology, Phytogeography and Biodiversity conservation	Major	4	4	-	3	40	60	100
	24BOTP0316	Practical -4: Genetics and Genomics, Angiosperms Systematics and Economic Botany & Plant ecology, Phytogeography and Biodiversity conservation	Major	2	-	4	3	60	40	100
	24BOTP03DX	Elective: Discipline Centric	Discipline Centric	3	3	-	3	40	60	100
	24BOTP03MX	Modular course	Modular	2	2	-	-	50	-	50
	24BOTP0317	Field Visit	Major	1	-	2	-	50	-	50
	24EXNP03V1	Village Placement Programme	VPP	2	-	-	-	50	-	50
			Total	**22**	**17**	**6**				

IV	24BOTP0418	Fundamentals of Microbiology	Major	4	4	-		40	60	100
	24BOTP0419	Plant Biotechnology and Genetic Engineering	Major	4	4	-		40	60	100
	24BOTP0420	Herbal Botany and Phytochemistry	Major	4	4	-		40	60	100
	24BOTP0421	Practical -5: Fundamentals of Microbiology & Plant Biotechnology & Genetic Engineering and Herbal Botany & Phytochemistry	Major	2	-	4		60	40	100
	24BOTP04MY	Modular course	Modular	2	2	-	-	50	-	50
	24BOTP0422	Dissertation	Major	6	-	10		75	75*+ 50**	200
	24GTPP00H1	Human Values and Professional Ethics	-	2	2	-		50	-	50
			Total	**24**	**16**	**14**				
		Grand Total credit		**92**						

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO1: To gain technical aptitude and in-depth knowledge in the relevant field.

PEO2: To independently carry out practicals, project and interpret the results scientifically.

PEO3: To utilize the skills developed for lucrative employment.

PEO4: To update their knowledge periodically to match international standards.

PEO5: To enhance the intellectual foundation and to prepare themselves for life in a complex, dyna, technological world.

PEO6: To preserve, add, and transmit knowledge in the relevant field.

PROGRAM OUTCOME (PO)

PO1: Become knowledgeable in the subject and apply the principles of the same to the needs of the Employer/ Institution/ Enterprise/ Society

PO2: Gain Analytical skills in the relevant field.

PO3: Be able to design/conduct investigations and develop solutions to solve problems using appropriate tools.

PO4: Use knowledge gained from the public health and safety, cultural, societal and environmental needs which are friendly and sustainable.

PO5: Work individually/as a group, have professional ethics, able to prepare & execute projects and use the knowledge obtained /update it lifelong.

PROGRAMME SPECIFIC OUTCOME (PSO)

After completion of the M.Sc., Botany Programme, the students are expected to

PSO1: Apply the knowledge of Botany in the domain of scientific development

PSO2: Solve the complex problems in the field of Botany with an understanding of the societal, legal and cultural impacts

PSO3: Use specialized knowledge and practical training in Botany to address contemporary problems in academia, industry and the needs of society

PSO4: Gain research-oriented learning that develops analytical and integrative problem-solving approaches.

PSO5: Relate scientific knowledge to research on the topic, perform experimentation, collect, analyze and present data.

M.Sc., BOTANY PROGRAMME

Name of the programme	**M.Sc. BOTANY**				
Year of Introduction	**2008**				
Year of revision	**2024**				**Total**
Semester-wise courses and credit distribution	**I**	**II**	**III**	**IV**	
No. of Courses	**7**	**8**	**8**	**7**	**30**
No. of Credits	**22**	**24**	**22**	**24**	**92**

# courses may be offered under MOOC/NPTEL based on availability and the syllabus will be modified as per MOOC/ NPTEL with equal credits	**@ A portion of the course may be offered under MOOC/NPTEL based on availability**
*Evaluation by External examiner	C-Credits
**Evaluation by External examiner and internal examiners	CFA- In semester continuous Assessment
L- Lecture hours	ESE- End semester Assessment
P- Practical hours	VPP- Village Placement Programme
E – Exam hours	

List of Discipline-Centric Courses (3 credits)	**List of Modular Courses (2 Credits)**	**Generic Course offered to other Departments (3 credits)**
24BOT P03D1 Medicinal plant Resources utilisation and human healthcare	24BOT P03M1 Advanced Molecular Techniques	24BOTP02G1 Herbal Botany and Dietetics
24BOT P03D2 Ethnobotany	24BOT P03M2 Commercial plant tissue culture	24BOTP02G2 Preservation and Processing of Fruits and Vegetables
24BOT P03D3 Paleobotany	24BOT P04M3 Lifesciences for competitive examinations	24BOTP02G3 Biofertilizer and Mushroom technology
24BOT P03D4 Trends in Modern Botany	24BOT P04M4 Entrepreneurial Opportunities in Botany	
24BOT P03D5 Phylogeny of Angiosperms	24BOT P04M5 Intellectual Property Rights	
24BOT P03D6 Reproductive Biology of Angiosperms	24BOTP04M6 Horticulture and landscape management	Any other Major Elective Courses under MOOC / NPTEL available online with equal credits

VALUE ADDED COURSES

Course code	**Course Title**	**Credit**
21BOTP0VA1	Life sciences for competitive examinations	2
21BOTP0VA2	Commercial Plant Tissue Culture	2
21BOTP0VA3	Preservation and Processing of Fruits and Vegetables	2
21BOTP0VA4	Biofertilizer and Mushroom technology	2
21BOTP0VA5	Horticulture and landscape management	2

Semester	**First**	Course Code	**24BOTP0101**
Course Title	**PLANT DIVERSITY I (Algae, Fungi, Lichens and Bryophytes)**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	New Course	If revised, Percentage of revision effected (Minimum 20%)	-
Category	Core		
Scope of the Course (may be more than one)	1. Understand various forms of lower plants 2. Acquire knowledge of the diversity and reproduction of Algae, fungi, lichens and Bryophytes 3. Understand the phylogeny and economic importance of lower plants		
Cognitive Levels addressed by the Course	K1- Inculcate the advancement of distribution and phylogeny of lower plants K2- Observation on diversity and reproduction of lower plants K3- Acquire knowledge of economic importance of lower plants K4- Observation of diversity and distribution of lower plants K5- Create awareness among the people on reproduction and sexuality of lower plants		
Course Objectives (Maximum: 5)	**The Course aims** • To evaluate knowledge on distribution and phylogeny of lower plants • To analyse the diversity, reproduction and economic importance of Algae To demonstrate the diversity and reproduction of fungi and bryophytes • To evaluate the diversity, reproduction and economic importance of fungi and lichens. • To analyse the diversity and reproduction of lichens		

Unit	**Content**	**No. of Hours**
I	**Algae** Classification of Algae by F.E. Fritsch (1935); Salient features of major classes: Cyanophyceae, Chlorophyceae, Xanthophyceae, Chrysophyceae, Cryptophyceae, Dinophyceae, Chloromonadineae, Euglenophyceae, Charophyceae, Bacillariophyceae, Phaeophyceae and Rhodophyceae; Distribution, habitat, thallus organization, reproduction (vegetative, asexual, sexual) and life cycle of *Oscillatoria*, *Scytonema*, *Ulva*, *Codium*, *Diatoms*, *Dictyota* and *Polysiphonia*; Phylogeny and Economic importance of Algae.	13
II	**Fungi** Classification of Fungi by C.J. Alexopoulos (1962); General characters of major classes: Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina. Structure, reproduction and life histories of the following genera: *Plasmodiophora*, *Rhizopus*, *Taphrina*, and *Agaricus*. Economic importance of Fungi.Heterothallism, Parasexuality and sex hormones in fungi	12
III	**Pathogenic Fungi** History of plant pathology. A brief account of downy mildew of cucurbits, stem gall of coriander, peach leaf curl, Tikka disease of groundnut, the bacterial blight of rice, leaf curl of tomato, potato spindle tuber mosaic, ear cockles of wheat, phyllody of sesamum, citrus greening. Mode of infection and role of enzymes and toxins in plant disease. Defence mechanisms of plants against infection: Preexisting structural and chemical defence, induced structural and chemical defence, hypersensitive reaction, the role of phytoalexins and other phenolic compounds.	15
IV	**Lichens** Classification (Hale, 1969). General characteristics of fruticose, foliose, crustose, squamulose, leprose, gelatinous, filamentous, byssoid andstructureless; Occurrence and inter-relationship of phycobionts and mycobionts, structure and reproduction in Ascolichens, Basiodiolichens and Deuterolichens. Economic importance and phylogeny of lichens	14
V	**Bryophytes** Classification of Bryophytes by Rothmaler (1951); General characters of major classes; Marchantiales, Jungermaniales, Anthocerotales, Sphagnales, Funariales and Polytrichales. Distribution, habitat, vegetative and anatomic structures, reproduction (vegetative, asexual, sexual) and lifecycle of *Marchantia* and *Funaria;* Distribution, structural variations and evolution of gametophytes and sporophytes in Bryopsida, Anthoceropsida and Mosses. Economic importance of Bryophytes.	10

References	**Text Books:**
	1.Johri, R.M., Latha, S. and Sharma, S. 2004. Textbook of Algae. Dominant Publishers and distributors, New Delhi.

	2. Johri, R.M., Latha, S. and Sharma, S. 2004. Textbook of Broyophytes. Dominant Publishers and distributors, New Delhi. 3. Pandey, B. P. 2004. College Botany Volume I & II. S. Chand & company Ltd, New Delhi. 4. Hoek, C., Mann, D., Jahns, H.M. and Jahns, M. 1995. Algae: an introduction to phycology. Cambridge University Press. 5. Chapman, D.J., 1973. *The algae*. Springer. 6. Uetanabaro, A.P.T., Goes-Neto, A., Rosa, L.H., Salino, A., Wieloch, A.H. and Rosa, C.A., 2009. Diversity of Prokaryotes, Fungi, Protozoa, Bryophytes, and Pteridophytes in Tropical ecosystems. Tropical Biology and Conservation Management-Volume V: Ecology, p.13. 7. Sambamurty, A.V.S.S., 2006. A textbook of bryophytes, pteridophytes, gymnosperms and palaeobotany (No. QK533 S25). 8. Kakkar, R. K. and B. R. Kakkar.1995.The Gymnosperms (Fossils and Living) Central Publishing House, Allahabad. 9. Parihar, N. S. 1991.Bryophytes, Central Book Dept., Allahabad. **Reference Books** 1. Gilbert. M. Smith 1998. Cryptogamic Botany. Volume 1 & 2. Tata McGraw hill Publishing Company Ltd, NewDelhi. 2. Aleoxopolous, C.J., Mims, C.W. and Blackwell, M. 1996. Introductory Mycology. IV edition, John Wiley & Sons, New York. 3. Parihar. N.S. 1967. An introduction of Embryophyta, vol. III – Pteridophyta, Central book depot, Allahabad. 4. Chapman , V.J. 1962. The Algae. Macmillan & Co. Ltd. New York. 5. Sambamurty, A.V.S.S., 2005. *A textbook of algae*. IK International Pvt. Limited. 6. Sharma, O.P., 1986. *Textbook of algae*. Tata McGraw-Hill Education. 7. Gupta, R., 1981. *A textbook of fungi*. APH Publishing. 9. Siddiqui K.A.2003, Elements of Paleobotany. KITAB MHHAL Agencies, Allahabad.UP 10. Watkinson, S.C., Boddy, L. and Money, N., 2015. The fungi. Academic Press. 11. Dube, H.C., 2013. An introduction to fungi. Scientific Publishers. 12. Reddy, S.M., 2001. University botanyI:(algae, fungi, bryophyta and pteridophyta*)* (Vol. 1). New Age International. 13. Shaw, A.J. and Goffinet, B. eds., 2000. Bryophyte Biology. Cambridge University Press. 14. Webster, J. and Weber, R., 2007. *Introduction to fungi*. Cambridge university press. **Web resources** • https://academic.oup.com/plphys/article/116/1/9/6097377 • https://pubmed.ncbi.nlm.nih.gov/37792319/#:~:text=Results%3A%20The%20phylogeny%20resolves%20many,in%20the%20Cretaceous%20or%20later. https://www.britannica.com/science/fungus/Evolution-and-phylogeny-of-fungi.
	On completion of the course, students should be able to understand CO1: Diversified forms of plants CO2: Salient features of every classification and can describe the functions of classification CO3: Compare critically the biology and ecology of fossil groups of plants CO4: Economic importance and special characteristics of the specified examples under each category CO5: Identification of fossil forms of Pteridophytes and Gymnosperms.

Semester	**First**	Course Code	**24BOTP0102**
Course Title	**PLANT DIVERSITY II (Pteridophytes, Gymnosperms and Paleobotany)**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	New Course	If revised, Percentage of revision effected (Minimum 20%)	-
Category	Core		
Scope of the Course (may be more than one)	1. Understand various forms of Pteridophytes and Gymnosperms 2.Acquire knowledge of the diversity and reproduction of Pteridophytes, Gymnosperms, and palaeobotany 3. Understand the phylogeny and economic importance of vascular cryptogams		
Cognitive Levels Addressed by the Course	K1- Inculcate the advancement of classification and reproduction ofPteridophytes K2- Observation ofstructure, anatomy, reproduction and life histories of Pteridophytes K3- Acquire knowledge of distribution, vegetative, anatomy, reproduction and lifecycle of Gymnosperms K4- Analyse the distribution, vegetative, anatomy, reproduction and lifecycle of Gymnosperms K5- Create awareness among the people on fossilisation and fossil plants		
Course Objectives (Maximum: 5)	**The Course aims** • To evaluate knowledge on classification and phylogeny of Pteridophytes • To analyse the structure, anatomy, reproduction and life histories of Pteridophytes • To demonstrate the distribution, vegetative, anatomy, reproduction and lifecycle of Gymnosperms • To evaluate the distribution, vegetative, anatomy, reproduction and lifecycle of Gymnosperms • To analyse the fossilization and fossil plants		

Unit	**Content**	**No. of Hours**
I	**Pteridophytes** Classification of Pteridophytes by Reimer (1954). General characteristics of Psilophytopsida, Psilotopsida, Lycopsida, Sphenopsida and Pteropsida.Distribution and range of structure, reproduction and evolution of the gametophytes, Gametophyte types; sex organs. Apogamy and Apospory. Stellar evolution. Heterospory and seed habit, Telome theory.	13
II	**Pteridophytes** Structure, anatomy, reproduction and life histories of the following genera: *Selaginella*, *Isoetes*, *Equisetum*, *Angiopteris*, *Osmunda*, *Pteris* and *Azolla*. Phylogeny and Economic Importance of Pteridophytes	12
III	**Gymnosperms** Classification of Gymnosperms (K.R.Sporne, 1965). General characters of Cycadopsida, Coniferopsida and Gnetopsids. A general account of the distribution of Gymnosperms. Morphology, anatomy, reproduction, phylogeny and economic importance of Gymnosperms,	15
IV	**Gymnosperms** Distribution, vegetative, anatomy, reproduction and lifecycle of *Cycas*, *Welwitschia*, *Cupressus*, *Araucaria*, *Podocarpus*, *Gnetum* and *Ephedra*. Phylogeny and Economic Importance of Gymnosperms	14
V	**Paleobotany:** Geological time-scale; Radiocarbon dating; contribution of Birbal Sahni to Paleobotany. Gondwana flora of India. Study of fossils in understanding evolution. Fossilisation and fossil types. Study of organ genera: *Rhynia, Lepidocarpon, Calamites*,*Cordaites* and *Lyginopteris*. Economic importance of fossils; fossil fuels and industrial raw materials and uses.	10
References	• https://www.brainkart.com/article/Classification-of-Pteridophytes_32878/ • https://en.wikipedia.org/wiki/Pteridophyte_Phylogeny_Group#:~:text=The%20Pteridophyte%20Phylogeny%20Group%20(PPG,relationships%20discovered%20through%20phylogenetic%20studies. • https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9363647/#:~:text=Living%20gymnosperms%20comprise%20four%20major,have%20not%20been%20fully%20resolved. https://samnoblemuseum.ou.edu/common-fossils-of-oklahoma/plant-fossils/fossils-by-plant-group/	
	On completion of the course, students should be able to understand CO1: classification and reproduction of phylogeny of Pteridophytes CO2: Salient features of structure, anatomy, reproduction and life histories of Pteridophytes CO3: Compare distribution, vegetative, anatomy, reproduction and lifecycle of Gymnosperms CO4 distribution, vegetative, anatomy, reproduction and lifecycle of Gymnosperms CO5: Identification of fossil forms of Pteridophytes and Gymnosperms.	

semester	**First**	Course Code	**24BOTP0103**
Course Title	**ENVIRONMENTAL BIOLOGY**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	10
Category	Core		
Scope of the Course (may be more than one)	1. Understand the concepts of environment 2. Use of natural resources more effectively without harming the environment. 3. Importance of remote sensing, GIS, Environmental education, pollution and its effects, environmental quality monitoring, impact assessment and conservation.		
Cognitive Levels addressed by the Course	K1- Inculcate the advanced environmental concepts K2- Observation of environmental issues in the present scenario K3- Application of recent techniques in pollution reduction. K4- Survey and evaluation of natural resources and their management. K5- Awareness among the people on environmental issues		
Course Objectives (Maximum:5)	The Course aims • to provide fundamental environmental principles that provide an in-depth understanding of our environment. • to understand how environmental systems interfere with the population and wealth of our natural resources • to understand the importance of remote sensing, GIS and environmental education • to learn the impact of pollution on the environment and Environmental Acts • to assess the importance of environmental impact assessment and audit, biomonitoring and treatment		

Unit	Content	No. of Hours
I	**Environmental Concepts** Scope of Environmental Biology- Ecosystem- Abiotic and Biotic components -Types- Terrestrial- Forest and Grassland - Aquatic- Freshwater and Marine- Food chain and food web, ecological pyramids -Productivity- Primary and secondary- Biogeochemical cycles-Oxygen, carbon, nitrogen, sulphur and phosphorus- Population Ecology. Biogeographical Zones of India	13
II	**Natural Resources and Conservation** Natural Resources-Renewable-Biomass, biogas, solar energy, wind, tidal energy and Non-Renewable- Fossil fuels-coal, oil, natural gas, mineral and nuclear energy-Conservation of natural resources- Biodiversity -Status, types, threats and biodiversity hotspots- Wildlife conservation and management-Special Projects for Endangered species-Project Tiger, Lion and Snow- Leopard, National parks, sanctuaries and biosphere reserves.	14
III	**Remote Sensing, GIS and Environmental Education** Remote sensing; Components, types and applications; GIS and its application; Environmental Education; Objectives, goals, scope, guiding principles and Centre for Environmental Education.	8
IV	**Pollution and Environmental Acts** Pollution-Types-Air, water, soil and radio-active-sources, biological effects and control - Environmental protections Act - Air and water-Environmental Laws.	11
V	**Environmental Assessment, Monitoring and Treatment** Environmental Impact Assessment- steps and methods - Public participation in environmental decision making– Impact Analysis and Environmental Audit- Environmental Standards-Air and water- Bioindicators and Environmental Monitoring-Bioassay –Application in Environment - Physical, chemical and biological treatment of liquid effluents.	18

References

Text Books

1. P.S.Verma and V.K.Agarwal. 2019. Environmental Biology. S. Chand and Company, New Dehi.
2. P.D. Sharma 2017. Ecology and Environment- Rastogi Publication, Meerut.
3. Purohit, Shammi & Agrawal 2012 Environmental Sciences – A New Approach Agrobios (India), Jodhpur.
4. Metcalf and Eddy 2011 Waste water Engineering- Treatment and Reuse.Tata Mc Graw Hill Education Pvt.Ltd, New Delhi. Pp.311-1026.
5. S.K.Agarwal. 2002 Eco – informatics. Vol I, III, IV APH pub. Company, New Delhi. Vol. I: 135 – 165 : 265 – 311; Vol. III : 221 – 259; Vol. IV : 1-140.
6. Kailash Thakur 1997 Environmental protection law and policy in India. Deep and Deep pub. New Delhi. pp. 184-197; 210 – 248.

Reference Books

1. G.Tyler Miller and Scott E. Spoolman. 2019. Environmental Science.Cengage Learning India Pvt.Ltd.Delhi.

	2. P.D. Sharama 2013, Environmental Biology and Toxicology- Rastogi Publication, Meerut. 3. Pushpa Dahiya and Manisha Ahlawat 2013 Environmental Science- A New Approach,Narosa Pub. House, New Delhi.pp.2.1-2.60. 4. V.S. Kulkariani, S.N. Kaw and R.K. Trivedy 2002. Environmental Impact Assessment for wetland protection. Scientific publishers (India). 5. Kaiser Jamil 2001 Bio indicators and biomarkers of Environmental pollution and Risk assessment. Oxford and IBH Pub. Co. Pvt. Ltd, New Delhi. pp.1 – 168. 6. Rajesh Gopinath and N. Balasubramanya. 2018. Environmental Science and Engineering. Cengage Learning India Pvt.Ltd.pp.36-179.
	E-Resources 1. http://nptel.ac.in/courses/122103039/40 2. http://b-ok.xyz/book/671429/bc900f 3. http://b-ok.xyz/book/2463090/f0ce34
Course Outcomes	On completion of the course, students should be able to
	CO1 : Understand the components of environment, ecosystems, and interactions of organisms, and appreciate how elements are cycling in the environment CO2 : Identify the natural resources, types of biodiversity and status and importance of national parks, sanctuaries and biosphere reserves CO3 : Understand remote sensing, GIS and their applications CO4 : Describe the types, biological effects and control of pollution and the importance of Environmental Acts. CO5 : Recognize the need for Environmental impact assessment, environmental audit, monitoring and treatment of effluents.

Semester	**First**	Course Code	**24BOTP0104**
Course Title	**CELL AND MOLECULAR BIOLOGY**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	New Course	If revised, Percentage of revision effected	-
Category	Core		
Scope of the Course (may be more than one)	1. Basic understanding of the biology of cellsand its communication 2. Developing skills to understand the cell division, cycle and their regulations 3. Creates employability scope in the molecular screening laboratories		
Cognitive Levels addressed by the Course	K-1 Ability to recognize the cell organells K-2 Comprehensive knowledge of the cell cycle and regulation of the cell cycle K-3 Capacity to remember cell communication and cell signalling K-4 Better understanding of structures of DNA, RNA and Proteins K-5 Make new techniques to analyse transcription in prokaryotes and eukaryotes K-6 Assessment of functions of DNA, RNA and Proteins		
Course Objectives	**The course aims** • to impart updated information on the principles of cell communication • to give in-depth knowledge on the control of the cell cycle • to make the student knowledgeable on concepts and mechanism of DNA replication process • to expose the students to mechanisms of transcription process in prokaryotes and eukaryotes. • to enhance students' interest in distinguishing prokaryote translation processes from eukaryotes.		

Units	**Content**	**No. of Hours**
I	**Structure of Cell and cell membranes** Ultrastructure of plant and animal cells; Membrane structure and function; Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes. Structural organisation and function of intracellular organelles: Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.	14
II	**Cell communication and cell signaling** Cellsignaling; hormones and their receptors, cell surface receptors, membrane-associated receptors for peptide and steroid hormones; signaling through G-protein coupled receptors, signal transduction pathways. General principles of cell communication: extracellular space and matrix, interaction of cells with other cells and non-cellular structures.Bacterial and plants two-component systems, light signalling in plants, bacterial chemotaxis and quorum sensing.	12

III	**Cell cycle and cell growth** Cell cycle - types of cell division - mitosis and meiosis. Control and regulation of cell cycle - cell volume - size - internal/external checkpoints in G1 - G2 - S and M. Positive regulators - cyclin A - B - D and E - Cdks and cyclin-Cdk complex. Negative regulators - Rb protein - E2 Factors - p53 - and p21. Extracellular control system - survival factors and growth factors. Programmed cell death - apoptosis - ageing and its theories.	12
IV	**Transcription** Basic factors of RNA synthesis; RNA ploymerases – I, II and III. Transcription mechanisms in prokaryotes and eukaryotes; chain Initiation, elongation and termination. Significance of pribnow box, TATA box, CAAT box and enhancers in transcription initiation. Rho-dependent and Rho-independent termination of transcription. Classes of RNA Molecules – Messenger, ribosomal and transfer RNA. Post-transcriptional modification; RNA splicing – the role of lysozyme – Spliceosomes, Group I and Group II introns Self-splicing. Capping and tailing of 5' and 3' termini of Eukaryotic mRNA molecules.	13
V	**Translation** Genetic code – Definition, deciphering of codons; Universality of the code; Wobble hypothesis and codon degeneracy - codon dictionary. Mechanism of protein synthesis; importance of Initiation (IF), elongation (EF) and releasing factors (RF), post-translational modifications – protein splicing and folding – role of molecular chaperones. Regulation of gene expression in prokaryotes;Operon concept – inducible and repressible operons Eg. lac, trp, ara, and his operons; Feedback inhibition and Allosteric enzymes. A brief account of Molecular Pharming. Genome Editing tools: ZFNs, TALENs and CRISPR-Cas9.	13
References	**Text Books** 1. Sundara Rajan, S. 2003. Introduction to Cell Biology. Vikas Publishing House Pvt. Ltd., New Delhi. 2. Nair, P.K.G. and Prabhakar Achari, K. 1999. A Text Book of Cell Biology. Konark Publishers Pvt. Ltd., Delhi. 3. David Freifelder, 2020, Molecular Biology, 4th Reprint., Narosa Publishing House, New Delhi, India. 4. Lansing M. Prescott, John P. Harley and Donald A. Klein (2020). Microbiology (11thEd.). Mc Graw Hill companies.	
	Reference Books 1. Geoffrey M. Cooper - The Cell A Molecular Approach, 8th Edition, Oxford University Press (2019). 2. Lizabeth A. Allison., Fundamental Molecular Biology, 2nd Edition, 2012 John Wiley & Sons, Inc. 3. David P. Clark, Molecular Biology, 3 rd Edition, 2019 Elsevier Inc. 4. Robert F. Weaver, Molecular Biology, 5th Edition 2012 by The McGraw-Hill Companies, Inc. 5. Bruce Alberts, Molecular Biology of Cell, 6th Edition,2015, Garland Science, Taylor & Francis Group, LLC 6. Michael M. Cox, Molecular Biology Principles and Practice, 2012 by W. H. Freeman and Company. 7. James D. Watson, Molecular biology of the gene, 7th Edition,2014, Cold Spring Harbor Laboratory. *(NPTEL) - National Programme on Technology Enhanced Learning.	
	E-Resources 1. www.cellbio.com/education.html 2. https://www.loc.gov/rr/scitech/selected- interval/molecular.html 3. global.oup.com/uk/orc/biosciences/molbio/ 4. https://www.loc.gov/rr/scitech/selected-internet/molecular.html 5. https://courses.lumenlearning.com/suny-wmopen-biology1/chapter/signaling-molecules-and-cellular-receptors/ 6. https://en.wikipedia.org/wiki/Pribnow_box 7. https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/post-transcriptional-modification	
Course Outcomes	On completion of the course, students should be able to	
	CO1: Outline the fundamental concepts of cell communication CO2: Discuss the positive and negative regulations CO3: Explain the mechanisms of DNA replication & repair mechanisms CO4: Evaluate the differences in transcription process in prokaryotes and eukaryotes CO5: Compare the mechanisms of translation in prokaryotes with that in eukaryotes	

Semester	**First**	Course Code	**24BOTP0105**
Course Title	**PRACTICAL- I: PLANT DIVERSITY I & PLANT DIVERSITY II**		
No. of Credits	2	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected (Minimum 20%)	50
Category	Core		
Scope of the Course (may be more than one)	1. Understand the morphological characteristics of lower and higher plants 2. Acquire knowledge of the identification of lower and higher plants 3. Motivate the students to understand the structure and reproduction and to become plant taxonomists		
Cognitive Levels addressed by the Course	K1- Inculcate basic and advancement of structure of lower plants K2- Realize the structure of lower and higher plants K3- Mull over the techniques to solve the problems in plant identification K4- Expertise in the identification of lower plants and higher plants. K5- Realize the importance of identification of plant diversity on various botanical issues		
Course Objectives (Maximum: 5)	The Course aims • To develop the skill in the identification of lower and higher plants with their salient features • To develop skills in lower and higher plant identification • To create an overall knowledge of the identification of all groups of plants, including fossil • To understand the vegetative and reproductive characteristics of various plants		

Unit	**Content**	**No. of Hours**
I	Morphology of vegetative and reproductive characteristics of the following: **Algae**:*Chlorella* and *Polysiphonia*; *Codium, Halimeda, Dictyota, Padina, Fucus, Batrochospermum, Sargassum,* and *Gracilaria,*	13
II	**Fungi**: *Rhizopus, Peziza, Aspergillus, Agaricus*, *Polyporus* and *Lycoperdon* **Bryophytes**: *Riccia, Marchantia, Plagiochasma, Dumortiera* and *Polytrichum, Funaria*	26
III	**Pteridophytes**: *Psilotum, Lycopodium, Selaginella, Adiantum, Pteridium, Polypodium* and *Azolla*	6
IV	**Gymnosperms**: *Cycas, Pinus* and *Gnetum*	10
V	**Lichens**: *Usnea*	3
VI	**Fossil forms**: *Agalophyton* (*Rhynia), Calamites, Bothrodendron, Calamostachys, Lyginopteris, Heterangium, Cordaites,* and *Cardiocarpus*	6
VII	1-2 days study tour for the lower plant collection and identification. Processing and preparation of wet specimens of Algae, Fungi, Bryophytes, Pteridophytes and Gymnosperms.	-
	Total	64 Hrs

References

Reference Books:

1. Vashishta, K.M. 2008. Singa, A.K. and Singh, V.P. Algae. 9th Edition. S. Chand & Company Ltd, New Delhi. .
2. Vashista, P.C., Sinha, A.K. and Kumar, A. 2006. Gymnosperms. Revised Edition. S. Chand & Company Ltd, New Delhi.
3. Vashista, P.C., Sinha, A.K. and Kumar, A. 2005. Pteridophyta. Revised Edition. S. Chand & Company Ltd, New Delhi.
4. Sharma, P.D. 2005. Fungi and Allied Organisms. Narosa Publishing House, New Delhi.
5. Johri, R.M. 2005.Taxonomy. Vols. I-IV, Sonali Publication, New Delhi.
6. Pathak, C. 2003. Latest Portfolio of Theory and Practice in Bryophyta. Dominant Publishers and Distributors, New Delhi.
7. Raven PH, Mertens TR. Plant systematics: theory and practice. BSCS Pam. 1964-1965;23:1-36. PMID: 5870805.
8. Sporne. K.R., 1976. Morphology of Pteridophytes. 4th edition, B.I. Publication.
9. Gupta. M.N. 1972. The Gymnosperms (2nd Edition) Shiva Lal Agarwala & Co., Agra.
10. Parihar. N.S. 1967. An introduction of Embryophyta. vol. III Pteriodophyta. Central book depot, Allahabad.
11. Sporne. K. R. 1950. Morphology of Gymnosperms. Hutchinson University Library, USA.

Gamble, J.S. 1919-1925. The Flora of Presidency of Madras. Vol. I, II and III. Bishen Singh and Mahendra Pal Singh, Dehra Dun.

Course Outcomes

On completion of the course, students should be able to
CO1: identification of lower and higher plants with their salient features.

	CO2: develop skills in lower and higher plant identification CO3: Acquire overall knowledge of the identification of all groups of plants, including fossil CO4: Provides skill to identify the lower plants with specific key characters CO5:Acquire practical knowledge on the vegetative and reproductive characteristics of various plants

Semester	**First**	Course Code	**24BOTP0106**
Course Title	**Practical 2: ENVIRONMENTAL BIOLOGY & CELL AND MOLECULAR BIOLOGY**		
No. of Credits	2	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected (Minimum 20%)	40
Category	Core		
Scope of the Course (may be more than one)	1. Opportunity to understand the basic concepts of experiments in Environmental Biology and Molecular Biology 2. Exposure of students to approaches and techniques of Environmental Biology and Molecular Biology 3. Providing skills to handle the experiments in Environmental Biology and Molecular Biology		
Cognitive Levels addressed by the Course	K1- Emphasis on the importance of physicochemical parameters in the Environment K2- Understand the different parameters of the environment K3 - Analyze the importance of remote sensing, GIS and Environmental Education K4- Assess the different techniques in Molecular Biology K5 - Know the molecular techniques of isolation, separation and amplification of DNA		
Course Objectives (Maximum:5)	The Course aims • to estimate total dissolved solids, dissolved oxygen, carbon dioxide, total alkalinity, chloride, hardness in different water samples • to know the importance of BOD and COD in polluted water samples • to understand how to study the population of plants. • to understand Isolation, Separation and identification of genomic DNA to know the applications of molecular biology in plant sciences		
Unit	**Content**		**No. of Hours**
I	Estimation of Total Solids and Dissolved solids		3
I	Estimation of Dissolved oxygen		3
I	Estimation of Carbon dioxide		3
I	Estimation of Chloride		3
I	Estimation of Total hardness		3
II	Observation of the plant cell structure with onion peel-out		3
II	Microscopic views of cell organelles in plant cell ;Chloroplast (Hydrilla/ Thespesia leaf)		3
II	Separation of giant chromosomes (Chironomus larvae).		3
III	Nucleus (Onion peel out) Squash and Smear techniques (Mitosis in onion root tips; Meiosis in Rheo/ onion flower buds).		3
III	Isolation of plant organelles by centrifugation techniques (Demonstration)		6
III	Isolation of RNA from plant Materials (CTAB protocol) Demonstration).		6
IV	DNA isolation from Plant Materials (Onion, Papaya, Cauliflower) (Demonstration).		6
V	Regulation of gene expression (with the help of Models / Charts / Book diagram).		3
V	RFLP genetic Mapping (Demonstration).		6

Reference Books

1. P.K.Gupta 2012 Methods in Environmental Analysis Water, Soil and Air. Agrobios (India), Jodhpur.
2. APHA 2012 Standard Methods for the examination of water and waste water (20th Edition). American Public Health Association, Washington. D.C.
3. P.V.G.K. Sarma. 2021. Molecular Biology A Practical Manual. MJP publishers (First edition).
4. S.K.Gakhar. 2019. Molecular Biology:A Laboratory Manual. Dreamtech press.

On completion of the course, students should be able to

CO1 : Understand how to estimate Total Solids & Dissolved solids, Dissolved oxygen, Carbon dioxide, Chloride, and hardness in different water samples

CO2 : Understand how to estimate BOD and COD in polluted water samples

CO3 : Know the Isolation of genomic DNA from bacteria

CO4 : Know the separation and quantification of DNA

CO5 : Know the Amplification technique of DNA by PCR

24GTPP0001 – GANDHI IN EVERYDAY LIFE
(– 2 Credits - 2 Hours/wk.)

(The syllabus of this paper will be approved by the Department of Gandhian Thought and Peace Science)

Semester	**Second**	Course Code	**24BOTP0207**

Course Title	**BIOINSTRUMENTATION AND RESEARCH METHODS**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	5
Category	Core		
Scope of the Course (may be more than one)	1. Facilitate the students to understand the instrumentation techniques 2. Learn the fundamental and working principles of instruments 3. Understand the concept of research methodology.		
Cognitive Levels addressed by the Course	K1- Enrich the knowledge in the field of bioinstrumentation K2- Gaining factual ideas in bioinstrumentation and research methods K3- Application of recent instrumentation techniques in research K4- Focus on the working principles of instruments in the field of Biology K5- Developing competence and writing skills in thesis and publications K6- Promote and establish the research activities in the field of Zoology		
Course Objectives (Maximum:5)	The Course aims • To understand the principles and applications of ordinary and electron microscopes • To learn the techniques in isolation and separation of cell organelles, micro and macromolecules. • To imbibe the principle and applications of Electrophoresis, colorimetry and calorimeter • To understand the research methods, thesis writing and presentation • To learn the article publication, ethics and IPR.		

Unit	**Content**	**No. of Hours**
I	**Microscopy, pH and Buffer** Microscopy- Principle and Applications- Light, phase contrast, Confocal and Fluorescence – Electron Microscopy -SEM and TEM(Source: NPTEL) - pH basic principles – pH electrodes- Principles, application and preparation of common buffers- Citrate, acetate, tris and phosphate	11
II	Centrifugation and Chromatography Homogenization- Manual, mechanical and sonication- Centrifugation techniques- Basic principles, Different types of Centrifuges, Analytical and preparative ultracentrifugation methods (Source: NPTEL) – Chromatography- Paper, thin layer, Ion-exchange, column- separation of amino acids and sugars- Gas liquid chromatography, HPLC. Isolation of cellular constituents- Chloroplasts, mitochondria, nucleic acids and enzymes	13
III	**Electrophoresis, Colorimetry and Calorimeter** Electrophoresis- General Principles Horizontal & Vertical gel electrophoresis and immune electrophoresis (Source: NPTEL) -Electrophoresis of proteins and nucleic acids- Spectroscopic techniques- UV-Visible and FT-IR – Flame photometer, Bomb calorimeter, AAS, Mass Spectra, NMR – Principle and applications. Radioisotophic techniques	13
IV	**Research, Thesis writing and Presentation** Research- Definition, objectives, types and importance- Research methods in Biological Sciences- Research process- Literature and reference collection – sources- Role of Libraries in research-e-journals and e-books- Scientific databases- Indexing databases, Citation data bases: Web of Science, Scopus, Google Scholar-Research report writing- Parts of Thesis and Dissertation- Presentation in seminars and conferences	13
V	**Article Publication, Ethics and Intellectual Property Rights** Writing scientific paper- Organization of scientific paper- Publication in research journals-Standards of Research journals- Peer review-Types- Impact factor- citation index, h-index,i10 index-Preparation of manuscript- Proof correction- proof correction symbols- Method of correcting proof- Ethics in research-Plants and animals-Intellectual Property Rights- Origin and history of Indian Patent system-Basis of patentability- Patent application procedure in India.	14

References	Text Books
	1. L.Veerakumari.2019.Bioinstrumentation.MJP Publishers, Chennai.p.39-98;113-153;185-375. 2. C.R. Kothari and Gaurav Garg.2019. Research Methodology- Methods and Techniques. New Age International Publishers, New Delhi.pp.1-25. 3. Biju Dharmapalan 2012 Scientific Research Methodology. Narosa Publishing House, New Delhi. 4. S. Palanichamy and M. Shunmugavelu 2009. Research methods in biological sciences. Palani paramount publications, Palani

	5. G.R.Chatwal and S.K.Anand. 2014. Instrumental Methods of Chemical Anlysis. Himalaya Publishing House
	Reference Books 1. N. Gurumani 2010 Research Methodology for Biological Sciences. MJP Publishers, Chennai. 2. G.H. Mitchell 2017. Gel Electrophoresis: Types, Applications and Research.Nova Science Publishers Inc 3. B.K.Sharma 2014 Instrumental Method of Chemical Analysis. Krishna Prakashan Media(P) Ltd. 4. Sahu, P.K. 2013. Research Methodology: A Guide for Researchers in Agricultural Science, Social Science and other related fields. Springer, New Delhi. 5. Keith Wilson and John Walker 2002 Practical biochemistry – Principles and techniques. Fifth Edn. Cambridge Univ. Press.
	E-Resources 1. http://nptel.ac.in/syllabus.php?subject Id= 102107028. 2. http://b-ok.xyz/book/674611/288bc3 3. http://www.researchgate.net/publication/317181728- Lecture Notes on LaboratoryInstrumentation and Techniques. 4. iiscs.wssu.edu/drupal/node/4673 5.http://www.studocu.com/en/search/research methodology?languages=language_en&type =document *(NPTEL) -National Programme on Technology Enhanced Learning.
Course Outcomes	On completion of the course, students should be able to CO1: Enabling the students to understand the principles and applications of different types of microscopes, pH meter and buffers. CO2: Providing excellence in isolation and separation techniques. CO3: Enhance the application and separation techniques of various micro and macromolecules CO4: Explain the basic information on research methods CO5: Crate awareness on the importance of article publication and IPR.

Semester	**Second**	Course Code	**24BOTP0208**
Course Title	**PLANT PHYSIOLOGY, BIOPHYSICS AND BIOCHEMISTRY**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected (Minimum 20%)	50
Category	Core		
Scope of the Course (may be more than one)	1. Comprehend the mechanism of physiology and biochemistry of plants 2. Realize the physical mechanism of light and the role of biomolecules in system physiology 3. Motivate the students to understand the biochemistry and physiology of plants to become Plant Scientists		
Cognitive Levels addressed by the Course	K1- Motivate to understand the basics and advancement of plant physiology K2- Realize the various physiological and biochemical pathways of plants K3- Understand the role of light in the photosynthesis of plants K4- Gain the knowledge from this paper to appear in national-level competitive exams K5- Utilize the knowledge acquired through this paper in various botanical research		
Course Objectives (Maximum: 5)	**The Course aims** • To understand the physiological mechanism of plants • To study the various biochemical pathways of plants • To create knowledge on the role of light in plants • To explain the enzymes, nitrogen and fat metabolismin plants • To acquire knowledge on growth and development & stress physiology of plants.		

Unit	Content	No. of Hours
I	**Plant-water relations** Water relations in plants: physical and chemical properties of water – imbibition, diffusion, osmosis, component of water potential. Transpiration and evapotranspiration - Stomatal structure and function – stomatal opening and closing mechanism. Water absorption by root - Apoplast and symplast concept – water transport through the xylem. Mineral nutrients and deficiency symptoms, mineral ion uptake. Various mechanisms of solute transport. Organization conducting tissue, source-sink relation – phloem loading and unloading – theories of translocation.	14
II	**Photosynthesis** Photosynthesis: structure of photosynthetic machinery; Light harvesting protein complex; light absorption and photosynthetic electron transport; Emerson enhancement effect; cyclic, non-cyclic and pseudo-cyclic photophosphorylation. Oxygen Evolving Complex (OEC), photosynthetic carbon reduction cycles (PCR cycles): C3, C4 and CAM pathway, Respiration and its significance.	14

	Structure and function of Rubisco and PEP Carboxylase	
III	**Biophysics** Bioenergetics: laws of thermodynamics, Enthalpy, entropy and free energy, free energy changes of chemical reaction. Oxidation - redox reactions in biological systems and their importance, oxidation-reduction potential -Redox couple, redox potential, standard redox potential. ATP bioenergetics, NADP/NADPH redox couple bioenergetics, mitochondrial and chloroplast bioenergetics. Energy states, de-excitation. Light emission; fluorescence, Phosphorescence and Bioluminescence.	11
IV	**Enzymes, Nitrogen and fat metabolism** Major classes of enzymes - Oxidoreductases, Transferases Hydrolases, Lyases, Isomerases and Ligases. Concept of active site, mechanism of enzyme action: Michaelis-Menton equation. Classification of protein, significance. Essential and non-essential amino acids, Nitrogen metabolism: No_3, No_2 and NH_3 assimilation, nitrogen fixation; symbiotic and asymbiotic. Lipids: Classification and importance, lipid metabolism; β-Oxidation and Glyoxalate cycle.	11
V	**Growth and development & Stress physiology** Plant hormones – Biosynthesis, storage, breakdown and transport; Physiological effects and mechanisms of action; Vernalisation.Seed biology; Photoperiodism and biological clocks; Sensory photobiology - Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins. Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses	14
References	**TextBooks**: 1. Pandey, S.N. and Sinha, B.K. 2009. Plant Physiology. IV Edition, Vikas Publishing company, Noida, UP. 2. Sinha, S. K. 2004. Modern Plant Physiology. Narosa publishing House, New Delhi, Chennai, Mubai. 3. Verma, S. K. 1995. A text book of Plant Physiology and Biochemistry. S. Chand & Company Ltd. Ram Nagar, New Delhi. 4. Taiz, L. and Zeiger, E. 2002.Plant Physiology, III Edition Sinauer Associates. 5. Noggle, G.R. and Fritz, G.J. 2001, Introductory Plant Physiology, Prentaice - Hall, India.Hopkins, W.G., 1999. Introduction to plant physiology (No. Ed. 2). John Wiley and Sons. 6. Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A., 2015. Plant physiology and development (No. Ed. 6). Sinauer Associates Incorporated.JainVK, 2008. Fundamentals of Plant Physiology.S Chand and Co. 7. Kochhar P L, Krishnamoorthy H N. Plant Physiology. Atmaram and sons, Delhi. 8. Malik CP, 2002. Plant Physiology. Kalyani publishers. 9. Mukherjii S, Ghosh AK, 2005. Plant Physiology. New Central Book Agency, Calcutta. 10. Noggle GR, Fritz GJ, Introductory Plant Physiology, Prentice Hall of India. 11. Pandey SN, Sinha BK, 2006. Plant physiology. Vikas Publishing House, New Delhi. 12. Salisbury F B, Ross C W, 1992. Plant Physiology. CBS publishers and distributors, New Delhi. 13. Sinha A K, 2004. Modern Plant Physiology. Narosa Publishing House, New Delhi. 14. Srivastava H S, 2004. Plant physiology and Biochemistry. Rasthogi publications. **Reference Books** 1. Devlin, R.M., 2000, Plant Physiology, Affiliated East West Press Pvt. Ltd. 2. Epstein, E. 2000, Mineral Nutrition in Plants-Principles and Perspectives. 3. John Charles Walker,1997. Plant Physiology. McGraw Hill Book Company, New York. 4. Devlin and Witham, 1996. Plant Physiology. CBS Publishers and Distributors, Delhi. 5. Mukhevji, S. and Ghosh, A. K. 1996. Plant Physiology. Tata McGraw- Hill publishing Company Ltd. New Delhi. 6. Hopkins W G, Norman P A, Huner, 2008. Introduction to Plant Physiology. John Wiley & Sons, 2. Lincoln Taiz, Eduardo Zeiger, 2015. Plant physiology and Development (VI Edn). Sinauer Associates Inc. 8. Noggle, G.R. and Fritz, G.J., 1983. Introductory plant physiology (No. Ed. 2). Prentice-Hall Inc. 9 . Meyer, B.S., Anderson, D.B. and Bohning, R.H., 1960. Introduction to plant physiology. Introduction to plant physiology. 10 .Curits, O.F. and Clark, D.G., 1951. An introduction to plant physiology (Vol. 71, No. 1, p. 78). LWW. 11. Taiz, L. and Zeiger, E., 1998. Plant Physiology pp.544-557 and 564-571, 2nd edition, Sinauer Associates, Sunderland, Mass. 12. Dey P.M., Harborne J. B., eds. (1997) Plant Biochemistry, Academic Press, San Diego. 13. Lea P.J., Leegood R.C. 1993. Plant Biochemistry and Molecular Biology, Wiley. 14. Buchanan B.B., Gruissem W., Jones R.J. 2000. Biochemistry and Molecular biology of plants, American Society of Plant Physiologists, M.D. 15. Taiz and Zeiger.2002. Plant Physiology.pp.519-538, 3rd edition, Sinauer Associates, Inc., Publishers. 16. Davies, P.J ed. 1995. Plant Hormones and their Role in Plant Growth and Development, pp. 118-139; 372-394;486-508, Kluwer, Dordrecht. **Web sources** • https://www.easybiologyclass.com/plant-physiology-free-lecture-notes-online-tutorials-lecture-notes-ppts-mcqs/ https://www.biologydiscussion.com/notes/plant-physiology-notes/lecture-notes-on-plant-physiology/34647	

	• https://www.brainkart.com/article/Theories-of-Translocation-for-Plant---Passive-absorption-and-Active-Absorption_948/ • https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/oxygen-evolving-complex • https://pubmed.ncbi.nlm.nih.gov/18294858/ • https://en.wikipedia.org/wiki/Laws_of_thermodynamics • https://www.ncbi.nlm.nih.gov/books/NBK9911/#:~:text=Mitochondria%20are%20responsible%20for%20generating,2%20and%20H2O. • https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/glyoxylate-cycle https://onlinelibrary.wiley.com/doi/pdf/10.1562/0031-8655(2000)0710001PCPPII2.0.CO2
Course Outcomes	On completion of the course, students should be able to do CO1: Predict the physiological phenomena of plants in terms of mechanisms CO2: Identify the overview of biorhythms CO3: Critique the different metabolic pathways CO4: Analyse the nitrogen and lipid metabolism CO5: Compare the structure and metabolism of Primary and Secondary biomolecules.

Semester	**Second**	Course Code	**24BOTP0209**
Course Title	**ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected (Minimum 20%)	30
Category	Core		
Scope of the Course (may be more than one)	1. Acquire knowledge on various aspects of the Anatomy and embryology of Angiosperms 2. Utilize the knowledge of this paper to solve the problems in other botanical issues 3. Make use of this knowledge for preparation of other competitive examinations		
Cognitive Levels addressed by the Course	K1- Motivate to understand the basics and advancement of plant anatomy and morphogenesis K2- Realize the various aspects of plant anatomy and embryology K3- Understand the role of anatomy and embryology in solving the issues in botanical sciences K4- Expand the knowledge acquired from this paper to utilise in national-level competitive exams K5- Realize the importance of plant anatomy in herbal medicine preparation		
Course Objectives (Maximum: 5)	**The Course aims** • To understand the phytotomy of primary and secondary structures • To know the organisation, Structure and function of meristems • To understand the organisation of shoot and root apical meristems • To evaluate the process of Microsporogenesis and pollen development • To acquire knowledge on pollination and embryo development.		

Unit	**Content**	**No. of Hours**
I	**Anatomy** Cell- structure and components; Organization and types of tissues. Anatomy of root (Primary and Secondary Structure of Mono and Dicots). Anatomy of Stem; Primary, Secondary structure of Monocots and Dicots; and Anomalous structure of *Boerhaavia* and *Dracena*. Anatomy of leaf and petiole. Nodal Anatomy, Anatomy of Seed. Ecology in relation to Anatomy: brief note on adaptation of hydrophytes, xerophytes and halophytes.	14
II	**Morphogenesis** Plant morphogenesis: Meristems – types; Theories and organization of shoot and root apical meristem; shoot and root development; Root - stem transition; floral development in *Arabidopsis* and *Antirrhinum;* leaf development and phyllotaxy; transition to flowering, floral meristems. Molecular mechanism of shoot & Root morphogenesis (Root Apical Meristem and Shoot Apical Meristem).	12
III	**Cambium and wood:** Cambium: Origin, Structure, function and factors affecting cambial activity; Wood: structure, physical and mechanical properties, reaction - wood, compression and tension wood, preservation of wood.Use of ICT tools: Artificial intelligence, Pattern Recognition, Image processing techniques for visualization plant cells.	18
IV	**Microsporogenesis and Megasporogenesis** Microsporogenesis: Anther and Pollen development - physiological relationship of tapetum and sporogenous tissues, pollen viability, pollen storage and pollen germination. Megasporogenesis; Female gametophyte development, structure and types of embryosac ; Monosporic - Bisporic and Tetrasporic - Nutrition of embryo sac; structure of pistil.	11

V	**Pollination and post-pollination évents** Pollination; types, pollen - pistil interactions, Double fertilisation; Endosperm types : Nuclear, cellular, helobial and ruminate endosperms. Development of monocot and dicot embryos. Incompatibility;sporophytic and gametophytic incompatibility. Methods to overcome incompatibility. Apomixis; genetics of Apomixis , polyembryony: types and importance. Apospory - role in plant improvement programs and seed development.	9
	Textbooks : 1. Bhojwani, S.S. and Bhatnagar, S.P. 2008. The Embryology of Angiosperms. V Edition, Vikas publishing house Pvt Ltd., Noida, India. 2. Gupta, P.K. 2002. Cytology, Genetics, Evolution and Plant breeding. Deep and Deep Publications, New Delhi. 3. Pandey, S.N. and Chadha, A. 2000. Embryology. Vikas Publishing House, New Delhi. 4. Pandey, B.P. 1995. Embryology of Angiosperms. S. Chand & Company Ltd., New Delhi. 5. Pandey, B.P. Plant Anatomy, 2004. S. Chand & Company Ltd., New Delhi. 6. Burgess, J. An Introduction to Plant Cell Development. Cambridge University Press, Cambridge, 1985. 7. Fageri, K. and Van der Pijl, L. The Principle of Pollination Ecology. Pergamon Press, Oxford, 1979. 8. Fahn, A. Plant Anatomy. (3rd edition). Pergamon Press, Oxford, 1982. 9. Fosker, D.E.Plant Growth and Development. A Molecular Approach. Academic Press, San Diego, 1994. 10. Howell, S.H. Molecular Genetics of Plant Development. Cambridge University Press, Cambridge, 1998. **Reference Books** 1. Kierman, J.A. 1999. Histological and Histochemical methods. Butterworth Publications, London. 2. Fahn, A. 1989. Plant anatomy. Peragamon Press, Oxford, New York. 3. Esau, K. 1987. The Anatomy of seed plants. Wiley Eastern Ltd, New Delhi. 4. Maheswari, P. 1950. An introduction to embryology of Angiosperms. McGraw hill, New York. 5. Atwell, B.J. Kriedcrmann, P.E. and Jumbull, C.G.N. Plants in Action: Adaption in Nature Performance, in Cultivation, MacMillan Education. Sydney, Australia, 1999. 6. Bewley. J.D. and Black, M. Seeds: Physiology of Development and Germination, Plenum Press. New York, 1994. 7. Leins, P., TucKer, S.C. and Endress, P.K. Aspects of Floral Development, J. Cramer, Germany, 1988. 8. Lyndon, R.F. Plant Development. The Cellular Basis, UnninByman, London, 1990. 9. Murphy, T.M. and Thompson, W.E. Molecular Plant Development. Prentice Hall, New Jersey, 1988. 10. Proctor, M. and Yeo, P. The Pollination of Flowers. William Collins Sons, London, 1973. 11. Raghavan, V. Molecular Embryology of Flowering Plants. Cambridge University Press, Cambridge, 1997. 12. Raghavan, V. Developmental Biology of Flowering Plants. Springer-Verlag, New York, 1999. 13. Raven, P.H., Evrt, R.F. and Eichhorn, S. Biology of Plants (5th edition). Worth, New York, 1992. 14. Salisbury, P.B. and Ross, C.W. Plant Physiology (4th edition). Wadsworth Publishing, Belmont, California, 1992. 15. Steeves, T.A. and Sussex, I.M. Patterns in Plant Development (2nd edition). Cambridge University Press, Cambridge, 1989. 16. Sedgely, M. and Griffin, A.R. Sexual Reproduction to Tree Crops. Academic Press, London, 1989. 17. Shivanna, K.R. and Sawhney, VK. Pollen Biotechnology for Crop Production and Improvement. Cambridge University Press, Cambridge, 1997. 18. Shivanna, K.R. and Rangaswamy, N.S. Pollen Biology : A Laboratory Manual. Springer Verlag. Berlin, 1992. 19. Shivanna, K.R. and Johri, B.M. The Angiosperm Pollen : Structure and Function. Wiley Eastern Ltd.. New York, 1895. **Web resources** https://www.rlsycollegebettiah.ac.in/wp-content/uploads/2023/02/file_63e39d4bc14b7.pdf https://cmpcollege.ac.in/wp-content/uploads/2020/04/e-study-Theories-of-root-shoot-apices.pdf https://www.ncbi.nlm.nih.gov/pmc/articles/PMC160352/pdf/051183.pdf https://mgcub.ac.in/pdf/material/202004300509276c475952aa.pdf	
Course Outcomes	CO1:Analyse the structural elements of plants' meristems, organogenesis and embryology CO 2: Demonstrate the micro and mega sprogenesis; sexual incompatibility, types of endosperm CO3 :Outline the combined knowledge with special emphasis on microtechniques. CO4: Evaluate the different modes of Pollination in Plants CO5: Critique the Knowledge on Primary and secondary anatomical Structure of plants.	

Semester	**Four**	Course Code	**24BOTP0210**
Course Title	**ADVANCED BIOSTATISTICS**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	New Course	If revised, Percentage of revision effected	-
Category	Core		
Scope of the Course (may be more than one)	1. It helps researchers determine sample sizes and designing scientific experiments 2. Choose appropriate statistical methods based on the data type 3. Biostatistical techniques to draw conclusions about populations based on sample data		
Cognitive Levels addressed by the Course	**K1**- Understanding advanced concepts in Bio-Statistics **K2**- Comprehending statistical measures in the biological data analysis **K3**- Ability to interpret the statistical inference		
Course Objectives	The Course aims • To be familiar with summarize statistics and its applications in biology • To develop proficiency in carrying out multivariate statistical analyses efficiently. • To understand the impact of sampling variability on decision-making. • To evaluate treatment effects, group differences, and associations. • To identify scenarios where nonparametric approaches are appropriate		

Unit	Content	No. of Hours
I	**Basics of Biostatistics:** Definition and Applications of Biostatistics. Descriptive and Inferential Statistics. Level of Measurement. Descriptive Statistics: Measures of central tendency and dispersion. Frequency distribution and graphical representation of data.	8
II	**Multivariate Analysis:** Correlation – Concept – Types – Simple Correlation - Karl Pearson and Spearman rank - Multiple Correlation (Three variables). Regression – Concept – Types – Simple linear and Multiple Linear (Three variables) regression.	6
III	**Sampling Distribution and Hypothesis Testing:** Sampling distribution – Student t distribution, F distribution, $\chi 2$ distribution – Applications and properties - Basic concepts and types of hypotheses – Standard error - Type I and II error – Level of significance – Confidence Interval – Testing procedure.	8
IV	**Parametric Test:** Large sample tests - Tests for single mean and difference between two means, confidence intervals for mean(s), Test for single proportion and difference between two proportions. Small sample tests - Test for single mean and difference between two means, paired t – test, $\chi 2$ test, F – test. ANOVA: one-way and two-way classification.	12
V	**Non-Parametric Test:** One sample test - Run test, Sign test and Wilcoxon-Signed Rank tests (single and paired samples). Two independent sample tests - Median test, Wilcoxon, Mann-Whitney U test. Kruskal-Wallis test, Friedman's Rank test.	12

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1. Gupta. C.B, An Introduction to Statistical Methods, New Delhi: Vikas Publishers, (23rd Ed), 2004.
2. Gupta. S.P, Statistical Methods, New Delhi: Sultan Chand, 2017.
3. Goon, A.M., M. K. Gupta and B. Das Gupta, Fundamentals of Statistics- Vol. II., World Press, Ltd, Kolkata. 2016.
4. Hogg. R.T. and A.T. Craig. A.T, Introduction to mathematical Statistics, (7thEd), 2012.
5. Rangaswamy, A Textbook of Agricultural Statistics, (3rd Ed), New Age International Publishers, New Delhi, 2020.

Reference Books

1. Qazi Shoeb Ahmad, Viseme Ismail, Biostatistics, University Science press, new Delhi, (1st Edition), 2008.
2. Rohatgi, V. K. and Md. Ehsanes Saleh. A.K, An Introduction to Probability Theory and Mathematical Statistics, 2nd Edition, Wiley Eastern Limited, New Delhi, 2009.
3. Siegel, Sideny, Non-Parametric Statistics for Behavioral Sciences, New Delhi: MCGraw Hill, 2006.
4. Verma B.L, Shukla G.D and Srivastava.R.N, Biostatistics – Perspectives in Health Care; Research and Practice, New Delhi: CBS Publishers & Distributors, 1993.
5. Veer Bala Rastogi, Biostatistics, Medtech publication, (3rd revised Edition), 2017.

E-Resources

1. https://www.biostat.washington.edu/about/biostatistics
2. http://sphweb.bumc.bu.edu/otlt/MPH-Modules/BS/BS704_BiostatisticsBasics
3. https://www.edx.org/course/biostatistics-0

	4. https://www.agrimoon.com/wp-content/uploads/Statistics.pdf 5. https://www.coursera.org/courses?query=biostatistics
Course Outcomes	On completion of the course, students should be able to
	On completion of the course, students will be able to do the following: **CO1**: Get acquainted with advanced concepts of statistics and its relevance subject. **CO2**: Known about the various sampling techniques to real-world scenarios. **CO3**: Acquire knowledge distributions and hypothesis testing allows drawing meaningful conclusions from data **CO4**: Interpret from the various estimation and parametric hypothesis testing procedures covered. **CO5**: Suitable scenarios chose to data non-normal conditions, select other tests.

Semester	**Second**	Course Code	**24BOTP0211**
Course Title	**PRACTICAL-III: BIOINSTRUMENTATION AND RESEARCH METHODS, PLANT PHYSIOLOGY, BIOPHYSICS & BIOCHEMISTRY, ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS**		
No. of Credits	2	No. of contact hours per week	4
New Course/ Revised Course	New Course	If revised, Percentage of revision effected (Minimum 20%)	-
Category	Core		
Scope of the Course (may be more than one)	1. Comprehend the mechanism of physiology and biochemistry of plants 2. Realize the importance of understanding of Genetics 3. Motivate the students to understand the physiology, biochemistry and anatomy and embryology of plants to become Plant Scientists		
Cognitive Levels addressed by the Course	K1- Motivate to understand various techniques of plant physiology K2- Realize the various physiological and biochemical pathways of plants by different techniques K3- Understand the role of physiology, biophysics and biochemistry in the growth of plants K4- Gain the knowledge from this paper to improve the knowledge of genetics and genomics K5- Utilize the knowledge acquired through this paper in anatomy and Embryology		
Course Objectives (Maximum: 5)	**The Course aims** •To develop skills in quantitative and qualitative analysis of various biochemical components of plants •To estimate the various biochemicals and their importance to the physiology of plants •To understand the aspects of cell biology and genetics •To analyse the role of biochemicals in the physiological mechanism of plants. •To develop practical skills in physiology, biochemistry, anatomy, embryology, genetics and genomics		

Experiment no.	**Content**	**No. of Hours**
1.	Preparation of buffers and determination of pH	4
2.	Separation of plant pigments by thin-layer chromatography	6
3.	Separation of amino acids by paper and thin layer chromatography	6
4.	Demonstration of Gel Electrophoresis	6
5.	Demonstration of PCR technique (Virtual mode)	6
6.	Estimation of total carbohydrates in plant tissues (sugars/starch)	6
7.	Estimation of protein and lipid in plant tissues	5
8.	Estimation of chlorophyll content of C3 and C4 plants	4
9.	Extraction of chlorophyll from leaves and preparation of the absorption spectrum of pigments	4
10.	Primary and secondary anatomical sections of monocot and dicot stem and Root	4
11.	Anomalous secondary thickening in *Boerhhavia* and *Dracena*	5
12.	Observation of embryo development in monocot	4
13.	Observation of embryo development in dicot	4
	Total	64
References	**TextBooks**: 1.Palanivelu, P. 2009. Analytical biochemistry and separation techniques. IV Edition Twenty-first century publication, Madurai.	

	2. Sawhney, S.K. and Randhir Singh, R. 2000. Introductory Practical Biochemistry Narosa Publishers, New Delhi. Reference Books 3. Harborne, J.B., 1998. Phytochemical Method. Springer (India) Pvt. Ltd., New Delhi, 1998. 4.Bhatacharya, D. 2003. Experiments in Plant Physiology, Narosa Publishing House, New Delhi. 5. Sadasivam, S. and Manickam, A. 1992. Biochemical Methods for Agricultural Science. Wiley Eastern Limited, New Delhi. 6. Mannar Mannan, R. 1989. A Short Term Course Manual in Plant Physiology for College Teachers. Madurai Kamaraj University, Madurai. **Web resources** • https://www.youtube.com/watch?v=DwAFZb8juMQ • https://www.youtube.com/watch?v=ej2zXOwASVI • https://www.youtube.com/watch?v=OlgCIxMZRtw • https://www.youtube.com/watch?v=jNJqlanhj5w • https://www.youtube.com/watch?v=usFaPDOFFHM • https://www.youtube.com/watch?v=d1QHWdTpax8	
Course Outcomes	On completion of the course, students should be able to do CO1: Analyze the physiology and biochemistry of plant samples CO2: Explain the photosynthetic mechanism and related events of plants CO3: Demonstrate the components of the cells CO4: Evaluate the knowledge of genetics in biological system CO5: Identify the importance of physiology, biochemistry, anatomy, embryology, and genetics	

24ENGP00C1 – COMMUNICATION AND SOFT SKILLS
(Soft Skills Course – Compulsory Non Credit course – 2 Credits - 2 Hours/wk.)
(For all PG students except MA ECS students)

(The syllabus of this paper will be approved by the School of English & Foreign Languages)

Semester	**Third**	Course Code	**24BOTP0313**
Course Title	**GENETICS AND GENOMICS**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	New Course	If revised, Percentage of revision effected (Minimum 20%)	-
Category	Core		
Scope of the Course (may be more than one)	1. Understand the various aspects of genetics and genomics 2. Realize the importance of studying genetics in various health disorders 3. Motivate the students to understand the different aspects of genetics and genomics to prepare for National level competitive examinations		
Cognitive Levels addressed by the Course	K1- Understand the basics and advancement of classical and modern genetics K2- Realize knowledge of the organization of genes and chromosomes K3- Understand the role of genetics in solving the issues in biological sciences K4- Expand the knowledge of genetics and genomics to utilize in national-level competitive exams K5- Realize the importance of genetics and genomics in the medical field		
Course Objectives (Maximum: 5)	**The Course aims** • To evaluate the Mendelian principles • To demonstrate the importance of extrachromosomal inheritance and human genetics • To analyse the various aspects of Modern genetics • To create broad knowledge of Genomics in relation to biological research • To explain the details of Proteomics in relation to biological research		

Unit	**Content**	**No. of Hours**
I	**Mendelian genetics** Mendelian principles: Dominance, segregation, independent assortment: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy. Linkage and crossing over, mechanism of crossing over, sex limited and sex influenced characters. Multiple alleles, pseudo-allele, complementation tests. Sex determination and Sex-linked inheritance. Concept of the gene; Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, Eugenics - human betterment.	13

II	**Extra chromosomal inheritance and human genetics** Extra chromosomal inheritance: inheritance of mitochondrial and chloroplast genes, maternal inheritance. Cytoplasmic inheritance; Predetermination - Virus-like inclusions and infective particles, milk factor, kappa particles, plastid inheritance. Structural and numerical alterations of chromosomes: deletion, duplication, inversion, translocation, ploidy and their genetic implications. Human genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders. Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping.	13
III	**Mutation and Modern genetics** Nature of Mutations, types of mutations, methods of detection of mutation: Ames test, CIB method and attached method, Molecular mechanism of spontaneous mutation. Mutagenic effects of food additives and drugs. DNA damage and repair. Homeotic mutants in *Arabidopsis* and *Antirrhinum*. Transposable elements and their types. Induced mutations, site-directed mutagenesis.	14
IV	**Genomics** Introduction to Genomics, Transcriptomics, Proteomics, Metabolomics and single-cell genomics. Genome sequencing, Whole genome shotgun sequencing, Physical mapping of genomes, Clone-by-clone sequencing, new generation sequencing technologies, Bioinformatics tools to analyse genomes, Examples of sequenced genomes (*Saccharomyces*, *Drosophila* and *Arabidopsis*)	12
V	**Proteomics** Protein isolation and identification methods SDS -PAGE, Isoelectric focusing, 2D gel electrophoresis, Peptide sequencing, Mass Spectrometry methods used in proteomics, Peptide databases, Immunological methods to study protein functions, Protein-protein and Protein-DNA interactions, Comparative proteomics, subcellular proteomics, quantitative proteomics	12
References	**TextBooks**: 1. Verma, P.S. and Agarwal, V.K. 2004. Cell biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand & Company Ltd. New Delhi. 2. Gupta and Jains, 1991. The Cell and Biotechnology, 1st Edition, Agro Botanical Publication, New Delhi. 3. Benjamin A. Pierce. 2012. Genetics- A conceptual Approach. W.H. Freeman and Company, New York, England. 4. Lesk AM (2017). Introduction to Genomics. Oxford University press. Oxford, UK. 5. Twyman R (2013). Principles of Proteomics. Garland Science, Taylor & Francis Group, LLC, New York, USA. **Reference Books** 1. Eldon J. Gardner. 2004. Principles of Genetics 8th edition, John Wiley and Sons, New York. 2. Molecular Genetics of Bacteria, 4th Edition- (2013)-Larry Snyder, Joseph E. Peters, Tina M. Henkin, Wendy Champness. ASM press. 3. Lewin's Genes XII (2017)-Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick. Jones and Bartlett Publishers, Inc. 4. Hilde de Reuse, Stefan Bereswill (2009). Microbial Pathogenomics. Karger Medical and Scientific Publishers, Switzerland. 5. Proteomics- From peptide sequence to Function: SR Pennington and MJ Dunn (2002). **Web resources** http://xgu.zool.iastate.edu http://www-cse.ucsd.edu/groups/bioinformatics/GRIMM/ http://www.cs.unm.edu/~moret/GRAPPA/	
Course Outcomes	On completion of the course, students should be able to do CO1: Explain the structure and function of cell and its organelles CO2: Understand the mechanism of Cell signaling CO3: Compare knowledge on Cell division and cell cycle CO4: Analyse the concept of proteomics, genomics and metabolomics. CO5: Determine the various bioinformatic tools used to analyze the genomes.	

Semester	**Third**	Course Code	**24BOTP03014**
Course Title	**ANGIOSPERMS SYSTEMATICS AND ECONOMIC BOTANY**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	New Course	If revised, Percentage of revision effected (Minimum 20%)	-
Category	Core		
Scope of the Course (may be more than one)	1. Understand the basic and advanced aspects of angiosperm Systematics 2. Acquire knowledge of various aspects of angiosperm taxonomy 3. Motivate the students to understand the various aspects of plant taxonomy to become Plant taxonomists		

Cognitive Levels addressed by the Course	K1- Inculcate basic and advancement of angiosperm taxonomy K2- Realize the various issues on angiosperm taxonomy K3- Mull over the techniques to solve the problems in botanical nomenclature K4- Expertise in the identification of various angiosperm families. K5- Realize the importance of angiosperm taxonomy on various nomenclatural issues
Course Objectives (Maximum: 5)	**The Course aims** • To compare the various systems of classification proposed in plants • To analyse the various aspects of plant nomenclature and classification • To understand the classical and modern trends of Angiosperm taxonomy • To study the salient features of angiosperm families with special reference to sexual characters • To analyse the salient features of angiosperm families with special reference to sexual characters.

Unit	Content	No. of Hours
I	**Introduction to plant taxonomy** History of plant classification; Detailed study on the sexual system: Carolus Linnaeus; Natural system: G.Bentham & J.D.Hooker; Phylogenetic systems: C.E.Bessey; J. Hutchinson; Angiosperm Phylogenic Group: Brief outline of Angiosperm Phylogeny group; APG - I (1998), APG - II (2003), APG - III - (2009), AGP-IV (2016). Construction of taxonomic keys: Indented and bracketed keys. Concepts of Taxonomic Hierarchy – Species concept	13
II	**Botanical nomenclature** ICBN: International Code of Botanical Nomenclature (Brief account); ICN; International code of nomenclature for algae, fungi, and plants; Principles, Rules and recommendations, provision for governance.Type methods; Author citation; Retention and rejection of names; Publication of names; Effective and valid publication. Methods of Herbarium preparation	12
III	**Taxonomy related to allied sciences** Plant Taxonomy in relation to morphology, anatomy, Palynology, Embryology. Chemotaxonomy, Numerical taxonomy, Sero taxonomy. Molecular taxonomy; DNA barcoding – Molecular markers in taxonomy; Computer applications in plant systematics; e-floras; Virtual herbaria. Origin and evolution of angiosperms.	15
IV	**Systematic study of Basal angiosperms, Magnoliids, Eudicots &** Core Eudicots Morphological features, description and economic Botany of the following families, Basal angiosperm - Nymphaeaceae, Magnoliids: Myristicaceae, Lauraceae. Lillidae (Monocots): Lilliaceae. Commelinids: Arecaceae Commelinaceae, Orchidaceae and Poaceae. Eudicots: Ranunculaceae. Core Eudicots: Super Rosids; Malvids; Malvaceae, Myrtaceae, Sapindaceae Portulacaceae, Rubiaceae, Apocynaceae, Bignoniaceae,	14
V	**Systematic study of Core Eudicots; Super Rosids & Super Asterids** Morphological features, description and economic Botany of the following families – Core Eudicots: Super Rosids; Fabid; Cucurbitaceae, Fabaceae, Combretaceae, Lythraceae, Meliaceae, Super Asterids; Asterids; Lamiids: Lamiaceae, Solanaceae, Gentianaceae. Campanulids; Asteraceae, Apiaceae	10

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2. Sharma, O.P., 1993. Planttaxonomy. Tata McGraw-Hill Education.
3. Mondal, A.K. 2005. Advanced Plant Taxonomy. New Central Book Agency (P) Ltd., New Delhi.
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6. Subramanyam, N.S.1999. Modern Plant Taxonomy. Vikas Publishing House, New Delhi.
7. Stace, C.A., 1991. Plant taxonomy and biosystematics. Cambridge University Press.
8. Sivarajan, V.V. (Ed. Robson). Introduction to Principles of Plant Taxonomy Lawrence, G.H.M., 1955. An introduction to plant taxonomy. An Introduction to Plant Taxonomy.
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2. Pullaiah, T. 2007. Taxonomy of Angiosperms. 3rd Edition, Regency Publication, New Delhi.
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4. Lawrence: Taxonomy of Vascular Plants
5. Douglas C. Daly, Kenneth M. Cameron, Dennis W. Stevenson, Plant Systematics in the Age of

Genomics, *Plant Physiology*, Volume 127, Issue 4, December 2001, Pages 1328–1333.
6. Donovan Bailey, C., 2008. Plant Systematics: A Phylogenetic Approach.
7. Raven PH, Mertens TR. Plant systematics: theory and practice. BSCS Pam. 1964-1965; 23:1-36.
8. Cronquist, R. The Evolution and classification of flowering plants (1988)
9. Cronquist 1981. An integrated system of classification of flowering plants
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13. Henry & Chandrabose. An aid to International Code of Botanical Nomenclature
14. Dunn, C. and B.S. Veritt. An introduction to Numerical Taxonomy
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- https://www.iapt-taxon.org/nomen/main.php#:~:text=The%20 International%20Code%20of%20Nomenclature, chytrids%2C%20oomycetes%2C%20slime%20moulds%2C
- https://biologyboom.com/introduction-to-plant-systematics/
- https://courses.botany.wisc.edu/botany_400/Lecture/0pdf/01Introduction.pd
- https://biocyclopedia.com/index/plant_systematics.php
- https://byjus.com/neet/important-notes-of-biology-for-neet-plant-taxonomy/
- https://www.biologydiscussion.com/essay/angiosperms-essay/taxonomy-of-angiosperms-aims-and-principles-essay-botany/76587 https://www.mobot.org/mobot/research/apweb/

On completion of the course, students should be able to
CO1: Describe the types; merits & demerits of various systems of classification
CO2: Compare the classical plant taxonomy with modern molecular phylogeny
CO3: Assess the concepts of and applications of phylogeny of Angiosperms
CO4: Critique the norms of ICBN and the Construction of keys
CO5: Identify the angiosperms families with specific key characters.

Semester	**Third**	Course Code	**24BOTP0315**
Course Title	**PLANT ECOLOGY, PHYTOGEOGRAPHY AND BIODIVERSITY CONSERVATION**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	New Course	If revised, Percentage of revision effected (Minimum 20%)	-
Category	Core		
Scope of the Course (may be more than one)	1. Facilitate the students to understand the ecological significance of plants and Biodiversity 2. Understanding the various issues related to plant ecology and phytogeography 3. Acquire knowledge of Biodiversity and conservation to prepare for various competitive examinations		
Cognitive Levels addressed by the Course	K1- Enrich the knowledge of plant ecology K2- Gaining factual ideas on the phytogeographical significance of various habitats K3- Understanding the phytogeographical zones and vegetation types K4- Realize the current methods of biodiversity and conservation K5- Understanding the value of biodiversity status and management		
Course Objectives (Maximum: 5)	**The Course aims** • To know the various facts of Plant Ecology • To understand the components of Plant Ecology & Phytogeography • To explain the importance of phytogeographical zones and vegetation types • To evaluate the status of Biodiversity of India and loss of biodiversity • To identify the current practices of biodiversity conservation and management		

Unit	**Content**	**No. of Hours**
I	**Plant Ecology** History and scope of ecology, Autecology: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age-structured population. Synecology; Characteristics of community, composition and structure, origin and development, ecotone, edge effect, ecological niche. Ecological interdependence and interaction - positive and negative interaction. Competition: interspecific and intraspecific. Ecological Succession: Types, mechanisms, concept of climax	13

II	**Plant Ecology & Phytogeography** Concept and dynamics of Ecosystem: Types of Ecosystem, components, Food chain, food webs. Concept of trophic level, ecological-pyramid-its-types, Energy flow ecosystem. Structure and function of ecosystems: terrestrial (forest, grassland) and aquatic (freshwater, marine, Estuarine). Principle of plant geography - Dispersal and migration barrier hypothesis, Willis age and area hypothesis. Continues range, cosmopolitan, circumboreal and circumaustral, pantropical, Discontinuous distribution Wegner's theory continental drift hypothesis, land bridges hypothesis	12
III	**Phytogeography** Phytogeographical Zones - Vegetation types of India and Tamil Nadu, Distribution: Continuous andDiscontinuous; Geographical Information System (GIS), the role of remote sensing and its applications. Endemism, types; factors influence endemism, biodiversity hotspot region of India and world.	12
IV	**Biodiversity loss and conservation** Basic concepts of Biodiversity, values of biodiversity, biodiversity hotspots, various threats and loss of biodiversity, IUCN red list categories; threats to biodiversity-Indian context, biological invasions and Biodiversity damage. Biodiversity conservation strategies: *in situ* conservation&*ex-situ* conservation: botanical garden, zoological park, *in vitro* conservation: germplasm or gene bank, tissue culture. Organizations involved in Biodiversity conservation	12
V	**Biodiversity Status and Management** National Biodiversity Authority (NBA) etc., protected area network (PAN)-biosphere reserves. Global approaches to biodiversity conservation, Indigenous approaches to biodiversity conservation, biodiversity & ethnomedicinal resources, Indian initiatives in biodiversity conservation; Biodiversity Act 2002, Biodiversity Rules 2004, National Biodiversity Strategy and Action Plan (NBSAP), Plant Varieties Protection and Farmer's Rights Act, 2001.	15
References	**Text Books:** 1. Smith, J. M. (1974). Models in Ecology. Cambridge University Press, London. 2. Bawa K.S., Primack, R.V. and Oommen, M.A. 2011. Conservation biology: A Primer for South Asia, ATREE, Bangalore. 3. Krishnamurthy, K.V. 2003. An advanced text book on Biodiversity, Oxford and IBH Publishing Co. Pvt Ltd. New Delhi. 4. Swaminathan, M.S. and Cocchar S.L. (Eds) 1999. Plants and society. MacMillan Publications Ltd. London. 5. Agrawal, K. C. (1987). Environmental Biology. Agro-botanical Publications, India. 6. Ambasht, R. S. (1974). A Textbook of Plant Ecology. 3rd ed. Students' Friends Co., Varanasi, India. 7. Ananthakrishnan, T. N. (1982). Bioresources Ecology. Oxford & IBH Publications, New Delhi. 8. Billings, W. B. (1965). Plants and the Ecosystem. Wardsworth Publishing Co. Inc., Belmont. 9. Jogdand, S. N. (2003). Environmental Biotechnology (Industrial Pollution Management). Himalaya Publishing House, Delhi. 10. Kershaw, K. A. (1973). Quantitative and Dynamic Plant Ecology. Edward Arnold Publishers Ltd., London. 11. Kormandy, E. J. (1978). Concepts of Ecology. 2nd ed. Prentice Hall of India Pvt. Ltd., New Delhi. 12. Krishnan Kannan (1997). Fundamentals of Environmental Pollution. S. Chand and Co. Ltd., New Delhi. 13. Kumar, H. D. (1978). Modern Concepts of Ecology. Vikas Publishing House Pvt. Ltd., New Delhi. 14. Levitt, J. (1980). Responses of Plants to Environmental Stresses. Academic Press, New York. 15. Mistra, R. (1968). The Ecology Workbook. Oxford & IBH Publications, Calcutta. 16. Mistra, R. C. (1974). Manual of Plant Ecology. Oxford & IBH Publications, New Delhi. 17. Odum, E. P. (1971). Fundamentals of Ecology. W. B. Saunders & Co., Philadelphia, USA. 18. Odum, E. P. (1975). Ecology. 2nd ed. Oxford & IBH Publications, New Delhi. 19. Puri, G. S. (1960). Indian Forest Ecology. Vol. I & II. Oxford & IBH Publications, New Delhi. **Reference Books** 1. Pandey, B.P. 1998. Economic Botany, S. Chand & Co., New Delhi. 2. Frankel, O.H.Brown and Burdon, J.J. 1995. The conservation of plant diversity. Cambridge University Press, Cambridge. 3. Hill, F.A. 1952. Economic Botany: A textbook of useful plants and plants products, Tata McGraw Hill Publishing Co., Ltd., New Delhi. 4. Walter's Vegetation of the Earth: Ecological Systems of the Geo-Biosphere (4th Edition) by Heinrich Walter, Siegmar-Walter Breckle. Paperback - October 2002 5. Plant geography by George Simonds Boulger (Jan 1, 1912) 6. Advanced Plant Geography Author: Shiv Manikant Dube. 2011 Swastik Publications. ISBN 789381084700 7. Textbook of the Plant Geography of India. by F.R. Bharucha ISBN: 0195612620 ISBN-13: 9780195612622 **Web resources** https://www.vedantu.com/geography/metapopulation http://www.kaliganjgovtcollege.ac.in/studyMaterial/0039Autecology-and-Synecology-organisation-limiting-factor.pdf https://www.geeksforgeeks.org/ecological-pyramid-its-types/ https://esj-journals.onlinelibrary.wiley.com/doi/full/10.1111/1440-1703.12313 https://www.geeksforgeeks.org/natural-vegetation-in-india/	

	http://www.nbaindia.org/ https://www.indiacode.nic.in/bitstream/123456789/2046/4/a2003-18.pdf
Course Outcomes	On completion of the course, students should be able to do CO1:Identify the ecological significance of plants and Biodiversity CO2:Analyse the components of Plant Ecology & Phytogeography CO3: Create knowledge on phytogeographical zones and vegetation types CO4: Identify the current practices of biodiversity conservation CO5: Design the principles of conservation, major approaches to management, Indian case studies on conservation

Semester	**Third**	Course Code	**24BOTP0316**
Course Title	**PRACTICAL- I: GENETICS AND GENOMICS, ANGIOSPERMS SYSTEMATICS AND ECONOMIC BOTANY&PLANT ECOLOGY, PHYTOGEOGRAPHY AND BIODIVERSITY CONSERVATION &**		
No. of Credits	2	No. of contact hours per week	4
New Course/ Revised Course	New Course	If revised, Percentage of revision effected (Minimum 20%)	-
Category	Core		
Scope of the Course (may be more than one)	1. Understand the characteristics of Angiosperms 2. Acquire knowledge of the ecology and distribution of higher plants 3. Motivate the students to understand the importance of plant taxonomy, ecology and environmental biology to become Plant taxonomists		
Cognitive Levels addressed by the Course	K1- Inculcate basic and advancement of plant taxonomy K2- Realize the various issues in the identification of plant ecology K3- Mull over the techniques to solve the problems in phytogeography and biodiversity conservation K4- Expertise in the identification of various pollutants in the environment K5- Realize the importance of identification of laboratory techniques in plant sciences		
Course Objectives (Maximum: 5)	The Course aims • To develop the skill in the advancement of plant taxonomy • To develop the skills in the understanding of plant ecology • To create an overall knowledge of phytogeography and biodiversity conservation • To understand the importance of laboratory techniques in plant sciences • To expertise in the identification of various pollutants in the environment		

Unit	**Content**	**No. of Hours**
I	Salient features, vegetative and sexual characters of the following families: Nymphaeaceae, Myristicaceae, Lauraceae, Ranunculaceae, Malvaceae, Myrtaceae, Sapindaceae Portulacaceae, Rubiaceae, Apocynaceae, Bignoniaceae, Cucurbitaceae, Fabaceae, Combretaceae, Lythraceae, Meliaceae, Lamiaceae, Solanaceae, Gentianaceae, Asteraceae, Apiaceae, Lilliaceae. Arecaceae Commelinaceae, Orchidaceae, Poaceae.	32
II	Preparation of dichotomous key for angiosperm families studied	4
III	Vegetation studies through quadrat methods	4
IV	GIS mapping of Trees on the GRI campus	6
V	Analysis of plant diversity through various biodiversity indices	6
VI	Problem-solving on dihybrid phenotypic, genotypic and test cross ratios.;	3
VII	Problem-solving on Interactions of factors and modified dihybrid ratios.	3
VIII	Problem-solving on Multiple alleles in plants, blood group inheritance in humans.	3
IX	Problem-solving on Sex-linked inheritance in Drosophila and plants	3
X	2-4 days study tour for the Plant collection, identification and key preparation. Preparation and submission of 25 herbarium specimens.	-
	Total	64 Hrs

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3. Raven PH, Mertens TR. Plant systematics: theory and practice. BSCS Pam. 1964-1965;23:1-36. PMID: 5870805.

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Taylor, D. V. and L. J. Hickey 1997. Flowering Plants: Origin, Evolution and Phylogeny. CBS Publishers & Distributers, New Delhi.

Course Outcomes	On completion of the course, students should be able to CO1: develop the skill in the advancement of plant taxonomy CO2: develop the skills in understanding plant ecology CO3: Acquire practical experience phytogeography and biodiversity conservation CO4: Provides skill of laboratory techniques in plant sciences CO5:Acquire practical knowledge on the identification of various pollutants in the environment	

Semester	**Four**	Course Code	**24BOTP0418**
Course Title	**FUNDAMENTALS OF MICROBIOLOGY**		
No. of credits	**4**	No. of contact hours per week	**4**
New Course / Revised Course	Revised Course	If revised, percentage of Revision effected **(Minimum 20%)**	20%
Category	Core course		
Scope of the Course (May be more than one)	❖ Basic understanding of the morphology and functions of the structures with the prokaryotes and eukaryotes ❖ Skill development of microbiological cultural techniques ❖ Creates employability scope in the microbiological laboratories/hospitals / industries		
Cognitive Levels addressed by the course	K-1 Ability to remember historical and recent developments in microbiology K-2 Grasp the comprehensive knowledge of Systematic bacteriology K-3 Use microbiological tools for better understanding of microbial structures and their functions K-4 Capacity to analyze factors influencing microbial growth K-5 Make new techniques to study microbial activity in nature K-6 Assessment of disease-causing microorganisms		
Course Objectives	The course aims to: • enhance the student's knowledge in historical aspects and microscopic techniques • acquire an overall knowledge on the morphology and functions of the structures with the prokaryotes and eukaryotes. • develop knowledge in microbial control techniques • make the students knowledgeable on the various culture techniques used in the microbiological lab • give an overview on the diseases caused by various microorganisms		

UNIT	Content	No. of Hours
I	**History and classification of Microorganisms** Historical and recent developments -Scope of microbiology- Spontaneous generation and germ theory of disease - Major contribution of scientists– – Leeuwenhoek, Edward Jenner, and Alexander Fleming, Joseph Lister, Robert Koch and Louis Pasteur. Modern Microbiology - Landmark achievements in 20th century. Microscopy: Dark field, Fluorescence Phase contrast and Electron microscopy.	13

II	**Prokaryotic and Eukaryotic Cell (Source NPTEL course)** Ultra structure of Prokaryotic and Eukaryotic cell- The Prokaryotic Cell: Size, shape and arrangement of bacterial cells; structure of cell wall, and structures external (glycocalyx, flagella, pili, etc.,) and internal (plasma membrane, cytoplasm, inclusion bodies, etc.,) to the cell wall. The Eukaryotic Cell: Cilia, flagella, cytoskeleton, cytomembrane systems, mitochondria and chloroplast Comparison of Prokaryotic and Eukaryotic cell.	13
III	**Microbiological Techniques I** Microbial control – Physical methods - Heat, (Low & High temperatures), Filtration, high pressure, Osmotic pressure, Radiation, and Desiccation. Chemical methods – chemical agents, types and mode of action- Evaluation and monitoring of sterilization procedures- Use dilution tests, Disc-Diffusion method – Decimal reduction time (D Value)	12
IV	**Microbiological Techniques II (Source NPTEL course)** Cultural techniques: pure culture techniques, types of media - media preparation - preservation of cultures - aerobic and anaerobic culture techniques - growth of bacteria: batch and synchronous culture - factors influencing growth - growth curve-Microbial nutrient -macro nutrients, micronutrients, growth factors and sources of nutrients- Methods to study microbial morphology - wet mount and hanging drop method. Staining techniques - Gram's, acid fast, spore and capsule staining.	13
V	**Microbiology of Diseases** Infections: types of infection, sources of infection, reservoirs and vectors of infection. Normal microflora of the human body. Classification of medically important microorganisms; Diseases of Man-Bacterial: Staphylococcus, Streptococcus, Neisseria; Corynebacterium, Clostridium, Vibrio and Mycobacterium. Fungal: Dermatophytes, opportunistic fungal pathogens. Viral: diseases: Pox viruses; Hepatitis viruses, coronaviruses and Human Immunodeficiency viruses (HIV)	13
Refere nes	**TextBooks**: 1. Jeffery C. Pommerville (2016). Alcamo's Fundamentals of Microbiology (Third Edition). Jones and Bartlett Learning. LLC, Burlington, MA 01803. 2. Tortora, G.J, Funke B.R. and Case,C.L..2010. Microbiology: An introduction 10th Ed, Benjamin Cummings, N.Y. 3. Wiley, J.M., Sherwood, L.M. and Wodverton, C.J. 2009. Prescott's principle of Microbiology, Mc Graw Hill, New York. 4. Dubey, R.C and Maheswari, D.K 2005. A text book of Microbiology, Revised Edt., S.Chand Publishers, New Delhi. 5. Pelczar, Jr., Michael, Chan E. C. S. and Kreig Noel. 2000. Microbiology. 5th Ed. Tata McGraw Hill Book Company. **ReferenceBooks**: 1. Stanier, Y. Roger, John L. Ingrahm, Mark L. Wheelis and Page R. Painter. 2003. General Microbiology. V Ed. MacMillan Press Ltd. New Jersey. pp: 621-626; 655-670. 2. Sundararajan, S. 2003. Microorganisms. I Ed. Anmol Publications Pvt. Ltd. New Delhi.. 3. Hans G. Schlegel. 2012(Reprint). General Microbiology. VII Ed. Cambridge University Press. UK. 4. Salle, A. J. 2001. Fundamental and Principles of Bacteriology. 7th Ed. Tata McGraw Hill Publishing Co. Ltd. 5. John L. Ingrahm and Catherine Ingrahm.. 2000. Introduction to Microbiology. II Ed. Brooks/Cole, Thompson Learning division. USA. 6. Lansing M. Prescott, John P. Harley and Donald A. Klein. 2002. Microbiology. V Ed. WCB/McGraw Hill Company. 7. Brock, T. D., Smith, D. W and Madigene, M. T. 1997. Biology of Microorganisms: Milestones in Microbiology. Prentice-Hall International Inc. London. 8. Talaro, K and Talaro, A. 1996. Foundations in Microbiology, 2en Ed., Wm. C. Brown publishers, Toronto. 9. Heritage, J. Evans E.G.V. and Killington, R.A. (1996). Introductory Microbiology. Cambridge University Press. **Web resources**: https://www.cliffsnotes.com › biology › microbiology https://www.livescience.com https://www.nature.com › ... › microbiology techniques	
Course Outco mes	On completion of the course, students should be able to: CO 1: Discuss important milestones and accomplishments to appreciate the historical aspects CO2: Identify key organelles and their functions in both eukaryotes and prokaryotes CO3: Describe the overall classification and diversity of microorganisms CO4: Demonstrate microbial control measures and various culture techniques in microbiology. CO5: Explain the diseases caused by various microorganisms	

Semester	**Four**	Course Code	**21BOTP0419**
Course Title	**PLANT BIOTECHNOLOGY AND GENETIC ENGINEERING**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected (Minimum 20%)	20
Category	Core		
Scope of the Course (may be more than one)	1. Comprehend the knowledge of plant biotechnology and genetic engineering 2. Realize the role of plant biotechnology and genetic engineering in Science 3. Motivate the students to understand the importance of plant biotechnology and genetic engineering and become Plant Scientists		
Cognitive Levels addressed by the Course	K1- Motivate to understand the basics and advancement of plant tissue culture K2- Realize the various aspects of Immobilization and Cell & Suspension culture K3- Understand the role of Biotransformation and Biosensors and Plant Genetic Engineering K4- Gain the knowledge from this paper to appear in national level competitive exams K5- Utilize the knowledge acquired through this paper in various botanical research		
Course Objectives (Maximum: 5)	**The Course aims** • to impart knowledge on the concepts & scope of biotechnology • to provide an in-depth study on biotransformation techniques and biosensors • to enhance interest in Gene cloning strategy • to understand genetic engineering concepts & techniques. • to know about transgenic organisms and to acquire knowledge on GMOs.		

Unit	Content	No. of Hours
I	**Plant Tissue Culture** Introduction to plant tissue culture. Culture media preparation, sterilisation, Inoculation; Callus generation, Micropropagation, Somatic embryogenesis. Protoplast culture; isolation, fusion and culture methods, cybrids, spheroplasts; possibilities, achievements and limitations of protoplast research. Anther and pollen culture and production of gameto-clones. Production of haploid and triploid plants. Embryo rescue in hybrid plants. Application of plant tissue culture in agriculture, Horticulture and forestry.	14
II	**Immobilization and Cell Suspension Culture** Cell Suspension culture: culture vessels and bioreactors, culture initiation, growth curve, cell aggregates and secondary compound synthesis, use of precursors and elicitors, cell immobilization, and bio-transformations.	14
III	**Biotransformation and Biosensors *(Source NPTEL course)*** Biotransformation and production of useful compounds: Glycerol, butanol, acetone, alkene oxide, Poly hydroxybutyrate and valerate(PHBV), Xanthangum and Microbial Leaching. Biosensors – definition and outline design- types of electrode systems – Oxygen electrode system, Fuel cell type electrode, potentiostatic, Piezoelectric membrane and Dye-coupled electrode membrane filter systems –	11
IV	**Plant Genetic Engineering *(Source NPTEL course)*** Components of plant genetic engineering. Recombinant DNA technology - molecular tools – nomenclature and characteristics of Restriction enzymes, DNA modifying enzymes. Vectors used in molecular cloning: Plasmids – properties and classification; PBR pUC 18. lambda (gt 10) and M13 phage vector. Cosmids (pJB 8), Yeast vectors	11
V	**Gene cloning strategy & Applications of Genetic engineering** Gene cloning strategy. Transformation; Screening and selection. Expression of cloned genes; brief account of methods for analysis of differential gene expression in plants. Agrobacterium and Ti Plasmid based and physical DNA delivery methods. Analysis of transgenic plants. Approaches to marker-free transgenics. Development of transgenic crops for disease resistance, insect resistance, herbicide tolerance, salt tolerance, drought tolerance, and nutritional quality. Brief outline on Bt Cotton & golden rice. Rules and regulation in biotechnology; biosafety, bioethics, hazards of environmental engineering.	14
References	**TextBooks** 1. Dubey R.C., 2014.Advanced Biotechnology 1st Edition. S.Chand & Company Ltd., New Delhi. 2. S.B. Primrose, R.M. Twyman, and R.W. Old (2012).Principles of Gene Manipulations; 6th Edn. Blackwell Science. 3. Chhatoval G.R., 1995. Text book of Biotechnology, 1st Ed, Anmol Publications Pvt. Ltd., New Delhi. 4. Kumar H.D., 1991. A text book on Biotechnology 2nd Ed, East-west Press Private Ltd., New Delhi. Pg.1-250; 411-	

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Course Outcomes	Upon completion of this course, students will be able to: CO1: to impart knowledge on the concepts & scope of biotechnology CO2: to provide an in-depth study on biotransformation techniques and biosensors CO3: to enhance interest in Gene cloning strategy CO4: to understand genetic engineering concepts & techniques. CO5: to know the transgenic organisms and to acquire knowledge on GMOs.

Semester	**Four**	Course Code	**24BOTP0420**
Course Title	**HERBAL BOTANY AND PHYTOCHEMISTRY**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	New Course	If revised, Percentage of revision effected (Minimum 20%)	-
Category	Core		
Scope of the Course (may be more than one)	1. Understand various aspects of herbal botany plants and plant pathology 2. Utilize the knowledge of herbal plants and plant pathology in other botanical research 3. Comprehend the knowledge of medicinal plants and plant pathology for various competitive examinations.		
Cognitive Levels addressed by the	K1- Inculcate the advancement of medicinal plants and plant pathology K2- Acquire the knowledge on methods of preparation of drugs		

Course	K3- Understand the mechanism of pharmacognosy& pharmacological action of plant drugs K4- Survey and evaluation and understanding of the various plant pathogens K5- Create awareness of the management of plant diseases
Course Objectives (Maximum: 5)	**The Course aims** • To evaluate the history of medicinal plants • To analyse the methods of preparation of drugs • To evaluate the pharmacognosy& pharmacological action of plant drugs • To understand the various plant pathogens and their mechanism of infection • To create the awareness on management of various plant diseases

Unit	Content	No. of Hours
I	**Brief history of medicinal plants** Brief history and scope of raw drugs of plant origin. Herbals; classification and description. Indian systems of medicines: Siddha, Ayurveda, Unani, Homeopathy and Naturopathy. Traditional and Folklore medicine. Ethnobotany and Ethnomedicine; Herbal home remedies of South India; Herbal formularies; Infusions and decoctions, oil extractions, ointments, lotions, washes, suppositories;	12
II	**Methods of preparation of drugs** Definition of Drug, Classification of natural drugs: Morphological, Pharmacological and Chemical. Factors involved in the production of drugs; cultivation of wild medicinal plants, collection, drying and storage. Deterioration of drugs; primary factors, mould and bacterial attack, control of insect pests.Drug adulteration, Drug evaluation, Chemical evaluation and biological evaluation of drugs.	15
III	**Pharmacognosy & Pharmacological action of plant drugs** Source and medicinal value of the phytochemicals: glycosides, alkaloids, phenols, saponins and steroidal saponins. Chemistry of drugs (Alkaloids, Flavonoids, Glycosides and Tannins) Quality control of herbal drugs. Pharmacognosy - Definition and scope. A brief account of drugs acting on the central nervous system (CNS stimulants, CNS depressants and Hallucinogenics). Drugs used in disorders of the gastrointestinal tract (Carminatives, Bulk laxatives and Purgatives) and cardiovascular drugs (Cardiotonics, Cardio-depressants and Antihypertensives).	10
IV	**Phytochemistry** Phytochemistry - Definition, history, principal, secondary metabolites: Definition, classification, occurrence and distribution in plants, their function, chemical constituents. Alkaloids, Terpenoids, flavonoids, steroids coumarins, volatile oils and other related compounds.	12
V	**Biosynthetic pathway of secondary metabolites** Biosynthetic pathway of secondary metabolites: Shikimic acid pathway, Acetate-Mevalonate pathway, pathway for commercially important phytochemicals: Ephedrine, taxol and Vinca Alkaloids. Application of phytochemicals in medicine, pharmaceuticals, food, flavor and cosmetic industries.	14

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Course Outcomes	On completion of the course, students should be able to CO1: gain insight into the knowledge on the history of medicinal plants CO2: understand the methods of preparation of drugs CO3: evaluate the importance of pharmacognosy& pharmacological action of plant drugs CO4: analyse the details of various plant pathogens and their mechanism of infection CO5: create the awareness on management of various plant diseases

Semester	**Four**	Course Code	**24BOTP0421**
Course Title	**PRACTICALS- 5 : FUNDAMENTALS OF MICROBIOLOGY & PLANT BIOTECHNOLOGY & GENETIC ENGINEERING AND HERBAL BOTANY &PHYTOCHEMISTRY**		
No.of Credits	2	No.of contact hours per Week	3
New Course/ Revised Course	Revised Course	If revised, Percentage of Revision effected (Minimum20%)	
Category	Core Course		
Scope of the Course (may be more than one)	Demonstrate practical skills in the use of tools and methods common to microbiology Hands on training in sampling of microorganisms from various environments		
Cognitive Levels addressed by the Course	K-1:(Remember) K-2:(Understand) K-3:(Apply) K-4:(Analyze) K-5:(Evaluate)		

Course Objectives(Maximum:5)	The Course aims to enhance the student's knowledge and impress upon them on the important aspects of microorganisms provide practical knowledge and skills in the isolation and handling of microorganisms to understand the working procedure and principles of microscopes.know pure culture techniques, methods of culturing preservation and maintenance of microorganisms gain skill in isolation of microorganisms from various samples.

UNIT	Content	No. of Hours
1	a) Safety measures and rules of conduct to be followed in a microbiological laboratory. b) Cleaning of Glassware c) Handling and Care of Microbiological Instruments	3
2	a) Microscopic Examination of Living Organisms – Demonstration of Motility (Hanging drop method). b) Measurement of Microorganisms using Micrometry.	3
3	Staining Techniques – Gram's staining, capsular staining, endospore staining and acid fast staining	3
4	Preparation of Culture Media for Microorganisms. Preparation and sterilization.	3
5	Demonstration techniques for pure culture of microorganisms- serial dilution technique, pour plate, spread plate and streak plate technique.	3
6	Methods of culture preservation and maintenance- maintenance by sub culturing	3
7	Estimation of Alkaloids and phenols from plant tissues	3
8	Isolationandquantification of plant essential oil from leaves	3
9	Isolationandquantification of plant crude extracts through a series of solvents	3
10	Isolation of anaerobic bacteria	3
11	Isolation of DNA from Plant samples	3
12	Demonstration of Plant Tissue culture techniques	3
13	Production of Synthetic seeds; somatic embryos	3
References	Text Books James. G. Cappucino. And Natabe Sherman, 2004. Microbiology – A Laboratory Manual, VI Ed., (I Indian Reprint). Pearson Education (Singapore) Pvt. Ltd., India. Dubey, R.C and Maheswari, D.K. 2002. Practical Microbiology, I Ed., Chand and Company Ltd., India. Aneja. K.R, 2002. Experiments in Microbiology plant pathology tissue culture and mushroom production technology, III Ed. New Age International publishers (P) Ltd, New Delhi. Breed and Buchanan. Bergey's Manual of Systematic Bacteriology. 2nd Edition, (Volumes. 1 – 5) (2001 – 2003). P.PAlanivel. Analytical Biochemistry and Separation Techniques. Twenty-first centuary Publications, Madurai	
	Reference Books: Goldman, E. and Green, L.H. eds., 2015. Practical handbook of microbiology. CRC press. O'Leary, W.M., 1989. Practical handbook of microbiology. CRC press.	
	E-Resources(URLsofe-books/YouTubevideos/onlinelearningresources,etc.) https://microbiologysociety.org/publication/education-outreach-resources/practical-microbiology-for-secondary-schools.html https://www.micropia.nl/en/discover/stories/experiments/	
CourseOutcomes	On completion of the course, students should be able to do CO 1: Demonstrate standard methods for the isolation, identification and culturing of microorganisms. CO2: Explain the ubiquitous nature of microorganisms CO3: Identify the different groups of microorganisms from different habitats. CO4: Evaluate the microbial load in soil and food samples CO5: Examine the microbial quality of air	

21GTPP00H1-HUMAN VALUES AND PROFESSIONAL ETHICS
(Two Credits)
MODULAR COURSE FOR P.G. PROGRAMMES

Credits: 2 **CFA: 20+25+5**

Total: 50

(The syllabus of this paper will be approved by the Department of Gandhian Thought and Peace Science)

DISCIPLINE CENTRIC COURSES

Semester	-	Course Code	**24BOT P03D1**
Course Title	**MEDICINAL PLANT RESOURCES, UTILIZATION AND HUMAN HEALTHCARE**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	New Course	If revised, Percentage of revision effected (Minimum 20%)	-
Category	Discipline Centric		
Scope of the Course (may be more than one)	1. Understand the basic and advanced aspects of medicinal plant research 2. Acquire knowledge of various aspects of Herbal remedies 3. Motivate the students to understand the various aspects of medicinal plant research and to become Plant researchers		

Cognitive Levels addressed by the Course	K1- Inculcate commercial and medicinal importance of herbals K2- Realize the utilization of various medicinal plants K3- Mull over the techniques to prepare and utilize various herbal formularies K4- understand the Classification and cultivation of herbal drugs for commercial importance K5- Realize the utilization of herbal formularies for human healthcare
Course Objectives (Maximum: 5)	**The Course aims** • To compare the various medicinal plants used commercially for human healthcare • To know the useful parts, active principles and therapeutics values of various medicinal plants • To understand the classification and cultivation of herbal drugs • To analyse formulations and their effects on various medicinal plants • To study the medicinal herbs for societal health care

Unit	Content	No. of Hours
I	**Traditional Medicinal System in India** History, scope and importance Medicinal plants – traditional and alternative system of medicine – naturopathy, folk medicine, Ayurveda, Siddha, homeopathy and Unani. WHO regulation of herbal medicine. National Medicinal Plants Board of India, AYUSH	13
II	**Overview of selected medicinal plants** Morphology, family, vernacular and botanical names, useful parts, active principle and therapeutics values of whole plant; *Phyllanthus amarus*, Root; *Catharanthus roseus, Chrysopogon zizanioides*, Bark; *Cinnamomum verum*, *Terminalia arjuna*, leaves; *Azadirachta indica*, *Aloe vera*, *Ocimum tenuiflorum*, flower; *Syzygium aromaticum*, *Crocus sativus*, underground stem; *Curcuma longa*, *Gingifer officinale*, *Alpinia calcarata*. Gum; *Ferula assa-foetida*, resin – *Pinus ponderosa*, oil – *Ricinus communis*	12
III	**Classification and cultivation of herbal drugs** Definition of Drug - Classification of crude drugs: Alphabetical, Morphological, Pharmacological and Chemical. Cultivation, collection, harvesting, processing and storage of herbal drugs conservation of medicinal plants.	15
IV	**Medicinal plants; formulations and their effects** Herbal concoctions – Kashayam, chooranam, lagiyum, tincture, poultice, Food: herbal salad, chutney, soup and herbal tea. Plants used for treatment of heart and blood circulation, nervous disorders, respiratory and intestinal disorders, jaundice, urinary, skin, hair, diabetics, cancer, gynecological disorders and infertility. Plants used as general tonics	14
V	**Herbs for societal health care** Cosmetic preparation: incorporating the herbal extract in various cosmetic formulations like skin care preparations (crèmes and lotions), sunscreens and sunburn application, hair care preparations – hair oil, hair shampoo, hair was powder .Beautifying preparation – lipstick, face powder and nail polish, herbal dish wash.	10
References	**Text Books** 1.Kirtikar K.R. and Basu, B. D. 1932. Indian Medicinal Plants. 2 Nadkarni, A. K. 1954. Indian Materia Medica Vol. I & II. 3. Sivarajan, V.V. and Indira, B. 1994. Ayurvedic drugs and their plant sources. Oxford & IBH publishing Co., New Delhi 4. Trease, G, E. and Evans, W. L, 1983. Pharmacognosy 12th ed. Baillie Tindal, London 5. Vaidya, B, 1982. Some controversial drugs in Indian Medicine. Chaukamba Oriental, Varanasi 6. Harborne, J. 1984. Phytochemical methods. Ed Chapman & Hall, London 7. Mann, J., Davidson, R. S., Hobbs, J. B., Benthorpe, D. V, and Harborne Natural Products, Longman Scientific and Technical Co., Essex. 8. Smith, P.M 1976. The Chemotaxonomy of Plants. Edward Arnold, London. 9. Prajapati., Purohit., Sharma and Kumar. 2007. Hand Book of Medicinal Plants: A complete Source Book, Agrobios India. 10. Maheshwari, J. K. 2000. Ethno-botany and Medicinal Plants of Indian Subcontinent, Scientific Publishers, India. 11. Prajapati et al., 2003. A Hand Book of Medicinal plants - A complete Source Book. Agrobios, Jodhpur, India. 12. Rastogi R. P. and Meharota B. N. 1991. Compendium of Medicinal Plants. Vol. I & II. 1993. CDIR, Lucknow and publication and information directorate New Delhi India. Cotton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and Sons – Chichester.	

	2. Faulks, P.J. 1958. An introduction to Ethnobotany, Moredale Pub. Ltd., London. 3. Jain S.K., (ed.) 1981 Glimpses of Indian Ethnobotany, Oxford and I B.H., New Delhi. 4. Jain S.K., (ed.) 1989. Methods and approaches in ethnobotany. Society of Ethnobotanists, Lucknow, India. 5. Jain S.K., 1990. Contributions of Indian ethnobotany. Scientific publishers, Jodhpur. 6. Jain S.K., 1995 Manual of Ethnobotany, Scientific Publishers, Jodhpur.	
	On completion of the course, students should be able to CO1: compare the various medicinal plants used commercially for human healthcare CO2: know the useful parts, active principles and therapeutic values of various medicinal plants CO3: understand the classification and cultivation of herbal drugs CO4: analyse formulations and their effects on various medicinal plants CO5: study the medicinal herbs for societal health care	

Semester	-	Course Code	**24BOT P03D2**
Course Title	**ETHNOBOTANY**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	New Course	If revised, Percentage of revision effected (Minimum 20%)	-
Category	Core		
Scope of the Course (may be more than one)	1. Understand the basic and advanced aspects of Ethnobotany 2. Acquire the knowledge on various aspects of Ethnobotany 3. Motivate the students to understand the various aspects of Ethnobotany and to become Plant taxonomists		
Cognitive Levels addressed by the Course	K1- Inculcate basic and advancement of Ethnobotany K2- Realize the status, economy and ethnobotany of Ethnic community in India K3- Mull over the techniques to solve the problems in Ethnobotany K4- Expertise on the identification of various ethnobotanical knowledge of India K5- Realize the importance of Bioprospecting and knowledge sharing		
Course Objectives (Maximum: 5)	**The Course aims** • To realise the importance of basic and advancement of Ethnobotany • To analyse the status, economy and ethnobotany of Ethnic community in India • To understand the Botanical knowledge and practice by the tribal community • To analyse the various ethnobotanical knowledge of India • To study the importance of Bioprospecting and knowledge sharing		

Unit	**Content**	**No. of Hours**
I	**Concept of Ethnobotany.** History of Ethnobotany– Definition, scope and objectives, Ethnobotany studies in the world and in India – interdisciplinary approaches, knowledge of following sociological and anthropological terms of culture, values and norm, institution, culture diffusion and ethnocentrism.	13
II	**Ethnic community in India.** Distribution of ethnic groups in India – basic knowledge of the following Ethnic groups in Tamil Nadu (Irulas, Kanis, Paliyars, Badagas, Kurumbres, Thodas and Malayali) –lifestyle and traditional practices of the above ethnic group.	12
III	**Botanical knowledge and practice** Ethnobotanical knowledge and communities – Folk taxonomy – plants associated with culture and socio- religious activities. Non – timber forest products (NTFP) and livelihood – Sustainable harvest and value addition.	15
IV	**Documentation Methods** Source of Ethnobotanical data: Primary-Archeological source and inventories. Secondary– Travelogues, folklore and literary source, herbaria, Medicinal text and official records. Method in Ethnobotanical research – Prior informed consent –PRA techniques – Interviews and questionnaire methods – choice of resource persons	14
V	**Bioprospecting and Knowledge Sharing** Bioprospecting and commercial use of traditional knowledge, developing research partnership codes of ethics and research guidelines, equitable research relationship, traditional knowledge (TK) in Relation to Intellectual property Right and Biopiracy. Equitable benefit sharing models of the world – problems in equitable benefit sharing.	10

References	Text books: 1. Gokhale, S.B., Kokate, C.K and Gokhale, A. (2016). Pharmacognosy of traditional drugs, nirali prakashan, 2. Jain, S.K. (2010). Manual of ethnobotany. Scientific publishers, New Delhi 3. Singh, V. (2009). Ethnobotany and Medicinal Plants of India and Nepal (Vol. 3). Scientific Publishers. New Delhi 4. Gringauz (2012). Introduction to Medicinal Chemistry: How Drugs Act & Why? Wiley India Pvt, Ltd., Noida 5. Joshi, S.G. (2018). Medicinal Plants. Oxford & IBH Publishing C., Pvt., Ltd., New Delhi. 5. Kumar, N. (2018). A Textbook of Pharmacognosy. Aitbs Publishers, India 6. Premendra Singh (2013). Medicinal Plants: Conservation, Cultivation and Utilization. Daya Publishing House, New Delhi. Reference Books 1. Albuquerque, U.P., Ramos, M.A., Júnior, W.S.F., and De Medeiros, P.M. (2017). Ethnobotany for beginners. Springer International Publishing, US. 2. Balick, M.J., and Cox, P.A. (1996). Plants, people, and culture: the science of ethnobotany. Scientific American Library, US 3. Qadry, J.S. (2014). A textbook of Pharmacognosy Theory and Practicals. 17th ed. CBS Publishers & Distributors, New Delhi. 4. Prajapati, N.D., Purohit, S.S, Sharma, A.K, Tarun Kumar, (2006). A Handbook of Medicinal Plants: A Complete Source Book. Vedic Books Sales Rank 5. Cotton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and Sons – Chichester. 6. Faulks, P.J. 1958. An introduction to Ethnobotany, Moredale Pub. Ltd., London. 7. Jain S.K., (ed.) 1981 Glimpses of Indian Ethnobotany, Oxford and I B.H., New Delhi. 8. Jain S.K., (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India. 9. Jain S.K., 1990. Contributions of Indian ethnobotany. Scientific publishers, Jodhpur. Jain S.K., 1995 Manual of Ethnobotany, Scientific Publishers, Jodhpur.	
	On completion of the course, students should be able to CO1: Realize the importance of basic and advancement of Ethnobotany CO2: Compare the status, economy and ethnobotany of Ethnic communities in India CO3: Assess the Botanical knowledge and practice of the tribal community CO4: Critique the various ethnobotanical knowledge of India CO5: Identify the importance of Bioprospecting and knowledge sharing	

Semester	-	Course Code	**24BOTP03D3**
Course Title	**PALEOBOTANY**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	New Course	If revised, Percentage of revision effected (Minimum 20%)	-
Category	Discipline centric		
Scope of the Course (may be more than one)	1. Understand the various aspects of Paleobotany 2. Acquire knowledge on botanical fossil sediments in relation to evolution 3. Motivate the students to understand the evolution of plants based on the fossil sediments		
Cognitive Levels addressed by the Course	K1- Inculcate the information on various aspects of Paleobotany K2- Realize the importance of botanical fossils to study the plant evolution K3- Understand the evolution of plants based on the fossil sediments K4- Expertise in the orgin of life and plants. K5- Realize the pathway of origin the higher plants from lower plants		
Course Objectives (Maximum: 5)	**The Course aims** • To understand on various aspects of Paleobotany • To analyse importance of botanical fossils to study the plant evolution • To understand the evolution of plants based on the fossil sediments • To analyse the various stages of Origin of plants and organs • To study the various stages of origin and evolution of flowering plants		

Unit	Content	No. of Hours
I	**Introduction to fossils** Preservation of plants as fossils: Definition; taphonomy; process of fossilization; modes of preservation; types; major rock types, rock cycle and rocks containing Fossils; systematics, reconstruction and nomenclature. Geologic Time: Geologic timescale, relative vs. numerical age, physical and biological principles for defining relative and numerical age.	13
II	**Origin of life and plants** Early Life: The origin of the earth, earliest environment, theories on the origin of life, evidence for the origin of life - prokaryotes, the evolution of eukaryotes and fossil records, diversified life - algae and fungi.	12
III	**Botanical-fossil evidences** Colonization of land by plants: vegetative and reproductive adaptations to land-dwelling, fossil evidence - transitional plants with land adaptive features, early non-vascular land plants (bryophytes), early vascular land plants (pteridophytes). Early vascular plants to early spore-producing trees (arborescent pteridophytes & progymnosperms): Geologic time, environment, advancement in plant adaptive features for land dwelling with fossil evidences.	15
IV	**Origin of plants and organs** Early spore-producing trees to early seed-producing trees (gymnosperms): From isospores to free sporing heterospores, origin of ovule, hydrasperman reproduction with fossil evidences.	14
V	**Origin and evolution of flowering plants** Origin and evolution of flowering plants (angiosperms): Geologic time, evolutionary trends - angiosperm derived characteristics, fossil evidence for early flowering plants, place of origin, radiation, phylogeny. Aspects and Appraisal of Palaeobotany: Palaeobotanical study in exploring - mysteries in the living planet; origin, evolution, diversification and extinction of species; plant-animal interaction and coevolution; plate movement, geological age and correlation of strata; palaeogeography, palaeoclimate; fossil fuel.	10
References	**Text Books** 1. Atchlay, W.R & Woodnuff, D.S. (1981). Evolution and speciation, Cambridge University Press, Cambridge. 2. Kimura, M. (1983). The natural theory of molecular evolution, Cambridge University Press, Cambridge. 3. Arora, M.P. (1990). Evolutionary biology, Himalaya Publication House, Delhi. 4. Arnold, C.A (1947).An Introduction to Paleobotany, McGraw Hill Book Company Inc. New York & London 5. Kirkaldy, J.E. (1963). The study of Fossils. Hutchinson Educational, London 6. Steward W.NPalaeobotany and evolution of plants. Cambridge University Press, New York. 7. Stewart, W.N and Rothwell, G.W. (2013). Palaeobotany and the evolution of plants. 2 ed.	

	Cambridge University Press, Ltd, New Delhi 8. Edith L. Taylor, Thomas N. Taylor and Michael Krings (2009). Palaeobotany: The Biology and Evolution of Fossil Plants. Academic Press 9. Andrews, H. N. (1961): Studies in Paleobotany, Wiley, N. Y. 10. Arnold, C. A. (1947): An introduction to Paleobotany, McGraw Hill, N. Y	
	On completion of the course, students should be able to CO1: Understand the information about the fossils CO2: Analyse the Origin of life and plants CO3: understand the Botanical-fossil evidences to study the plant evolution CO4: Critique the various stages of Origin of plants and organs CO5: Identify the various stages of origin and evolution of flowering plants.	

Semester	-	Course Code	**21BOT P03D4**
Course Title	**TRENDS IN MODERN BOTANY**		
No. of Credits	3	No. of contact hours per week	3
New Course/ Revised Course	New Course	If revised, Percentage of revision effected (Minimum 20%)	-
Category	Discipline centric		
Scope of the Course (may be more than one)	1. Understand the various advancement of plant sciences 2. Acquire knowledge on Plant ontology, taxonomy, molecular biology and genetic engineering 3. Improve the knowledge of various aspects of botany to become plant researchers		
Cognitive Levels addressed by the Course	K1- Analyse the importance of various aspects of modern Botany K2- Examine aspects of Plant ontology, taxonomy, molecular biology and genetic engineering K3- Improve the knowledge of modern Botanical sciences K4- Motivate the students to enhance their knowledge of Plant ontology, molecular biology and genetic engineering K5- Update the skills in botanical sciences to appear in competitive examinations		
Course Objectives (Maximum: 5)	**The Course aims** • To have comprehensive knowledge of modern aspects of Plant anatomy and Photosynthesis • To understand the mechanism of secondary metabolite production • To understand the various aspects of gene transfer methods • To understand the mechanism of genetic recombination		

Unit	Content	No. of Hours
I	**Plant ontology photosynthesis:** Bridging Plant Anatomy and Genomics in the Digital Era, tools, ontology brochure and applications. Advances in photosynthesis and respiration. Photosystems, Photophysics of light absorption, excitation energy transfer; C4 photosynthesis and regulations; and from X-ray crystallography of proteins to the morphology of organelles and intact organisms. Genetic engineering of photosynthesis and artificial photosynthesis	12
II	**Plant Tissue Culture**: Applications of plant cell, tissue and organ culture, Media types, preparation; callus formation, organogenesis. Somatic embryogenesis, somaclonal variation, embryo culture, artificial seeds .Production of secondary metabolites from plant cell cultures - Processes for enhancing the production of secondary metabolites- Technology of plant cell culture for production of chemicals. methods and protocol	12
III	**Plant Genomics** Introduction to Genomics, Transcriptomics, Proteomics, Metabolomics and single cell genomics. Genome sequencing, Whole genome shotgun sequencing, Physical mapping of genomes, Clone-by-clone sequencing, New generation sequencing technologies, Bioinformatics tools to analyse genomes, Examples of sequenced genomes (yeast, *Arabidopsis* and rice)	10
IV	**Proteomics** Protein isolation and identification methods SDS -PAGE, Isoelectric focussing, 2D gel electrophoresis, Peptide sequencing, Mass Spectrometry methods used in proteomics, Peptide databases, Immunological methods to study protein functions, Protein-protein and Protein-DNA interactions, Comparative proteomics, subcellular proteomics, quantitative proteomics	14
V	**Application of Plant Biotechnology** Application of Plant biotechnology for the production of quality oil, Industrial enzymes, paper, biodegradable plastics, antigens (edible vaccine) and antibodies. Production of crops resistance to abiotic and biotic stresses, crop quality improvement, nutrient enhancement, nitrogen fixation,	13

	nutrition up-take, production of male sterile lines, plantibodies, vaccines, plant secondary products, biofuel, bioplastics and plants as bioreactors	
References	1. Torr, J. D. 2006. Genetic Engineering-Current Controversies. Greenhaven Press. 2. Magnien, E. & De Nettancourt, D. 1985. Genetic Engineering of Plants and Micro-Organisms Important for Agriculture. Springer Verlag. 3. Gerald Karp 2013. Cell and Molecular Biology: Concepts and Experiments. 7th Edition, Wiley, NJ, USA. 4. Geoffrey M. Cooper & Robert E. Hausman 2013. The Cell: A Molecular Approach,6th Edition, Sinauer Associates, Inc., Sunderland, USA. 5. Harvey Lodish, Arnold Berk, Chris A. Kaiser & Monty Krieger 2012 Molecular Cell Biology. 7th Edition, W. H. Freeman, NY, USA. 6. Stephen R. Bolsover, Elizabeth A. Shephard, Hugh A. White & Jeremy S. Hyams 2011. Cell Biology: A Short Course Wiley-Blackwell, NJ, USA. 7. Doods, J. H. and Roberts, L. W. 1985. Experiments in Plant Tissue culture, Cambridge University Press. 8. George, E. F. 1993-96. Plant propagation by Tissue culture-2 vols. Exegetics Ltd. **Journals and Web-resources:** 1. https://link.springer.com/journal/11240 2. https://www.journals.elsevier.com/journal-of-molecular-biology/ 3. http://www.springer.com/life+sciences/journal/11008 4. http://www.sciencedirect.com/science/journal/00222836?sdc=1 5. http://www.scirp.org/journal/ajmb/ 6. https://www.nature.com/nsmb/ 7. https://www.gmb.org.br/	
	On completion of the course, students should be able to CO1: comprehend the knowledge modern aspects of Plant anatomy and Photosynthesis CO2: understand the mechanism of secondary metabolites production CO3: understand the various aspects of gene transfer methods To understand the mechanism of genetic recombination	

Semester	-	Course Code	**21BOT P03D5**
Course Title	**PHYLOGENY OF ANGIOSPERMS**		
No. of Credits	3	No. of contact hours per week	3
New Course/ Revised Course	New Course	If revised, Percentage of revision effected (Minimum 20%)	-
Category	Discipline centric		
Scope of the Course (may be more than one)	1. Able to realise the advancement of plant systematics 2. Acquire knowledge on plant systematic and its role in botanical research 3. Understanding the knowledge plant systematically and helps to improve the research career in Botany		
Cognitive Levels addressed by the Course	K1- Inculcate the importance of plant systematics K2- Examine the various aspects of the advancement of plant systematics K3- Understand the importance of the advancement of plant systematics K4- Acquire the knowledge on basic and advancement of plant systematics K5- Promote the students to become plant taxonomists		
Course Objectives (Maximum: 5)	**The Course aims** • To have comprehensive knowledge of the history and evolution of plant systematics. • To understand the classical and modern aspects of plant classification. • To understand the various aspects of the International Code of Nomenclature (ICN). • To understand the evolutionary tendencies of different orders		

Unit	**Content**	**No. of Hours**
I	History of developments in taxonomy: Linnaean to post-Linnaean era; Systematics - concepts and components; Evolutionary ecology-concepts and principles; Microevolution - theory and concepts; Species and speciation; Phylogenetic systematics; Macroevolution - inferring phylogenies. Evolutionary tendencies noticed in Ranales, Rosales, Centrospermae, Tubiflorae, Amentiferae, Helobiales, Liliflorae, Glumiflorae.	12

II	Systems of angiosperm classification: Phenetic versus phylogenetic system; Cladistics in taxonomy; relative merits and demerits of major systems of classification Takhtajan, Cronquist, Thorne. Systems of Angiosperm Classification. Cladistics in taxonomy, Angiosperm phylogeny group (APG).	15
III	Diversity and classification of flowering plants; Biological diversity-concepts and applications; Diversity- patterns, indices and applications. The species concept: Taxonomic hierarchy, species, genus, family and other categories; Principles used in assessing relationship delimitation of taxa and attribution of rank, BSI and its role.	10
IV	International code of Nomenclature (ICN); History of Botanical Nomenclature principles of ICBN; Types method; Author citation; Retention and rejection of names; Publication of names, Phylogeny of Angiosperms: Origin and evolution of angiosperms; Important phylogenetic concepts; Taxonomic evidence obtained from Anatomy, Embryology and Palynology, Chemotaxonomy and Molecular taxonomy.	14
V	Salient features, vegetative and sexual characters and phylogenetic significance of Fabaceae, Sapindaceae, Menispermaceae, Rutaceae, Euphorbiaceae, Myrtaceae, Lamiaceae, Rubiaceae, Orchidaceae, Cyperaceae and Poaceae.	13
References	1. Simpson, M.G. 2006. Plant Systematics. Academic Press, London 2. Sivarajan, V. V. 1996. Principles of plant taxonomy. Oxford and IBH publishing Co. Pvt. Ltd, New Delhi. 3. Sharma, O.P. 2013. Plant Taxonomy. McGraw Hill Education Pvt. Ltd. New Delhi. 4. Mondal, A.K. 2005. Advanced Plant Taxonomy. New Central Book Agency (P) Ltd., New Delhi. 5. Johri, R.M. 2005.Taxonomy. Vols. I-IV, Sonali Publication, New Delhi. 6. Bhtacharyya, B. 2005. Systematic Botany. Narosa Publishing House, New Delhi. 7. Subramanyam, N.S.1999. Modern Plant Taxonomy. Vikas Publishing House, New Delhi. 8. Singh, V., Pandey, P.C. and Jain, D.K.1997. A text book of Botany: Angiosperms. Rastogi Publications, Meerat. 9. Singh, V. and Jain, D. K. 1997. Taxonomy of Angiosperms. Rastogi publications. Shivaji Road, Meerat. **Journals and Web-resources:** 1. http://www.springer.com/life+sciences/plant+sciences/journal/12225 2. https://biotaxa.org/phytotaxa 3. http://www.worldcat.org/title/bulletin-of-the-botanical-survey-of-india/oclc/1752752 4. http://www.iaat.org.in/journal.html 5. http://www.nordicjbotany.org/ 6. https://www.banglajol.info/index.php/BJPT 7. http://www.tandfonline.com/toc/tweb20/current/ 8. https://www.jstor.org/journal/taxon	
	On completion of the course, students should be able to CO1: comprehend the knowledge on history and evolution of plant systematics. CO2: understand the classical and modern aspect of plant classification. CO3: understand the various aspects of International Code of Nomenclature (ICN). CO4: understand the evolutionary tendencies of different orders	

Semester	-	Course Code	**21BOTP03D6**
Course Title	**REPRODUCTIVE BIOLOGY OF ANGIOSPERMS**		
No. of Credits	3	No. of contact hours per week	3
New Course/ Revised Course	New Course	If revised, Percentage of revision effected (Minimum 20%)	20
Category	Discipline centric		
Scope of the Course (may be more than one)	1. Comprehend the knowledge on the sexuality of Angiosperms 2. Acquire knowledge on the phenology, pollination and seeds biology of Angiosperms 3. Understand the importance of studying reproduction in Angiosperms		
Cognitive Levels addressed by the Course	K1- Inculcate the importance of the study on the sexuality of Angiosperms K2- Understand the various stages of Angiosperms reproduction K3- Realize the importance of this study in other botanical research K4- Understanding the role of pollination and advertisement in plant biology K5- Create awareness among the students to understand reproductive biology and to appear for national level examinations		
Course Objectives (Maximum: 5)	**The Course aims** • To understand the reproductive biological mechanism of plant taxa and its role in conservation. • To expose the students on the understand the phenology, floral biology, pollination, pollen-pistil interaction, seed biology and analysis on reproductive constrains of trees. • Create awareness among the students to understand the reproductive biology and to appear for national level examinations		

Unit	Content	No. of Hours
I	**Reproductive biology of plants** Reproductive biology in relation withConservation Biology, Crop Productivity and Release of Transgenics; Phenology; population Phenology, Floral Phenology and Community Phenology. Floral Morphology and Sexuality; Morphology of Flower, Sexuality of Flowers, Plants and Populations, Cryptic Sexuality, Reproductive Allocation	12
II	**Pollen & Pistil Biology;** Pollen Production, pollen Morphology Pollen Fertility and Viability, Pollen Vigour. Morphology and Anatomy of the Stigma and Style, Stigma Receptivity, Ovule Receptivity	15
III	**Pollination:** Types and agents help with pollination. Floral Attractants and Rewards, Advertisement in flower- color, shape, nectar and scent, plant-pollinators interface, field methodologies. Non-mutualistic Pollination, Floral Visitors and Pollinators, Pollination Efficiency, Pollination Limitation, Pollen Travel and Gene Flow	10
IV	**Pollen–Pistil Interaction & Breeding Systems** Evolutionary Significance of the Pistil, Pollen Germination and Pollen Tube Growth, Pollen Tube Guidance, Double Fertilization. Breeding Systems: Outbreeding Devices, Self-Incompatibility; Heteromorphic Self-Incompatibility, Homomorphic Self-Incompatibility, Apomixis; Non-recurrent Apomixis, Recurrent Apomixis, Pollen:Ovule Ratio and the Breeding System, Reproductive Assurance Through Autogamy.	14
V	**Fruit and Seed Biology;** Types of fruits, morphology, anatomy, types components of seeds; Seed Viability and Germination, Seed Dormancy. Seed dispersal: agents, mechanism, seedling recruitment; constrains, competition and availability of resources to the seedlings. Seed Rain, Soil Seed Bank. Constraints for Seed Production, dispersal, Seed Germination and seedling establishment	13
References	Anderson, G. J. 1995. Systematics and reproductive biology. In: *Experimental and molecular approaches to plant systematics*. Hoch, P. C. and Stephenson, A. G. (eds.). St. Louis, Mo.: Missouri Botanical Garden (Monographs in Systematic Botany). pp. 263 - 272. Augspurger, C. K. 1982. A cue for synchronous flowering. In: *The ecology of a tropical forest, seasonalrhythms and long term changes*. Leigh, E. G. J., Rand, A. and Windsor, D. M. (eds.). Smithsonian Institute Press, Washington. pp. 133 - 150. Baker, H. G., Baker, I. and Opler, P. A. 1973. Stigmatic exudates and pollination. In: *Pollination and Dispersal*. Brantjes, N. B. M. and Linskens, H. F. (eds.). Department of Botany, University of Nijmegen, Nijmegen, Netherlands. Bewly, J. D. and Black, M. 1982. *Physiology and biochemistry of seed relation to germination*, Springer-Verlag, Berlin, Heidelberg, New York. Bronstein, J. L. 1995. The plant-pollinator landscape. In: *Mosaic Landscapes and Ecological Processes*.	

Hansson, L., Fahrig, L. and Merriam, G. (eds.), Chapman & Hall, London. pp. 256 -258.
Copeland, L. O. and McDonald. M. B. 1995. Principles of seed science and technology. 3rd edition. Chapman and Hall, New York, pp.409.
Dafni, A. 1992. *Pollination ecology: A practical approach.* Oxford University Press, New York. pp. 250.
Dafni, A., Kevan, P. G. and Husband, B. C. 2005. *Practical Pollination biology*, Enviroquest Ltd, Cambridge, Otntario, Canada.
Kramer, P. J. and Kozlowski, T. T. 1960. *Physiology of trees*, McGraw Hill, New York.
Shivanna, K. R. and Johri, B. M. 1985. *The angiosperm pollen structure and function*, Wiley Eastern Ltd Publisher, New Delhi.
Shivanna, K. R. and Rangaswamy, N. S. 1992. *Pollen Biology - A Laboratory Manual*, Narosa Publishing House, New Delhi.
Shivanna, K. R. and Rajesh Tandon. 2014. *Reproductive Ecology of Flowering Plants: A Manual*, Springer, India.

Course Outcomes	On completion of the course, students should be able to CO1: understand the reproductive biological mechanism of plant taxa and its role in conservation. CO2: expose the students on the understand the phenology, floral biology, pollination, pollen-pistil interaction, seed biology and analysis on reproductive constrains of trees. CO3: Create awareness among the students to understand the reproductive biology and to appear for national level examinations

MODULAR COURSES

Semester		Course Code	**21BOTP03M1**
Course Title	**ADVANCED MOLECULAR TECHNIQUES**		
No. of Credits	2	No. of contact hours per week	2
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected (Minimum 20%)	-
Category	Modular		
Scope of the Course (may be more than one)	1. Inculcate the principle and applications of chromatographic and spectrophotometric techniques 2. Learn the separation of proteins by electrophoresis 3. Understand the amino acid sequencing and blotting techniques		
Cognitive Levels addressed by the Course	K1 -Realize the scope and applications of different molecular techniques K2 - Compare the native PAGE and SDS PAGE analysis K3 - Gain knowledge of DNA microarray techniques K4 – Realize the importance of PCR amplification in disease diagnosis K5 – Understand the mapping of the genome in forensic studies		
Course Objectives (Maximum:5)	The course aims • to give knowledge on working principles and applications of electrophoresis techniques • to develop an interest in acquiringthe latest information on molecular sequencing and its applications • to gain knowledge of PCR techniques and their applications • to impart in-depth knowledge of chromatographic and spectrophotometric techniques and their uses • to create interest in the importance of genome sequencing and physical mapping analysis		

Unit	Content	No. of Hours
I	**Chromatographic and Spectrophometric techniques** Principle and applications of Gas Chromatography (GC), High Performance Liquid Chromatography (HPLC). Principle and applications of Atomic Absorbance Spectra (AAS), Infra –red (IR) Spectra and LC-MS technique.	7
II	**Electrophoresis:** Principle and application: paper electrophoresis, agarose gel electrophoresis, polyacrylamide gel electrophoresis (Native PAGE and SDS- PAGE) and Immuno-elctrophoresis	7
III	**Molecular Sequencing** Amino acid sequencing and analysis -MALDI-TOF, DNA sequencing –Enzymatic & chemical methods and new generation sequencing – 16S & 18S rRNA sequencing. Blotting techniques – Southern, northern, western and Dot blots. Microarray techniques – oligonucleiotide array and cDNA array and its applications.	6
IV	**PCR techniques** Principle and applications- types of PCR - enzymology- primer types-methods. PCR amplification for Detection of mutation, monitoring cancer therapy, detect bacterial & viral infections, sex determination of prenatal cells, linkage analysis in sperm cells and studies on molecular evolution.	6

V	**Molecular mapping of genome** Physical mapping and map -based cloning – choice of mapping population & simple sequence repeat loci – southern and fluorescence in situ hybridization for genome analysis - chromosome microdissection and microcloning - molecular markers in genome analysis (RFLP, RAPD, and AFLP analysis) – molecular markers linked disease resistance genes – application of RFLP in forensic, disease prognosis, genetic counselling, pedigree, varietal analysis, animal trafficking and poaching - germplasm maintenance and taxonomy. Molecular mapping of genome.	6
References	Text Books 1. Glick, B.R. and Pasternak, J.J 1994. Molecular Biotechnology, ASM Press, Washington DC. 2. James .D.Watson, Michael Gilman, Jan Wit Koeski and Mark Zuller, 2001. Recombinant DNA. IInd Ed. Scientific American Book, New York. 3. B. Lewin 2000. Genes VII Oxford University Press. 4. E.J. Gardener*et al*.,. 1991. Principles of Genetics (8th Ed.,) John Wiley & Sons, New York.	
	Reference Books 1. S. Palanichamy and M. Shunmugavelu 2009. Research methods in biological sciences. Palani paramount publications, Palani. 2. K. Kannan 2003 Hand book of Laboratory culture media, reagents, stains and buffers Panima publishing corporation, New Delhi. 3. Keith Wilson and John Walker 2002 practical biochemistry – Principles and techniques. Fifth edn. Cambridge Univ. Press. 4. P. Asokan 2002. Analytical biochemistry – Biochemical techniques. First edition – Chinnaa publications, Melvisharam, Vellore 5. Rodney Boyer, 2001. Modern Experimental Biochemistry. III Ed. Addison Wesley Longman Pte. Ltd, Indian Branch, Delhi, India.	
	E-Resources 1. www.cellbio.com/education.html 2. https://www.loc.gov/rr/scitech/selected- interval/molecular.html 3. global.oup.com/uk/orc/biosciences/molbio 4. https://www.loc.gov/rr/scitech/selected-internet/molecular.html	
Course Outcomes	On completion of the course, students should be able to	
	CO1: Outline the working principle and applications of electrophoresis techniques CO2: Explain molecular sequencing techniques CO3: Discuss PCR techniques and their applications CO4: Uses of chromatographic and spectrophometric techniques CO5: Demonstrate methods involved for genome sequencing and physical Mapping	

Semester	-	Course Code	**21BOTP04M2**
Course Title	**COMMERCIAL PLANT TISSUE CULTURE**		
No. of Credits	2	No. of contact hours per week	2
New Course/ Revised Course	New Course	If revised, Percentage of revision effected (Minimum 20%)	20
Category	Modular		
Scope of the Course (may be more than one)	• Understand various media, sterilisation, totipotency, cell induction, organogenesis of plant tissue culture • Apply the techniques to develop a standard protocol for Plant Tissue Culture • Have comprehensive knowledge on GM technology, bio-safety relations and germplasm storage • Acquire the knowledge on various stages of plant tissue culture and become an industrialist		
Cognitive Levels addressed by the Course	K1- Inculcate the importance of plant tissue culture K2- Examine the of various stages of plant tissue culture K3- Implement the process of various stages of plant tissue culture in other botanical research K4- Identify the novel methodology to higher plant production K5- Create awareness among students to understand the various stages of plant tissue culture and to become a industrialist		
Course Objectives (Maximum: 5)	**The Course aims** • To understand the basic principles and methodologies of plant tissue culture • To understand the different standard protocol for the production of viable clones • To learn the knowledge on various methods of Tissue Culture and secondary metabolites production.		

Unit	**Content**	**No. of Hours**
I	**Introduction to plant tissue culture.** Concept and history of plant tissue culture; pioneering work and significant achievements of Indian scientists. Plant tissue culture laboratory design; basic requirements and sterilization practices, Explants selection, sterilization and inoculation; Various media preparations; MS, B5, SH PC L-2;	12
II	**Plant tissue culture technique** Washing, packing and sterilization of glassware; composition, types, preparation and sterilization of culture media; selection, isolation, surface sterilization and inoculation of explants; establishment of *in vitro* cultures, ideal conditions for incubation of cultures, maintenance of cultures and subculture; regeneration of plantlets; acclimatization of tissue cultured plantlets in greenhouse/polyhouse.	15
III	**Cellular totipotency and differentiation** Concept of cellular totipotency and differentiation (dedifferentiation and redifferentiation); role of plant growth regulators in tissue culture; role of meristems in tissue culture; characteristics of callus tissue; somaclonal variation; organogenesis and somatic embryogenesis. Preparation of synthetic seeds.	10
IV	**Principle, protocol and applications types of culture:** callus culture, meristem culture, embryo culture, root culture, anther and pollen culture; micro-propagation. Cell Suspension Culture - methods for isolation of single cells, testing viability of cells, protocol for cell suspension culture, types of suspension cultures (batch and continuous), growth pattern of cells in batch culture, methods for measurement of growth of cells in suspension and applications of cell suspension cultures.	14
V	**Commercial production of crops by Tissue culture** Commercial Plant tissue culture industries in world in India commercial, ornamental and medicinal crops propagated, Propagation of Horticultural & Floriculture crops; Production of cut flowers and home floriculture. Disease and pest control in gardening- Fungicides and pesticides. Plant growing problems and their control, cold house storage. Propagation of Banana, Sugarcane, Papaya, Mango and some Medicinal and Aromatic plants.	13
References	**Text Books** 1. Kesavachandran, R. and Peter, K.V. 2008. Plant Biotechnology: Methods in Tissue cultute and gene transfer. University Press Ltd. Hyderabad. 2. Bhojwani , S.S. and Razdan , M.K. 1996. Plant Tissue Culture : Theory and Practice (revised edition). Elsevier Science Publishers, New York, USA 3. Jain, S.M.Sopory, S.K. and Veilleux, R.E.1996. In Vitro Haploid Production in HigherPlants, Vols. 1-5,	

	Fundamental Aspects and Methods. Kluwer Academic Publishers,Dordrecht, The Netherlands 4. Bhaojwani, S.S. 1990 , Plant Tissue Culture: Applications and Limitations Elsevier Science Publishers , New York , USA 5. Kartha, K.K. 1985. Cryopreservation of Plant Cells and Organs. CRC Press, Boca Raton, Florida, USA. **Reference Book** Vasil, I.K. and Thorpe, T.A.1994. Plant Cell and Tissue Culture. Kluwer Academic Publishers, The Netherlands.
Course Outcomes	On completion of the course, students should be able to CO1:To understand the basic principles and methodologies of plant tissue culture CO2:To understand the different standard protocol for the production of viable clones CO3:To learn the knowledge on various methods of Tissue Culture and secondary metabolites production

Semester	-	Course Code	**21BOTP04M3**
Course Title	**LIFE SCIENCES FOR COMPETITIVE EXAMINATIONS**		
No. of Credits	2	No. of contact hours per week	4
New Course/ Revised Course	New Course	If revised, Percentage of revision effected (Minimum 20%)	-
Category	Modular		
Scope of the Course (may be more than one)	1. Understand the basic and advanced aspects of life sciences for examination purposes 2. Acquire knowledge on different field of biological science 3. Motivate the students to understand the various aspects of life sciences to clear life science based competitive examinations		
Cognitive Levels addressed by the Course	K1- Inculcate basic and advancement of life sciences K2- Realize the various aspects, theory and concepts of life sciences K3- Mull over the knowledge of genetics, cell, biology and molecular biology K4- Expertise on the areas of plant ecology and Evolution K5- Recall the information of all related fields of life sciences		
Course Objectives (Maximum: 5)	**The Course aims** • Impart knowledge on structure, metabolism and function of biomolecules • Understand the importance of inheritance biology. • Discuss in-depth about the different types of ecosystems and their importance. • Outline the major drivers in biodiversity and various conservation approaches. • Introduce basic concepts of evolution and biological clock.		

Unit	**Content**	**No. of Hours**
I	Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins). Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA). Metabolism of carbohydrates, lipids, amino acids, nucleotides and vitamins. Structure of atoms, molecules and chemical bonds. Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.). Bioenergetics. Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins). Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA). Metabolism of carbohydrates, lipids, amino acids, nucleotides and vitamins. Structure of atoms, molecules and chemical bonds. Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.). Bioenergetics	13
II	Cellular Organisation, Cell division and cell cycle, Membrane structure and function, Organization of genes and chromosomes, Structural organization and function of intracellular organelles, DNA replication, repair and recombination, Protein synthesis and processing. Cellular Organisation,Cell division and cell cycle,Membrane structure and function,Organization of genes and chromosomes,Structural organization and function of intracellular organelles,DNA replication, repair and recombination,Protein synthesis and processing.	12
III	Inheritance Biology, Mendelian principles- Dominance, segregation, independent assortment, Linkage and Gene mapping, Karyotyping, Extrachromosomal inheritance - Inheritance of Mitochondrial and chloroplast genes, maternal inheritance. Human genetics; Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders. Inheritance Biology,Mendelian principles- Dominance, segregation, independent assortment,Linkage and Gene mapping, Karyotyping,Extrachromosomal inheritance - Inheritance of Mitochondrial and chloroplast genes, maternal inheritance. Human genetics-Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders	15
IV	Ecology-Habitat and Niche,biotic and abiotic interactions, Biome- biogeographical zones of India.Ecological Succession,Population Ecology- Characteristics of a population; population growth curves,Environmental pollution- global environmental change, Biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches.Biodiversity Management approaches. Indian case studies on Conservation/Management strategy (Project Tiger, Biosphere Reserves).	14
V	Evolution and Behaviour- Evolution - Theories- Darwin's, Lamarck's, Oparin Haldane. Paleontological, Embryological and Molecular evidence. Hardy Weinberg's Law. Speciation; Allopatricity and Sympatricity. Adaptive radiation and Convergent evolution; Sexual selection; Co-evolution. Altruism, Biological clocks, Migration and Parental care. Molecular Evolution-Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny. Evolution and Behaviour- Evolution - Theories- Darwin's, Lamarck's, Oparin Haldane. Paleontological, Embryological and Molecular evidence. Hardy Weinberg's Law. Speciation; Allopatricity and Sympatricity. Adaptive radiation and Convergent evolution;	10

	Sexual selection; Co-evolution. Altruism, Biological clocks, Migration and Parental care. Molecular Evolution- Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny.	
References	Text books: 1. Gokhale, S.B., Kokate, C.K and Gokhale, A. (2016). Pharmacognosy of traditional drugs, nirali prakashan, 2. Jain, S.K. (2010). Manual of ethnobotany. Scientific Publishers, New Delhi 3. Singh, V. (2009). Ethnobotany and Medicinal Plants of India and Nepal (Vol. 3). Scientific Publishers. New Delhi 4. Gringauz (2012). Introduction to Medicinal Chemistry: How Drugs Act & Why? Wiley India Pvt, Ltd., Noida 5. Joshi, S.G. (2018). Medicinal Plants. Oxford & IBH Publishing C., Pvt., Ltd., New Delhi. 6. Kumar, N. (2018). A Textbook of Pharmacognosy. Aitbs Publishers, India 7. Premendra Singh (2013). Medicinal Plants: Conservation, Cultivation and Utilization. Daya Publishing House, New Delhi. **Reference Books** 1. Albuquerque, U.P., Ramos, M.A., Júnior, W.S.F., and De Medeiros, P.M. (2017). Ethnobotany for beginners. Springer International Publishing, US. 2. Balick, M.J., and Cox, P.A. (1996). Plants, people, and culture: the science of ethnobotany. Scientific American Library, US 3. Qadry, J.S. (2014). A textbook of Pharmacognosy Theory and Practicals. 17th ed. CBS Publishers & Distributors, New Delhi. 4. Prajapati, N.D., Purohit, S.S, Sharma, A.K, Tarun Kumar, (2006). A Handbook of Medicinal Plants: A Complete Source Book. Vedic Books Sales Rank 5. Cotton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and Sons – Chichester. 6.. Faulks, P.J. 1958. An introduction to Ethnobotany, Moredale Pub. Ltd., London. 7. Jain S.K., (ed.) 1981 Glimpses of Indian Ethnobotany, Oxford and I B.H., New Delhi. 8. Jain S.K., (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India. 9. Jain S.K., 1990. Contributions of Indian ethnobotany. Scientific publishers, Jodhpur. 10. Jain S.K., 1995 Manual of Ethnobotany, Scientific Publishers, Jodhpur.	
	On completion of the course, students should be able to CO1: Define, classify and assess the structure, biological functions and interactions of Biomolecules. CO2: Validate the knowledge of collective and progressive notions of cellular organization. CO3: Assess and describe the importance of inheritance biology. CO4: Establish acquaintance and understanding of ecology & Biodiversity in a broader sense. CO5: Understand the processes of evolution, relate with natural selection, adaptation and speciation.	

Semester	-	Course Code	**21BOTP04M4**
Course Title	**ENTREPRENEURIAL OPPORTUNITIES IN BOTANY**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected (Minimum 20%)	20
Category	Modular		
Scope of the Course (may be more than one)	• To understand the importance of floriculture and nursery management. • Understand the different classifications of horticultural crops, nursery management, and use of technology in horticulture. • Develop their competency on pre and post-harvest technology in horticultural crops.		
Cognitive Levels addressed by the Course	K1- Inculcate the information organic manures and vermicompost K2- Realize the various information on Garden and Nursery management K3- Mull over the techniques Herbal products and marketing K4- Expertise knowledge on Fruit preservation and processing K5- Realize the importance of Mushroom cultivation and value addition		
Course Objectives (Maximum: 5)	**The Course aims** • Impart knowledge on organic manures and vermicompost • Understand the importance of Garden and Nursery management • Discuss in-depth about the Herbal products and marketing • Outline the major drivers in Fruit preservation and processing • Introduce basic concepts of Mushroom cultivation and value addition		

Unit	Content	No. of Hours
I	**Organic manures and vermicompost** Organic manures and fertilizers. Composition of fertiliser, NPK content of various fertilizers. Common organic manures; bone meal, cow dung, poultry waste, oil cakes, organic mixtures and compost. Preparation of compost, aerobic and anaerobic – advantages. Vermicompost preparation, vermiwash. Panchakaviyam.	13
II	**Garden and Nursery management** Gardening – types of garden, ornamental, indoor garden, kitchen garden, terrace garden, vegetable garden for marketing. Rockery and artificial ponds. Methods of plant propagation by seeds. Vegetative propagation, cutting, grafting, budding and layering.	12
III	**Herbal products and marketing** Cultivation of common medicinal plants, collection, drying and storage. Classification of natural drugs: preparation of crude drug; formulations. Deterioration of drugs; Drug evaluation, Chemical evaluation and biological evaluation of drugs. Value addition and marketing	15
IV	**Fruit preservation and processing** Packaging of fruits, vegetables. Preservation techniques drying, heat treatment, low temperature storage and by chemicals. Preparation of wine, vinegar and dairy products.	14
V	**Mushroom cultivation and value addition** Significance of mushrooms. Types of mushrooms (button mushroom, oyster mushroom). Spawn preparation. Cultivation. Value-added products from mushrooms – pickles, candies and dried mushrooms.	10

References	1. Adams, C.R. Banford, K.M. and Early, M.P. 1993. Principles of Horticulture. 2. Sathe,T.V. 2004. Vermiculture and Organic farming, Daya Publishers. 3. Peter, K.V. 2017. Basic Horticulture. 4. Hartman, H.T. and D.F. Kestler. 1976. Plant propagation principles and practice. Prentice Hall of India, New Delhi. 5. Jules Janick, 1982. Horticulture Science. Surjeet publications, New Delhi. 6. Ignacimuthu, S.1998. Plant Biotechnology. Tata Mc Graw Hill Ltd., New Delhi. 7. Gupta. P.K.,1998. Elements of Biotechnology. Rastogi publications, Meerut. 8. Edmond Musser and Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi. Janick Jules. 1979. Horticultural Science. (3rd Ed.), W.H. Freeman and Co.,San Francisco, USA. 1. https://www.kobo.com/in/en/ebook/composting-process-organic-manures-through-eco-friendly-waste-management-practices 2. https://books.google.co.in/books/about/Plant_Propagation.html?id=K-gQh6OI7GcC&redir_esc=y 3. https://www.ebooks.com/en-us/subjects/gardening/ 4. https://www.amazon.in/Preservation-Techniques-Publishing-Technology-Nutrition-ebook/dp/B00RXCXB3Q https://www.elsevier.com/books/food-preservation-techniques/zeuthen/978-1-85573-530-9
	On completion of the course, students should be able to CO1:Define, classify and assess the structure, biological functions and interactions of Biomolecules. CO2:Validate

	the knowledge of collective and progressive notions of cellular organization. CO3:Assess and describe the importance of inheritance biology. CO4:Establish acquaintance and understanding of ecology & Biodiversity in a broader sense. CO5:Understand the processes of evolution, relate with natural selection, adaptation and speciation. CO1: Describe the knowledge on organic manures and vermicompost CO2: Understand the importance of Garden and Nursery management CO3: Assess the concepts of about the Herbal products and marketing CO4: Critique the Fruit preservation and processing CO5: Identify the concepts of Mushroom cultivation and value addition

Semester		Course Code	**24BOTP04M5**
Course Title	**INTELLECTUAL PROPERTY RIGHTS**		
No. of Credits	2	No. of contact hours per week	2
New Course/ Revised Course	New Course	If revised, Percentage of revision effected (Minimum 20%)	-
Category	Modular		
Scope of the Course (may be more than one)	1. Understand the importance of Intellectual property Rights 2. Acquire the knowledge on Copyright, Trademarks and Registration of patents for innovations 3. Understand the Process of patentability and IPR opportUnities in life sciences		
Cognitive Levels addressed by the Course	K1- Inculcate the importance of IPR K2- Examination of Copyright and Trademarks and Registration of IPRs K3- Implement the process of patent application K4- Motivate the innovations to get copyrights K5- Create awareness among the people on patent application process		
Course Objectives (Maximum: 5)	**The Course aims** • To evaluate knowledge on Intellectual property Rights • To understand the Copyright and Trademarks and Registration of IPRs • To evaluate the process of Patents & Patentability • To analyse the details of various process of IPR in Life Sciences		

Unit	Content	No. of Hours
I	**Introduction to IPRs.** Basic concepts and need for Intellectual property- Patents, Copyrights, Geographical Indications, Nature of Intellectual Property, Industrial Property, technological Research. Introduction to Intellectual property – Invention and Creativity – Importance – Protection of IPR	6
II	**Copyright and Trademarks and Registration of IPRs:** Copy right – definition, protection, Related Rights, Distinction between related rights and copyrights. Nature of Copyright - Subject matter of copyright: original literary, dramatic, musical, artistic works; cinematograph films and sound recordings. Trade mark – definition, rights, kind of signs, types of trademarks, protection and registration.	6
III	**Patents:** Introduction to Patents – Patentability criteria - Novelty, Non Obviousness and industrial applicability - The Patent Act, 1970 – Inventions not patentable – Patent Specifications: Provisional and complete - Types of patent applications – compulsory licensing – Patent application Forms and fees –Patent search- Types. Patents:	7
IV	**Patents & Patentability;** Patents - Elements of Patentability: Novelty , Non Obviousness (Inventive Steps), Industrial Application - Non - Patentable Subject Matter - Registration Procedure, Rights and Duties of Patentee, Assignment and license , Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties	7
V	**IPR in Life Sciences:** Patentability of Biotechnology Inventions - Protection of Genetic Resources - Patenting of seeds Moral Issues in Patenting Biotechnological Inventions – case studies on biotechnology patents Legal protection of Biotechnological inventions. Patenting of Basmati Rice in USA, case study of Glyphosate tolerance, betaine production and revocation of Neem and Turmeric patents.	6

References

1. Deborah E. Bouchoux- Intellectual: The Law of Trademarks, Copyrights, Patents and Trade secrets, Cengage Learning. Third Edition, 2012
2. Prabuddha Ganguli Intellectual Property Rights: Unleashing the knowledge Economy. McGraw Hill Education, 2011
3. Edited by Derek Bosworth and Elizabeth Webster. The Management of Intellectual Property. Edward Elgar Publishing Ltd.,2013.
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E-resources:

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2. World Intellectual Property Organisation. (2004). WIPO Intellectual property Handbook. Retrieved from https://www.wipo.int/edocs/pubdocs /en/intproperty/489/wipo_pub _489.pdf

Reference Journal:

1. Journal of Intellectual Property Rights (JIPR): NISCAIR

Useful Websites:

1. Cell for IPR Promotion and Management (http://cipam.gov.in/)
2. World Intellectual Property Organization (https://www.wipo.int/about-ip/en/)
3. Office of the Controller General of Patents, Designs & Trademarks (http://www.ipindia.nic.in/)

On completion of the course, students should be able to

CO1: gain the knowledge on Intellectual property Rights

CO2: understand the Copyright and Trademarks and Registration of IPRs

CO3: evaluate the process of Patents & Patentability

CO4: analyse the details of various process of IPR in Life Sciences

Semester	-	Course Code	**24BOTP04M6**
Course Title	**HORTICULTURE AND LANDSCAPE MANAGEMENT**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected (Minimum 20%)	20
Category	Modular		
Scope of the Course (may be more than one)	• To understand the importance of floriculture and nursery management. • Understand the different classifications of horticultural crops, nursery management, and use of technology in horticulture. • Develop their competency on pre and post-harvest technology in horticultural crops. • Analyze the different methods of weed control and harvest treatments of horticultural crops. Examine the economic implications of cultivation of tropical and sub-tropical vegetable crops Evaluate the importance of floriculture and contribution spices and condiments on economy		
Cognitive Levels addressed by the Course	K1- Inculcate basic and advancement of basics of horticulture K2- Realize the various aspects of plant propagation K3- Mull over the techniques in fruit crops propagation K4- Expertise on the flower and vegetable crops cultivation K5- Realize the importance of Landscape Management		
Course Objectives (Maximum: 5)	**The Course aims** • Inculcate basic and advancement of basics of horticulture • Realize the various aspects of plant propagation • Mull over the techniques in fruit crops propagation • Expertise on the flower and vegetable crops cultivation • Realize the importance of Landscape Management		

Unit	Content	No. of Hours
I	**Basics of Horticulture** Importance and scope of Horticulture - Divisions of Horticulture – Climate, soil and nutritional needs – Manures and fertilizers – Organic manures – Inorganic fertilizers – Biofertilizers – Methods of applications of manures and fertilizers - Water irrigation – Surface irrigation – Sub irrigation – Special irrigation methods – Plant protection and pest control for horticulture crops.	13
II	**Plant propagation** Natural method: Propagation through seeds and specialized vegetative structures - Artificial methods: Cutting: types (root, stem, leaf cuttings), advantages and disadvantages - Layering: types (simple, compound, tip, trench, mound, air-layering) advantages and disadvantages - Grafting: types (inarching, side, splice, whip/tongue, veneer, cleft, bark, epicotyl, top-working) advantages and disadvantages - Budding: Types (T-budding, shield, patch, and ring budding) advantages and disadvantages - Stock – scion relationships – Micropropagation.	12
III	**Fruit crops** Training and pruning methods for fruit plants – Induction of flowering, flower thinning - fruit setting and fruit development – Seedlessness in horticultural fruits – Importance of plant growth regulators in fruit crops – Cultivation and harvesting methods of important fruit crops; Mango, Sapota, Pomegranate, Grapes and Guava.	15
IV	**Flower and vegetable crops** Floriculture – Cultivation of commercial flower crops – Rose, Jasmine, Chrysanthemum, Crossandra, Anthurium and Gerberas – Cut flowers – Vase life period – Packages for export of cut flowers - Flower decoration – Dry and wet decoration - State Integrated Board of Studies – Botany PG 32 Classification of vegetables – Cultivation of important vegetables - Tomato, Potato, Onion, Cabbage and Snake guard – Layout for a model kitchen garden.	14
V	**Landscape Management** 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; Training and pruning - Terrace garden - Cultivation of tree species – Eucalyptus and teak.	10
References	1. Edmond, J.B. 1977. Fundamentals of Horticulture. Tata McGraw Hill Publishers Co. Ltd., New Delhi. 2. Kumar, N. 2017. Introduction to Horticulture, Midtech Publisher. 3. Manibushan Rao, K. 1991. Textbook of Horticulture. Macmillan Publishing Co., New York. 4. Rao, K.M. 2000. Text book of Horticulture. Macmillan India Ltd, New Delhi. 5. George, A. 2002. Horticulture Principles and Practices. 2nd Edition. Pearson Education, Delhi. 6. Bohra, M.P.S. and Arora, 2017. Introduction to Horticulture, 2 nd Edition.	

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	On completion of the course, students should be able to CO1:Define, classify and assess the structure, biological functions and interactions of Biomolecules. CO2:Validate the knowledge of collective and progressive notions of cellular organization. CO3:Assess and describe the importance of inheritance biology. CO4:Establish acquaintance and understanding of ecology & Biodiversity in a broader sense. CO5:Understand the processes of evolution, relate with natural selection, adaptation and speciation.

GENERIC COURSES

Semester	-	Course Code	**24BOTP02G1**
Course Title	**HERBAL BOTANY AND DIETETICS**		
No. of Credits	2	No. of contact hours per week	2
New Course/ Revised Course	New Course	If revised, Percentage of revision effected (Minimum 20%)	25
Category	Core		
Scope of the Course (may be more than one)	1. Understand the importance of herbal botany and dietetics 2. Utilize the natural resources for day to day life for better health 3. Realize the importance of the course and promote research in botanical and nutrition sciences		
Cognitive Levels addressed by the Course	K1- Understand the importance of botanical herbs and food. K2- Observation on Methods of preparation of drugs for human kind K3- Understanding the mechanism of pharmacognosy& Pharmacological action of plant drugs K4- Realize the nutritional status of various food habits. K5- Awareness among the people on dietary management in Fever		
Course Objectives (Maximum: 5)	**The Course aims** • To acquire the knowledge on importance and usage of medicinal plants • To understand the techniques on Methods of preparation of drugs • To evaluate the mechanism of Pharmacognasical and Pharmacological action of plant drugs • To Assess nutritional status of various food items of human • To realize the various aspects of Dietary management		

Unit	Content	No. of Hours
I	**Brief history of medicinal plants.** Brief history and scope of raw drugs of plant origin. Herbals, classification and description. Indian systems of Medicine: Siddha, Ayurvedha, Homeopathy, and Unani and Naturopathy. Traditional and Folklore medicine. Ethnobotany and Ethnomedicine; Herbal home remedies of South India; Herbal formularies-Infusions and decoctions, oil extractions, ointments, lotions, washes, suppositories; Ethnobotany of South India.	12
II	**Methods of preparation of drugs** Definition of Drug - Classification of natural drugs: Alphabetical, Morphological, Pharmacological and Chemical. Factors involved in the production of drugs – climate; cultivated and wild plants – collection, drying and storage. Deterioration of drugs – primary factors, mould and bacterial attack, control of insect pests. Drug adulteration, Drug evaluation, Chemical evaluation and Biological evaluation of drugs.	15
III	**Pharmacognosy& Pharmacological action of plant drugs** Basic study of the source and medicinal value of the phytochemicals, glycosides, alkaloids, phenols, saponins and steroidal saponins. Chemistry of drugs (Alkaloids, Flavonoids, Glycosides and Tannins) Quality control of herbal drugs. Pharmacognosy - Definition and scope. A brief account of drugs acting on the central nervous system (CNS stimulants, CNS depressants and Hallucinogenics). Drugs used in disorders of the gastrointestinal tract (Carminatives, Bulk laxatives and Purgatives) and cardiovascular drugs (Cardiotonics, Cardio-depressants and Antihypertensives).	10
IV	**Assessment of nutritional status**: Nutritional assessment, Importance and Objectives, Indirect assessment of Nutritional status-Age, specific mortality rates, cause-specific mortality rates, nutritionally relevant morbidity rates, ecological factors. Direct assessment of nutritional status - Nutritional Anthropometry-Height, length, weight, waist circumference, waist hip ratio, body fat, skin fold measurements. Clinical assessment of Nutritional disorders, Biochemical assessment for nutritional deficiencies and Dietary assessment. Family diet survey, Individual diet survey, quantitative diet surveys, Institutionalized surveys and Food balance sheet.	14
V	**Dietary management:** Types, metabolic changes, dietary management. Dietary management in Human Immunodeficiency Disease (AIDS): pathophysiology, etiology and classification, manifestations and stages of HIV infection, opportunistic infections and other complications, pediatric consideration, relationship between malnutrition and AIDS, medical nutrition therapy. Diet in Overweight/Obesity: Aetiology, assessment, types, complications, management of obesity – medical, nutritional, lifestyle management, Diet in Diabetes Mellitus - Types, GDM, aetiology, symptoms, prevention of MODY diagnosis, treatment- insulin, oral hypoglycemic agents, dietary modifications, glycemic index, factors affecting glycemic index, glycemic load, sweetners, complications of diabetes.	13

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Course Outcomes	On completion of the course, students should be able to CO1: acquire the knowledge on importance and usage of medicinal plants CO2: understand the techniques on Methods of preparation of drugs CO3: evaluate the mechanism of Pharmacognasical and Pharmacological action of plant drugs CO4: assess nutritional status of various food items of human CO5: realize the various aspects of Dietary management	

Semester	-	Course Code	24BOTP02G2
Course Title	**PRESERVATION AND PROCESSING OF FRUITS AND VEGETABLES**		
No. of Credits	**Credits – 2**	No. of contact hours per week	2
New Course/ Revised Course	New Course	If revised, Percentage of revision effected (Minimum 20%)	-
Category	Core		
Scope of the Course (may be more than one)	1. Understand the concepts of fruits and vegetable preservation 2. Utilize the various methodologies of fruits and vegetable preservation. 3. Comprehend the information on the techniques and motivate the students to become Entrepreneur and Industrialists		
Cognitive Levels addressed by the Course	K1- Inculcate the advancement of fruits and vegetable preservation K2- realize the various techniques involved in fruits and vegetable preservation K3- Apply the knowledge on various techniques in Industrial level K4- Understand the problems and facts of fruits and vegetable preservation K5- Motivate the people to become fruits and vegetable preservation Entrepreneur and Industrialists		
Course Objectives (Maximum: 5)	**The Course aims** • To evaluate methodologies of fruits and vegetable preservation • To understand the various processing Technologies on fruits and vegetable preservation • To evaluate the process of Cooling and Freezing techniques for fruits • To validate the importance of thermal drying of foods • To identify the role of preservatives on Preserving vegetables		

Unit	Content	No. of Hours
I	**Preservation of Fruits and Vegetables** Introduction**.** Safety Issues on the Preservation of Fruits and Vegetables State of the Art, Microbial Hazards-Positive effects of micro-organisms in food, Negative effects of micro-organisms in food.	12
II	**Processing Technologies** Physiological Aspects Affecting the Postharvest Life of Fruits, Minimal Processing Technologies used in fruit preservation- Washing and Sanitizing of Fruits- Chlorine, Chlorine Dioxide, Acidified Sodium Chlorite, Hydrogen Peroxide, Peracetic acid, Peroxyacetic Acid, Trisodium Phosphate, Electrolyzed Water, ozone, Minimal Processing Methods to Extend Shelf-Life of Fresh-Fruits- Refrigeration, Natural Preservatives, Blanching, Ultraviolet Light, Irradiation, Pulsed Light, Ultrasound, High Hydrostatic Pressure, Food Packaging. The Hurdle Concept	15
III	**Cooling and Freezing** Cooling and Freezing of Fruits and Fruit Products- Cooling of Fruits, Pre-cooling Treatments and Refrigeration, Controlled and Modified Atmosphere. Novel Technologies: Thermal Treatments, UV-C Irradiation, Minimally Processed Fruits, Edible Coatings. Freezing of Fruits- The Freezing Process: Ice Formation, Homogeneous and Heterogeneous Nucleation. Recommended Packaging and Industrial Freezing Methods for Fruits- Shelf-Life of Frozen Fruits	10
IV	**Thermal Drying of Foods-** Drying Equipment and Design. Drying Mechanisms. Packing and storage. Quality of the fresh product Consuming dried products- Drying potatoes, Drying tomatoes, Drying mangos, R&D Opportunities in Drying. Pressure-Driven Membrane Processes.	14
V	**Preserving vegetables with preservatives** Preserving vegetables with salt and/or vinegar- Preserving with salt. Jam and juice making, syrups,jellies and candied fruit- Making fruit juices, Preparation of other fruit products. Developing a small-scale food processing enterprise- Marketing a fresh or processed product, Organizing a processing enterprise	13
References	1. Processing and preservation of tropical and subtropical foods: Kordylas, J.M. (1990), Mac Millan Education Ltd., Hong Kong, 432p. 2. Prevention of post-harvest food losses: Fruit, vegetables and root crops: Food and Agricultural Organization of the United Nations(1989), Rome, 154p. 3. Preservation of fruit and vegetables: Ife Fitz James Bas Kuipers.(2003), Agromisa Foundation, Wageningen.44-64p 4. Fruit Preservation Novel and Conventional Technologies: Amauri Rosenthal Rosires Deliza Jorge Welti-Chanes Gustavo V. Barbosa-Cánovas.(2018), 233 Spring Street, New York, NY 10013, U.S.A 1-130p	
Course Outco	On completion of the course, students should be able to CO1: evaluate methodologies of fruits and vegetable preservation CO2: understand the various processing Technologiesforfruit and vegetable preservation	

mes	CO3: evaluate the process of Cooling and Freezing techniques for fruits CO4: validate the importance of thermal drying of foods CO5: identify the role of preservatives on Preserving vegetables	

Semester	-	Course Code	**24BOTP02G3**
Course Title	**BIOFERTILIZERS AND MUSHROOM TECHNOLOGY**		
No. of Credits	**Credits – 2**	No. of contact hours per week	4
New Course/ Revised Course	New Course	If revised, Percentage of revision effected (Minimum 20%)	20
Category	Core		
Scope of the Course (may be more than one)	1. Understand the concepts biofertilizers and Mushroom production 2. Utilize the various methodologies of biofertilizers and Mushroom for income generation. 3. Comprehend the information on the techniques and motivate the students to become Entrepreneur and Industrialists		
Cognitive Levels addressed by the Course	K1- Inculcate the advancement of biofertilisers and Mushroom production K2- realize the various techniques involved in biofertilisers and Mushroom cultivation K3- Apply the knowledge of various techniques at the Industrial level K4- Understand the problems and facts of biofertilisers and Mushroom cultivation K5- Motivate the people to become biofertilisers and Mushroom cultivation Entrepreneur and Industrialists		
Course Objectives (Maximum: 5)	**The Course aims** • To evaluate Knowledge and techniques of Biofertilizers • To understand the various processing Technologies of Azolla cultivation • To evaluate the process of information about mushroom biology: • To validate the importance of tropical mushroom cultivation technology • To identify Nutrient profile of Mushrooms		

Unit	Content	No. of Hours
I	**Biofertilizers** Introduction, scope. A general account of plant growth promoters and regulators – Cyanobacterial Biofertilizer: Algalization – mass cultivation of cyanobacterial biofertilizers. Nitrogen fixing Bacteria: Isolation, characterization, identification, mass cultivation and inoculation method of *Rhizobium* and *Azospirillum*. Mechanism of nitrogen fixation (free-living and symbiotic)	12
II	**Azollacultivation** Structure and Morphology – Mass cultivation method and Application. Economic and Ecological importance of Azolla. Phosphate solubilizing Bacteria: Isolation, characterization, identification, mass cultivation and inoculation method of Phosphobacteria. Mycorrhizal fungi as biofertilizers - Introduction, scope. A general account of Ecto, Endo and Arbuscular mycorrhizae (AM). Isolation and method of inoculation of Arbuscular mycorrhizae (AM), Legume - AM interactions.	15
III	**Introduction to mushroom biology:** characteristics, importance of mushrooms - as food, tonics and medicines. Different parts of a typical mushroom. Key to differentiate edible from poisonous mushrooms. phases of mushroom technology - pure culture, spawn, preparation of compost, mushroom development	10
IV	**Prospects of tropical mushroom cultivation technology**: Oyster mushroom technology, paddy mushroom technology, milky mushroom and button mushroom technology, postharvest technology. Mushroom farming and prospects.	14
V	**Nutrient profile of Mushrooms;** Protein, aminoacids, calorific values, carbohydrates , fats, vitamins &minerals. In therapeutic diets for adolescence, for aged persons & diabetes mellitus. Health benefits: Antiviral value, antibacterial effect, antifungal effect, anti-tumour effect, haematological value, cardiovascular and renal effect.	13
References	**Reference Books** 1. Kannaiyan, S., Kumar, K. and Govindarajan, K., 2010. Biofertilizers Technology. Scientific Publishers. 2. Kumar, R., Kumawat, N. and Sahu, Y.K., 2017. Role of biofertilizers in agriculture. Popular kheti, 5(4), pp.63-66. 3. Rao, N.S., 1982. Biofertilizers. Interdisciplinary science reviews, 7(3), pp.220-229. 4. Verma, A. (1999). Mycorrhiza. Springer Verlag, Berlin. 5. Subba Rao, N.S. (1982). Advances in Agricultural Microbiology. Oxford &IBH Publishing Co. Pvt. Ltd., New Delhi. 6. Niir Board, 2004. The Complete Technology Book On Bio Fertilizer and Organic Farming, National Institute Of Industrial Research, Delhi.	

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Course Outcomes	On completion of the course, students should be able to CO1:evaluate Knowledge and techniques of Biofertilizers CO2:understand the various processing Technologies of Azolla cultivation CO3: evaluate the process of information about mushroom biology: CO4: validate the importance of tropical mushroom cultivation technology CO5: identify Nutrient profile of Mushrooms

VALUE ADDED COURSES

Semester	-	Course Code	**24BOTP04VA1**
Course Title	**RURAL ENTREPRENEURSHIP**		
No. of Credits	2	No. of contact hours per week	2
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	20
Category	Value added Course		
Scope of the Course (may be more than one)	1. Understand the importance of biogas technology 2. Learn the effective way of utilization of vermicompost 3. Field observation of mushroom farms, spirulina industries and fish farms		
Cognitive Levels addressed by the Course	K1 -Create awareness on utilization of bioresources for rural economy K2 - Remember the scope and applications of biogas and vermiculture technology K3 - Gain knowledge on mushroom cultivation K4 - Assess the techniques for spirulina cultivation K5 -Analyze the importance of biotechnology in enhancing rural economy		
Course Objectives (Maximum:5)	**The course aims** • to create interest on the fundamentals of biogas technology • to expose the technologies related to composting • to impart information on scope of mushroom culture technology • to impart knowledge on *Spirulina* cultivation technology • to know Ornamental Fish culture technology		

Unit	Content	No. of Hours
I	**Biogas technology** Introduction and history – anaerobic digestion – microbes involved – factors influencing methane production – Stages of methane generation – Wastes used in methanogenesis – various bioreactors used for methane generation – Advantages and disadvantages. Visit to biogas production Units with field demonstration.	7
II	**Composting technology** Historical background – waste availability – factors influencing – methods- biomaturity-enrichment of Compost and crop productivity. Vermiculture Technologies: History – species – life cycles – methods – different types of waste suitable for vermicomposting. Utilization of vermicompost for crop production. Visit to vermicompost industries with field demonstration.	7
III	**Mushroom technology** Bioconversion of organic wastes into protein - Oyster mushroom technology, paddy mushroom technology, milky mushroom and button mushroom technology, post harvest technology. Mushroom farming and prospects. Visit to mushroom farms with field demonstration.	6
IV	***Spirulina* cultivation technology** Biology of *Spirulina* - cultivation methods, post harvest technology and single cell protein formulation. Visit to *Spirulina* industries with field demonstration.	6
V	**Ornamental Fish Culture** National and International status and importance – Selection of ornamental fishes, Commercially important fresh water and marine ornamental fishes. Setting and maintenance of aquarium tanks. Kinds of feeds and feeding methods, breeding techniques; goldfish, angel fish, fighter, guppy, molly, platy, zebra fish and swordtail – Economics.	6

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	Reference Books 1. Srivastava, C.B.L, 2002. Aquarium fish keeping. Kitab Mahal, Allhabad. 2. Gaur, A.C., 1999. Microbial technology for Composting of Agricultural Residues by 3. Improved Methods, 1st print, ICAR, New Delhi. 4. Subba Rao, N.S., 1999. Soil Microbiology, 4th Ed., Oxford IBH Publishing Co. Pvt. Ltd., New Delhi. 5. Philip G. Miles, Shu-Ting Chang, 1997. Mushroom biology, World Scientific,Singapore. 6. Chatwal, G.R., 1995. Textbook of Biotechnology, Anmol Publications Pvt. Ltd., New Delhi 7. Bahl, N. 1988. Handbook on mushrooms. Oxford &IBH Publishing Co., Pvt. Ltd., New Delhi.
	E-Resources 1. https://www.eesi.org 2. https://agritech.tnau.ac.in/org_farm/orgfarm_composting.html 3. https://www.rpcau.ac.in 4. https://www.techno-preneur.net 5. https://www.ncdc.in/
Course Outcomes	On completion of the course, students should be able to
	CO1: Evaluate the different aspects of biogas production technology CO2: Discuss the different types of composting technologies and how to establish a composting Units CO3: Explain the methods of mushroom culture and start a mushroom farm CO4: Summerise *Spirulina* cultivation by low-cost method CO5: Understand the culture technique of different ornamental fish and establish an aquarium farm

Semester	-	Course Code	**24BOTP04VA2**
Course Title	**COMMERCIAL PLANT TISSUE CULTURE**		
No. of Credits	2	No. of contact hours per week	2
New Course/ Revised Course	New Course	If revised, Percentage of revision effected (Minimum 20%)	20
Category	Value added Course		
Scope of the Course (may be more than one)	• Understand various media, sterilization, totipotency, cell induction, organogenesis of plant tissue culture • Apply the techniques to develop a standard protocol for Plant Tissue Culture • Have comprehensive knowledge of GM technology, bio-safety relations and germplasm storage • Acquire knowledge on various stages of plant tissue culture and to become a industrialist		
Cognitive Levels addressed by the Course	K1- Inculcate the importance of plant tissue culture K2- Examine the of various stages of plant tissue culture K3- Implement the process of various stages of plant tissue culture in other botanical researches K4- Identify the novel methodology to higher plant production K5- Create awareness among students to understand the various stages of plant tissue culture and to become a industrialist		
Course Objectives (Maximum: 5)	**The Course aims** • To understand the basic principles and methodologies of plant tissue culture • To understand the different standard protocol for the production of viable clones • To learn the knowledge on various methods of Tissue Culture and secondary metabolites production.		

Unit	Content	No. of Hours
I	**Introduction to plant tissue culture.** Concept and history of plant tissue culture; pioneering work and significant achievements of Indian scientists. Plant tissue culture laboratory design; basic requirements and sterilization practices, Explants selection, sterilization and inoculation; Various media preparations; MS, B5, SH PC L-2;	12
II	**Plant tissue culture technique** Washing, packing and sterilization of glassware; composition, types, preparation and sterilization of culture media; selection, isolation, surface sterilization and inoculation of explants; establishment of *in vitro* cultures, ideal conditions for incubation of cultures, maintenance of cultures and subculture; regeneration of plantlets; acclimatization of tissue cultured plantlets in greenhouse/polyhouse.	15

III	**Cellular totipotency and differentiation** Concept of cellular totipotency and differentiation (dedifferentiation and redifferentiation); role of plant growth regulators in tissue culture; role of meristems in tissue culture; characteristics of callus tissue; somaclonal variation; organogenesis and somatic embryogenesis. Preparation of synthetic seeds.	10
IV	**Principle, protocol and applications types of culture:** callus culture, meristem culture, embryo culture, root culture, anther and pollen culture; micro-propagation. Cell Suspension Culture - methods for isolation of single cells, testing viability of cells, protocol for cell suspension culture, types of suspension cultures (batch and continuous), growth pattern of cells in batch culture, methods for measurement of growth of cells in suspension and applications of cell suspension cultures.	14
V	**Commercial production of crops by Tissue culture** Commercial Plant tissue culture industries in world in India commercial, ornamental and medicinal crops propagated, Propagation of Horticultural & Floriculture crops; Production of cut flowers and home floriculture. Disease and pest control in gardening- Fungicides and pesticides. Plant growing problems and their control, cold house storage. Propagation of Banana, Sugarcane, Papaya, Mango and some Medicinal and Aromatic plants.	13
References	**Text Books** 1. Kesavachandran, R. and Peter, K.V. 2008. Plant Biotechnology: Methods in Tissue cultute and gene transfer. University Press Ltd. Hyderabad. 2. Bhojwani , S.S. and Razdan , M.K. 1996. Plant Tissue Culture : Theory and Practice (revised edition). Elsevier Science Publishers, New York, USA 3. Jain, S.M.Sopory, S.K. and Veilleux, R.E.1996. In Vitro Haploid Production in HigherPlants, Vols. 1-5, Fundamental Aspects and Methods. Kluwer Academic Publishers,Dordrecht, The Netherlands 4. Bhaojwani, S.S. 1990 , Plant Tissue Culture: Applications and Limitations Elsevier Science Publishers , New York , USA 5. Kartha, K.K. 1985. Cryopreservation of Plant Cells and Organs. CRC Press, Boca Raton, Florida, USA. **Reference Book** Vasil, I.K. and Thorpe, T.A.1994. Plant Cell and Tissue Culture. Kluwer Academic Publishers, The Netherlands.	
Course Outcomes	On completion of the course, students should be able to CO1:To understand the basic principles and methodologies of plant tissue culture CO2:To understand the different standard protocol for the production of viable clones CO3:To learn the knowledge on various methods of Tissue Culture and secondary metabolites production	

Semester	-	Course Code	**24BOTP0VA3**
Course Title	**PRESERVATION AND PROCESSING OF FRUITS AND VEGETABLES**		
No. of Credits	**Credits – 2**	No. of contact hours per week	2
New Course/ Revised Course	New Course	If revised, Percentage of revision effected (Minimum 20%)	-
Category	Value added Course		
Scope of the Course (may be more than one)	1. Understand the concepts of fruits and vegetable preservation 2. Utilize the various methodologies of fruits and vegetable preservation. 3. Comprehend the information on the techniques and motivate the students to become Entrepreneur and Industrialists		
Cognitive Levels addressed by the Course	K1- Inculcate the advancement of fruits and vegetable preservation K2- realize the various techniques involved in fruits and vegetable preservation K3- Apply the knowledge on various techniques in Industrial level K4- Understand the problems and facts of fruits and vegetable preservation K5- Motivate the people to become fruits and vegetable preservation Entrepreneur and Industrialists		
Course Objectives (Maximum: 5)	**The Course aims** • To evaluate methodologies of fruits and vegetable preservation • To understand the various processing Technologies on fruits and vegetable preservation • To evaluate the process of Cooling and Freezing techniques for fruits • To validate the importance of thermal drying of foods • To identify the role of preservatives on Preserving vegetables		

Unit	Content	No. of Hours
I	**Preservation of Fruits and Vegetables** Introduction**.** Safety Issues on the Preservation of Fruits and Vegetables State of the Art, Microbial Hazards-Positive effects of micro-organisms in food, Negative effects of micro-organisms in food.	12

II	**Processing Technologies** Physiological Aspects Affecting the Postharvest Life of Fruits, Minimal Processing Technologies used in fruit preservation- Washing and Sanitizing of Fruits- Chlorine, Chlorine Dioxide, Acidified Sodium Chlorite, Hydrogen Peroxide, Peracetic acid, Peroxyacetic Acid, Trisodium Phosphate, Electrolyzed Water, ozone, Minimal Processing Methods to Extend Shelf-Life of Fresh-Fruits- Refrigeration, Natural Preservatives, Blanching, Ultraviolet Light, Irradiation, Pulsed Light, Ultrasound, High Hydrostatic Pressure, Food Packaging. The Hurdle Concept	15
III	**Cooling and Freezing** Cooling and Freezing of Fruits and Fruit Products- Cooling of Fruits, Pre-cooling Treatments and Refrigeration, Controlled and Modified Atmosphere. Novel Technologies: Thermal Treatments, UV-C Irradiation, Minimally Processed Fruits, Edible Coatings. Freezing of Fruits- The Freezing Process: Ice Formation, Homogeneous and Heterogeneous Nucleation. Recommended Packaging and Industrial Freezing Methods for Fruits- Shelf-Life of Frozen Fruits	10
IV	**Thermal Drying of Foods-** Drying Equipment and Design. Drying Mechanisms. Packing and storage. Quality of the fresh product Consuming dried products- Drying potatoes, Drying tomatoes, Drying mangos, R&D OpportUnities in Drying. Pressure-Driven Membrane Processes.	14
V	**Preserving vegetables with preservatives** Preserving vegetables with salt and/or vinegar- Preserving with salt. Jam and juice making, syrups, jellies and candied fruit- Making fruit juices, Preparation of other fruit products. Developing a small-scale food processing enterprise- Marketing a fresh or processed product, Organizing a processing enterprise	13
References	1. Processing and preservation of tropical and subtropical foods: Kordylas, J.M. (1990), Mac Millan Education Ltd., Hong Kong, 432p. 2. Prevention of post-harvest food losses: Fruit, vegetables and root crops: Food and Agricultural Organization of the United Nations(1989), Rome, 154p. 3.Preservation of fruit and vegetables: Ife Fitz James Bas Kuipers.(2003), Agromisa Foundation, Wageningen.44-64p 4.Fruit Preservation Novel and Conventional Technologies: Amauri Rosenthal RosiresDeliza Jorge Welti-Chanes Gustavo V. Barbosa-Cánovas.(2018), 233 Spring Street, New York, NY 10013, U.S.A 1-130p	
Course Outcomes	On completion of the course, students should be able to CO1: evaluate methodologies of fruits and vegetable preservation CO2: understand the various processing Technologies on fruits and vegetable preservation CO3: evaluate the process of Cooling and Freezing techniques for fruits CO4: validate the importance of thermal drying of foods CO5: identify the role of preservatives on Preserving vegetables	

Semester	-	Course Code	24BOTP0VA4
Course Title	**BIOFERTILIZERS AND MUSHROOM TECHNOLOGY**		
No. of Credits	**Credits – 2**	No. of contact hours per week	4
New Course/ Revised Course	New Course	If revised, Percentage of revision effected (Minimum 20%)	20
Category	Value added Course		
Scope of the Course (may be more than one)	1. Understand the concepts biofertilizers and Mushroom production 2. Utilize the various methodologies of biofertilizers and Mushroom for income generation. 3. Comprehend the information on the techniques and motivate the students to become Entrepreneur and Industrialists		
Cognitive Levels addressed by the Course	K1- Inculcate the advancement of biofertilizers and Mushroom production K2- realize the various techniques involved in biofertilizers and Mushroom cultivation K3- Apply the knowledge on various techniques in Industrial level K4- Understand the problems and facts of biofertilizers and Mushroom cultivation K5- Motivate the people to become biofertilizers and Mushroom cultivation Entrepreneur and Industrialists		
Course Objectives (Maximum: 5)	**The Course aims** • To evaluate Knowledge and techniques of Biofertilizers • To understand the various processing Technologies of Azolla cultivation • To evaluate the process of information about mushroom biology: • To validate the importance of tropical mushroom cultivation technology • To identify Nutrient profile of Mushrooms		

Unit	Content	No. of Hours
I	**Biofertilizers** Introduction, scope. A general account of plant growth promoters and regulators – Cyanobacterial Biofertilizer: Algalization – mass cultivation of cyanobacterial biofertilizers. Nitrogen fixing Bacteria: Isolation, characterization, identification, mass cultivation and inoculation method of *Rhizobium* and *Azospirillum*. Mechanism of nitrogen fixation (free-living and symbiotic)	12
II	**Azollacultivation** Structure and Morphology – Mass cultivation method and Application. Economic and Ecological importance of Azolla. Phosphate solubilizing Bacteria: Isolation, characterization, identification, mass cultivation and inoculation method of Phosphobacteria. Mycorrhizal fungi as biofertilizers - Introduction, scope. A general account of Ecto, Endo and Arbuscular mycorrhizae (AM). Isolation and method of inoculation of Arbuscular mycorrhizae (AM), Legume - AM interactions.	15
III	**Introduction to mushroom biology:** characteristics, importance of mushrooms - as food, tonics and medicines. Different parts of a typical mushroom. Key to differentiate edible from poisonous mushrooms. phases of mushroom technology - pure culture, spawn, preparation of compost, mushroom development	10
IV	**Prospects of tropical mushroom cultivation technology**: Oyster mushroom technology, paddy mushroom technology, milky mushroom and button mushroom technology, postharvest technology. Mushroom farming and prospects.	14
V	**Nutrient profile of Mushrooms;** Protein, aminoacids, calorific values, carbohydrates , fats, vitamins &minerals. In therapeutic diets for adolescence, for aged persons & diabetes mellitus. Health benefits: Antiviral value, antibacterial effect, antifungal effect, anti-tumour effect, haematological value, cardiovascular and renal effect.	13

References

Reference Books

1. Kannaiyan, S., Kumar, K. and Govindarajan, K., 2010. Biofertilizers Technology. Scientific Publishers.
2. Kumar, R., Kumawat, N. and Sahu, Y.K., 2017. Role of biofertilizers in agriculture. Popular kheti, 5(4), pp.63-66.
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Course Outcomes	On completion of the course, students should be able to CO1:evaluate Knowledge and techniques of Biofertilizers CO2:understand the various processing Technologies of Azolla cultivation CO3: evaluate the process of information about mushroom biology: CO4: validate the importance of tropical mushroom cultivation technology CO5: identify Nutrient profile of Mushrooms	

Semester	-	Course Code	**24BOTP04M6**
Course Title	**HORTICULTURE AND LANDSCAPE MANAGEMENT**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected (Minimum 20%)	20
Category	Modular		
Scope of the Course (may be more than one)	• To understand the importance of floriculture and nursery management. • Understand the different classifications of horticultural crops, nursery management, and use of technology in horticulture. • Develop their competency on pre and post-harvest technology in horticultural crops. • Analyze the different methods of weed control and harvest treatments of horticultural crops. Examine the economic implications of cultivation of tropical and sub-tropical vegetable crops Evaluate the importance of floriculture and contribution spices and condiments on economy		
Cognitive Levels addressed by the Course	K1- Inculcate basic and advancement of basics of horticulture K2- Realize the various aspects of plant propagation K3- Mull over the techniques in fruit crops propagation K4- Expertise on the flower and vegetable crops cultivation K5- Realize the importance of Landscape Management		
Course Objectives (Maximum: 5)	**The Course aims** • Inculcate basic and advancement of basics of horticulture • Realize the various aspects of plant propagation • Mull over the techniques in fruit crops propagation • Expertise on the flower and vegetable crops cultivation • Realize the importance of Landscape Management		

Unit	Content	No. of Hours
I	**Basics of Horticulture** Importance and scope of Horticulture - Divisions of Horticulture – Climate, soil and nutritional needs – Manures and fertilizers – Organic manures – Inorganic fertilizers – Biofertilizers – Methods of applications of manures and fertilizers - Water irrigation – Surface irrigation – Sub irrigation – Special irrigation methods – Plant protection and pest control for horticulture crops.	13
II	**Plant propagation** Natural method: Propagation through seeds and specialized vegetative structures - Artificial methods: Cutting: types (root, stem, leaf cuttings), advantages and disadvantages - Layering: types (simple, compound, tip, trench, mound, air-layering) advantages and disadvantages - Grafting: types (inarching, side, splice, whip/tongue, veneer, cleft, bark, epicotyl, top-working) advantages and disadvantages - Budding: Types (T-budding, shield, patch, and ring budding) advantages and disadvantages - Stock – scion relationships – Micropropagation.	12
III	**Fruit crops** Training and pruning methods for fruit plants – Induction of flowering, flower thinning - fruit setting and fruit development – Seedlessness in horticultural fruits – Importance of plant growth regulators in fruit crops – Cultivation and harvesting methods of important fruit crops; Mango, Sapota, Pomegranate, Grapes and Guava.	15
IV	**Flower and vegetable crops** Floriculture – Cultivation of commercial flower crops – Rose, Jasmine, Chrysanthemum, Crossandra, Anthurium and Gerberas – Cut flowers – Vase life period – Packages for export of cut flowers - Flower decoration – Dry and wet decoration - State Integrated Board of Studies –	14

	Botany PG 32 Classification of vegetables – Cultivation of important vegetables - Tomato, Potato, Onion, Cabbage and Snake guard – Layout for a model kitchen garden.	
V	**Landscape Management** 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; Training and pruning - Terrace garden - Cultivation of tree species – Eucalyptus and teak.	10

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1. Edmond, J.B. 1977. Fundamentals of Horticulture. Tata McGraw Hill Publishers Co. Ltd., New Delhi.
2. Kumar, N. 2017. Introduction to Horticulture, Midtech Publisher.
3. Manibushan Rao, K. 1991. Textbook of Horticulture. Macmillan Publishing Co., New York.
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7. Singh, J. 2018. Fundamentals of Horticulture. Kalyani Publishers.
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11. Sharma V. K. 1999. Encyclopaedia of Practical Horticulture, Vol I –IV, Deep And Deep Publ. Pvt. Ltd.
12. Adams, C.R. Banford, K.M. and Early, M.P. 1993. Principles of Horticulture.
13. Sathe,T.V. 2004. Vermiculture and Organic farming, Daya Publishers.
14. Peter, K.V. 2017. Basic Horticulture.
15. Hartman, H.T. and D.F. Kestler. 1976. Plant propagation principles and practice. Prentice Hall of India, New Delhi.
16. Jules Janick, 1982. Horticulture Science. Surjeet publications, New Delhi.
17. Ignacimuthu, S.1998. Plant Biotechnology. Tata Mc Graw Hill Ltd., New Delhi.
18. Gupta. P.K.,1998. Elements of Biotechnology. Rastogi publications, Meerut.
19. Edmond Musser and Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
20. Janick Jules. 1979. Horticultural Science. (3rd Ed.), W.H. Freeman and Co.,San Francisco, USA.

Web resources

- https://www.kobo.com/in/en/ebook/composting-process-organic-manures-through-eco-friendly-waste-management-practices
- https://books.google.co.in/books/about/Plant_Propagation.html?id=K-gQh6OI7GcC&redir_esc=y
- https://www.ebooks.com/en-us/subjects/gardening/
- https://www.amazon.in/Preservation-Techniques-Publishing-Technology-Nutrition-ebook/dp/B00RXCXB3Q
- https://www.elsevier.com/books/food-preservation-techniques/zeuthen/978-1-85573-530-9
- https://courses.opened.uoguelph.ca/contentManagement.do?method=load&code=CM000019
- www.teachervision.com/gardening
- https://pace.oregonstate.edu/catalog/master-gardener-series-oregon-master-gardener-program
- https://www.amazon.in/Gardening-Landscape-Design-and-Botanical-Garden/s?rh=n%3A1318122031%2Cp_27%3Aand+Botanical+Garden
- https://www.overdrive.com/subjects/gardening

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

On completion of the course, students should be able to

CO1:Define, classify and assess the structure, biological functions and interactions of Biomolecules. CO2:Validate the knowledge of collective and progressive notions of cellular organization.

CO3:Assess and describe the importance of inheritance biology.

CO4:Establish acquaintance and understanding of ecology & Biodiversity in a broader sense.

CO5:Understand the processes of evolution, relate with natural selection, adaptation and speciation.