M.Sc., BOTANY

SYLLABUS
(with effect from July 2021)

Department of Biology
The Gandhigram Rural Institute (Deemed to be University)
Gandhigram - 624 302
Dindigul District
Tamil Nadu
India

OBE Elements for M.Sc., Botany Programme

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 gainful employment.

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

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

PEO6: To preserve, add to 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 group, have professional ethics, able to prepare & execute projects and use knowledge obtained /update it lifelong.

PROGRAMME SPECIFIC OUTCOME (PSO)

After completion of 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 on Botany to address contemporary problems in academia, industry and needs of society

PSO4: A 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	MSc. BOTANY				
Year of Introduction	2008				
Year of revision	2021				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

SCHEME OF EXAMINATION

S.No	Semester	Course Code	Course Title	Nature of the course	C	L	P	E	CFA	ESE	Total Marks
1.1	I	21BOTP0101	Plant Diversity	Major	4	4	-	3	40	60	100
1.2		21BOTP0102	Systematics of Angiosperms	Major	4	4	-	3	40	60	100
1.3		21BOTP0103	Environmental Biology	Major	4	4	-	3	40	60	100
1.4		21BOTP0104	Molecular Biology#	Major	4	4	-	3	40	60	100
1.5		21BOTP0105	Practical -1: Plant Diversity and Systematics of Angiosperms	Major	2	-	4	3	60	40	100
1.6		21BOTP0106	Practical -2: Environmental Biology	Major	2	-	4	3	60	40	100
1.7		21GTPP0001	Gandhi in Everyday Life	-	2	2	-	-	50	-	50
				Total	**22**	**18**	**8**				
2.1	II	21BOTP0207	Plant Physiology and Biochemistry	Major	4	4	-	3	40	60	100
2.2		21BOTP0208	Anatomy, Morphogenesis and Embryology of Angiosperms	Major	4	4	-	3	40	60	100
2.3		21BOTP0209	Cell Biology and Genetics	Major	4	4	-	3	40	60	100
2.4		21BOTP0210	Biostatistics	Major	4	4	-	3	40	60	100
2.5		21BOTP0211	Practical -3: Plant Physiology, Biochemistry, Anatomy and Embryology of Angiosperms	Major	2	-	4	3	60	40	100
2.6		--	Elective: Generic	Generic	3	3	-	3	40	60	100
2.7		21ENGP00C1	Communication and Soft Skills	Soft Skills	2	2	-	-	50	-	50
2.8		21BOTP0212	Summer Internship / Mini Project (15 to 30 days during II -Semester Break)	Major	1	--	-	-	50	-	50
				Total	**24**	**21**	**4**				

S.No	Semester	Course Code	Course Title	Nature of the course	C	L	P	E	CFA	ESE	Total Marks
3.1	III	21BOTP0313	Bioinstrumentation	Major	4	4	-	3	40	60	100
3.2		21BOTP0314	Plant Resource Utilization and Biodiversity conservation	Major	4	4	-	3	40	60	100
3.3		21BOTP0315	Forest Ecology, Phytogeography and Remote sensing	Major	4	4	-	3	40	60	100
3.4		21BOTP0316	Practical -4: Bioinstrumentation	Major	2	-	4	3	60	40	100
3.5		21BOTP03DX	Elective: Discipline Centric	Discipline Centric	3	3	-	3	40	60	100
3.6		21BOTP03MX	Modular course	Modular	2	2	-	-	50	-	50
3.7		21BOTP0317	Field Visit	Major	1	-	2	-	50	-	50
3.8		21EXNP03V1	Village Placement Programme	VPP	2	-	-	-	50	-	50
				Total	**22**	**17**	**6**				
4.1	IV	21BOTP0418	Fundamentals of Microbiology	Major	4	4	-		60	40	100
4.2		21BOTP0419	Plant Biotechnology and Genetic Engineering@	Major	4	4	-		60	40	100
4.3		21BOTP0420	Applied Mycology and Plant Pathology	Major	4	4	-		60	40	100
4.4		21BOTP0421	Practical -5: Fundamentals of Microbiology and Plant Biotechnology	Major	2	-	4		40	60	100
4.5		21BOTP04MY	Modular course -	Modular	2	2	-	-	50	-	50
4.6		21BOTP0422	Dissertation	Major	6	-	10		75	75* + 50**	200
4.7		21GTPP00H1	Human Values and Professional Ethics	-	2	2	-		50	-	50
				Total	**24**	**16**	**14**				
			Grand Total credit		**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)
21BOT P03D1 Trends in Modern Botany	21BOT P03M1 Advanced Molecular Techniques	21BOTP02G1 Herbal Botany and Dietetics
21BOT P03D2 Phylogeny of Angiosperms	21BOT P03M2 Bioinformatics	21BOTP02G2 Preservation and Processing of Fruits and Vegetables
21BOT P03D3 Reproductive Biology of Angiosperms	21BOT P04M3 Rural Biotechnology	21BOTP02G3 Biofertilizer and Mushroom technology
	21BOT P04M4 Commercial Plant tissue Culture	
Any other Major Elective Courses under MOOC / NPTEL available online with equal credits	21BOT P04M5 Intellectual Property Rights	

VALUE ADDED COURSES

Course code	Course Title	Credit
21BOTP0VA1	Rural Biotechnology	2
21BOTP0VA2	Commercial Plant tissue Culture	2
21BOTP0VA3	Preservation and Processing of Fruits and Vegetables	2
21BOTP0VA4	Biofertilizer and Mushroom technology	2

Semester	**First**	Course Code	**21BOTP0101**
Course Title	**PLANT DIVERSITY**		
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%)	25
Category	Core		
Scope of the Course (may be more than one)	1. Understand various forms of lower plants 2. Acquire the knowledge on diversity and reproduction of Algae, Bryophytes, Pteridophytes and Gymnosperms 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 on economic importance of lower plants K4- Survey and evaluation of lower plant forms K5- Create awareness among the people on fossilization and fossil 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 evaluate the diversity, reproduction and economic importance of Fungi and Gymnosperms. • To demonstrate diversity and reproduction of Bryophytes and Pteridophytes • To analyse the demonstrate diversity and reproduction of Gymnosperms		
Unit	Content		No. of Hours
	Algae Classification of Algae by F.E. Fritsch (1935); General characteristics of all classes of Algae; Distribution, habitat, thallus organization, reproduction (vegetative, asexual, sexual) and life cycle of *Chlorella* and *Polysiphonia*; Phylogeny and Economic importance of Algae.		13
	Fungi & Lichens Classification of Fungi by C.J. Alexopoulos (1962); General characteristics of all classes of fungi; Distribution, habitat, reproduction (vegetative, asexual, sexual) and lifecycle of *Rhizopus* and *Agaricus;* Economic importance of Fungi. General characteristics of Lichens. Brief account on structure and reproduction in Ascolichens, Basiodiolichens and Deuterolichens.		12
	Bryophytes Classification of Bryophytes by Reimers (1954); General		15

	characteristics of all classes of Bryophytes; Distribution, habitat, vegetative and anatomic structures, reproduction (vegetative, asexual, sexual) and lifecycle of *Marchantia* and *Funaria;* Phylogeny and Economic importance of Bryophytes.	
	Pteridophytes Classification of Pteridophytes by G.M. Smith (1955); General characteristics of all classes of Pteridophytes; Distribution, Morphology, anatomy, reproduction and lifecycle of *Selaginella* and *Adiantum*; Phylogeny and Economic importance of Pteridophytes.	14
	Gymnosperms & Paleobotany Classification of Gymnosperms by K.R. Sporne (1965); General characteristics of all classes of Gymnosperms; Distribution, vegetative, anatomy, reproduction and lifecycle of *Gnetum*; Phylogeny and Economic importance of Gymnosperms. Brief account of process of fossilization, type studies on *Agalophyton* (*Rhynia*) and *Leginoptris.*	10
References	Text Books: 1. Vashista, P.C., Sinha, A.K. and Kumar, A. 2006. Gymnosperms. Revised Edition. S. Chand & Company Ltd, New Delhi. 2. Johri, R.M., Latha, S. and Sharma, S. 2004. Textbook of Algae. Dominant Publishers and distributors, New Delhi. 3. Johri, R.M., Latha, S. and Sharma, S. 2004. Textbook of Broyophytes. Dominant Publishers and distributors, New Delhi. 4. Vashista, P.C., Sinha, A.K. and Kumar, A. 2005. Pteridophyta. Revised Edition. S. Chand & Company Ltd, New Delhi. 5. Pandey, B. P. 2004. College Botany Volume I & II. S. Chand & company Ltd, New Delhi. 6. Hoek, C., Mann, D., Jahns, H.M. and Jahns, M. 1995. Algae: an introduction to phycology. Cambridge university press. 7. Chapman, D.J., 1973. *The algae*. Springer. Reference Books 1. Gilbert. M. Smith 1998. Cryptogamic Botany. Volume 1 & 2. Tata McGraw hill Publishing Company Ltd, New Delhi. 2. Aleoxopolous, C.J., Mims, C.W. and Blackwell, M. 1996. Introductory Mycology. IV edition, John Wiley & Sons, New York. 3. Sporne. K.R. 1976. Morphology of Pteridophytes, 4th edition, B.I. Publication. 4. Parihar. N.S. 1967. An introduction of Embryophyta, vol. III – Pteridophyta, Central book depot, Allahabad.	

	5. Chapman , V.J. 1962. The Algae. Macmillan & Co. Ltd. New York. 6. Sambamurty, A.V.S.S., 2005. *A textbook of algae*. IK International Pvt. Limited. 7. Sharma, O.P., 1986. *Textbook of algae*. Tata McGraw-Hill Education. 8. Gupta, R., 1981. *A textbook of fungi*. APH Publishing. 9. Webster, J. and Weber, R., 2007. *Introduction to fungi*. Cambridge university press. 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 botany I:(algae, fungi, bryophyta and pteridophyta) (Vol. 1). New Age International. 13. 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. 14.Sambamurty, A.V.S.S., 2006. A textbook of bryophytes, pteridophytes, gymnosperms and paleobotany (No. QK533 S25). 15. Biswas, C. and B. M. Johri. 2004.The Gymnosperms, Narosa Publishing House, New Delhi. 16. Kakkar, R. K. and B. R. Kakkar.1995.The Gymnosperms (Fossils and Living) Central Publishing House, Allahabad. 17. Parihar, N. S. 1991.Bryophytes, Central Book Dept., Allahabad. 19.Rashid, A. (1976) An introduction to Pteridophyta, Vikas Publishing House Ltd., New Delhi. 20. Sharma O. P. (2002) Gymnosperms, Pragati Prakashan, Meerut. 21.Sharma P. N. and Sahni K. C. (2005) Gymnosperms of India and Adjacent Countries Publisher Bhishan Singh Mahendra Pal Singh, Dehradun. 22. Sporne, K. R. (1976) Morphology of Pteridophyta. Hutchinson University Library, London. 23. Shaw, A.J. and Goffinet, B. eds., 2000. *Bryophyte Biology*. Cambridge University Press. 24. Siddiqui K.A.2003., Elements of paleobotany. KITAB MHHAL Agencies, Allahabad.UP	
	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.	

Mapping of Cos with PSOs

PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	1	2	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	2	3	3	3	2

Semester	**First**	Course Code	**21BOTP0102**
Course Title	**SYSTEMATICS 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%)	20
Category	Core		
Scope of the Course (may be more than one)	1. Understand the basic and advanced aspects of angiosperm Systematics 2. Acquire the knowledge on various aspects of angiosperm taxonomy 3. Motivate the students to understand the various aspects of plant taxonomy and 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 on the identification of various angiosperm families. K5- Realize the importance of angiosperm taxonomy on various botanical issues		
Course Objectives (Maximum: 5)	**The Course aims** • To compare the various system 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 analyse the methodology and applications of phylogeny of Angiosperms • To study 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 sexual system: Carolus Linnaeus; Natural system: Bentham & Hooker; Phylogenetic systems: Bessey, Hutchinson and Takhtajan; Angiosperm Phylogenic Group: Brief outline of APG - I (1998), APG - II (2003), APG - III - (2009), AGP-IV (2016). Construction of taxonomic keys: Indented and bracketed keys.		13
II	**Botanical nomenclature** ICBN : International code of Botanical Nomenclature; principles of ICBN; Types method; Author citation; Retention and rejection of		12

	names; Publication of names; Effective and valid publication; Brief account on rules and regulations of ICN. Taxonomic evidences obtained from Anatomy, Embryology and Palynology, Chemotaxonomy; Brief account on software based plant identification systems; e-floras; Virtual herbaria; Interactive keys.	
III	Phylogeny of Angiosperms: Origin and evolution of angiosperms; Phylogenetic systematics: The principles, methodology and applications of phylogenetic analyses includes taxon selection, character analysis, cladogram construction and cladogram analysis. Molecular data for phylogenetic analysis and identification:	15
IV	**Morphology and Characters of important families** Salient features; Vegetative and sexual characters of Magnoliaceae, Capparidaceae, Menispermaceae, Rhamnaceae, Meliaceae, Lythraceae, Fabaceae, Sapindaceae, Combretaceae, Vitaceae, Myrtaceae, Euphorbiaceae, Passifloraceae and Polygalaceae.	14
V	**Morphology and Characters of important families** Salient features; Vegetative and sexual characters of Rutaceae, Acanthaceae, Bignoniaceae, Lamiaceae, Lauraceae, Aristolochiaceae, Loranthaceae, Rubiaceae, Commelinaceae, Orchidaceae, Cyperaceae and Poaceae.	10
References	**Text Books**: 1. Sharma, O.P. 2013. Plant Taxonomy. McGraw Hill Education Pvt. Ltd. New Delhi. 2. Sharma, O.P., 1993. Plant taxonomy. Tata McGraw-Hill Education. 3. Mondal, A.K. 2005. Advanced Plant Taxonomy. New Central Book Agency (P) Ltd., New Delhi. 4. Johri, R.M. 2005.Taxonomy. Vols. I-IV, Sonali Publication, New Delhi. 5. Bhattacharyya, B. 2005. Systematic Botany. Narosa Publishing House, New Delhi. 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. Reference Books 1. Simpson, M.G. 2018. Plant Systematics. Academic Press, London 2. Pandurangan, A.G. Vrinda, K.B. and Mathew Dan. 2013. Frontiers in plant taxonomy. JNTBGRI, Thiruvananthapuram, Kerala. 3. Pullaiah, T. 2007. Taxonomy of Angiosperms. 3rd Edition, Regency Publication, New Delhi. 4. Sivarajan, V. V. 1996. Principles of plant taxonomy. Oxford and	

IBH publishing Co. Pvt. Ltd, New Delhi.
5. Lawrence: Taxonomy of Vascular Plants
6. 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.
7. Jeffrey, C., 1982. *An introduction to plant taxonomy*. CUP Archive.
8. Sivarajan, V.V., 1991. *Introduction to the principles of plant taxonomy*. Cambridge University Press.
9. Rouhan, G. and Gaudeul, M., 2014. Plant taxonomy: A historical perspective, current challenges, and perspectives. In Molecular Plant Taxonomy (pp. 1-37). Humana Press, Totowa, NJ.
10. Simpson, M.G., 2019. Plant systematics. Academic press.
11. 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.
12. Donovan Bailey, C., 2008. Plant Systematics: A Phylogenetic Approach.
13. Raven PH, Mertens TR. Plant systematics: theory and practice. BSCS Pam. 1964-1965; 23:1-36. PMID: 5870805.
14. Cronquist, R. The Evolution and classification of flowering plants (1988)
15. Cronquist 1981. An integerated system of classification of flowering plants
16. Takhtajan, K. Outline of classification of flowering plants. Botanical Rev. 46:225- 359),1980
17. Jones, S.B. & Luchsinger, A.E. Plant systematics,1988
18. Davis, P.H. & V.H. Heywood. Principles of Angiosperm Taxonomy
19. Henry & Chandrabose. An aid to Interntional Code of Botanical Nomenclature
20. Dunn, C. and B.S. Veritt. An introduction to Numerical Taxonomy
21. International code of Botanical Nomenclature – 2000. (Int. Association of Plant Taxonomist Pub.) Utrecht.
22. Takhtajan 1997. Diversity and Classification of flowering plants. Columbia Univ. Press, New York.
23. Nordenstam B., El/Gazalay and Kasas M. 2000. Plant Systematics for 21st Century. Portland Press Ltd., London.
24. Woodland DW 1991, Contemporary Plant systematics, Prentice Hall, New Jersy.

Websites

https://biologyboom.com/introduction-to-plant-systematics/

https://courses.botany.wisc.edu/botany_400/Lecture/0pdf/01Introductio

	n.pdf 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	
	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 Construction of keys CO5: Identify the angiosperms families with specific key characters.	

Mapping of Cos with PSOs

PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	2	2	3
CO2	3	3	2	3	3
CO3	3	2	3	2	2
CO4	3	3	3	3	3
CO5	2	3	3	2	2

Semester	**First**	Course Code	**21BOTP0103**
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	20
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 to the present scenario K3- Application of recent techniques in pollution reduction. K4- Survey and evaluation of natural resources and its management. K5- Awareness among the people on environmental issues		
Course Objectives (Maximum:5)	The Course aims • to provide fundamental environmental principles that provides an in-depth understanding of our environment. • to understand how environmental systems interfere with 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 environment and Environmental Acts • to assess the importance 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.		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		14

	conservation and management- National parks, sanctuaries and biosphere reserves.	
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 acts - Air and water-Environmental Laws.	11
V	**Environmental Impact Assessment, Monitoring and Treatment** Environmental Impact Assessment- steps and methods - Public participation in environmental decision making– Impact Analysis and Environmental Audit- Green Audit - Environmental Standards-Air and water- Bio indicators 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, NewDehi. 2. P.D. Sharma2017. 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, interactions of organisms, and appreciate howelements are cycling in the environment CO2 :Identify thenatural 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 of Environmental impact assessement, environmental audit, monitoring and treatment of effluents.

Mapping of Cos with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	1	2	3
CO2	3	3	3	3	2
CO3	2	2	2	2	2
CO4	2	3	2	2	3
CO5	2	3	3	3	2

Semester	**FIRST**	Course Code	**21BOTP0104**
Course Title	**MOLECULAR BIOLOGY**		
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 course		
Scope of the Course (May be more than one)	❖ Basic understanding on the molecules of life ❖ Developing skills to for analysis mutagenesis ❖ Creates employability scope in the molecular screening laboratories		
Cognitive Levels addressed by the course	K-1 Ability to remember historical developments of molecular biology K-2 Comprehensive knowledge on molecules of life K-3 Use molecular techniques for better understanding of structures of DNA, RNA and Proteins K-4 Capacity to analyse mutagenesis and molecular recombination K-5 Make new techniques to study molecular mechanism of antisense molecules K-6 Assessment of functions of DNA, RNA and Proteins		
Course Objectives	The course aims to: • impart information on the historical developments of molecular biology and molecules of life • give an in-depth knowledge on mutagenesis • make the student knowledgeable on concepts and mechanism of DNA replication process • expose the students on mechanisms of transcription process in prokaryotes and in eukaryotes. • enhance student's interest to distinguish translation processes in prokaryotes with eukaryotes.		

UNIT	**Content**	**No. of Hours**
I	**Introduction to Molecular Biology** Introduction and historical development - Central dogma of Molecular biology. The Logic of molecular biology – the efficient argument, examination of models and strong inference. Molecules of life – DNA world – RNA world and protein world. Prokaryotic and Eukaryotic Chromosome organization. Genes – definition, types and functional organization. Fine structure of gene - Benzers classical studies on rII locus. Structure of DNA - primary, secondary and different forms (A, B & Z). Gene transfer mechanism- bacterial transformation, conjugation and transduction.	13

II	**Mutagenesis and Recombination at the molecular level** Mutation – Types – Molecular and biochemical basis of mutation. Mutagenesis – Spontaneous and induced – Base – analog, physical agents, chemical mutagens, intercalating substances and mutator genes. Reversion – definition – Types – Mechanisms – application (Ames test). Mutants – Types and Uses – bacterial mutants, plant mutants and animal mutants. Recombination at the molecular level. Crossing over during cell divisionbreakage and rejoining of intact DNA molecules, Holliday model of homologous recombination – events at the molecular level; role of recA, recBC and chi sequences, Site- specific recombination – eg. bacteriophageλ; FLP/FRT and Cre/Lox recombination**.**	13
III	**DNA Replication** Basic rule. The Geometry of DNA replication – Semi-conservative replication of double – stranded DNA and Circular DNA molecules. Enzymology – DNA Polymerases, DNA ligase and DNA gyrase. Events in the replication fork – Continuous and discontinuous. Plasmid and Ø174 DNA replication- DNA damages – DNA repair mechanism – photoreactivation, excision repair, recombinant repair and DSOS function..	13
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 – role of lysozyme – Spliceosomes, Group I and Group II introns Self-splicing. Capping and tailing of 5' and 3' termini of Eukaryotic mRNA molecules. Antisense and Ribozyme technology – Molecular mechanism of antisense molecules -inhibition of splicing, polyadenylation, and transition – disruption of RNA structure and capping -biochemistry of ribozyme (hammerhead, hairpin, and other ribozyme) – strategies for designing ribozymes – applications of antisense and ribozyme technologies.	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; global nutrient (carbon, nitrogen) status sensing mechanisms – link to gene expression. Bacterial small RNA (sRNA) and its role in regulation of gene expression.Functional genomics, Validation of gene function. Gene silencing, PTGS, RNai, Antisense technology, Applications. Molecular Pharming. Genome Editing tools- ZFNs, TALENs and CRISPR-Cas9.	12

References	Text Books 1. David Freifelder, 2020, Molecular Biology, 4th Reprint., Narosa Publishing House, New Delhi, India. 2. Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick, 2017. Lewin's Genes XII Oxford University Press. 3. Lansing M. Prescott, John P. Harley and Donald A. Klein(2008). Microbiology(7th Ed.). Mc Graw Hill companies. 4. H.D. Kumar, 1993, Molecular Biology & Biotechnology, Vikas publishing house Pvt. Ltd., New Delhi. Reference Book 1. R.F. Weaver and P.W. Hedrick 1992, Genetics Wh.C. Brown publishers, Dubuque. 2. E.J. Gardner, M.J. Simmons, D.P. Snustad, 2006. Principles of Genetics (8th Ed.,) John Wiley & Sons, New York. 3. Buchanan, Gruissum and Jones, (2000). Biochemistry and Molecular Biology of Plant; ASPP, USA. 4. David Rawn(2012). Biochemistry. Panima Publishers. 5. Richard Calendar (2005). The Bacteriophages, 2nd Edition, Oxford University Press. 6. Alberts et al., Molecular Biology of the Cell, Garland Publications, (2012). *(NPTEL) - National Programme on Technology Enhanced Learning. **Web 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	Upon completion of this course, students be able to: CO1: Outline the fundamental concepts of molecules of life CO2: Discuss the various kinds of mutagenesis and their importance CO3: Explain the mechanisms of DNA replication & repair mechanisms CO4: Evaluate the differences of transcription process in prokaryotes with eukaryotes CO5: Compare the mechanisms of translation in prokaryotes with that in eukaryotes

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	1	2	2
CO2	2	2	1	2	2
CO3	2	2	1	2	2
CO4	2	2	1	2	2
CO5	2	2	1	2	2

Semester	**First**	Course Code	**21BOTP0105**
Course Title	**PRACTICAL- I: PLANT DIVERSITY AND SYSTEMATICS OF ANGIOSPERMS**		
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%)	20
Category	Core		
Scope of the Course (may be more than one)	1. Understand the characteristics of lower and higher plants 2. Acquire the knowledge identification of lower and higher plants 3. Motivate the students to understand the importance of plant taxonomy and to become Plant taxonomists		
Cognitive Levels addressed by the Course	K1- Inculcate basic and advancement of plant taxonomy K2- Realize the various issues on identification of plant diversity K3- Mull over the techniques to solve the problems in plant identification K4- Expertise on 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 on the identification of lower and higher plants with their salient features • To develop the skills on preparation of herbarium for identification • To create an overall knowledge on the identification of all group of plants including fossil • To understand the dichotomous key preparation of angiosperm families.		
Unit	Content		No. of Hours
I	Morphology of vegetative and reproductive characteristics of the following: **Algae**: *Hydrodictyon, Bulbochaete, Pithophora, Stigeoclonium, Fritschiella, Codium, Halimeda, Dictyota, Padina, Fucus* and *Batrochospermum, Sargassum, Gracilaria,* **Fungi**: *Rhizopus, Peziza, Aspergillus, Agaricus, Polyporus* and *Lycoperdon* **Bryophytes**: *Riccia, Marchantia, Plagiochasma, Dumortiera* and *Polytrichum, Funaria* **Pteridophytes**: *Psilotum, Lycopodium, Selaginella, Adiantum, Pteridium, Polypodium* and *Azolla* **Gymnosperms**: *Cycas, Pinus* and *Gnetum* **Fossil forms**: *Agalophyton* (*Rhynia), Calamites, Bothrodendron,*		13

	Calamostachys, Lyginopteris, Heterangium, Cordaite, and *Cardiocarpus* **Lichens**: Usnea	
II	Salient features, vegetative and sexual characters of the following families: Salient features; Vegetative and sexual characters of Magnoliaceae, Capparidaceae, Menispermaceae, Rhamnaceae, Meliaceae, Lythraceae, Fabaceae, Sapindaceae, Combretaceae, Vitaceae, Myrtaceae, Euphorbiaceae, Passifloraceae, Polygalaceae. Acanthaceae, Bignoniaceae, Lamiaceae, Lauraceae, Aristolochiaceae, Rutaceae, Loranthaceae, Rubiaceae, Commelinaceae, Orchidaceae, Cyperaceae and Poaceae	29
III	Preparation of dichotomous key for angiosperm families	6
IV	Analysis and identification of fresh and herbarium specimens of Angiosperms	13
V	Identification of names/ family of photograph of the angiosperms specimen using online based software system	6
	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. 12. 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:Evaluate and discuss groups of plants in terms of their diversity and describe their evolution, phylogeny. CO2: Apply the taxonomic principles in preparing keys and herbaria CO3: Acquire practical experience on identification of Angiosperms CO4: Provides skill to identify the lower plants with specific key characters CO5:Acquire practical knowledge on identification of various groups of plants	

Mapping of Cos with PSOs

PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	1	2	3
CO2	2	2	2	3	3
CO3	2	3	2	3	2
CO4	3	2	3	22	2
CO5	2	3	3	3	2

Semester	**First**	Course Code	**21BOTP0106**
Course Title	**PRACTICAL –II: ENVIRONMENTAL BIOLOGY**		
No. of Credits	2	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	25
Category	Core		
Scope of the Course(may be more than one)	1. Opportunity to understand the basic concepts of experiments in Environmental Biology 2. Exposure of students to approaches and techniques of Environmental Biology 3. Providing skills to handle the experiments in Environmental Biology		
Cognitive Levels addressed by the Course	**K1-** Emphasis the importance of physico-chemical parameters in Environment **K2**- Understand the different parameters of the environment **K3** -Apply the methods of studying the population of plants **K4**- Analyze the importance of remote sensing, GIS and Environmental Education **K5** -Evaluate the effect of industrial effluents and pesticides on Organisms		
Course Objectives (Maximum:5)	The Course aims • to estimate total solids, dissolved solids and suspended solids, dissolved oxygen, carbon dioxide, total alkalinity, chloride, hardness, and turbidity 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 how to design bioassay studies on industrial effluents/ pesticides using fish, aquatic insects and larvae. • to know the applications of remote sensing and GIS		

Unit	Content	No. of Hours
1.	Estimation of Total Solids, Dissolved solids and Suspended Solids.	3
2.	Estimation of Dissolved oxygen	3
3.	Estimation of Carbon dioxide	3
4.	Estimation of BOD & COD in different water samples (Demonstration).	6
5.	Estimation of Total Alkalinity.	3
6.	Estimation of Chloride.	3
7.	Estimation of Total hardness.	3
8.	Estimation of Turbidity	3
9.	Vegetative studies by line Quadrate and belt transect methods	5
10.	Calculation of biodiversity index	6

	Productivity of Aquatic ecosystems by planktons study	6
11.	Reagent Preparation	6
	CFA	10
12.	Record Work	4
	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.	
Course Outcomes	On completion of the course, students should be able to	
	CO1 : Understand how to estimate Total Solids, Dissolved solids, suspended Solids, Dissolved oxygen,Carbon dioxide, Total alkalinity, Chloride, hardness, turbidity, BOD and COD in different water samples CO2 : Understand how to study on population of plants. CO3 :Understand the Bioassay studies on industrial effluents/ pesticides Using fish, aquatic insects and larvae. CO4 : Understand the applications of remote sensing and GIS in environment. CO5 : Know the methods of treating drinking and effluent water samples.	

Mapping of Cos with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	1	1	1	1	1
CO4	3	3	3	3	3
CO5	3	3	3	3	3

21GTPP0001 - GANDHI IN EVERYDAY LIFE

Credits: 2 **CFA: 20+25+5**
Total: 50

Objectives:

- To understand and appreciate the principles and practices of Gandhi and their relevance in the contemporary times.
- To develop noble character and attitude to enable the students to cope up with the challenges of daily life.

Specific Objectives of Learning:
To enable students to:

- To understand the life and message of Gandhi in modernity.
- To know the Gandhian way of Management.
- To practice the Gandhian model of conflict resolution.
- To lead a humane life on Gandhian lines.
- To become a Gandhian constructive worker.

Unit 1 Understanding Gandhi: Childhood days, Student days, influence of dramas, books, individuals, religions, family and social factors - Gandhi as rebel, mimicking western civilization,acquaintance with vegetarianism, as lawyer - encountering and transforming humiliation in India: with British Agent - in south Africa: train incident, Coach incident, on path way, at court, attack by protesters - Gandhi as political leader, social reformer and Constructive worker.

Unit 2 Management: Gandhi's experiments in managing family - Eleven vows - Managing Organizations - community living and financial ethics - Managing Social and political movements - Transvaal March - Noncooperation movement and Salt Satyagraha - non - attachment to position.

Unit 3 Conflict Resolution: Pursuance of Truth and nonviolence - Rights and duties, Ends and means - Openness, love and kindness in handling relationship - nonviolent communication - nonviolent Direct Action (Satyagraha) and conflict Transformation - Conflict resolution practices in interpersonal relations, forgiveness and reconciliation - Shanti Sena.

Unit 4 Humanism: Trust in goodness of human nature - Respect for individual and pluralistic nature of society - equal regard for all religions (Sarvadharma Samabhava) - simple and ethical life - swadeshi and unity of humankind.

Unit 5 Sarvodaya: Concept of Sarvodaya - Constructive Programmes - Gandhian alternatives to poverty, terrorism, environmental degradation, issues in education, science and technology, centralization of power and governance and health and hygiene.

References:

M.K. Gandhi, *An Autobiography or The Story of My Experiments with Truth*, Navajivan Publishing House, Ahmedabad.

---. *Satyagraha in South Africa*, Navajivan Publishing House, Ahmedabad.

---. *Constructive Programme: Its Meaning and Place*, Navajivan Publishing House, Ahmedabad.

---. *Key to Health*, Navajivan Publishing House, Ahmedabad.

---. *Diet and Diet Reform*, Navajivan Publishing House, Ahmedabad.

---. *Basic Education*, Navajivan Publishing House, Ahmedabad.

---. *Village Industries*, Navajivan Publishing House, Ahmedabad.

---. *Hind Swaraj*, Navajivan Publishing House, Ahmedabad.

---. *Trusteeship*, Navajivan Publishing House, Ahmedabad.

---. *India of my Dreams*, Navajivan Publishing House, Ahmedabad.

Vinoba, *Shanti Sena*, Sarva Seva Sangh Prakashan, Varanasi.

V.P.Varma, *Political Philosophy of Mahatma Gandhi and Sarvodaya*, Lakshmi Narain Agarwal, Agra.

Louis Fisher, *Gandhi: His Life and Message* .

B.R. Nanda. *Mahatma Gandhi: A Biography*, Allied Publishers Private Ltd., New Delhi.

N.K. Bose. *Studies in Gandhism*, Navajivan Publishing House, Ahmedabad.

Gopinath Dhawan, *The Political Philosophy of Mahatma Gandhi*, Navajivan Publishing House, Ahmedabad.

N. Radhakrishnan, *Gandhi's Constructive Programmes: An Antidote to Globalized Economic Planning?*, Gandhigram Rural Institute, 2006.

Web Link:

- www.mkgandhi.org
- https://www.mkgandhi.org/ebks/gandhian_thought.pdf

Films.

- Richard Attenborough, **Gandhi.**
- Syam Benegal**, Making of The Mahatma.**
- Anupam P. Kher, **Mein Gandhi Ko Nahin Mara**.
- Peter Ackerman and Jack Duvall, **A Force More Powerful**.

Semester	**Second**	Course Code	**21BOTP0207**
Course Title	**PLANT PHYSIOLOGY 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%)	20
Category	Core		
Scope of the Course (may be more than one)	1. Comprehend the mechanism of physiology of plants 2. Realize 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 basic and advancement of plant physiology K2- Realize the various physiological and biochemical pathways of plants K3- Understand the role of physiology and biochemistry in growth of plants K4- Gain the knowledge from this paper to appear national level competitive exams K5- Utilize the knowledge acquired through this paper in various botanical researches		
Course Objectives (Maximum: 5)	**The Course aims** • To understand the physiological mechanism of plants • To study the various biochemical pathways of plants • To create a knowledge on physiology and developmental aspects of plants • To explain the nitrogen metabolism in plants • To acquire the knowledge on carbohydrates, enzymes and fat metabolism.		
Unit	Content		No. of Hours
I	**Plant - water relations** Different Bio-physico-chemical phenomena; Diffusion; Imbibitions; Osmosis; Cell as an osmotic system Absorption and translocation of water and minerals - Definition, pathway, mechanism, factor, significance Mineral nutrition – Absorption theories Macro and Micronutrients - Source, function, deficiency symptoms; Solution and sand culture Transpiration – Definition, types, mechanism, factor, significance.		14
II	**Carbohydrate metabolism** Photosynthesis - Light harvesting complexes; mechanisms of electron transport; photoprotective mechanisms CO_2 fixation-C_3, C_4 and CAM pathways Respiration and photorespiration – Citric acid cycle Plant mitochondrial electron transport and ATP synthesis Alternate oxidase; photorespiratory pathway.		14

III	**Nitrogen and fat metabolism** Classification of protein based on source, shape, composition and solubility Essential and non-essential amino acids Nitrogen metabolism: No_3, No_2 and NH_3 assimilation, biosynthesis of amino acids, nitrogen fixation Lipids: Classification, and importance, lipid metabolism - β Oxidation and Glyoxalate cycle.	11
IV	**Enzymes** Classification and nomenclature of enzymes: IUB, Isolation and purification of enzymes: Major classes of enzymes - Oxidoreductases, Transferases Hydrolases, Lyases, Isomerases and Ligases. Concept of active site, mechanism of enzyme action: Michaelis Menton equation and Km value. Enzyme modifiers – activators, inhibitors, allosteric enzymes : Regulation of enzyme action: Isozymes – diagnostic applications.	11
V	**Unit V** **Growth and development & Stress physiology** Plant hormones – Biosynthesis, storage, breakdown and transport; Physiological effects and mechanisms of action, Vernalisation, 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 (Stress physiology water, temperature and salt) stresses	14
References	**Text Books**: 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. 6. Hopkins, W.G., 1999. Introduction to plant physiology (No. Ed. 2). John Wiley and Sons. 7. Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A., 2015. Plant physiology and development (No. Ed. 6). Sinauer Associates Incorporated. 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. JohnWiley & Sons, NewYork.
13. JainVK, 2008. Fundamentals of Plant Physiology.S Chand and Co.
14. Kochhar P L, Krishnamoorthy H N. Plant Physiology. Atmaram and sons, Delhi.
15. Malik CP, 2002. Plant Physiology. Kalyani publishers.
16. Mukherjii S, Ghosh AK, 2005. Plant Physiology. New Central Book Agency, Culcutta.
17. Noggle GR, Fritz GJ, Introductory Plant Physiology.Prentice Hall of India.
18. Pandey SN, Sinha BK, 2006. Plant physiology.Vikas Publishing House, New Delhi.
19. Salisbury F B, Ross C W, 1992. Plant Physiology. CBS publishers and Distributers, New Delhi.
20. Sinha A K, 2004. Modern Plant Physilogy. Narosa publishing House, NewDelhi.
21. Srivastava H S, 2004. Plant physiology and Biochemistry. Rasthogi publications.
22. Lincoln Taiz, Eduardo Zeiger, 2015. Plant physiology and Development (VI Edn). Sinauer Associates Inc.
18. Noggle, G.R. and Fritz, G.J., 1983. Introductory plant physiology (No. Ed. 2). Prentice-Hall Inc.
19 . Meyer, B.S., Anderson, D.B. and Bohning, R.H., 1960. Introduction to plant physiology. Introduction to plant physiology.
20 .Curits, O.F. and Clark, D.G., 1951. An introduction to plant physiology (Vol. 71, No. 1, p. 78). LWW.
21. Taiz, L. and Zeiger, E., 1998. Plant Physiology pp.544-557 and 564-571, 2nd edition, Sinauer Assosiates, Sunderland, Mass.
22. Dey P.M., Harborne J. B., eds. (1997) Plant Biochemistry, Academic Press, San Diego.
23. Lea P.J., Leegood R.C. 1993. Plant Biochemistry and Molecular

	Biology, Wiley. 24. Buchanan B.B., Gruissem W., Jones R.J. 2000. Biochemistry and Molecular biology of plants, American Society of Plant Physiologists, M.D. 25. Taiz and Zeiger.2002. Plant Physiology.pp.519-538, 3rd edition, Sinauer Associates, Inc., Publishers. 26.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	
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.	

Mapping of Cos with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	2	3
CO2	3	2	3	2	2
CO3	1	1	1	1	1
CO4	3	2	3	3	3
CO5	2	3	3	2	2

Semester	**Second**	Course Code	**21BOTP0208**
Course Title	**ANATOMY, MORPHOGENESIS 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 the knowledge on various aspects of 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 basic 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 to solve the issues in botanical sciences K4- Expand the knowledge acquired from this paper to utilize in national level competitive exams K5- Realize the importance of plant anatomy in herbal medicines preparation		
Course Objectives (Maximum: 5)	**The Course aims** • To understand the anatomy of primary and secondary structures • To know the organization, Structure and function of meristems • To understand the organization of shoot and root apical meristems • To evaluate the process of Microsporogenesis and pollen development • To acquire the knowledge on pollination and embryo development.		
Unit	Content		No. of Hours
I	**Anatomy** Cell- structure and components; Organization and types of Tissue. Anatomy of root (Primary and Secondary Structure of Mono and Dicots). Anatomy of Stem (Primary, Secondary structure of Mono and Dicots; and Anomalous Structure of *Boerhaavia*). Anatomy of the 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; Organization of shoot		12

	apical meristem; Theories of organization of meristems; Root - stem transition; Cambium: Origin, Structure and function, Factors affecting cambial activity; Wood: Structure, physical and mechanical properties, reaction wood, compression and tension wood, preservation of wood.	
III	**Morphogenesis and organogenesis :** Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in *Arabidopsis* and *Antirrhinum.* Molecular mechanism of shoot & Root morphogenesis (Root Apical Meristem and Shoot Apical Meristem	18
IV	**Embryology I** Microsporogenesis: Anther and Pollen development - Physiological relationship of tapetum and sporogenous tissues, pollen fertility, sterility, pollen storage and pollen germination. Megasporogenesis ; Female gametophyte development, structure of pistil.	11
V	**Embryology II** Pollination ; Pollen - Pistil interaction, Double fertilization ; Endosperm types : Nuclear, cellular, helobial and ruminate endosperms. Development of monocot and dicot embryos Incompatibility ; Methods to overcome incompatibility. Apomixis ; genetics of Apomixis and polyembryony : Types and importance.	9
References	**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. **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. Bhojwani, S.S. Bhatnagar, S.P. and Dantu, P.K. The Embryology of Angiosperms (6th revised and enlarged edition). Vikas Publishing House, New Delhi, 2015.
8. Burgess, J. An Introduction to Plant Cell Development. Cambridge University Press, Cambridge, 1985.
9. Fageri, K. and Van der Pijl, L. The Principle of Pollination Ecology. Pergamon Press, Oxford, 1979.
10. Fahn, A. Plant Anatomy. (3rd edition). Pergamon Press, Oxford, 1982.
11. Fosker, D.E.Plant Growth and Development. A Molecular Approach. Academic Press, San Diego, 1994.
12. Howell, S.H. Molecular Genetics of Plant Development. Cambridge University press, Cambridge, 1998.
13. Leins, P., TucKer, S.C. and Endress, P.K. Aspects of Floral Development, J. Cramer, Germany, 1988.
14. Lyndon, R.F. Plant Development. The Cellular Basis, UnninByman, London, 1990.
15. Murphy, T.M. and Thompson, W.E. Molecular Plant Development. Prentice Hall, New Jersey, 1988.
16. Proctor, M. and Yeo, P. The Pollination of Flowers. William Collins Sons, London, 1973.
17. Raghavan, V. Molecular Embryology of Flowering Plants. Cambridge University Press, Cambridge, 1997.
18. Raghavan, V. Developmental Biology of Flowering Plants. Springer-Verlag, New York, 1999.
19. Raven, P.H., Evrt, R.F. and Eichhorn, S. Biology of Plants (5th edition). Worth, New York, 1992.
20. Salisbury, P.B. and Ross, C.W. Plant Physiology (4th edition). Wadsworth Publishing, Belmont, California, 1992.
21. Steeves, T.A. and Sussex, I.M. Patterns in Plant Development (2nd edition). Cambridge University Press, Cambridge, 1989.
22. Sedgely, M. and Griffin, A.R. Sexual Reproduction to Tree Crops. Academic Press, London, 1989.
23. Shivanna, K.R. and Sawhney, VK. Pollen Biotechnology for

	Crop Production and Improvement. Cambridge University Press, Cambridge, 1997. 24. Shivanna, K.R. and Rangaswamy, N.S. Pollen Biology : A Laboratory Manual. SpringerVerlag. Berlin, 1992. 25. Shivanna, K.R. and Johri, B.M. The Angiosperm Pollen : Structure and Function. Wiley Eastern Ltd.. New York, 1895.	
Course Outcomes	CO1:Analyse the structural elements of plants meristems, organogenesis and embroyology CO 2 : Demonstrate the micro and mega sprogenesis; sexual incompatibility, types of endosperm CO3 : Outline the combined knowledge with special emphasis microtechniques. CO4: Evaluate the different modes of Pollination in Plants CO5: Critique the Knowledge on Primary and secondary anatomical Structure of plants.	

Mapping of Cos with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	2	2
CO2	3	3	2	3	3
CO3	1	1	1	1	1
CO4	3	3	2	3	3
CO5	3	2	2	2	3

Semester	**Second**	Course Code	**21BOTP0209**
Course Title	**CELL BIOLOGY AND GENETICS**		
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. Understand the various aspects of Cell biology and Genetics 2. Realize the importance of study on genetics in various health disorders 3. Motivate the students to understand the different aspects of Cell biology and Genetics to prepare for National level competitive examinations		
Cognitive Levels addressed by the Course	K1- Understand the basic and advancement of modern genetics K2- Realize knowledge on organization of genes and chromosomes K3- Understand the role of genetics to solve the issues in botanical sciences K4- Expand the knowledge on Cell biology and Genetics to utilize in national level competitive exams K5- Realize the importance of Genetics in medical filed		
Course Objectives (Maximum: 5)	**The Course aims** • To evaluate the structure of cell and its various organelles • To demonstrate the organization of genes and chromosomes • To analyse the various aspects of organization of Chromosomes • To create broad knowledge on basic and recent trends of genetics • To explain the structure of Cell signaling; Hormones and their receptors.		
Unit	Content		No. of Hours
I	**Structure of Cell and cell membranes** Ultra structure of plant and animal cell; Membrane structure and function (Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes). Structural organization and function of intracellular organelles; Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.		13
II	Organization of genes and chromosomes (operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons). Cell division and cell cycle; Mitosis and meiosis regulation and control of cell cycle - positive (cyclins and cyclin-dependent kinases) and negative regulation (retinoblastoma protein		13

	(Rb), p53, and p21). Genetics and cancer: Differences between normal and cancer cell- Oncogenes- tumor inducing retroviruses and viral oncogenes-- Environmental factors inducting cancer.	
III	**Cell signaling** Cell signaling; Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two component systems, light signaling in plants, bacterial chemotaxis and quorum sensing. Cellular communication; Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.	14
IV	**Mendelian genetics** Mendelian principles : Dominance, segregation, independent assortment: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters. Concept of gene : Allele, multiple alleles, pseudoallele, complementation tests. Gene mapping methods : Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants. Eugenics - human betterment; Sex determination and Sex linked inheritance.	12
V	**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, maternal 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.	12
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. Verma, P.S. and Agarwal, V.K. 2004. Cell biology, Genetics,	

	Molecular Biology, Evolution and Ecology. S.Chand & Company Ltd. New Delhi. 4.Gupta and Jains, 1991. The Cell and Biotechnology, 1st Edition, Agro Botanical Publication, New Delhi. 5. Benjamin A. Pierce. 2012. Genetics- A conceptual Approach. W.H. Freeman and Company, New York, England. Reference Books 1.Eldon J. Gardner. 2004. Principles of Genetics 8th edition, John Wiley and Sons, New York. 2. Giese, A.C. 1999. Cell Physiology. 5th Edition, W.B. Sounders Company. 3. Chariotte J. Averse. 1995. Molecular Cell Biology. Addision Wesley Publ. Co. Gerald Karp, Cell Biology, II Edition – McGraw Hill International Book Co., New Delhi 4.Edmund, W. Sinnott, L.C. Dunn and Dobzhansky, T. 1990. Principles of Genetics, 5th edition, Tata McGraw Hill Publishing Company Ltd., New Delhi. 5. Goodenouth, U. 1984, Genetics 3rd edition CBS College Publishing, Halt, Rineshait and Winstion.	
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 various factors determining the heredity from one generation to another CO5: Critique the mechanism of Sex determination in organisms.	

Mapping of Cos with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	2	2
CO2	3	2	3	2	3
CO3	1	1	1	1	1
CO4	3	2	2	3	2
CO5	2	2	3	3	2

Course Code, Title & Credits	**BIOSTATISTICS**		**21BOTP0210** **Credits – 4**
Class	M.Sc. Botany	Semester	Second
Cognitive Level	K- 1 Knowledge, comprehension K-2 Application K -3 Analysis, synthesis, evaluation		
Course Objectives	The Course aims • to create graphs and diagrams using statistics to communicate important information about the data • to introduce sampling and its feature in biological investigations • to describe sample characteristics using central and dispersion measures • to familiar with relational measures and the relevance and need for regression analysis • to understand the biological measures such as rates, incidence, prevalence and their interpretations		

UNITS	**Contents**	**No. of Hours**
I	**Introduction to Biostatistics:** Development of Biostatistics and its applications - Sources of biological data - Secondary and Primary sources - Classification and tabulation of data - frequency distribution -Diagrammatic and Graphical representation of statistical data.	**12**
II	**Sampling Techniques:** Meaning - Advantages, concept of parameter and statistics, sample size, sampling error, sampling frame. Types of samples – Probability sampling – simple, systematic, stratified, cluster, multi-stage sampling. Non-probability sampling – Purposive, Convenience, Judgment and snowball techniques.	**13**
III	**Descriptive Statistics:** Measures of central tendency - Mean, Median, Mode - Measures of Dispersion: –Range, Quartile Deviation, Mean Deviation, and Standard Deviation. Absolute and relative measures of dispersion. Skewness and kurtosis measures.	**13**
IV	**Correlation and Regression Analysis:** Definition, uses, types of correlation, Regression Lines – Properties of regression lines and coefficients; Introduction to probability and its applications – Theoretical Distributions – Binomial, Poisson, and Normal distributions; Properties, uses and applications.	**13**
V	**Inferential Statistics and Biological Measures:** Hypothesis testing and Tests of significance - Test of attributes, small and large sample tests - Analysis of variance – one-way and two-way classifications;	**13**

	Measurement of risk, odds ratio and Bioassay and dose responses.	
References	• Gupta. C.B, An Introduction to Statistical Methods, New Delhi: Vikas Publishers, (23rd Ed), 2004. • Gupta. S.P, Statistical Methods, New Delhi: Sultan Chand, 2017. • Hogg. R.T. and A.T. Craig. A.T, Introduction to mathematical Statistics, (7thEd), 2012. • Rangaswamy, A Textbook of Agricultural Statistics, (3rd Ed), New Age International Publishers, New Delhi, 2020. • Rohatgi, V. K. and A. K. md. Ehsanes Saleh(2009) An Introduction to Probability Theory and Mathematical Statistics, 2nd Edition, Wiley Eastern Limited, New Delhi. • Qazi Shoeb Ahmad, Viseme Ismail, Biostatistics, University Science press, new Delhi, (1st Edition), 2008. • Sampath Kumar V.S; Bio-Statistics, Manomaniam Sundaranar University Publication, Tirunelveli, 1997. • Verma B.L, Shukla G.D and Srivastava.R.N, Biostatistics – Perspectives in Health Care; Research and Practice, New Delhi: CBS Publishers & Distributors, 1993. • W.G.Cochran, Sampling Techniques, Wiley Eastern Ltd, New Delhi, (1985). • https://www.biostat.washington.edu/about/biostatististics • http://sphweb.bumc.bu.edu/otlt/MPH-Modules/BS/BS704_BiostatisticsBasics https://www.edx.org/course/biostatistics-0	
Course Outcomes	On completion of the course, students should able to do CO1 : Carryout data analysis using graphs/ diagrams and make interpretation suitably. CO2 : Identify sample surveys in biological research and portray sample features using appropriate statistics CO3 : Describe sample characteristics using central and variability measures CO4 : Analyze correlation between variables interpretation besides regression analysis for estimation production CO5 : Compute the biological data with appropriate rates and ratios	

Mapping of COS with PSOs & POs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	1	2	2
CO2	2	2	1	2	2
CO3	2	2	1	2	2
CO4	2	2	1	2	2
CO5	2	2	1	2	2

Semester	**Second**	Course Code	**21BOTP0211**
Course Title	**PRACTICAL-III: PLANT PHYSIOLOGY & BIOCHEMISTRY, ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS**		
No. of Credits	1	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected (Minimum 20%)	45
Category	Core		
Scope of the Course (may be more than one)	1. Comprehend the mechanism of physiology of plants 2. Realize 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 various techniques of plant physiology K2- Realize the various physiological and biochemical pathways of plants by different techniques K3- Understand the role of physiology and biochemistry in growth of plants K4- Gain the knowledge from this paper to improve the laboratory technical knowledge K5- Utilize the knowledge acquired through this paper in various botanical researches		
Course Objectives (Maximum: 5)	**The Course aims** •To develop the skills on 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 various physiological mechanism of plants. •To analyse the role of biochemicals in the physiological mechanism of plants. •To evaluate the usage of various instruments in plant physiology.		

Experiment no.	Content	No. of Hours
1.	Determination of osmotic potential of cell sap by plasmolytic method	4
2.	Isolation of enzyme (amylase/ xylanase) from germinating finger millet seeds and estimating crude enzyme activity.	6
3.	Estimation of total carbohydrates in plant tissues (sugars / starch)	6
4.	Estimation of protein and lipid in plant tissues	6
5.	Extraction of chloroplast pigments from leaves and preparation of the absorption spectrum of chlorophylls and carotenoids	
6.	Extraction and determination of chlorophyll a /chlorophyll b ratio in C3 and C4 plants.	6
7.	Separation of anthocyanins by paper chromatography and thin layer chromatography	6
8.	Extraction and estimation of leghaemoglobin from root nodules	5
9.	Bioassay of IAA and GA3	4

10.	Determination of catalase and peroxidase activity by Chance and Maehly (1955).	4
11.	Estimation of total phenolics	4
12.	Effect Hormones on Seed germination and seedling establishment	5
13.	Anatomical sections of Monocot and dicot stem and Root Anatomical sections of leaf and meristem	4
14.	Observation of monocot and dicot embryos	4
References	**Text Books**: 1.Palanivelu, P. 2009. Analytical biochemistry and separation techniques. IV Edition Twentyfirst 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.	
Course Outcomes	On completion of the course, students should be able to do CO1: Analyze the biochemical components of any plant samples CO2: Explain the photosynthetic mechanism and related events of plants CO3: Demonstrate the role of various growth promoting substances and their action CO4: Evaluate the knowledge on physiological response of plants to various factors CO5: Identify the role of biochemicals in the physiological mechanism of plants.	

Mapping of Cos with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	2
CO2	3	3	3	3	2
CO3	1	1	1	1	1
CO4	3	3	2	3	3
CO5	3	2	2	2	2

21ENGP00C1 – COMMUNICATION AND SOFT SKILLS
(Soft Skills Course – Compulsory Non Credit course –
2 Credits - 2 Hours/wk.)

(For all PG students except MA ECS students)

Objectives:

- To help the students improve their communication and life and soft skills; and
- To enhance their personality and employability skills.

UNIT I

- Basics of Communication
- Barriers to Communication

UNIT II

- Communication and Language Skills
- Communicating in a Global Language

UNIT III

- Resumes and Cover Letters
- Group Discussions

UNIT IV

- Business communication
- Intercultural Communication

UNIT V

- Professional Communication
- Interviews

Textbook:

Krishnaswamy, Dhariwal and Krishnaswamy. *Mastering Communication Skills and Soft Skills*. Blomsbury, 2015.

Assessment: There is no ESE. Assessment is totally internal and is performance-based.

Semester	**Third**	Course Code	**21BOTP0313**
Course Title	**BIOINSTRUMENTATION**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	20
Category	Core		
Scope of the Course (may be more than one)	1.Facilitate the students to understand the instrumentation techniques 2.Learning 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 of 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 presention • 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	**Isolation and Separation** Isolation of cellular constituents- Chloroplasts, mitochondria, nucleic acids and enzymes- 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, GC-MS,HPLC.		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.	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 data bases, 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- Peerreview-Types- Impact factor- citation index,h-index,i10 index-Preparation of manuscript- Proof correction- proof correction symbols- Method of correcting proof- Plagiarism checking-Use of plagiarism softwares – Preparation of Research proposal and funding agencies and Research fellowships- 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. pp.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. NarosaPublishing House, New Delhi. 4. N. Gurumani 2010 Research Methodology for Biological Sciences. MJP Publishers, Chennai. 5. S. Palanichamy and M. Shunmugavelu 2009. Research methods in biological sciences. Palani paramount publications, Palani	
	Reference Books 1. Sahu, P.K. 2013. Research Methodology: A Guide for Researchers in Agricultural Science, Social Science and other related fields. Springer, New Delhi. 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 WesleyLongman Pte. Ltd, Indian Branch, Delhi, India.
	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 Laboratory Instrumentation 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: Create awareness on the importance of article publication and IPR.

Mapping of Cos with PSOs

PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2
CO2	3	2	3	3	2
CO3	3	3	3	3	3
CO4	3	2	3	3	3
CO5	2	3	3	3	2

Semester	**Third**	Course Code	**21BOTP0314**
Course Title	**PLANT RESOURCE UTILIZATION & BIODIVERSITY CONSERVATION**		
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.Facilitate the students to understand the economic importance of plants and Biodiversity 2. Understanding the various issues related with biodiversity and climate change 3. Acquire the knowledge on Economic botany and Biodiversity to prepare for various competitive examinations		
Cognitive Levels addressed by the Course	K1- Enrich the knowledge economic importance of different plants K2- Gaining factual ideas on origin and diversity of domesticated plants K3- Understanding the values, threats and the strategies of biodiversity conservation K4- Realize the current methods of biodiversity and conservation K5- Understanding the value of this course to utilize for various botanical research issues		
Course Objectives (Maximum: 5)	**The Course aims** • To know the economic importance of different plants • To understand the origin and diversity of domesticated plants • To explain the various threats of biodiversity and the strategies for conservation • To evaluate the status of Biodiversity of India and loss of biodiversity • To identify the current practices of biodiversity conservation		
Unit	Content		No. of Hours
I	**Economic Botany I** Botanical name, family, morphology of useful part and uses of Cereals - Paddy, wheat, maize; Millets: Minor millets major millets - Sorghum, Ragi, rye; Legumes - Blackgram, pigeon pea, green gram; Nuts - Ground nut, cashew nut, almond; Vegetables - Tomato, carrot, cabbage; Fruits - Apple, mango, date palm; Fibers - Cotton, jute.		13
II	**Economic Botany II** Botanical name, family, morphology of useful part and uses of Wood - Teak, rose wood; Essential oil - Sunflower oil, Groundnut oil, Sesame oil; Spices and condiments - Cinnamon, Pepper, Cardamom, Nut-meg, Clove, Turmeric, Chillies; Beverages - Coffee, Cocoa; Tannin - Myrobalan; Latex - Rubber; Dyes - Indigo, Henna; Gum - Gum arabic; Sugars - Sugarcane; Fumigatory and mastigatory – Tobacco, Areca nut.		12

III	**Biodiversity Status and Loss** Basic concepts of biodiversity, levels and types; values of biodiversity -evolutionary, economic, social, cultural and intrinsic values, biodiversity hotspots, their characteristic flora and fauna, Biodiversity resources of the Western Ghats of India, IUCN red list categories; threats to biodiversity-Indian context, important threatened/endemic plant and animal taxa of India, biodiversity and ecosystem services; Climate change and biodiversity; Threatened categories, biological invasions and Biodiversity.	12
IV	**Status and Management of Biodiversity** 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. Indian case studies on conservation and management strategies (Project Tiger, Biosphere reserves).	12
V	**Conservation of Biodiversity** History of biodiversity conservation; Biodiversity conservation strategies: *in situ* conservation case studies: Biosphere reserve (NBR), sanctuaries, national parks, *ex situ* conservation: botanical garden, zoological park, *in vitro* conservation: germplasm or gene bank, tissue culture; National biodiversity authority (NBA) etc; protected area network (PAN)-biosphere reserves, Hotspots in the world, Tiger Reserve (Anamalai Tiger Reserve) national park (Silent valey), sanctuary (Megamalai Wildlife Sanctuary), community conservation area (Ayyalur RF); important protected areas of the Western Ghats of India.	15
References	**Text Books:** 1.Kochhar, S.L. 2011. Economic Botany in the Tropics. IV edition. Macmillan Publishers India Pvt. Ltd. New Delhi. 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. MacMillien Publications Ltd. London. 5.Sambamurthy, A.V.S.S. and Subramanian, N.S. 1999. A text Book of Economic Botany, Wiley Eastern Limited ,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 text book of useful plants and plants products, Tata McGraw Hill Publishing Co., Ltd., New Delhi.	
Course Outcomes	On completion of the course, students should be able to do CO1:Identify the economically important plants with binomial names,	

	family & uses and strategies for green revolution CO2:Analyse the biogeography, status and loss of biodiversity, initiatives for biodiversity conservation CO3: Create knowledge on biodiversity management, role of biotechnology, organization involved, ITK, IPR and biopiracy. CO4: Identify the current practices of biodiversity conservation CO5: Design the principles of conservation, major approaches on management, Indian case studies on conservation	

Mapping of Cos with PSOs

PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2
CO2	3	2	3	3	2
CO3	3	3	3	3	3
CO4	3	2	3	3	3
CO5	2	3	3	3	2

Semester	**Third**	Course Code	**21BOTP0315**
Course Title	**FOREST ECOLOGY, PHYTOGEOGRAPHY AND REMOTE SENSING**		
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 concepts of Forest Ecology 2.Realize the facts of Forest Ecosystem Function & Dynamics 3. Motivate the students to appear competitive examinations in the field of Forestry		
Cognitive Levels addressed by the Course	K1- Expose the knowledge on Forestry related sciences K2- Realize the importance of forest and other resources K3- Understand the various phytogeographical regions of World K4- Incorporate the knowledge of forest ecosystems K5- Integrate the knowledge obtained from this paper to become forest conservationist.		
Course Objectives (Maximum: 5)	The Course aims to know the basic facts of Forest ecology and its associates to acquire knowledge on Forest ecosystem and NWFP to survey and analyse the various phytogeographical regions of World to understand the role of remote sensing in forest survey and conservation to realize the importance of forest ecosystem function & dynamics.		

Unit	Content	No. of Hours
I	**Introduction to Forest Ecology** Forest ecology: History, scope, principles and concepts; ecology of tropical and temperate forests; General introduction to forest; Classification of Indian forests: Tropical, temperate, evergreen, semi-evergreen, deciduous, monoculture, social, industrial; Factors affecting vegetation: Locality factors, climatic factors, edaphic factors, ecological and physiographic factors, biotic factors, influence of plant competition, parasites, epiphytes, climber- weeds on forests.	13
II	**Use and misuse of forests by man & Forest dynamics** Strong interrelationships between forest and ecosystem: Forest genetics, forest physiology, forest ecology; Macro dynamic ecosystem reserves, hydrological cycles; Importance and value of wood and Non-wood forest products (NWFP); Major and minor	13

	forest products; Animal and human conflict management , Use and misuse of forests by man, direct and indirect forest wealth; forest protection through people committee.	
III	**Forest Ecosystem Function:** Primary productivity of forest ecosystems; methods of measurement; productivity patterns; litter production and decomposition; nutrient cycling and nutrient conservation strategies; forest hydrology; Measurement of forest productivity; Ecological Succession; Forest disturbances; Forest fragmentation. Species Interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.	12
IV	**Plant geography & distribution of vegetations** Principles and importance of plant geography; static and dynamic phytogeography; Geological history and evolution of plant life; factors affecting plant distribution; different types of distribution of vegetations on the earth; Patterns of plant distribution: continuous distribution- circumpolar, circumboreal, circum austral, pan tropical and discontinuous distribution- Theory of land bridges, Wegner's theory of theory of continental drift, theory of glaciation;	12
V	**Remote sensing and GIS mapping** Introduction to Remote Sensing. The electromagnetic spectrum, Energy instruction with atmosphere and earth surface, satellite and sensors, Remote sensing data acquisition. Principles and basic concepts of Multi spectral, Thermal and hyperspectral Scanning: Across-track and Along Track multispectral Scanning. History of Space Imaging Image Interpretation: Type of Imagery, elements of Interpretation, Techniques of Visual Interpretation, Role of remote sensing in ecological research.	14
References	**Text Books** 1. Smith DM, Larson BC, Ketty MJ and Ashton PMS. 1997. The Practices of Silviculture- Applied Forest Ecology. John Wiley & Sons. 2. Baldwin, H.I. 1942. Forest Tree Seed of the North Temperate Regions. Periodical Experts Book Agency, Delhi. 3. Khullar, P. et. al. 1992. Forest seed. ICFRE, New Forest, Dehra Dun. 4. Schmidt, L. 2000. Guide to handling of tropical and subtropical forest seed. DANIDA Forest Seed Centre, Denmark. 5. Willan, R. L. 1985. A guide to forest seed handling. FAO Forestry Paper 20/2, DANIDA Forest Seed Centre, Denmark and FAO, Rome.	

6. Nair PKR. 1993. An Introduction to Agroforestry. Kluwer Academic Pub.
7. Nair PKR, Rai MR and Buck LE. 2004. New Vistas in Agroforestry.

Reference Books

1. Buck LE, Lassoie, Fernandes ECM 1999. Agroforestry in Sustainable Agri. Systems, CRC Press.
2. Shah SA. 1988. Forestry for People. ICAR.
3. Tiwari KM. 1988. Social Forestry and Rural Development. International Book Distr.
4. Sharma LC. 1980. Forest Economics, Planning and Management. International Book Distributors, Dehra Dun.
5. Anonymous 2006. Report of the National Forest Commission. Govt. of India, New Delhi.
6. Gupta T., Gularia A. 1992. Non Wood Forest products in India: Economic Potentials. Oxford and IBH publishing Co. New Delhi.
7. Mishra T.K, Banerjee, Pal, D.C. 2004. An Omnibus of Non-Timber forest products of India, Prashant Gahlot at Valley. Offset Printers and Publishers, Dehra Dun.
8. Nautiyal S and. Kaul A.K. 2003. Non-Timber Forest Products of India. Jyothi Publishers and Distributors, Dehra Dun.
9. Tribhawan Mehta. 1981. A handbook of Forest Utilization. Periodical expert book agency
10. Tropical forests, Ed. Holm – Neilsen L.B. Nielsen. DC and balslev II Academic press, London, 1989.
11. De Vere Burton L. (2000). Introduction to Forestry Science. Delmar Publishers, New York.
12. Negi, S.S. (1994). India's Forests, Forestry and Wildlife. Indus Publishing Co., New Delhi.
13. Agarwal A. P. Forests in India. Oxford & IBH.
14. Puri G. S. Indian Forest Ecology, Vol I, II. Oxford, New-Delhi.

Champion G. H and Seth S. K. A revised survey of the forest types of India - An introductory text book. ITC, The Netherlands.

15.Quante, M. (Shanmughavel, P. 2014. Forest Botany, Pointer Publishers.

16.Bor, N.L. 2008. A Manual of Indian Forest Botany International Book Distributors.

17. Singh M.P., Singh J. K., Mohanka N. &Sah R.B. 2007. Forest Environment and Biodiversity. 2nd Edition. Daya Publishing House.

18. P.D. Sharma (2019). Plant ecology and Phytogeography. Rastogi

	Publications Reprint 19. Bharucha F.R. A text book of plant geography of India. Oxford University Press 20. Huismann, O. & de By R. A. (Editors) 2009. Principles of geographic system2010). Relict species: Phylogeography and Conservation biology. DOI:10.1007/978-3-540-92160-8 21. Bharucha, F. R. 1984. A Text Book of Plant Geography of India. Oxford University Press. 22. Ronald Good. 1964. The Geography of Flowering Plants. Longmans. 23. Furley P A et. al., (1983). Geography of the biosphere: An introduction to the nature, distribution and evolution of the world life zones. Butterworths. 24.Jones H G, Vaugham R A. Remote sensing of vegetation. Oxford university press.	
Course Outcomes	On completion of the course, students should be able to CO1:to know the basic facts of Forest ecology and its associates CO2:to acquire knowledge on Forest ecosystem and NWFP CO3:to survey and analyse the various phytogeographical regions of CO4:World CO5:to understand the role of remote sensing in forest survey and conservation.	

Mapping of Cos with PSOs

PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2
CO2	3	2	3	3	2
CO3	3	3	3	3	3
CO4	3	2	3	3	3
CO5	2	3	3	3	2

Semester	**Third**	Course Code	**21BOTP0316**
Course Title	**PRACTICALS-IV: BIOINSTRUMENTATION**		
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%)	30
Category	Core		
Scope of the Course (may be more than one)	1. Rewarding opportunity to update the recent techniques in bioinstrumentation 2. Able to learn the principles, procedures and applications of chromatography, electrophoresis, UV-Vis spectroscopy, FT-IR, SEM, AAS and NMR. 3. Enhance the potential to handle the bioinstruments		
Cognitive Levels addressed by the Course	K1- Exposure to the instruments in biological sciences K2- Imbibe the techniques involved in bioinstrumentation K3- Demonstrate knowledge and understanding on the basic principle of bioinstruments K4- Implementation of Experimental protocols K5- Assessment of experimental results		
Course Objectives (Maximum:5)	The Course aims • to know the preparation of buffers and determination of pH. • to separate amino acids and sugars using chromatography and electrophoresis • to separate gas and organic acids using GC and HPLC • to estimate proteins, sugars, nucleic acids, chlorophyll, sodium, potassium, calcium and magnesium using different equipments. • to know the protocols involved in the estimation of biological samples using SEM, FT-IR, AAS and NMR.		
Practicals	Content		No. of Hours
1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12	Preparation of buffers. Determination of pH in water and soil samples. Separation of amino acids and sugars using paper chromatography (2D) Separation of amino acids and sugars using thin layer chromatography Separation of pigments by column chromatography Differential centrifugation of samples. Separation of gas and organic acids using GC and HPLC (Demonstration). Separation of proteins using vertical gel electrophoresis. Estimation of Protein using Spectrophotometer Estimation of sodium, potassium, calcium and magnesium using Flame photometer Estimation of calorific value of feed/ fire wood samples. Demonstration of Biological samples using SEM, FT-IR, AAS, NMR.		

References	1.Rodney Boyer, 2001. Modern Experimental Biochemistry. III Ed. Addison Wesley Longman Pte. Ltd, Indian Branch, Delhi, India. 2. J.Jeyaraman 1981. Laboratory Manual in Biochemistry. New Age International publishers, New Delhi.
Course Outcomes	On completion of the course, students should be able to
	CO1: Prepare buffers of desired pH CO2: Separate amino acids and sugars using paper and thin layer chromatography CO3: Estimate proteins,sodium,potassium,calcium and magnesium using spectrophotometer and flame photometer. CO4: Separate proteins using vertical gel electrophoresis CO5: Know the biological applications of SEM, FT-IR, AAS and NMR

Mapping of Cos with PSOs

PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	3	3	3	3

Semester	**FOUR**	Course Code	**21BOTP0418**
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%)**	40%
Category	Core course		
Scope of the Course (May be more than one)	❖ Basic understanding on the morphology and functions of the structures with the prokaryotes and eukaryotes ❖ Skill development 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 on 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. • make the students knowledgeable on classification and diversity of microorganisms • develop knowledge in microbial control techniques and 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: Simple, Compound, Dark field, Phase contrast, Fluorescence and Electron microscopy.		13

I	**Taxonomy and Diversity of Microorganisms** General principles of classification of microorganisms – Major Characteristics Used in Taxonomy – Haekel's three kingtom concept – Whittaker's five kingdom concept – three domain concept of Carl Woese. Brief view on bacterial classification according to Bergey's manual of Systematic bacteriology. Classification and salient features of algae, fungi, protozoa and viruses. Overview on the microbial culture collections.	
III	**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
IV	**Microbiological Techniques** Microbial control – Physical methods - Chemical methods – Evaluation and monitoring of sterilization procedures- Use dilution tests, Disc-Diffusion method – Decimal reduction time (D Value). 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; Bacterial diseases: Staphylococcus, Streptococcus, Neisseria; Corynebacterium, Clostridium, Vibrio, Yersinia, Haemophilus, Mycobacterium. Fungal diseases of man, Epidemiology. Dermatophytes, dimorphic fungi, opportunistic fungal pathogens. Viral diseases: Pox viruses; Herpes virus, Hepatitis viruses, corona viruses and Human Immunodeficiency viruses (HIV)	12

References

Text Books:

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.
Pelczar, Jr., Michael, Chan E. C. S. and Kreig Noel. 2000. Microbiology. 5th Ed. Tata McGraw Hill Book Company.

Reference Books:

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 Outcomes	On completion of the course, students should be able to: CO 1: Discuss important milestones and accomplishments to appreciate the historic CO2: Identify key organelles and their functions in both eukaryotes and prok CO3: Describe the overall classification and diversity of microorganisms. CO4: Demonstrate microbial control measures and various culture techniques in m CO5: Explain the diseases caused by various microorganisms

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	1	1
CO2	3	2	1	1	1
CO3	3	2	2	1	2
CO4	3	2	2	1	2
CO5	3	3	3	3	3

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	New 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 on 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 become Plant Scientists		
Cognitive Levels addressed by the Course	K1- Motivate to understand the basic 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 national level competitive exams K5- Utilize the knowledge acquired through this paper in various botanical researches		
Course Objectives (Maximum: 5)	**The Course aims** • to impart knowledge on the concepts & scope in 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 the transgenic organisms and to acquire knowledge on GMOs.		
Unit	Content		No. of Hours
I	**Plant Tissue Culture** Basic techniques in plant tissue culture. Culture media preparation, sterilization, Micropropagation, cell suspension culture, Somatic embryogenesis, protoplast culture. Somatic hybridization.. Protoplast isolation, fusion and culture methods, hybrid selection and regeneration, cybrids, spheroplasts; possibilities, achievements and limitations of protoplast research. Production of haploid and triploid plants. Anther and pollen culture and production of gametoclones. Embryo rescue in hybrid plants. Application of plant tissue culture in agriculture, Horticulture and forestry.		14
II	**Immobilization and Cell & Suspension culture** Culture vessels and bioreactors, culture initiation, growth curve, cell aggregates and secondary compound synthesis, use of precursors and elicitors, cell immobilization, biotransformations. Immobilization		14
III	**Biotransformation and Biosensors *(Source NPTEL course)*** Biotransformation and production of useful compounds – Glycerol, butanol, acetone, alkene oxide, Poly hydroxy butyrate and		11

	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 –Biosensors for nutrients (glucose sensors). Sensor for cell population (Lactate sensor) - Biosensor for products (alcohol sensor, formic acid sensor and methane sensor) - Biosensor for environmental control (BOD sensor, Ammonia sensor, Nitrite sensor and Sulfite Ion sensor).	
IV	**Plant Genetic Engineering *(Source NPTEL course)*** Components of plant genetic engineering .Recombinant DNA technology - molecular tools – nomenclature and characteristics of Restriction enzymes, ligases and 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 – Isolation of foreign DNA and recombinant DNA construct – Transformation – Screening and selection. Expression of cloned genes – Brief account on 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. Rules and regulation in biotechnology – biosafety, bioethics, hazards of environmental engineering. Development of transgenic crops for disease resistance, insect resistance (Bt toxins and use of protease inhibitors), herbicide tolerance, salt tolerances, drought tolerance, and nutritional quality –Brief outline on Bt Cotton & golden rice.	14
References	**Text Books** 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; 411-472; 534-555. 5. Glick, B.R. and Pasternak, J.J 1994. Molecular Biotechnology, ASM Press, Washington DC. **Reference Books** 1. Dubey R.C., 2001. A text book of Biotechnology 1st Edition. S.Chand&Company Ltd., New Delhi. 2. Glick, B.R. and Pasternak, J.J 1994. Molecular Biotechnology, ASM Press, Washington DC. 3. Kumar, H.D. 1993. Molecular Biology & Biotechnology, Vikas Publishing House Pvt., Ltd., New Delhi. 4. Kumar, H.D. 1991 Biotechnology, 2nd Ed., East – West Press	

	Private Ltd., New Delhi. 5. Trevan, M.D, Boffey, S., Goulding, K.H. and Stanbury, P. 1990. Biotechnology- The basic Principles. Tata McGraw Hill, New Delhi. 6. Demain, A.L., Solomon, N.A. 1986. "Manual of Industrial Microbiology and Biotechnology", ASM Press, Washington. 7. Robert F. Weaver, 2012Molecular Biology; McGraw Hill 8. Keith Wilson and John Walker 2010 Principles and Techniques of Biochemistry and Molecular Biology; 7th Edn. 9. T. A. Brown 2006 Gene Cloning and DNA analysis- An Introduction;, 5th Edition, Wiley Blackwell Publishing **Web resources** 1.https://www.edx.org/learn/biotechnology 2.https://biog.feedspot.com/genetics-blogs/ 3.learn.genetics.utah.edu/ 4.http://bmc biotechnol.biomedcentral.com	
Course Outcomes	Upon completion of this course, students be able to: CO1: to impart knowledge on the concepts & scope in 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.	

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	3	3	3	3

Semester	Four	Course Code	**21BOTP0420**
Course Title	**APPLIED MYCOLOGY AND PLANT PATHOLOGY**		
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%)	20
Category	Core		
Scope of the Course (may be more than one)	1. Understand various aspects of Mycology and plant pathology 2.Utilize the knowledge of Mycology and plant pathology on other botanical researches 3. Comprehend the knowledge on Mycology and plant pathology for various competitive examinations.		
Cognitive Levels addressed by the Course	K1- Inculcate the advancement of Mycology and plant pathology K2- Acquire the knowledge on importance of Mycology in Industries K3- Understand the role of Mycorrhiza in agriculture and Forestry K4- Survey and evaluation and understanding the various plant pathogens K5- Create awareness on management of plant diseases		
Course Objectives (Maximum: 5)	**The Course aims** • To evaluate the diversity of various fungal species • To analyse role of Fungi as food and beverage • To evaluate the importance of Mycorrhizal technology in agriculture • To understand the various plant pathogens and its mechanism of infection • To create the awareness on management of various plant diseases		
Unit	Content		No. of Hours
I	**Fungal diversity** Fungal diversity in different ecosystems: Fungal Diversity: Anamorphic fungi- i) Nematophagous fungi ii) Aquatic hyphomycetous fungi iii) Aero-aquatic fungi. The structure and composition of fungal cell, effect of environment on fungal growth and behavior. Enzyme technology: Fungal enzymes of commercial importance, production of fungal enzymes, free and immobilized cells and enzymes. Fungal toxins: Mycotoxicoses- fungi in dermatomycosis, aspergillosis and fungi allergenic to man and animal.		12
II	**Fungi as food and beverage** Alcoholic beverage, mushrooms and other macro fungi, edible biomass from yeast and moulds, single cell proteins (SCP). Fungi in food processing: Bread, soybean products, cheese and fermented milk, other fermented foods. Fungal metabolites: Primary metabolites of economic importance, secondary metabolites in		15

	medicine and agriculture. Biodeterioration and biodegradation by fungi: Textiles, leather, plastic, hydrocarbons, metals and pesticides.	
III	**Mycorrhyzal technology** Mycorrhyzal technology: Ectophytic and endophytic mycorrhiza, mycorrhiza in plant growth promotion, mycorrhizal interactions with soil microorganisms, mycorrhiza in plant disease control. Future of fungal biotechnology: Production of mammalian proteins by fungi, other applications of gene cloning in fungi and their importance. Cultivation technology of Mycorrhiza and application	10
IV	**Plant pathology** Historical and developmental aspects of plant pathology. Mode of infection and role of enzymes and toxins in plant disease. Defense mechanisms of plants against infection: Preexisting structural and chemical defense, induced structural and chemical defense, hypersensitive reaction, role of phytoalexins and other phenolic compounds. Brief account on downy mildew of cucurbits, stem gall of coriander, peach leaf curl, Tikka disease of groundnut, bacterial blight of rice, leaf curl of tomato, potato spindle tuber mosaic, ear cockles of wheat, phylloidy of sesamum, Citrus greening	12
V	**Management of plant diseases** Management of plant diseases: Cultural, chemical, biological , biopesticides, breeding for resistant varieties, plant quarantine, integrated pest management. Fungi in plant disease control: Current limits to biological control of fungal phytopathogens, molecular approach in control of fungal pathogens, biotrophic mycoparasitism, strain selection and their improvement for biocontrol.	14
References	**Text Books** 1.Alexopoulos, C.J., Mims, C.W. and Blackwell, M., 1996. *Introductory mycology* (No. Ed. 4). John Wiley and Sons. 2. Deacon, J.W., 1997. *Modern mycology* (Vol. 3). Oxford: Blackwell Science. 3. Rai, M. and Bridge, P.D. eds., 2009. *Applied mycology*. CABI. 4. Galloway, L.D., 1939. *Applied mycology and bacteriology* (Vol. 48, No. 4, p. 356). LWW. 5. Arora, D.K., 1991. *Handbook of Applied Mycology: Volume 1: Soil and Plants*. CRC Press. 6. Satyanarayana, T., Deshmukh, S.K. and Johri, B.N. eds., 2017. *Developments in fungal biology and applied mycology* (pp. 525-541). Singapore:: Springer. 7. Mahendra, M., Dennis, P. and Dennis, P., Applied Mycology. 8. Ajello, L. and Mukerji, K., 1993. Handbook of applied	

mycology. *Revista do Instituto de Medicina Tropical de São Paulo*, *35*, pp.314-314.

9. Agrios, G.N. 1999. Plant Pathology. Academic Press
10. Chandanwala, K. 1986. Introduction to Plant Pathology. Ammol Publishers and Distributors.
11. Horsfall, J.G. & Cowelling. 1978. Plant Diseases – An Advance Treatise Vol. II& IV Acad Press.
12. Mehrotra, R.S. 1991. Plant Pathology. Tata Mcgraw – Hill Publishing Company Ltd.
13. Roberts, S. Fritz & Elien. I. Simms. 1992. Plant Resistance to Herbivors and Pathogens (Ecology, Evolutin and Genetics), University of Chicago Press.
14. Rudra P. Singh, Uma S. Singh & Keiisuke Kohmoto (eds.) 1995. Pathogenesis and host specificity in plant diseases. Vol. III Pergamon Press.
15. Scheffer, R.P. 199. The nature of disease in plants. Cambridge University Press.
16. Tarr, S.A.J . 1987. Principles of Plant Pathology. Academic Press 20. Verma, A & Hock, B. 1999. Mycorrhizae. Springer Publishers.
17. Alexopoulos C.J., Mims, C.W. & Blackwell, M. 1996. lntroductory Mycology. 4th edition. John Wiley& Sons lnc.
18. Ainsworth, G.C., Sparrow, K.F.&Susmann, A.S.(Eds.) 1973.The Fungi - An Advanced Treatise. Vol 1 -4. Academic Press.
19. Burnett, J.H. 1970. Fundamentals of Mycology. Edward Amolds.
20. Dubey, H.C. 1990. An lntroduction to Fungi. 2nd Edition. Vikas Publishers, New Delhi.
21. Jennings, D.H. &Lysek, G. 1999. Fungal |Biology. Bios Scientifìc Publishers.
22. Mehrotra, R.S. &Aneja, K.R. 1990. An lntroductión to Mycology. New Age International Publishers.
23. Landecker, Elizabeth Moore. 1996. Fundamentals of Fungi. 4th Ed. Prentice Hall.
24. Webster, John 1980. Introduction to Fungi. Cambridge University Press. 12. Agrios, G. N. 1997. Plant pathology. 4th Ed., Academic Press.
25. Bilgrami, K.H. &Dube, H C. A Text Book of Modern Plant Pathology. Vikas Publishers, New Delhi.
26. Mehrotra, R.S.1980. Plant Pathology. Tata McGraw Hill.
27. Pandey, B. P. 1999. Plant Pathology -pathogen and plant

	disease. S. Chand & Co.	
Course Outcomes	On completion of the course, students should be able to CO1: gain the knowledge on diversity of various fungal species CO2: understand the role of Fungi as food and beverage CO3: evaluate the importance of Mycorrhyzal technology in agriculture CO4: analyse the details of various process of IPR in Life Sciences CO5: create the awareness on management of various plant diseases	

Mapping of Cos with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	3	3
CO2	3	2	3	2	2
CO3	3	2	2	2	2
CO4	3	2	3	3	3
CO5	3	3	3	2	2

Semester	**First**	Course Code	**21BOTP0421**
Course Title	**PRACTICALS- 5 : FUNDAMENTALS OF MICROBIOLOGY AND PLANT BIOTECHNOLOGY**		
No.of Credits	2	No.of contact hours per Week	3
New Course/ Revised Course	Revised Course	If revised, Percentage of Revision effected (Minimum20%)	20%
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	Enumeration and isolation of Bacteria, Fungi and actinomycetes from soil using serial dilution and plating technique.	3
8	Enumeration of microorganisms from Air using Air sampler	3

9	Quality analysis of milk- Methylene blue reductase and standard plate count method	3
10	Standard Qualitative Analysis of Water by MPN test	3+3
11	Isolation of anaerobic bacteria	3
12	Isolation of DNA from Plant samples	3
13	Demonstration of Plant Tissue culture techniques	3
14	Production of Synthetic seeds	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	
	ReferenceBooks: 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 and water	

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

Credits: 2 **CFA: 20+25+5**
Total: 50

Objectives:

- To enable students to acquire basic knowledge and exposure to human values and professional ethics.
- to motivate the students to imbibe and practice values and ethics in their profession and social interactions.

Learning Outcome

Students will be able to

- Comprehend the significance and importance of values and their pervasiveness
- Gain knowledge on the different aspects of values and ethics
- Have exposure on the practical dimensions of professional ethics

Unit 1 **Concept of Human values:** need for values and ethics in human life, types of values: **Personal and moral values:** love, truth, tolerance, wisdom, sacrifice, sincerity, self-control, altruism and scientific vision - **Social values:** equality, humaneness, universal brotherhood, empathy, probity.

Unit 2 **Political and Constitutional values:** democracy, socialism, secularism, equality, justice, liberty, freedom and fraternity - **Religious values:** faith, love, compassion, forgiveness, tolerance, equal respect for all religions, selflessness, awareness, nonattachment, character and virtues.

Unit 3 **Aesthetic values:** appreciation of literature and fine arts and nature - **Economic values:** fairness, honesty, business integrity, eco-centric - **Environmental values:** respect and concern for nature and its fauna and flora - **Professional values:** quest for knowledge, competency, sincerity in profession, regularity, punctuality.

Unit 4 **Ethics:** Meaning, domains of ethics, need for ethics, challenges to ethics, ethics and morality, role of ethics in work environment.

Unit 5 **Professional Ethics:** pride in their work, trust with confidences, honesty, trustworthy, moral, corruption free and loyal, personal commitment to quality, sharing the burden - take responsibility, **Ethical Intelligence:** Do no harm, make things better, respect others, be fair (no bias / prejudice), be loving.

Reference Books:

- Dr.Shiva and Dr. Balaji Loganathan, 2011, Value Education', Sree Gomathi Publications, Chennai.
- Babu Muthuja and R. Usharani, 2009, 'Peace and Value Education', Centrum Press, New Delhi,.
- S.Srinivasan, 2005,Value Based Management', Jaico Books, Mumbai,.
- Herve Morisette, 2001, 'Paths to a New Value Education', Indian Catehetical Association, Bangalore.
- R.S. Naagarazan, 2006, A Textbook on Professional Ethics and Human Values', New Age International Publishers, New Delhi.
- Pushpam Kumar and B. Sudhakara Reddy, 2007, Ecology and Human Well Being', Sage Publications, New Delhi.
- Dr. Kiruba Charles and V. Arul Selvi, 2016, Value Education, Neelkamal; First edition, New Delhi.
- A.R. Mohapatra and Bijaya Mohapatra, 2014, Value Education: A Study in Human Values and Virtues, Readworthy Publications, New Delhi.
- Gaur R.R, Sangal R, 2010, A Foundation Course in Human Values and Professional Ethics, Excel Books, New Delhi.
- Justin Oakley , Dean Cocking, 2001, Virtue Ethics and Professional Roles, Cambridge University Press, United Kingdom.
- Gogate S.B, 2010, Human Values and Professional Ethics, Human Values and Professional Ethics, Vikas Publishing House; First edition, New Delhi.
- Gregory R Maio,2016, The Psychology of Human Values, Routledge Publications, New York.
- John Clammer, 2018, Cultural Rights and Justice: Sustainable Development, the Arts and the Body, Palgrave Macmillan,1st ed. 2019 edition, U.K.

Weblinks:

- Thich Nhat Hanh, 2008, Good Citizens: Creating Enlightened Society: http://archive.kdd.org/good_citizens_creating_enlightened_society_thich_nhat_hanh.pdf.
- Thought of Human Value education According to Mahatma Gandhi management.nrjp.co.in/index.php/JSSMMS/article/download/155/294.

Discipline centric Courses

Semester	**Fourth**	Course Code	**21BOT P03D1**
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 the knowledge on Plant ontology, taxonomy, molecular biology and genetic engineering 3. Improve the knowledge on 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 on modern Botanical sciences K4- Motivate the students to enhance knowledge on Plant ontology, molecular biology and genetic engineering K5- Update the skills on botanical sciences to appear competitive examinations		
Course Objectives (Maximum: 5)	**The Course aims** • To have comprehensive knowledge on modern aspects of Plant anatomy and Photosynthesis • To understand the mechanism of secondary metabolites 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		12

	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	
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 data bases, 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, nutrition up-take, production of male sterile lines, plantibodies, vaccines, plant secondary products, biofuel, bioplastics and plants as bioreactors	13
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	

Mapping of Cos with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	3	3	3	3

Semester	**Fourth**	Course Code	**21BOT P03D2**
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 realize the advancement of plant systematic 2. Acquire the knowledge on plant systematic and its role in botanical research 3. Understand the knowledge plant systematic and helps to improve the research career in Botany		
Cognitive Levels addressed by the Course	K1- Inculcate the importance of plant systematic K2- Examine the various aspects of advancement of plant systematics K3- Understand the importance of advancement of plant systematics K4- Acquire the knowledge on basic and advancement of plant systematics K5- Promote the students to become a plant taxonomists		
Course Objectives (Maximum: 5)	**The Course aims** • To have comprehensive knowledge on history and evolution of plant systematics. • To understand the classical and modern aspect of plant classification. • To understand the various aspects of 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,		10

	genus, family and other categories; Principles used in assessing relationship delimitation of taxa and attribution of rank, BSI and its role.	
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 evidences obtained from Anatomy, Embryology and Palynology, Chemotaxonomy and Molecular taxonomy.	14
V	Salient features, comparative account on vegetative and sexual characters and field characteristics 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. Bhattacharyya, 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	

Mapping of Cos with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	2	2
CO2	3	2	3	3	2
CO3	3	2	3	2	2
CO4	3	2	3	3	2
CO5	3	3	3	2	2

Semester		Course Code	**21BOTP03D3**
Course Title	**REPRODUCTIVE BIOLOGY OF ANGIOSPERMS**		
No. of Credits	3	No. of contact hours per week	3
New Course/ Revised Course	Revised 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 sexuality of Angiosperms 2. Acquire the knowledge on phenology, pollination and seeds biology of Angiosperms 3. Understand the importance of study on reproduction in Angiosperms		
Cognitive Levels addressed by the Course	K1- Inculcate the importance of study on sexuality of Angiosperms K2- Understand the various stages of Angiosperms reproduction K3- Realize the importance of this study in other botanical researches K4- Understanding the role of pollination and advertisement in plants biology K5- Create awareness among the students to understand the 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** Reproductive biology in relation with Conservation 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 helps for pollination. Floral Attractants and Rewards, Advertisement in flower- color, shape, nectar and scent, plant-pollinators interface, field methodologies. Non-mutualistic		10

	Pollination, Floral Visitors and Pollinators, Pollination Efficiency, Pollination Limitation, Pollen Travel and Gene Flow	
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	1. 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. 2. 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. 3. 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. 4. Bewly, J. D. and Black, M. 1982. *Physiology and biochemistry of seed relation to germination*, Springer-Verlag, Berlin, Heidelberg, New York. 5. 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. 6. Copeland, L. O. and McDonald. M. B. 1995. Principles of seed science and technology. 3rd edition. Chapman and Hall, New York, pp.409. 7. Dafni, A. 1992. *Pollination ecology: A practical approach*. Oxford University Press, New York. pp. 250. 8. Dafni, A., Kevan, P. G. and Husband, B. C. 2005. *Practical Pollination biology*, Enviroquest Ltd, Cambridge, Otntario, Canada. 9. Kramer, P. J. and Kozlowski, T. T. 1960. *Physiology of trees*, McGraw Hill, New York.	

	10. Shivanna, K. R. and Johri, B. M. 1985. *The angiosperm pollen structure and function*, Wiley Eastern Ltd Publisher, New Delhi. 11. Shivanna, K. R. and Rangaswamy, N. S. 1992. *Pollen Biology - A Laboratory Manual*, Narosa Publishing House, New Delhi. 12. 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	

Mapping of Cos with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	3	3	3	3

MODULAR COURSES

Semester	**Third**	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%)	20
Category			
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 genome in forensic studies		
Course Objectives (Maximum:5)	The course aims • to give knowledge on working principle and applications of electrophoresis techniques • to develop interest to acquire latest information on molecular sequencing and its applications • to make knowledge on PCR techniques and its applications • to impart in-depth knowledge on chromatographic and spectrophometric techniques and their uses • to create interest on 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 Immunoelctrophoresis		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.		6

	Microarray techniques – oligonucleiotidearray and cDNA array and its applications.	
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

Mapping of Cos with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	1	2	2
CO2	2	2	1	2	2
CO3	2	2	1	2	2
CO4	2	2	1	2	2
CO5	2	2	1	2	2

Semester	**Third**	Course Code	**21BOTP03M2**
Course Title	**BIOINFORMATICS**		
No. of Credits	2	No. of contact hours per week	2
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	
Category	Modular Course		
Scope of the Course (may be more than one)	1. Understand the basics of bioinformatics 2. Learn the analysis of sequence by computational methods 3. Know the importance of protein and nucleic acid databases		
Cognitive Levels addressed by the Course	K1 -Analyze the various tools used in bioinformatics K2 - Realize the use of computer in biological applications K3 - Gain knowledge on detecting DNA polymorphisms K4 - Realize the importance of molecular docking analysis K5 - Understand the significance of protein databases		
Course Objectives (Maximum:5)	The course aims • to study on Bioinformatics, microbial genomics and proteomics • to understand genome analysis, sequence analysis and protein analysis • to explain the tools used in Bioinformatics • to impart information on a comprehensive global view on DNA sequence, DNA expression and molecular confirmations • to know computational biology		
Unit	Content		No. of Hours
I	**Whole genome analysis** Preparation of ordered cosmid libraries, bacterial artificial chromosome libraries, shotgun libraries and sequencing.		6
II	**Sequence analysis** Computational methods, homology algorithms (BLAST) for proteins and nucleic acids. PROSITE, PEAM, and Profile Scan.		6
III	**Databases Analysis** Use of internet, public domain databases for nucleic acid and protein sequences (EMBL, GenBank); database for protein structures (PDB).		6
IV	**DNA microarray and general Analysis** DNA microarray printing or oligonucleotides and PCR products on glass slides, nitrocellulose paper. Whole genome analysis for global patterns of gene expressions using fluorescent labeled DNA or end labeled RNA probes. Analysis of single nucleotide polymorphisms using DNA chips.		7
V	**Protein analysis and Proteomics**		7

	Sequence analysis of individual protein spots by mass spectroscopy. Protein microarray. Advantages and disadvantages of DNA and protein microarrays. Introduction to docking.	
References	Text Books 1. Read, TD., Nelson, KE., Fraser, CH. 2004. Microbial Genomics. Humana Press Inc., USA. 2. Rashidi, H.H. and Buchler, L.K. 2002 Bioinformatics Basics :Applications in Biological Science and Medicines, CRC Press, London 3. Stephen P. Hont and Rick Liveey (OUP) 2000. Functional Genomics, A practical Approach. 4. Perysju, Jr. abdPeruski 1997. The Internet and the New Biology: Tools for Genomic and molecular Research. 5. Mark Schena (OUP). DNA Microarrays, A practical approach.	
	Reference Books	
	E-Resources 1. https://www.bioinformatics.org 2. bioinformaticsonline.com 3. www.ii.uib.no/~inge/list.html	
Course Outcomes	On completion of the course, students should be able to	
	CO1: Evaluate whole genome analysis methods CO2: Apply the computational tools used for sequence analysis tools CO3: Demonstrate the use of internet in data analysis CO4: Acquire knowledge on DNA microarray techniques CO5: Familiar with the different methods of protein analysis	

Mapping of Cos with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2
CO2	3	2	3	3	2
CO3	3	2	3	3	3
CO4	3	2	3	3	2
CO5	3	3	3	3	2

Semester	**Third**	Course Code	**21BOTP04M3**
Course Title	**RURAL BIOTECHNOLOGY**		
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	Modular 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		6

	button mushroom technology, post harvest technology. Mushroom farming and prospects. Visit to mushroom farms with field demonstration.	
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** Present status and importance – popular varieties – Natural,artificial and live feeds – breeding techniques of egg layers – gold fish, angel fish, fighter and barbs – live bearers – guppy, molly, platy and sword tail – Economics.	6
References	Text Books 1. Tripati, G. 2003. Vermiresources technology, 1st Ed., Discovery Publication House, New Delhi. 2. Anita Saxena, 2003. Aquarium management. Daya Pub. House, New Delhi. 3. Kaul, T.N. 1999. Introduction to mushroom science, Oxford & IBH Co., Pvt. Ltd.,New Delhi. 4. Kumar, H.D., 1991. A Textbook on Biotechnology, II Edition, East-west Press Pvt. Ltd., New Delhi. 5. Chawla O.P. 1986. Advances in Biogas Technology, ICAR, New Delhi.	
	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 Improved Methods, 1st print, ICAR, New Delhi. 3. Subba Rao, N.S., 1999. Soil Microbiology, 4th Ed., Oxford IBH Publishing Co. Pvt. Ltd., New Delhi. 4. Philip G. Miles, Shu-Ting Chang, 1997. Mushroom biology, World Scientific,Singapore. 5. Chatwal, G.R., 1995. Textbook of Biotechnology, Anmol Publications Pvt. Ltd., New Delhi 6. 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	On completion of the course, students should be able to	

Outcomes	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

Mapping of Cos with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	1	3
CO2	3	3	1	1	3
CO3	3	3	1	1	3
CO4	3	3	1	1	3
CO5	3	3	1	1	3

Semester	**Fourth**	Course Code	**21BOTP04M4**
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, sterilization, 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 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	

Mapping of Cos with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	3	2
CO2	3	2	3	2	2
CO3	3	2	2	2	3
CO4	3	2	3	2	2
CO5	3	3	2	2	3

Semester		Course Code	**21BOTP04M5**
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. 4. Baine. (2007). Biotechnology from A to Z, Agrobios, New Delhi. 5. Barum. (2006). Biotechnology, Thompson Publishers, New Delhi. 6. Chawla, H.S. (2007). Introduction to Plant Biotechnology. Oxford and IBH publishing Co (P) Ltd.New Delhi. 7. Das,H.K. (2010). Textbook of Biotechnology. Wiley India (P) Ltd. New Delhi. 8. Dubey, R.C. (2010). Textbook of Biotechnology, S. Chand and Co. Ltd., Ramnagar, New Delhi. 9. Prabuddha Ganguli (2017). Intellectual Property Rights: Unleashing the Knowledge Economy. McGraw Hill Education 10. R. Radhakrishnan and S. Balasubramanian (2008). Intellectual Property Rights: Text and Cases. Excel books 11. B.L. Wadehra (2016) Law relating to Intellectual Property, 2011. Universal Law Publishing – An imprint of LexisNexis, 5th Edition 12. Verma, S.K and Mohit Verma, (2010). Textbook of Plant Physiology, Biochemistry and Biotechnology. S.Chand and Co. New Delhi. 13. P. Narayanan(2010).Law of Copyright and Industrial Designs; Eastern law House, Delhi, 14. T. M Murray and M.J. Mehlman, (2000). Encyclopedia of Ethical, Legal and Policy issues in Biotechnology, John Wiley & Sons/ 15. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited. 16. Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited. **Reference book:** 1. Ahuja, V K. (2017). Law relating to Intellectual Property Rights.	

	India, IN: Lexis Nexis. **E-resources:** 1. Subramanian, N., & Sundararaman, M. (2018). Intellectual Property Rights – An Overview. Retrieved from http://www.bdu.ac.in /cells/ipr/ docs/ipr-eng-ebook.pdf 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	

Mapping of Cos with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	2	3	3	3
CO3	3	3	3	3	2
CO4	3	2	3	3	3
CO5	2	3	3	3	2

Generic courses

Semester	**Second**	Course Code	**21BOTP02G1**
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. Classification of vegetable drugs. Indian systems of Medicine: Siddha, Ayurvedha 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. Methods		15

	of preparation of drugs from various plantmaterials – extraction of plant material (including the traditional method of preparation) – separation and isolation of constituents – distillation, chromatography – TLC. Drug adulteration, Drug evaluation, Chemical evaluation and Biological evaluation of drugs.	
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 on drugs acting on central nervous system (CNS stimulants, CNS depressants and Hallucinogenics). Drugs used in disorders of gastrointestinal tract (Carminatives, Bulk laxatives and Purgatives) and cardio vascular drugs (Cardiotonics, Cardia 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, Institutionalised 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

References	1. Amruth, The Medicinal plants Magazine (All volumes) Medplant Conservatory Society, Bangalore. 2. Arumugam, K.R. and Murugesh, N. (1990). Text book of Pharmacognosy. Sathya Publishers, Chinnalapatti (Tamilnadu) 624 201. 3. Bhattacharjee, S.K. 2004. Hand Book of Medicinal plants. Pointer Publishers, Jaipur. 4. Gokhale, S.B., Kokate, C.K. and Purohit, A.P. (2003). Pharmacognosy. NiraliPrakashan, Pune. 5. GuhaBakshi, D.N. Sen Sharma, P. and Pal, d.C. (1996). A Lexicon of Medicinal Plants in India. Naya Prakash, Calcutta. 6. Handa, S. S. and V. K. Kapoor, (1993). Pharmacognosy. VallabhPrakashan. New Delhi. 7. Harbourne, J. B. (1998). Phytochemical methods: A Guide to Modern Techniques of Plant Analysis (3rd edition). Chapman and Hill Co., New York. 8. Jain, (2001). Medicinal plants. National Book Trust, New Delhi. 9. John JothiPrakash, E. (2003). Medicinal Botany and Pharmacognosy. JPR Publication, Vallioor, Tirunelveli. 10. Joshi, S.G. (2001). Medicinal plants. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi. 11. Medicinal Plants Source Book India, (1996). International Library Association, Switzerland. 12. Prajapathi, Purohit, Sharma and Kumar. (2003). A Hand book of Medicinal plants. Agrobios Publications, Jodhpur. 13. Purohit and Vyas, (2004). Medicinal Plants Cultivation. Agrobios Publications, Jodhpur. 14. Thirugnanam, (1995). Muligaimaruthuvam (Tamil). Selvipathipakam, Trichy. 15. Saroya AS. 2011. Herbalism, Phytochemistry and Ethnopharmacology, CRC Press, U 16. Chopra, R.N. Nager, S.L. and Chopra, I.C. 1956. Glossary of Indian Medicinal Plants. CSIR, New Delhi. 17. Nadkarni, K.M. 1982. Indian MateriaMedica. Popular Prakasham Pvt. Ltd. 18. Trease, G.E. and Evans, W.C. 1980. Text Book of Pharmacognosy. ELBS, Bailliere, Tindall. 19. Sambamurthy, A.V.S.S. and Subramanian, M.S. 1989. A text book of Economic Botany. Wiley Eastern Co., New Delhi. 20. Wallis, T.E. 1985. Text Book of Pharmacognosy. CBS Publishers and Distributors, New Delhi	

	21.Rantia P. Clinical Dietetics and Nutrition, 2nd edition, Oxford University press. 22.Garrrow J.S, James W. P.T, Ralph A, (2000), Human Nutrition and Dietetics, 10thedition, Churchill Livingston, London. 23.Guthrie H. A, Picciano M. F (1995), Human Nutrition, Mosby, St. Louis missionary. 24. Michael Sharon. 1994, Complete Nutrition, Avery publishing group. New York. 25. Mohan K. L, Krause M.V. 2002, 2nd edition Food, nutrition and Diet Therapy, W.S.suders Co, Philadelphia. 26. Srilakshmi B, Dietetics .2006. New age International publishing Ltd. 27. Robinson C.H., Lawler M.R, Cheweth W.L; and Gaswick A.E, Normal and Therapeutic Nutrition ,17th edition, Mac Milan Publishers. 28. Shills M.E.,Olson J:-Shike,M and Roos, C. 1998. Modern Nutrition in Health and Disease 9th Edition. Williams and Williams A Beverly Co. London. 29. Srilakshmi B. 2008: Nutrition Science, New age international P.Ltd., New Delhi.	
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	

Mapping of Cos with PSOs

PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	1	2	2
CO2	3	3	3	2	2
CO3	3	3	3	2	2
CO4	3	3	3	2	2
CO5	2	3	3	3	2

Semester	**Fourth semester**	Course Code	**21BOTP02G2**
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.		10

	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	
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 foodprocessing 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 rootcrops: 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	

Mapping of Cos with PSOs

PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	1	2	2
CO2	3	2	3	3	3
CO3	3	3	2	3	2
CO4	3	3	2	3	2
CO5	2	3	3	3	2

Semester	**Fourth semester**	Course Code	**21BOTP02G3**
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 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	**Azolla cultivation** 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,		15

	scope. A general account of Ecto, Endo and Arbuscular mycorrhizae (AM). Isolation and method of inoculation of Arbuscular mycorrhizae (AM), Legume - AM interactions.	
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. 7. Reddy, G.C., Goyal, R.K., Puranik, S., Waghmar, V., Vikram, K.V. and Sruthy, K.S., 2020. Biofertilizers toward sustainable agricultural development. Plant microbe symbiosis. Springer, Cham, pp.115-128. 8. Dudeja, S.S., Singh, N.P., Sharma, P., Gupta, S.C., Chandra, R., Dhar, B., Bansal, R.K., Brahmaprakash, G.P., Potdukhe, S.R., Gundappagol, R.C. and Gaikawad, B.G., 2011. Biofertilizer technology and pulse production. In Bioaugmentation, biostimulation and biocontrol (pp. 43-63). Springer, Berlin, Heidelberg.	

	9.https://www.biologydiscussion.com/essay/bio-fertilizers-types-and-importance-of-bio-fertilizers/1901 10. Tripathi, D.P. (2005). Mushroom Cultivation. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi. 11. Philip G. Miles, Shu-Ting Chang, 1997. Mushroom biology, World Scientific, Singapore. 12. Kaul, T.N. 1999. Introduction to mushroom science, Oxford & IBH Co., Pvt. Ltd., New Delhi. 13. Bahl, N. 1988. Handbook on mushrooms. Oxford &IBH Publishing Co., Pvt. Ltd., New Delhi.	
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	

Mapping of Cos with PSOs

PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	1	2	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	2	3	3	3	2

Value added Courses

Semester	**Third**	Course Code	**21BOTP04VA1**
Course Title	**RURAL BIOTECHNOLOGY**		
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)	4. Understand the importance of biogas technology 5. Learn the effective way of utilization of vermicompost 6. 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** Present status and importance – popular varieties – Natural,artificial and live feeds – breeding techniques of egg layers – gold fish, angel fish, fighter and barbs – live bearers – guppy, molly, platy and sword tail – Economics.	6
References	Text Books 6. Tripati, G. 2003. Vermiresources technology, 1st Ed., Discovery Publication House, New Delhi. 7. Anita Saxena, 2003. Aquarium management. Daya Pub. House, New Delhi. 8. Kaul, T.N. 1999. Introduction to mushroom science, Oxford & IBH Co., Pvt. Ltd.,New Delhi. 9. Kumar, H.D., 1991. A Textbook on Biotechnology, II Edition, East-west Press Pvt. Ltd., New Delhi. 10. Chawla O.P. 1986. Advances in Biogas Technology, ICAR, New Delhi.	
	Reference Books 7. Srivastava, C.B.L, 2002. Aquarium fish keeping. Kitab Mahal, Allhabad. 8. Gaur, A.C., 1999. Microbial technology for Composting of Agricultural Residues by Improved Methods, 1st print, ICAR, New Delhi. 9. Subba Rao, N.S., 1999. Soil Microbiology, 4th Ed., Oxford IBH Publishing Co. Pvt. Ltd., New Delhi. 10. Philip G. Miles, Shu-Ting Chang, 1997. Mushroom biology, World Scientific,Singapore. 11. Chatwal, G.R., 1995. Textbook of Biotechnology, Anmol Publications Pvt. Ltd., New Delhi 12. 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

Mapping of Cos with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	1	3
CO2	3	3	1	1	3
CO3	3	3	1	1	3
CO4	3	3	1	1	3
CO5	3	3	1	1	3

Semester	**Fourth**	Course Code	**21BOTP04VA2**
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 on GM technology, bio-safety relations and germplasm storage • Acquire the 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	

Mapping of Cos with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	3	2
CO2	3	2	3	2	2
CO3	3	2	2	2	3
CO4	3	2	3	2	2
CO5	3	3	2	2	3

Semester	**Fourth semester**	Course Code	**21BOTP0VA3**
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.		10

	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	
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 foodprocessing 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 rootcrops: 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	

Mapping of Cos with PSOs

PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	1	2	2
CO2	3	2	3	3	3
CO3	3	3	2	3	2
CO4	3	3	2	3	2
CO5	2	3	3	3	2

Semester	**Fourth semester**	Course Code	**21BOTP0VA4**
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	**Azolla cultivation** 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,		15

	scope. A general account of Ecto, Endo and Arbuscular mycorrhizae (AM). Isolation and method of inoculation of Arbuscular mycorrhizae (AM), Legume - AM interactions.	
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. 7. Reddy, G.C., Goyal, R.K., Puranik, S., Waghmar, V., Vikram, K.V. and Sruthy, K.S., 2020. Biofertilizers toward sustainable agricultural development. Plant microbe symbiosis. Springer, Cham, pp.115-128. 8. Dudeja, S.S., Singh, N.P., Sharma, P., Gupta, S.C., Chandra, R., Dhar, B., Bansal, R.K., Brahmaprakash, G.P., Potdukhe, S.R., Gundappagol, R.C. and Gaikawad, B.G., 2011. Biofertilizer technology and pulse production. In Bioaugmentation, biostimulation and biocontrol (pp. 43-63). Springer, Berlin, Heidelberg.	

	9.https://www.biologydiscussion.com/essay/bio-fertilizers-types-and-importance-of-bio-fertilizers/1901 10. Tripathi, D.P. (2005). Mushroom Cultivation. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi. 11. Philip G. Miles, Shu-Ting Chang, 1997. Mushroom biology, World Scientific, Singapore. 12. Kaul, T.N. 1999. Introduction to mushroom science, Oxford & IBH Co., Pvt. Ltd., New Delhi. 13. Bahl, N. 1988. Handbook on mushrooms. Oxford &IBH Publishing Co., Pvt. Ltd., New Delhi.	
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	

PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	1	2	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
	2	3	3	3	

@@@@@@@@@@