THIRUVALLUVAR UNIVERSITY

SERKKADU, VELLORE–632115

M.Sc. BOTANY

SYLLABUS

FROM THE ACADEMIC YEAR
2023 – 2024

P24

M.Sc. BOTANY

Credit Distribution for PG Programmes
Semester-wise papers

	Course Name	Hours Per week		Credits
		Lecture	Tutorial	
		1 contact hour = 1 credit		
SEMESTER 1				
Core	**Core I** Plant Diversity - I: Algae, Fungi, Lichens and Bryophytes	7		5
	Core II Plant Diversity - II: Pteridophytes, Gymnosperms and Paleobotany	7		5
	Core III Laboratory course- I: Covering Core Papers - I	3		2
	Core III Laboratory course- I: Covering Core Papers - II	3		2
Elective (Generic Discipline-Centric)	**EG1: (One from each Group A)** 1. Microbiology, immunology and plant pathology 2. Conservation of natural resources and policies 3. Mushroom cultivation 4. Phytopharmacognosy	5		3
Elective (Generic Discipline-Centric)	**ED1: (One from each Group B)** 1. Algal Technology 2. Ethnobotany, naturopathy and Traditional Healthcare 3. Horticulture 4. Herbal Technology	5		3
	Total	**30**		**20**
SEMESTER 2				
Core	**Core IV** Taxonomy of Angiosperms and Economic Botany	4		4
	Core V Plant Anatomy and Embryology of angiosperms	4		4
	Core VI Ecology, phytogeography, Conservation Biology and Intellectual property rights	4		3
	Core Laboratory course- II: Covering Core Papers IV	2		1
	Core Laboratory course- II: Covering Core Papers V	2		1
	Core Laboratory course- II: Covering Core Papers VI	2		1
Elective (Generic Discipline-Centric)	**EG2: (One from each Group C)** 1.Medicinal Botany (or) 2.Phytochemistry 3. Research methodology, computer applications & bioinformatics 4. Biopesticide Technology (4)	3		3
Elective (Generic Discipline-Centric)	**ED2: (One from each Group D)** 1. Applied bioinformatics 2. Biostatistics 3. Intellectual Property Rights 4. Nanobiotechnology (4)	3		3
Skill Enhancement (SE1)	**SE2** Agriculture and Food Microbiology	4		2
	MOOC Course	0		2
	Human Rights	2		2
	Total	**30**		**26**

SEMESTER 3			
Core	**Core VII** Cell and Molecular Biology	4	4
	Core VIII Genetics, Plant Breeding & Biostatistics	4	4
	Core IX Recombinant DNA technology and industrial applications	4	4
	Core Laboratory course- III Covering Core Papers VIII	2	1
	Core Laboratory course- III Covering Core Papers IX	2	1
	Core Laboratory course- III Covering Core Papers X	2	1
Industry Module	**Core X :** Industrial Botany:	6	4
Elective (Generic Discipline-Centric)	**EG3: (One from Group E) (4)** 1. Secondary Plant Products and Fermentation Biotechnology 2. Entrepreneurial Opportunities in Botany 3. Applied plant cell & tissue culture 4. Silviculture and Commercial Landscaping (4)	3	3
Skill Enhancement (SE1)	**SE4** Seminar paper (Open Choice) Professional Communication Skill (2)	3	2
	Internship / Industrial Activity (Carried out in Summer Vacation at the end of I year – 30 hours)	-	2
	Total	**30**	**26**
Semester 4			
Core	Core **XI Plant Physiology and Plant** metabolism	4	4
	Core XII Biochemistry & Applied Biotechnology	4	4
	Core Laboratory course- IV Covering Core Papers XI	2	1
	Core Laboratory course- IV Covering Core Papers XII	2	1
Project	**Project with Viva-voce**	10	7
Elective (Generic or Discipline-Centric)	**EG3: (One from Group F) (4)** 1. Organic farming 2. Forestry and Wood Technology 3. Gene Cloning And Gene Therapy 4. Farm Sciences- Green Wealth	4	3
Professional Competency Skill Enhancement	Training for Competitive Examinations Botany for NET/UGC-CSIR/SET/TRB competitive examinations (2 hours) General Studies for UPSC/TNPSC/other competitive examinations (2 hours) or Botany for Advanced Research (4 hours) Naan Mudhalvan Scheme	4	2
	Extension activities	0	1
	Total	**30**	**23**
	Total Credit		**95**

CONTENT

1. Introduction: PO & PSO

Programme Outcome, Programme Specific Outcome and Course Outcome

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

TANSCHE REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK FOR POSTGRADUATE EDUCATION	
Programme	**M.Sc. BOTANY**
Programme Code	24
Duration	**PG - 2 years**
Programme Outcomes (Pos)	**PO1: Problem Solving Skill** Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context. **PO2: Decision Making Skill** Foster analytical and critical thinking abilities for data-based decision-making. **PO3: Ethical Value** Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities. **PO4: Communication Skill** Ability to develop communication, managerial and interpersonal skills. **PO5: Individual and Team Leadership Skill** Capability to lead themselves and the team to achieve organizational goals.

	PO6: Employability Skill Inculcate contemporary business practices to enhance employability skills in the competitive environment. **PO7: Entrepreneurial Skill** Equip with skills and competencies to become an entrepreneur. **PO8: Contribution to Society** Succeed in career endeavors and contribute significantly to society. **PO 9 Multicultural competence** Possess knowledge of the values and beliefs of multiple cultures and a global perspective. **PO 10: Moral and ethical awareness/reasoning** Ability to embrace moral/ethical values in conducting one's life.
Programme Specific Outcomes **(PSOs)**	**PSO1 – Placement** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions. **PSO 2 - Entrepreneur** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations. **PSO3 – Research and Development** Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development. **PSO4 – Contribution to Business World** To produce employable, ethical and innovative professionals to sustain in the dynamic business world. **PSO 5 – Contribution to the Society** To contribute to the development of the society by collaborating with stakeholders for mutual benefit.

M.Sc. BOTANY CURRICULUM

Title of the Course		**PLANT DIVERSITY – I: ALGAE, FUNGI, LICHENS AND BRYOPHYTES**					
Paper Number		**CORE I**					
Category	Core	**Year**	I	**Credits**	5	**Course Code**	
		Semester	I				
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
					--	7	
Pre-requisite		Students should be familiar with the basics of algae, fungi, lichens and Bryophytes.					
Learning Objectives		1. To learn about the classification, distinguishing traits, geographic distribution, and reproductive cycle of algae, fungi, lichens, and bryophytes. 2. To gain knowledge about the ecological and economic importance of algae, fungi, lichens and bryophytes. 3. To spark interest in the evolutionary roots of plant development. 4. To study the biodiversity by describing and explaining the morphology and reproductive processes of algae, fungi, bryophytes and microorganisms. 5. To expose the beneficial and harmful viewpoint.					

UNIT	CONTENTS
I	**ALGAE:** General account of algology, Contributions of Indian Phycologist (T.V.Desikachary, V.Krishnamurthy and V.S. Sundaralingam), Classification of algae by F.E. Fritsch (1935-45) & R.E.Lee (2008). Salient features of major classes: Cyanophyceae, Chlorophyceae, Xanthophyceae, Chrysophyceae, Cryptophyceae, Dinophyceae, Chloromonadineae, Euglenophyceae, Charophyceae, Bacillariophyceae, Phaeophyceae and Rhodophyceae. Range of thallus organization, algae of diverse habitats, reproduction (vegetative, asexual and sexual) and life cycles. Phylogeny and inter-relationships of algae, origin and evolution of sex in algae. Structure, reproduction and life histories of the following genera: *Oscillatoria, Scytonema, Ulva, Codium, Diatoms, Dictyota* and *Gelidium.*
II	**FUNGI:** General Characteristics, occurrence and distribution. Mode of nutrition in fungi. Contributions of Indian Mycologists (C.V.Subramanian), Classification of Fungi by Alexopoulos and Mims (1979) & Recent trends in the classification of fungi - Phylogeny and inter-relationships of major groups of fungi. General characters of major classes: Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina. Heterothallism in fungi, sexuality in fungi, Para sexuality, sex hormones in fungi. Structure, reproduction and life histories of the following genera: *Plasmodiophora, Phytophthora, Rhizopus, Taphrina, Polyporus* and *Colletotrichum.*

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

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

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

Recommended texts:

1. Kumar, H.D.1999. Introductory Phycology. Affiliated East-West Press, Delhi.
2. Barsanti, L. and Guadtieri, P. 2014. Algae: Anatomy, Biochemistry and Biotechnology, 2nd Edition, CRC Press, ISBN: 1439867321.
3. Sharma, O.P. 2011. Fungi and Allied Microorganisms, Mc Graw Hill, ISBN:9780070700383, 0070700389

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

Reference Books:

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

Web resources:

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

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	3	2	3	2	1	2	2	2	2
CO 2	3	3	2	2	3	3	2	3	2	3
CO 3	2	2	3	3	1	2	1	3	1	3
CO 4	3	3	3	3	3	2	3	3	3	3
CO 5	3	3	2	3	2	3	3	3	3	3

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

.Title of the Course		PLANT DIVERSITY – II : (PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY)					
Paper Number		**CORE II**					
Category	**Core**	**Year**	I	**Credits**	4	**Course Code**	
		Semester	I				
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		3	2		--	5	
Pre-requisite		Students should know about the fundaments of Pteridophytes, Gymnosperms and fossil records.					
Learning Objectives		1. To investigate the classification, distinctive traits, distribution and reproduction and life history of the various classes and major types of Pteridophytes and Gymnosperms. 2. To identify and characterize diversity of lower vascular plants in order to comprehend the dynamics of diversity to realize the importance of diversity. 3. To research the classification, phylogeny and economic importance of Pteridophytes and Gymnosperms. 4. To study and understand the phylogeny and Paleontology of Pteridophytes and Gymnosperms. 5. To learn about the concept of fossils and process of fossilization; distinctive characteristics of fossil records of Pteridophytes and Gymnosperms.					

UNIT	CONTENTS
I	**PTERIDOPHYTES:** General characteristics and classification (Reimer, 1954). Range of structure, reproduction and evolution of the gametophytes, Gametophyte types – sex organs. Apogamy and Apospory. Life cycles. Stelar evolution. Heterospory and seed habit, Telome theory, morphogenesis, Economic importance of Pteridophytes.
II	**PTERIDOPHYTES:** Structure, anatomy, reproduction and life histories of the following genera: *Isoetes, Equisetum, Angiopteris, Osmunda, Pteris* and *Azolla.*
III	**GYMNOSPERMS:** General characters - A general account of distribution of Gymnosperms. Morphology, anatomy, reproduction, phylogeny and classification (K.R.Sporne, 1965). Economic importance of Gymnosperms.
IV	**GYMNOSPERMS:** Structure (Exomorphic and endomorphic), anatomy, reproduction and life histories of the following genera: *Thuja, Cupressus, Araucaria, Podocarpus, Gnetum* and *Ephedra*.
V	**PALEOBOTANY:** Geological Scale; Radiocarbon dating; Contribution of Birbal Sahni to Paleobotany. Gondwana flora of India. Study of fossils in understanding evolution. Fossilization and fossil types. Economic importance of fossils – fossil fuels and industrial raw materials and uses. Study of organ genera: *Rhynia, Lepidocarpon, Calamites, Cordaites* and *Lyginopteris.*

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

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

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

Recommended Text:

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

Reference books:

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

7. Taylor, E, Taylor, T, Krings, M. 2008. Paleobotany: The Biology and Evolution of Fossil Plants, 2nd Edition, Academic Press.

Web resources:

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

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	3	3
CO 2	3	3	3	3	3	3	3	3	3	3
CO 3	2	3	3	3	3	1	3	3	3	3
CO 4	3	3	2	3	3	3	3	2	3	2
CO 5	3	2	2	2	2	2	2	1	2	1

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

<table>
<tr><td>Title of the Course</td><td colspan="7">CORE-III LABORATORY COURSE-I
COVERING THEORY PAPERS I AND II</td></tr>
<tr><td>Paper Number</td><td colspan="7">CORE III</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">3</td><td colspan="2">--</td><td colspan="2">2</td><td>5</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">Students should be familiar with the fundamentals of algae, fungi, lichens, Bryophytes, Pteridophytes, Gymnospersms, Paleobotany and microbes in addition to essential laboratory techniques.</td></tr>
<tr><td rowspan="5">Learning Objectives</td><td colspan="7">1. To learn how to employ the use of instruments, technologies and methodologies related to thallophytes and non-flowering plant groups.</td></tr>
<tr><td colspan="7">2. To enhance information on the identification of each taxonomical group by developing the skill-based detection of the morphology and microstructure of algae, and fungi.</td></tr>
<tr><td colspan="7">3. To comprehend the fundamental concepts and methods used to identify Bryophytes, Pteridophytes and Gymnosperms through morphological changes and evolution, anatomy and reproduction.</td></tr>
<tr><td colspan="7">4. To develop the technical abilities in staining, sectioning, sterilizing, and characterizing. thallophytes, and other varieties of non-flowering plants.</td></tr>
<tr><td colspan="7">5. To compare the structural diversity of fossil and extant plant species.</td></tr>
<tr><td>UNIT</td><td colspan="7">EXPERIMENTS</td></tr>
<tr><td>I</td><td colspan="7">ALGAE
Study of algae in the field and laboratory of the genera included in theory.
External morphology and internal anatomy of the vegetative and reproductive structures of the following living forms: Oscillatoria, Scytonema, Ulva, Codium, Diatoms, Dictyota and Gelidium (depending onavailability of the specimen).
To record the local algal flora–Study of their morphology and structure.
Identification of algae to species level (at least One).
Preparation of culture media and culture of green algae and blue green algae in the laboratory (Demonstration).</td></tr>
<tr><td>II</td><td colspan="7">FUNGI
Study of morphological and reproductive structures of the following living forms: Plasmodiophora, Phytophthora, Rhizopus, Taphrina, Polyporus and Colletotrichum (depending on availability of the specimen).
Isolation and identification of fungi from soil, air, and Baiting method.
Preparation of culture media.
Cultivation of mushroom in the laboratory (Demonstration).
LICHENS
Study of morphological and reproductive structures of the genera Parmelia.</td></tr>
</table>

III	**BRYOPHYTES** External morphology and internal anatomy of the vegetative and reproductive organs of the following living forms: *Targionia*, *Lunularia*, *Porella* and *Polytrichum* (depending on availability of the specimen).
IV	**PTERIDOPHYTES** External morphology and internal anatomy of the vegetative and reproductive organs of the following living forms: *Isoetes, Equisetum, Angiopteris, Osmunda, Pteris* and *Azolla* (depending on availability of the specimen). *Fossil slides observation: Rhynia, Lepidocarpon, Calamites.*
V	**GYMNOSPERMS** External morphology and internal anatomy of the vegetative and reproductive organs of the following living forms: *Thuja, Cupressus, Araucaria, Podocarpus, Gnetum* and *Ephedra* (depending on availability of the specimen). Fossil slides observation*: Cordaites* and *Lyginopteris.*

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

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

Recommended Text:

1. Kumar, H.D. 1999. Introductory Phycology. Affiliated East-West Press, Delhi.
2. Das, S and Saha, R. 2020. Microbiology Practical Manual. CBS Publishers and Distributors (P) Ltd., New Delhi, India.
3. Sharma, O.P. 2012. Pteridophyta, Tata McGraw-Hills Ltd, New Delhi.
4. Sharma O.P and S, Dixit. 2002. Gymnosperms. Pragati Prakashan.
5. Johri, R.M, Lata, S, Tyagi, K. 2005. A text book of Gymnosperms, Dominate pub and Distributer, New Delhi.

Reference Books:

1. Chmielewski, J.G and Krayesky, D. 2013. General Botany laboratory Manual. Author House, Bloomington, USA.
2. Webster, J and Weber, R. 2007. Introduction to Fungi, 3rd Ed. Cambridge University Press, Cambridge.
3. Sharma, O.P. 2017. Bryophyta, MacMillan India Ltd, New Delhi.
4. Ashok, M. Bendre and Kumar. 2010. A text book of Practical Botany, Algae, Fungi, Lichen, Bryophyta, Pteridophyta, Gymnosperms and Palaeobotany. Revised edition. Published by Rakesh Kumar Rastogi publication.
5. Gangulee, H.C and A.K. Kar. 2013. College Botany. Vth Edition. S. Chand.

Web resources:

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

Mapping with Programme Outcomes:

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

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

<table>
<tr><td>Title of the Course</td><td colspan="7">MICROBIOLOGY, IMMUNOLOGY AND PLANT PATHOLOGY</td></tr>
<tr><td>Paper Number</td><td colspan="7">ELECTIVE I</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">ELECTIVE</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>3</td><td colspan="2">2</td><td>--</td><td colspan="2">5</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">The goal of the course is to provide students with basic understanding of microbiology, immunology, plant pathology and the etiology of specific plant diseases.</td></tr>
<tr><td rowspan="5">Learning Objectives</td><td colspan="7">1.To provide comprehensive knowledge about microbes and its effect on man and environment.</td></tr>
<tr><td colspan="7">2. To provide comparative analysis of major groups of microbes.</td></tr>
<tr><td colspan="7">3. To study the principles of immune system, immunizing agents like antibodies and vaccines and gene therapy methods.</td></tr>
<tr><td colspan="7">4. To enhance the knowledge and skills needed for self-employment using the microbial derived products.</td></tr>
<tr><td colspan="7">5. To appreciate the role of immune system in conferring disease resistance.</td></tr>
<tr><td>UNIT</td><td colspan="7">CONTENTS</td></tr>
<tr><td>I</td><td colspan="7">BACTERIA:
Types of microorganisms. General characteristic of bacteria – Outline classification of Bergey’s manual of 9th edition. Classification of bacteria based on Morphological, cultural, physiological and molecular characteristics. Bacterial growth – batch culture and continuous culture. Growth Curve. Factors affecting growth. Determination of bacterial growth – Direct method: Haemocytometer, Viable plate count; Indirect method: Turbidity. Nutritional types.
Reproduction - Fission and sporulation. Genetic recombination- Transformation, Transduction and Conjugation. Isolation and cultivation of bacteria. Maintenance of bacterial culture.</td></tr>
<tr><td>II</td><td colspan="7">VIRUSES:
General characters, Classification, Structure, Multiplication. Overview of Phycoviruses and Mycoviruses. Viruses of Eukaryotes – Animal & Plant viruses. Cultivation of viruses – in embryonated egg and in plants. Control of viral infections. Bacteriophages- classification, replication of DNA and RNA phages -Lytic and Lysogenic cycle. Viroids and prions. Mycoplasma: Structure and classification.</td></tr>
<tr><td>III</td><td colspan="7">FOOD MICROBIOLOGY:
Beneficial role of microbes – Yoghurt, Olives, Cheese, Bread, Wine, Tempeh, Miso & Fermented green tea. Spoilage of fruits, vegetables, meats, poultry, eggs, bakery products, dairy products and canned foods. Microbial toxins - Exotoxin, Endotoxin & Mycotoxin. Action of Enterotoxin, Cytotoxin& Neurotoxin. Food Preservation – temperature, drying, radiation and chemicals. Soil Microbiology: Importance of Microbial flora of soil and factors affecting the microbial community in soil.</td></tr>
</table>

	Interaction among soil microbes (positive and negative interactions) & with higher plants (rhizosphere &phyllosphere). Microorganisms in organic matter decomposition. Environmental Microbiology: Microbiology of water and air. Water borne diseases - diphtheria, chicken pox. Air borne diseases - Swine flu and Measles. Microbial degradation of chemical pesticides and hydrocarbon.
IV	**IMMUNOLOGY:** Introduction; Immune System; Types of Immunity - Innate and Acquired.Immune Cells - Hematopoiesis, B and T lymphocytes - Maturation, NK cells. Introduction to inflammation, Adaptive immune system, Innate Immune system. Antigen: Definition, Properties and types. Antibody – Structure, types and function. Generation of antibody diversity. Antigen - Antibody interactions: definition, types- Precipitation, Agglutination, Complement fixation. Immune Response – Humoral and Cell Mediated. Vaccines – history, types and recombinant vaccines. Immunodiagnosis – Blood Grouping, Widal test, Enzyme-Linked Immunosorbent Assay (ELISA), Immunoelectrophoresis and Immunodiffusion.
V	**PLANT PATHOLOGY:** History and significance of plant pathology. Classification of plant diseases, Symptomology (important symptoms of plant pathogens). Principles of plant infection –Inoculum, inoculum potential, Pathogenicity. Disease triangle. Host parasite interrelationship and interaction. Causal agents of plant diseases - biotic causes (fungi, bacteria, virus, mycoplasma, nematodes, parasitic algae, angiospermic parasites - Abiotic causes (Physiological, deficiency of nutrients & minerals and pollution). Mechanism of penetration- Disease development of pathogen (colonization) and dissemination of pathogens. Role of enzymes and toxins in disease development. Defence mechanism of host – structural and biochemical defences. Important diseases of crop plants in India - Sheath blight of rice, Late blight of potato, Little leaf of Brinjal and Red rust of tea. Principles of disease management – Cultural practices, physical, chemical and biological methods, disease controlled by immunization. Biocontrol - merits and demerits; Plant quarantine and legislation. Integrated Pest Management system. Diagnostic technique to detect pest/pathogen infection - Immunofluorescence (IF).

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

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

Recommended Text:

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

Reference Books:

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

Web resources:

1. https://www.wileyindia.com/a-textbook-of-plant-pathology.html
2. https://www.britannica.com/science/plant-disease.
3. https://www.planetatural.com/pest-problem-solver/plant-disease/
4. https://www.elsevier.com/books/plant-pathology/agrios/978-0-08-047378-9
5. https://www.elsevier.com/life-sciences/immunology-and-microbiology/books

Mapping with Programme Outcomes:

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

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

ELECTIVE-I

CONSERVATION OF NATURAL RESOURCES AND POLICIES

Title of the Course	**CONSERVATION OF NATURAL RESOURCES AND POLICIES**						
Paper Number	**ELECTIVE I**						
Category	**ELECTIVE**	**Year**	**I**	**Credits**	**3**	**Course Code**	
		Semester	**I**				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		3	**2**	**--**	**5**		
Pre-requisite		To create awareness of environmental problems and their consequences					
Learning Objectives		1. Explain the term natural resources.					
		2. Describe the reasons for degradation of natural resources and suggest measures to prevent these.					
		3. List the various endangered species of animals and plants.					
		4. State the various environmental laws passed to conserve the natural resources.					
		5. Explain sustainable development and justify its need; and describe the various conventional as well as non-conventional sources of energy.					
UNIT	**CONTENTS**						
I	**NATURAL RESOURCES:** Definition – Importance – Classification – Human physiological socio-economic and cultural development – Human Population Explosion – Natural Resource Degradation – Concept of conservation – Value system – Equitable resource use for sustainable life system.						
II	**FOREST RESOURCES:** Forest cover in India and the World – Importance – Desertification – Forest Wealth – Afforestation – Vanasamrakshna Samithi– Agroforestry – Social Forestry – Joint Forest Management Strategy for Forest Conservation. **Wild Life:** Resources – Importance – Benefits – Wild life Extinction – Causes for Extinction – List of Endanger species in India and in the World – Ecological approach in wild life management – Eco Tourism – Wild Life projects in India – Sanctuaries and National Parks In India – Man and Bio sphere Programme.						
III	**LAND AND SOIL RESOURCES:** Soil, Complexity of soil nature, regional deposits, Land use and capability classification systems, Land use Planning models and their limitations. Impacts of natural and man-made activities on land characteristics and land use planning– Soil Erosion – Loss of Soil Nutrients – Restoration of Soil Fertility – Soil Conservation Methods and Strategies in India. Wet Land Conservation and Management – Ecological Importance of wet lands in India – Conservation Strategy and ecological Importance. Water Resources: Rivers and Lakes In India – Water Conservation and ground water level increase - Watershed Programme.						

IV	**MINERAL RESOURCES:** Use and exploitation – Environmental effects of extracting and using mineral resources – Restoration of mining lands – Expansion of supplies by substitution and conservation. Food Resources: World Food Problems – Changes caused by agriculture – overgrazing effects of modern agriculture – Fertilizer-Pesticide problems – Water Logging – Salinity – Sustainable agriculture, life stock breeding and farming.
V	**ENVIRONMENTAL POLICY IN INDIA:** Need for policies- Public Policy – Economic policies – Relationship between economic development and environment – Implementing Environmental Public Policy Strategies in pollution control – Constitutional provisions in India regarding environment – Public Awareness and Participation in Environmental Management – National Land Use Policy 1988 – Industrial Policy 1991.

Course outcomes: CO	**On completion of this course the student will be able to**	**Programme outcomes**
CO1	Understand the concept of different natural resources and their utilization.	K1
CO2	Critically analyze the sustainable utilization land, water, forest and energy resources	K2 & K6
CO3	Evaluate the management strategies of different natural resources	K3
CO4	Reflect upon the different national and international efforts in resource management and their conservation.	K4
CO5	State the various environmental policy passed to conserve the natural resources.	K5

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

Recommended Text:

1. Trivedi R.K.1994. Environment and Natural Resources Conservation.
2. Murthy J.V.S.1994. Watershed Management in India.
3. Raymond, F Dasmann. 1984. Environmental Conservation, John Wiley.
4. Nalini, K.S. 1993. Environmental Resources and Management, Anmol Publishers, New Delhi.
5. Shyam Divan and Armin Rosencranz. 2001. Environmental Law and Policy in India, Oxford Uni.Press.

Reference Books:

1. Haue, R and Freed V.H. 1975. Environmental Dynamics of Pesticides, Menum Press, London
2. Singh, B. 1992. Social Forestry for Rural Development, Anmol Publishers, New Delhi.
3. Shafi. R. 1992. Forest Ecosystem of the World.
4. Stacy Keach. 2016. Natural Resources Management. Syrawood Publishing House.
5. Rathor B.S. 2013. Management of Natural Resource for Sustainable Development. Daya Publishing House, New Delhi.

Web resources:

1. https://www.amazon.in/conservation-natural-resources-Gifford-Pinchot-ebook/dp/B07HX76TVN
2. https://books.google.co.in/books/about/Natural_Resource_Conservation_and_Enviro.html?id=T2SRuhxpU
3. https://www.kobo.com/ww/en/ebook/natural-resources-conservation-law
4. https://www.scribd.com/document/354699536/Conservation-of-Natural-Resources

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	M	S	M	S	M	S
CO2	S	S	S	S	M	M	L	S	L	S
CO3	S	S	S	M	M	M	L	S	L	S
CO4	S	S	S	M	M	M	L	S	L	S
CO5	S	S	S	M	M	M	L	S	L	S

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

ELECTIVE-I MUSHROOM CULTIVATION

Title of the Course	**MUSHROOM CULTIVATION**						
Paper Number	**ELECTIVE I**						
Category	**ELECTIVE**	**Year**	**I**	**Credits**	**3**	**Course Code**	
		Semester	**I**				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		3	**2**	**--**	**5**		
Pre-requisite		Basic knowledge on structure and function of various groups of mushrooms.					
Learning Objectives		1. To teach the identification of mushrooms.					
		2. To differentiate the edible mushrooms with toxic and hallucinating fungi.					
		3. To study the cultivation technique of mushrooms					
		4. To learn the economic importance of mushroom in various fields.					
		5. To study how to establish mushroom cultivation as business enterprise.					
		6. To teach the identification of mushrooms.					
UNIT	**CONTENTS**						
I	**INTRODUCTION:** Mushroom, Edible Mushroom, commercial production, medicinal value of mushrooms, nutraceuticals and dietary supplements.						
II	**MORPHOLOGICAL AND MICROSCOPICAL IDENTIFICATION OF EDIBLE AND POISONOUS MUSHROOMS**: Keys for identification of edible mushrooms: *Agaricus bisporus*, *Pleurotus sajorcaju*, *Volvariella volvcea* and *Calocybe indica*. Key for identifying hallucinogenic mushroom (*Psilocybe* sp.) Medicinal Mushroom – *Cordyceps*, *Ganoderma lucidum* and *Lentinus edodes*.poisonous mushroom *Amanita* Sp.						
III	**CULTIVATION:** Substrate sterilization, bed preparation, cropping room and maintenance, raising of pure culture and spawn preparation, factors effecting button mushroom production (Temp, pH, air and water management, competitor moulds and other disease).						
IV	**POST-HARVEST MANAGEMENT:** Harvest, storage, quality assurance of mushrooms. Pestmanagement.						
V	World production edible mushroom, Legal and regulatory issues of introducing the medicinal mushrooms in different countries. Developing small scale industry and Government schemes. Mushroom Research Centres – International and National levels.						

Course Outcomes: CO	On completion of this course the student will be able to	Programme outcomes
CO1	Knowledge on identification of edible and toxic mushrooms belonging toAscomycota and Basidiomycota.	K1, K3
CO2	Outline the nutraceutical properties of edible mushrooms.	K2, K4
CO3	Knowledge on cultivation techniques of edible and medicinal mushrooms.	K3, K6
CO4	Understand the harvest and post-harvest techniques of mushroom crops.	K4
CO5	Knowledge on the production and marketing strategies for mushrooms.	K5

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

Recommended Text:

1. Cheung, P. C.K. 2008. Mushrooms as functional food. A John Wiley & Sons, Inc., Publication.
2. Dijksterhuis, J. and Samson, R.A. 2007. Food Mycology: A multifaceted approach in fungiand food.
   CRC press, Newyork.
3. Hall., R.I., Stepheson, S.L., Buchanan, P.K., Yun, W. and Cole, A.L.J. 2003. Edible andpoisonous mushrooms of the world. Timber Press, Portland, Cambridge.
4. Ting, S. and Miles, P.G. 2004. Mushrooms: Cultivation, nutritional value, medicinal effectand
   nutritional environmental impact. CRC press, Newyork.
5. Verma, 2013. Mushroom: edible and medicinal: cultivation conservation, strain improvement with their marketing. Daya Publishing House.

Reference books:

1. Tiwari., SC., Pandey K. 2018. Mushroom cultivation. Mittal publisher, New Delhi.
2. Philips, G., Miles, Chang, S-T. 2004. Mushrooms: Cultivation, nutritional value, medicinaleffect and environmental effect. 2nd ed. CRC Press.
3. Diego, C.Z., Pando-Gimenez, A. 2017. Edible and medicinal mushrooms: Technology andApplication. Wiley-Blackwell publishers.
4. Nita Bahl. 2002. Handbook on Mushroom 4th edition Vijayprimlani for oxford & IBH publishing co.,

   Pvt., Ltd., New Delhi. Dr.C. Sebastian Rajesekaran Reader in Botany Bishop Heber

College, Trichy – 17.

5. Suman. 2005. Mushroom Cultivation Processing and Uses, M/s. IBD Publishers and Distributors, New Delhi.

Web resources:

1. https://www.amazon.in/Mushroom-Cultivation-India-B-C/dp/817035479X
2. http://nrcmushroom.org/book-cultivation-merged.pdf
3. http://agricoop.nic.in/sites/default/files/ICAR_8.pdf
4. http://www.agrimoon.com/mushroom-culture-horticulture-icar-pdf-book/

5.https://books.google.co.in/books/about/Mushroom_Cultivation_in_India.html?id=6AJx99OGTKEC&redir_esc=y

Mapping with Programme Outcomes:

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

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

ELECTIVE I- PHYTOPHARMACOGNOSY

Title of the Course	**PHYTOPHARMACOGNOSY**						
Paper Number	**ELECTIVE I**						
Category	**ELECTIVE**	**Year**	I	**Credits**	3	**Course Code**	
		Semester	I				
Instructional Hours per week		**Lecture**		**Tutorial**	**Lab Practice**	**Total**	
		3		2	--	5	
Pre-requisite	Students should aware of traditional use of plant derived drugs in world.						
Learning Objectives	1. To learn the traditional knowledge on plant derived drugs and their conventional classification.						
	2. To elucidate the biosynthetic pathway of major classes of secondary metabolites.						
	3. To study the general pharmacological mode of action of crude drugs of few medicinal plants.						
	4. To elucidate the isolation and characterization of plant derived drugs using modern biotechniques.						
	5. Knowledge on pharmacological action of drugs.						
	6. To learn the traditional knowledge on plant derived drugs and their conventional classification.						

UNIT	CONTENTS
I	General introduction – History and scope of Pharmacognosy including indigenous system of medicine. Various systems of classification of drugs. Pharmacological action of plant drugs. Significance of Pharmacopoeial standards.
II	MORPHOLOGICAL AND MICROSCOPICAL Biosynthetic pathway of secondary metabolites: Acetate pathway (fatty acids and polyketides), mevalonate and deoxyxylulose phosphate pathway (terpenoids and steroids), shikimate pathway (phenols, amino acids etc.).
III	Characterization of Therapeutic drugs: Extraction, separation, isolation (Chromatographic techniques) and characterization of secondary metabolites (Spectroscopic techniques). Quality control of plant drugs: Classical and modern approaches of drugs. Significance of Pharmacopoeial standards.
IV	Pharmacological action of Plant Drugs: Anti-cancer, Bitter tonic, Carminatives and G.I. regulators, Cardiotonics, CNS-Stimulatant, Expectorant, Laxatives, Puragatives. Outline ofpharmacogenomics functions.
V	Hallucinogenic, allergenic and other toxic plants, poisonous plants - biopesticides -biocides – biofungicides.

Course outcomes	On completion of this course the student will be able to	Programme outcomes
CO1	Review on the traditional knowledge and classification of plant derived drugs.	K1
CO2	Knowledge on biosynthetic pathway of different classes of plant metabolites.	K2
CO3	Knowledge on modern instrumentation on characterization of plant metabolites.	K3,K6
CO4	Discuss various aspects of Pharmacological action of herbal drugs.	K4 & K5
CO5	Understanding medical and non-medical potential of plant derived in various sectors.	K6

Recommended Text:

1. Dewick P.M., 2002. Medicinal Natural Products: A biosynthetic approach, John Wiley &Sons Ltd.
2. Evans W.C., 2002, Trease and Evan's Pharmacognosy, W.B. Saunders.
3. Harborne, J.B., 1998. Phytochemical Methods, Chapman and Hall.
4. Harborne, J.B., 1998. Phytochemical Methods, Chapman and Hall.
5. Vickery M.L. and B. Vickery, 1981. Secondary Plant Metabolism, The MacMillan PressLtd.

Reference books:

1. Bruneton, J. 1999. Pharmacognosy, Phytochemistry, Medicinal Plants, Intercept Ltd., Paris.
2. Evans W.C. 2002, Trease and Evan's Pharmacognosy, W.B. Saunders.
3. Harborne, J.B. 1998. Phytochemical Methods, Chapman and Hall.
4. Vickery M.L and B. Vickery, 1981. Secondary Plant Metabolism, The MacMillan Press Ltd.
5. Wagner H., S. Bladt and E.M. Zgainski (Translated by A. Scott) 1984, Plant Drug Analysis,Springer-Verlag.

Web resources:

1. https://pharmabookbank.files.wordpress.com/2019/03/14.2.pharmacognosy-by-biren-shahavinash-seth-1.pdf
2. https://www.pdfdrive.com/pharmacognosy-books.html
3. https://www.amazon.in/Textbook-Pharmacognosy-Phytochemistry-Kumar-Jayaveera-ebook/dp/B06XKSY76H
4. https://www.amazon.in/Pharmacognosy-Dr-C-K-Kokate-ebook/dp/B07JHNNMWB
5. https://www.amazon.in/EXPERIMENTAL-PHYTOPHARMACOGNOSY-Comprehensive-Guide-Khadabadi-ebook/dp/B07ZFMYQK8

Mapping with Programme Outcomes:

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

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

ELECTIVE-II

ALGAL TECHNOLOGY

Title of the Course	**ALGAL TECHNOLOGY**						
Paper Number	**ELECTIVE II**						
Category	**ELECTIVE**	**Year**	**I**	**Credits**	**3**	**Course Code**	
		Semester	**I**				
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**		**Total**
		3	**2**		**--**		**5**
Pre-requisite		Students should be familiar with the basic and applied knowledge on algal biotechnology.					
Learning Objectives		1. To provide a basic overview of algae cultivation techniques and resource potentials.					
		2. To educate people about the widespread commercial uses of algae.					
		3. To educate people about the therapeutic uses of algae.					
		4. To enrich the current knowledge of how algae are used in basic research andtechnological applications.					
		5. To spread awareness of the value of algae biotechnology and its applications in diverse industries.					

UNIT	CONTENTS
I	**SCOPE OF ALGAL TECHNOLOGY** Scope of algal technology – Commercial potential and utility of algae. Algae as sources for food, feed, pigments, Pharmaceuticals and neutraceuticals, fine chemicals, fuel, biofertilizers and hormones. Economic importance of algae in India.
II	**ALGAL PRODUCTS** Industrial application of algae - fuel, algal lipids - transesterification to ester fuel - substitutes for petroleum derived fuel. Algal products - Spirulina mass cultivation and its applications. Mass cultivation of micro-algae as source of protein and as feed. Liquid seaweed fertilizers - method of preparation, applications and its advantages over inorganic fertilizers.
III	**ALGAL PRODUCTION AND UTILIZATION** Algal production systems; Strain selection; Algal growth curve; Culture media; cultivation methods – small scale and Large-scale cultivation of algae. Harvesting and packing. Therapeutic uses - antioxidant, anti-ulcerogenic, antifungal, antibiotics, antitumor and antiviral compounds. Production of pigments and their utilization.
IV	**IMMOBILIZATION AND RDNA TECHNOLOGY IN ALGAE** Algal immobilization and its applications - culturing for metabolite production and natural compounds. Methods of immobilization - alginate beads-extraction of compounds. Recombinant DNA technology in algae - Transformation systems in algae. Isolation of protoplasts, regeneration of fusion of macro algae. Role of algae in nanobiotechnology.

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

Course Outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Understand the applied facet of botany and acquire a complete knowledge about the cultivation methods in algae.	K1& K3
CO2	Realization of the commercial potential of algal products.	K5
CO3	Analyze emerging areas of algal biotechnology for identifying therapeutic importance of algal products and their uses.	K2 & K4
CO4	Gain more information about algae genetics.	K4
CO5	Translate various algal technologies for the benefit of the ecosystem.	K3 & K6

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

Recommended Text:

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

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2. Suganya, T and Renganathan, S. 2015. Biodiesel production using algal technology. Academic Press. ISBN: 0128009713.
3. Bajpai, Rakesh K., Prokop, Ales, Zappi, Mark E. 2014. Algal Biorefineries Volume 1:

Cultivation of Cells and Products. Springer. ISBN: 9400774931.
4. Hojnacka, K., Wieczorek, P.P., Schroeder, G., Michalak, I. (Eds.). 2018. Algae Biomass: Characteristics and Applications. Developments in Applied Phycology.
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9. Borowitzka, M.A. and borowizka, L.J. 1996. Microalgal Biotechnology. Cambridge University Press, Cambridge,
10. Bast, F. 2014. Seaweeds: Ancestors of land plants with rich diversity. Resonance, 19(2) 1032-1043 *ISSN*: 0971-8044.
11. Faizal, Band Yusuf, C. 2016.Algal biotechnology: Products and processes. Springer.
12. Gouveia, L. 2011. Microalgae as a feedstock for biofuels. Springer Briefs in Microbiology, London.

Web resources:

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

Mapping with Programme Outcomes:

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

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

ELECTIVE-II

ETHNOBOTANY, NATUROPATHY AND TRADITIONAL HEALTHCARE

Title of the Course		**ETHNOBOTANY, NATUROPATHY AND TRADITIONALHEALTHCARE**					
Paper Number		**ELECTIVE II**					
Category	ELECTIVE	**Year**	I	**Credits**	3	**Course Code**	
		Semester	I				
Instructional Hours per week		**Lecture**		**Tutorial**	**Lab Practice**		**Total**
		3		2	--		5
Pre-requisite		The training imparts the knowledge and abilities required to conduct field studies on how humans use plants.					
Learning Objectives		1. Understand the concept of ethnobotany and the life style and traditional practices of plants by Indian tribals.					
		2. Emphasize the importance of non-timber forest products for Indian tribal people livelihoods.					
		3. Evaluate the various research techniques to gather tribal knowledge of ethnobotany.					
		4. Use strategies to turn ethno botanical knowledge into goods with value additions.					
		5. To save and document ethno botanicals in order to use plant resources sustainably.					

UNIT	CONTENTS
I	**ETHNOBOTANY:** Concepts, important landmarks in the development, scope, sub disciplines of ethnobotany. Interdisciplinary approaches. Knowledge of following sociological and anthropological terms: culture, values and norms, institutions, culture diffusion and ethnocentrism. History of ethnobotany: A brief history of ethno botanical studies in the world and in India.
II	**PLANTS USED BY TRIBALS OF INDIA:** Distribution of tribes in India. Basic knowledge of following tribes of Tamil Nadu: Irulas, Kanis, Paliyars Badagas, Kurumbres, Thodas and Malayalis. Plants used by tribals of Tamil Nadu.
III	**SOURCES OF ETHNOBOTANICAL DATA:** Primary - archeological sources and inventories, Secondary - travelogues, folklore and literary sources, herbaria, medicinal texts and official records. Methods in ethnobotanical research. Prior Informed Consent, PRA techniques, interviews and questionnaire methods, choice of resource persons. Folk taxonomy – plants associated with culture and socio- religious activities. Non – timber forest products (NTFP) and livelihood – Sustainable harvest and value addition.
	NATUROPATHIC MEDICINE: Role of plants in naturopathy- Importance and relevance of medicinal drugs in India. Indian Systems of Medicine (Ayurveda, Siddha, Allopathy, Homeopathy, Unani,

IV	Tibetan, Yoga and Naturopathy). Disease diagnosis, treatment, and cure using natural therapies including dietetics, botanical medicine, homeopathy, fasting, exercise, lifestyle counseling, detoxification, and chelation, clinical nutrition, hydrotherapy, naturopathic manipulation, spiritual healing, environmental assessment, **TRADITIONAL HEALTH CARE:** Health practices, approaches, knowledge and beliefs incorporating plant, animal and mineral based medicines, spiritual therapies, manual techniques and exercises, applied singularly or in combination to treat, diagnose and prevent illnesses or maintain well-being.
V	**BIOPROSPECTING AND VALUE ADDITION:** Bioprospecting of drug molecules derived from Indian traditional plants; Methods for bioprospecting of natural resources; From folk Taxonomy to species confirmation - evidences based on phylogenetic and metabolomic analyses; Ethno botanical databases and Traditional Knowledge Digital Library (TKDL).

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Recall or remember concept of ethnobotany.	K1
CO2	Understand the life style and traditional practices of plants by Indian tribals.	K2 & K6
CO3	Highlight the role of Non-Timber Forest products for livelihood of tribal people of India	K3
CO4	Assess the methods to transform ethnobotanical knowledge into value added products.	K4
CO5	Build idea to make digitization of ethnobotanical knowledge.	K5

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

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

Recommended Text:

1. Subramaniam, S.V and V.R. Madhavan (Eds,). 1983. Heritage of the Tamil Siddha Medicine. International Institute of Tamil Studies. Madras.
2. Jain, A. and Jain, S.K. 2016. Indian Ethno botany - Bibliography of 21st Century Scientific Publishers (India).
3. Gokhale, S.B., Kokate, C.K and Gokhale, A. 2016. Pharmacognosy of Traditional Drugs. 1st ed. NiraliPrakashan, Pune.
4. Gringauz. 2012. Introduction to Medicinal Chemistry: How Drugs Act & Why? Wiley India Pvt Ltd. Noida.
5. Joshi, S.G. 2018. Medicinal Plants. Oxford & IBH Publishing C., Pvt., Ltd., New Delhi.

Reference Books:

1. CSIR. 1940-1976. Wealth of India. A Dictionary of Raw Materials and Industrial Products - Raw Materials. Vol.1-11. CSIR Publication & Information Directorate. New Delhi.
2. Gokhale, S.B., Kokate, C.K and Gokhale, A. 2016. Pharmacognosy of Traditional Drugs. 1st ed. Nirali Prakashan, Pune.
3. Laird, S.A. 2002. Biodiversity and Traditional knowledge equitable partnerships in Practice. Earthscan Publications Ltd., London.
4. Ministry of Environment and Forests. 1994. Ethno biology in India. A Status Report. All India Coordinated Research Project on Ethno biology. Ministry of Environment and Forests. New Delhi.
5. Kumar, N. 2018. A Textbook of Pharmacognosy. Aitbs Publishers, India.
6. Premendra Singh. 2013. Medicinal Plants: Conservation, Cultivation and Utilization. Daya Publishing House, New Delhi.
7. Albuquerque, U.P., Ramos, M.A., Júnior, W.S.F., and De Medeiros, P.M. 2017. Ethnobotany.

Web resources:

1. file:///C:/Users/HP/Downloads/8-Vol.-5-Issue-3-March-2014-IJPSR-1178-A-Paper-81.pdf 2
2. http://www.plantsjournal.com/archives/2017/vol5issue3/PartB/5-3-8-217.pdf 3
3. https://shodhganga.inflibnet.ac.in/bitstream/10603/116454/7/07_chapter%201.pdf 4
4. https://www.cell.com/action/showPdf?pii=S1360-1385%2817%2930001-8 5
5. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3465383/pdf/pnas.201202242.pdf 6
6. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4151377/pdf/1746-4269-10-48.pdf 7 Jain, S. K. 1994. http://www.worldcat.org/identities/lccn-n85-4353/
7. http://www.frlht.org/

Mapping with Programme Outcomes:

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

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

ELECTIVE-II

HORTICULTURE

Title of the Course	**HORTICULTURE**						
Paper Number	**ELECTIVE II**						
Category	**ELECTIVE**	**Year**	I	**Credits**	3	**Course Code**	
		Semester	I				
Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**			
	3	2	--	5			
Pre-requisite	Students should know fundamental knowledge on horticulture applications.						
Learning Objectives	1. Know about the brief history, divisions, classification and structure of horticultural plants.						
	2. Acquire knowledge on plant growth processes and stages of plant growth.						
	3. Understand the plant growth environment in relation to soil, nutrients, fertilizers, and bio inoculants.						
	4. Study the sexual and vegetative propagation methods including propagation through specialized vegetative structures.						
	5. Develop practical skills in micro propagation techniques and soil-less production of horticultural crops.						

UNIT	CONTENTS
I	**INTRODUCTION TO HORTICULTURE** Definition: Brief History, Divisions of Horticulture, Classification of horticultural plants, Structure of Horticultural Plants –Cell and Tissue systems, Anatomy of stem root and leaf, Morphological structures, Plant growth processes- A brief account of Photosynthesis, Respiration, Transpiration and Translocation, Stages of plant growth.
II	**FACTORS AFFECTING PLANT GROWTH** Plant Growth Environment: Abiotic factors, Soil –Profile structure, Primary and Secondary nutrients and their functions, Organic matter, Fertilizers –organic, Inorganic and Potting Media, Bio inoculants, Methods of fertilizer application, Directing Plant growth-Training -Pruning and thinning.
III	**PLANT PROPAGATION** Plant propagation: Seeds –Advantages, Viability, Mechanism of Dormancy and Dormancy Breaking: Methods of Direct and Indirect Seedling Production in Nurseries and Transplantation; Propagation through specialized underground structures –Corm, Tuber, Sucker, Bulb, Bulbil, Rhizome; Vegetative Propagation – Cutting, Layering, Grafting and Budding.
IV	**MICROPROPAGATION TECHNIQUES** Stages, multiplication by shoot tip, Nodal culture and Callus culture-Application and Limitations, Somatic embryogenesis, Synthetic seeds –Preparation and Potential

	uses of artificial seeds, Embryo Rescue, Soil-less Production of Horticultural crops –Hydroponics, sand culture, gravel culture.
V	**AESTHETICS OF HORTICULTURE** Design: Elements and Principles of Design, Flower Arrangement, Terrarium Culture, Bonsai, Growing Plants Indoors, Turf Production, Landscaping-Principles, Types of Parks, Xeriscaping. Postharvest handling of Horticultural Products – Harvesting, Storage, Processing, Elements of Marketing. Robotics in Horticulture.

Course outcomes:	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Identify and categorize various horticultural plants and the conditions that affect their growth and productivity.	K1
CO2	Explain the various structures and growth processes of horticultural plants.	K2
CO3	Demonstrate the propagation, growth, and maintenance of plants in horticulture systems.	K3
CO4	Correlate the soil characteristics and fertility to good plant growth.	K4
CO5	Utilize the role plant tissue culture techniques in the production of quality planting stock in horticulture.	K5
CO6	Apply horticultural skills and knowledge to explore career opportunities in horticulture industry.	K6

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

Recommended Text:

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

Reference Books:

1. Acquaah, G. 2002. Horticulture Principles and Practices. 2nd ed. Pearson Education (Singapore) Pvt. Ltd.
2. Ashman, M.A. and Puri, G. 2002. Essential soil science-A clear and concise

introduction to soil science. Blackwell scientific publishers, London.
3. Denisen, E.L. 1979. Principles of Horticulture. MacMillan Publishing co, Inc. New York.
4. Dirr, M. and Heuser, C.W. 2009. The Reference Manual of Woody Plant Propagation: From Seed to Tissue Culture. Timber Press, Oregon, USA.
5. Thomson, L.M. and Troen, F.R. 1975. Soils and soil fertility Tata, McGraw Hill Publication Co. Ltd. New Delhi.
6. Tolanus, S. 2006. Soil fertility, Fertilizer and Integrated Nutrient management. CBS Publication, Delhi, India.

Web resources:

1. https://www.kobo.com/in/en/ebooks/horticulture
2. https://www.gale.com/gardening-and-horticulture
3. https://www.iaritoppers.com/p/horticulture-icar-ecourse-pdf-books.html
4. https://www.researchgate.net/publication/316438576_Polyembryony_in_Horticulture_and_ its_significance

Mapping with Programme Outcomes:

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

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

ELECTIVE-II HERBAL TE4CHNOLOGY

Title of the Course		**HERBAL TECHNOLOGY**					
Paper Number		**ELECTIVE II**					
Category	**ELECTIVE**	**Year**	I	**Credits**	3	**Course Code**	
		Semester	I				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		3	2	--	5		
Pre-requisite		To understand the importance of herbal technology.					
Learning Objectives		1. To understand various plants based drugs used inayurvedha, unani, homeopathy, siddha etc.					
		2. To apply the knowledge to cultivate medical plants.					
		3. To know the pharmacological importance of medicinal plants.					
		4. To enlist phytochemicals and secondary metabolites of market and commercial value.					
		5. To design and develop their own business prepositions such as theo in the making of herbal insecticides.					

UNIT	CONTENTS
I	**PHARMACOGNOSY** Pharmacognosy scope and importance - source - Crude Drugs – Scope and Importance, Classification (Taxonomical, Morphological Chemical, Pharmacological); Cultivation, Collection and processing of crude drugs. Cultivation and utilization of medicinal and aromatic plants in India.
II	**PLANT TISSUE CULTURE AS SOURCE OF MEDICINES** Plant tissue culture as source of medicines, Role of plant tissue culture in enhancing secondary metabolite production (*Withania somnifera, Rauwolfia serpentina, Catheranthus roseus, Andrographis paniculata* and *Dioscorea sp*) - Elicitation - Biotransformation, Hairy root culture. Factors affecting secondary metabolites production. Biogenesis of phytopharmaceuticals.
III	**PLANT PROPAGATION** **ANALYSIS OF PHYTOCHEMICALS** Methods of Drug evaluation (Morphological, microscopic, physical and chemical). Phytochemical investigations – standardization and quality control of herbal drugs. Preliminary screening, Assay of Drugs - Biological evaluation/assays, Microbiological methods - Chemical Methods of Analysis, Detection of Adulterants: Chemical estimations, Spectrophotometry and fluorescence analysis. Drug adulteration - Types of adulterants.
IV	**GENERAL METHODS OF PHYTOCHEMICAL AND BIOLOGICAL SCREENING** Carbohydrates and derived products: Glycosides - extraction methods (*Digitalis, Dioscorea*); Tannins (Hydrolysable and Condensed types); Volatile oils - extraction methods (Clove, Mentha). Study of some herbal formulation techniques as drug cosmetics.

V	**TYPES OF PHYTOCHEMICALS** Alkaloids - extraction methods (*Taxus, Cinchona*); Flavonoids- extraction methods, Resins- extraction method: Application of phytochemicals in phytopharmacueticals; Biocides, Biofungicides, Biopesticides. Women entrepreneurship development – marketing cultivated medicinal plants – National Medicinal Plants Board of India.

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Recollect the importance of herbal technology.	K1
CO2	Understand the classification of crude drugs from various botanical sources.	K2
CO3	Analyze on the application of secondary metabolites in modern medicine.	K3
CO4	Create new drug formulations using therapeutically valuable phytochemical compounds for the healthy life of society.	K4
CO5	Comprehend the current trade status and role of medicinal plants in socio economic growth.	K5 & K6

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

Recommended Text:

1. Kokate, C.K., Purohit, A.P and S.B. Gokhale. 1996. Pharmacognosy. NiraliPrakashan, 4th Ed.
2. Roseline, A. 2011. Pharmacognosy. MJP publishers, Chennai.
3. Tilgner, Sharol Marie. 2018. Herbal ABC's: The Foundation of Herbal Medicine.
4. Natural Products in medicine: A Biosynthetic approach. 1997. Wiley. Hornok, L. (Ed.).
5. Chichister, U.K.J. 1999. Cultivation and Processing of Medicinal Plants, Wiley & Sons. Treaseand Evans.
6. Mukherjee, P.K. 2008. Quality control of herbal drugs. 3rd edition. Business Horizons Pharmaceutical Publishers, New Delhi, India.
7. Kirthikar and Basu. 2012. Indian Medicinal Plants. University Bookstore, Delhi. India
8. Biswas, P.K. 2006. Encyclopedia of Medicinal plants (Vol. I-VII). Dominant Publishers, New Delhi.
9. Chaudhuri, A.B. 2007. Endangered Medicinal Plants. Daya Publishing House, New Delhi.
10. Tilgner, Sharol Marie. 2018. Herbal ABC's: The Foundation of Herbal Medicine.

Reference Books:

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

Web resources:

1. https://www.kopykitab.com/Herbal-Science
2. https://kadampa.org/books/free-ebook-download-howtotyl?gclid=CjwKCAiA6vXwBRBKEiwAYE7iS5t8yenurClUCTdV9olKo9TbyAh4fsoFqPYWGs5qBTbytD22z7lo0BoCYnUQAvD_BwE
3. https://www.barnesandnoble.com/b/free-ebooks/nook-books/alternative-medicine-natural-healing/herbal-medicine/_/N-ry0Z8qaZ11iu
4. http://cms.herbalgram.org/heg/volume8/07July/HerbalEBooks.html?t=1310004932&ts= 1579066352&signature=1dd0d5aef818b19bcdcd6c063a78e404
5. https://www.dattanibookagency.com/books-herbs-science.html
6. https://www.springer.com/gp/book/9783540791157

Mapping with Programme Outcomes:

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

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

SKILL ENHANCEMENT (SE1)

NURSERY AND GARDENING

Title of the Course	**NURSERY AND GARDENING**						
Paper Number	**SKILL ENHANCEMENT**						
Category	**Skill Enhancement**	**Year**	**I**				
		Semester	**I**	**Credits**	**2**	**CourseCode**	
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		2	**1**	**--**	**3**		
Pre-requisite	Students should know nursery and gardening practices.						
Learning Objectives	1. To recognize the importance of nursery and gardening						
	2. To gain an understanding of nursery management.						
	3. To develop skills necessary to manage a wholesale nursery.						
	4. To acquire knowledge regarding theory and practice of rising plants.						
	5. To develop an interest to become an entrepreneur.						

UNIT	CONTENTS
I	**NURSERY:** Definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants.
II	**SEED:** Structure and types - Seed dormancy; causes and methods of breaking dormancy - Seed storage: Seed banks, factors affecting seed viability, genetic erosion - Seed production technology - seed testing and certification.
III	**VEGETATIVE PROPAGATION:** Air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings - Hardening of plants - green house - mist chamber, shed root, shade house and glasshouse.
IV	**GARDENING:** definition, objectives and scope - different types of gardening - landscape and home gardening - parks and its components - plant materials and design - computer applications in landscaping.
V	**GARDENING OPERATIONS:** Soil laying, manuring, watering, management of pests and diseases and harvesting. Sowing/raising of seeds and seedlings: Transplanting of seedlings - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes, and carrots - Storage and marketing procedures.

Course outcomes: CO	On completion of this course, the students will be able to:	Programme outcomes
CO1	Recognize the basic process required for growing and maintaining plants in nurseries.	K1
CO2	Explain the different methods of plant propagation and various gardening styles.	K2
CO3	Apply techniques for effective hardening of plants and computer applications for creative gardening.	K3 & K6
CO4	Compare and contrast cultivation of different vegetables and growth of plants in nursery and gardening.	K4
CO5	Develop new strategies to enhance growth and quality of nursery plants.	K5 & K6

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

Recommended Text:

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

Reference Books:

1. N.L. Patel, S.L. Chawla, T.R. Ahlawat: Commercial Horticulture‖, 2016, ASPEE College of Horticulture, Navsari Agricultural University, Navsari 396 450, Gujarat,
2. Prasad S & Kumar U. 2005. Greenhouse Management for Horticultural Crops. 2nd Ed. Agrobios.
3. George Acquaah, 2002, Horticulture-principles and practices. Prentice-Half of India pvt. Ltd., New Delhi.
4. Abraham, A and Vatsala, P. 1981. Introduction to Orchids. Trop. Bot. Garden, Trivandrum.
5. Hartman, H.T and Kester, D.E. 1989. Plant propagation. Printice Hall Ltd., New Delhi.

Web resources:
1. https://www.kopykitab.com/Nursery-And-Gardening-SEC-by-Prof-C-D-Patil-Dr-G-M-Rane-Dr-S-A-Patil 2. https://www.wonderslate.com/nursery-and-gardening-management/ebook-details?siteName=books&bookId=38078&preview=true 3. https://books.google.co.in/books/about/Nursery_Hindi_Book_Bonsai_Plants_Nursery.html?id=-nfDDwAAQBAJ&redir_esc=y 4. https://www.amazon.in/Gardening-Books/b?ie=UTF8&node=1318122031 5 . https://www.worldcat.org/title/handbook-of-horticulture/oclc/688653648

Mapping with Programme Outcomes:

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

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

CORE-IV TAXONOMY OF ANGIOSPERMS AND ECONOMIC BOTANY

Title of the Course	**PLANT TAXONOMY OF ANGIOSPERMS AND ECONOMIC BOTANY**						
Paper Number	**CORE IV**						
Category	**Core**	**Year**	I	**Credits**	4	**Course Code**	
		Semester	II				

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

Pre-requisite	Prior knowledge on morphological, anatomical characteristics and uses of plants.
Learning Objectives	1. To be familiar with the basic concepts and principles of plant systematics.
	2. To develop a suitable method for correct characterization and identification of plants.
	3. To understand the importance of taxonomic relationships in research of plant systematics.
	4. To provide information on various classification systems
	5. To know about the economic importance of plants.

UNIT	**CONTENTS**
I	**TAXONOMY AND SYSTEMATICS** Botanical exploration and contribution with special reference to India by William Roxburgh, J.D. Hooker, Robert Wright, Nathanial Wallich and Gamble, J.S. Principles of classification as proposed – Artificial – Linnaeus, Natural – Bentham and Hooker, Phylogenetic system - Hutchinson, Modern – Takhtajan. Botanical gardens and herbaria of world, preparation and maintenance of Herbarium, Botanical survey of India – its organization and role.
II	**MODERN TRENDS IN TAXONOMY** Modern trends in taxonomy, chemotaxonomy, numerical taxonomy, biosystemics. ICBN uninominal systems- genesis binomial nomenclature, importance and principle. Important articles, typification, principles of priority, effective and valid publication, author citation, recommendations and amendents of code. Glossories and dictionaries, Taxonomic literature (Index Kewensis)
III	**SYSTEMATIC ANALYSIS OF PLANTS-I** Polypetalae – Nympheaceae, Sterculiaceae, Portulaceae, Rhamnaceae, Vitaceae, Sapindaceae, Combretaceae, Turneraceae.
IV	**SYSTEMATIC ANALYSIS OF PLANTS-II** Gamopetalae – Sapotaceae, Oleaceae, Boraginaceae, Scrophulariaceae, Bignoniaceae, Convolvulaceae, Acanthaceae, Verbenaceae. Monochlamydeae – Nyctaginaceae, Aristolochiaceae, Casuarinaceae. Monocots – Orchidaceae, Amarylidaceae, Lilliaceae, Commelinaceae, Cyperaceae.

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

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

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

Recommended Text:

1. Pandey, B.P. 2013. Taxonomy of Angiosperms, S. Chand Publishing, New Delhi.
2. Sharma, O.P. 2017. Plant Taxonomy. (II Edition).The McGraw Hill Companies.
3. Singh, G. 2007. Plant systematics theory and practices. Oxford and IBH Publishing Co.
4. Jain, S.K and Rao R.R. 1993. A handbook of field and herbarium methods. Today and Tomorrow Publ.
5. Pandurangan, A.G., Vrinda, K.B and Mathew Dan. 2013. Frontiers in plant taxonomy. JNTBGRI, Thiruvananthapuram, Kerala.
6. Vardhana, R. 2009. Economic Botany. 1st ed. Sarup Book Publishers Pvt Ltd. New Delhi.
7. Subramaniam, N.S. 1997. Modern plant taxonomy. Vikas Publishing House, New Delhi.

Reference Books:

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

Web resources:

1.https://www.ipni.org/
2.http://www.theplantlist.org/
3.https://www.amazon.in/PLANT-TAXONOMY-Sharma/dp/0070141592
5.https://www.tropicos.org/home
6.http://apps.kew.org/herbcat/gotoHerbariumGrowthPage.do
7.https://www.absbooksindia.com/shop/science/botany/textbook-of-economic-botany

Mapping with Programme Outcomes:

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

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

CORE-V PLANT ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS

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

UNIT	CONTENTS
I	**CELL WALL:** Morphological and physico-chemical changes; Plasmodesmata- types of pits – growth of cell wall – formation of intercellular spaces; Meristems: Classifications: Theories of shoot and root apices, Cytological zonation in shoot apex. Vascular Cambium: Composition and organization – multiplicative and additive divisions. Xylem: Primary and secondary xylem – tracheary elements and vessels – vesselless dicots – xylem rays and axial parenchyma of angiosperm wood; Dendrochronology – grain, texture and figure in wood; reaction wood; ring porous and diffuse porous wood. Phloem: Ultra structure and ontogeny of sieve tube elements and companion cell. Evolution of tracheary elements.
II	**PERIDERM:** Structure, organization and activity of phellogen. Polyderm and Rhytiderm – wound periderm. Normal secondary thickening in Dicots; Anomalous secondary growth in Dicots (Amaranthaceae, Aristolochiaceae, Bignoniaceae, Piperaceae, Nyctaginaceae) and arborescent Monocots. Primary thickening in palms; Ontogeny of leaf, Structure and types of Stomata; Leaf abscission; Major nodal types; Kranz anatomy and its significance. Microtechnique: Principle of killing and fixation, dehydration and rehydration of botanical specimens. Stains: Principle of double staining (fast-green and light green) of free hand sections; Protocol for serial sectioning of paraffin wax impregnated specimens; Mounting and mounting media.

III	**MICROSPORANGIUM AND MALE GAMETOPHYTE:** Structure and development of Anther; Ultrastructure and physiology of anther tapetum; Male gametophyte; Palynology: Morphology and ultrastructure of pollen wall, pollen kitt, pollen analysis, pollen storage, pollen sterility and pollen physiology.
IV	**MEGASPORANGIUM AND FEMALE GAMETOPHYTE:** Structure and development of Megasporangium; Types of ovules, Endothelium, obturator and nucellus. Megasporogenesis: Female gametophyte: Structure, types, haustorialbehavior and Nutrition of embryo sacs. Fertilization: Double fertilization and triple fusion; Endosperm: Development of endosperm, types, physiological efficiency of endosperm haustoria and functions; Ruminate endosperm. Embryogeny: Development of monocot (Grass) and dicot (Crucifer) embryos.
V	**POLYEMBRYONY:** Causes of Polyembryony, classification, induction and practical application. Apomixis and its significance. Seed and Fruit development and role of growth substances. Parthenocarpy and its importance.

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Learn the structures, functions and roles of apical *vs* lateral meristems in monocot and dicot plant growth.	K1& K2
CO2	Study the function and organization of woody stems derived from secondary growth in dicot and monocot plants.	K1&K4
CO3	Apply their idea on sectioning and dissection of plants to demonstrate various stages of plant development.	K2& K6
CO4	Understand the various concepts of plant development and reproduction.	K3& K6
CO5	Profitably manipulate the process of reproduction in plants with a professional and entrepreneurial mindset.	K5

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

Recommended Text:

1. Bhojwani, S.S. Bhatnagar, S.P and Dantu, P.K. 2015. The Embryology of Angiosperms (6th revised and enlarged edition). Vikas Publishing House, New Delhi.
2. Maheshwari, P. 1963. Recent Advances in Embryology of Angiosperms. Intl. Soc. Plant Morphologists, New Delhi.
3. Sharma, P.C. 2017. Text Book of Plant Anatomy. Arjun Publishing House, New Delhi.
4. Pandey.S.N and Ajanta Chandha. 2006. Plant Anatomy and Embryology. Vikas Publishinf House Pvt. Ltd, New Delhi.
5. Narayanaswamy, S. 1994. Plant Cell and Tissue Culture. Tata McGraw Hill Ltd. New Delhi.

Reference Books:

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

Web resources:

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

Mapping with Programme Outcomes:

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

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

CORE-VI ECOLOGY, PHYTOGEOGRAPHY, CONSERVATION BIOLOGY & INTELLECTUAL PROPERTY RIGHTS

Title of the Course	**ECOLOGY, PHYTOGEOGRAPHY, CONSERVATION BIOLOGY & INTELLECTUAL PROPERTY RIGHTS**						
Paper Number	**CORE VI**						
Category	**Core**	**Year**	I	**Credits**	4	**Course Code**	
		Semester	II				

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

Pre-requisite	Understanding the environmental factors impacting biodiversity is crucial after taking this course and Basic understanding of how laws are structured and interpreted.
Learning Objectives	1.To analyze and comprehend the fundamental ideas of plant ecology as a scientific study of environment.
	2.To study the plant communities and plant succession stages.
	3.To be aware of the causes, impacts and control measures of pollution.
	4.To study biodiversity management and conservation.
	5.To enhance the knowledge of the students and equip them in evaluate and protecting invaluable components of nature and interactions with the environment.

UNIT	**CONTENTS**
I	**ECOLOGICAL PRINCIPLES:** Introduction – History, scope, concepts. Diversity of plant life; growth form, life form. Basic concepts of population ecology– population dynamics – Regulation of population density. Basics concepts of community – characteristics, composition, structure, origin and development – community dynamics – trends of succession.
II	**ECOSYSTEM ECOLOGY AND RESOURCE ECOLOGY:** Introduction – kinds – major types – functional aspects of ecosystem: Food chain and food web, energy flow, laws of thermodynamics. Productivity – primary and secondary productivity – GPP & BPP. **Resource Ecology:** Energy resources; renewable and non-renewable. **Soil**: Formation, types and profile - erosion and conservation, Water resources – conservation and management. **Environment Deterioration:** Climate change - Greenhouse effect and global warming, ozone depletion and acid rain. Waste management - Solid and e-waste, recycling of wastes. Eco-restoration/remediationecological foot prints - carbon foot print - ecolabeling - environmental auditing
III	**PHYTOGEOGRAPHY:** Phytogeographical Zones - Vegetation types of India and Tamil Nadu, Distribution: Continuous, Discontinuous and Endemism. Theories of discontinuous distribution: Continental drift, Age and area hypothesis. Geographical Information System (GIS) Principles of remote sensing and its applications.

IV	**BIODIVERSITY AND CONSERVATION ECOLOGY:** Definition, types of biodiversity – values of biodiversity – Hot spots – Threats to biodiversity: habitat loss. Poaching of wild life – Invasion of exotic species, man and wild life conflicts - endangered and endemic plant species of India, Red list categories of IUCN, Biotechnology assisted plant conservation- *in situ* and *ex situ* methods.
V	**INTELLECTUAL PROPERTY RIGHTS:** Intellectual Property Rights – Introduction, Kinds of Intellectual Property Rights- Patents, Trademarks, Copyrights, Trade Secrets. Need for intellectual property right, Advantages and Disadvantages of IPR. International Regime Relating to IPR – TRIPS, WIPO, WTO, GATTS. IPR in India genesis and development. Geographical Indication – introduction, types. Patent filing procedure for ordinary application.

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

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

Recommended Text:

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

Reference Books:

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

Web resources:

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

Mapping with Programme Outcomes:

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

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

CORE-VII LABORATORY COURSE-II COVERING PAPERS, IV, V AND VI

Title of the Course	**LABORATORY COURSE-II**						
Paper Number	**CORE VII**						
Category	Core	**Year**	I	**Credits**	4	**Course Code**	
		Semester	II				

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

Pre-requisite	Theoretical understanding of plant taxonomy, ecology and phytogeography, plant anatomy and embryology as well as basic laboratory skills for the relevant core course.
Learning Objectives	1. Understand and develop skill sets in plant morphological, floral characteristics and artificial key preparation.
	2. Expedite skilled workers to carry out research in frontier areas of plant science.
	3. Classify meristems and identify their structures, functions and roles in monocot and dicot plants growth and secondary growth of woody plants
	4. Learn the importance of plant anatomy in plant production systems.
	5Know about different vegetation sampling methods.

UNIT	**EXPERIMENTS**
I	**TAXONOMY AND ECONOMIC BOTANY OF ANGIOSPERMS** Preparation of artificial keys. Description of a species, based on virtual herbarium and live specimens of the families mentioned in the theory. Study the products of plants mentioned in the syllabus of economic botany with special reference to the morphology, botanical name and family. Solving nomenclature problems. **Field trip:** A field trip at least 3-4 days to a floristically rich area to study plants in nature and field report submission of not less than 20 herbarium sheets representing the families studied.
II	**ANATOMY** 1. Study of shoot apex of *Hydrilla* 2. Observation of cambial types. 3. Sectioning and observation of nodal types. 4. Study of anomalous secondary growth of the following: STEM- *Nyctanthus, Boerhavia, Aristolochia, Bignonia, Piper* and *Mirabilis*. ROOT: *Acyranthus* 5. Observation of stomatal types by epidermal peeling. 6. Maceration of wood and observation of the components of xylem. 7. Double staining technique to study the stem anomali.
III	**EMBRYOLOGY** 1. Observation of T.S. of anther. 2. Observation of ovule types. 3. Observation of mature embryo sacs. 4. Dissection and observation of embryos (globular and cordate embryos).

	5. Study of pollen morphology 6. Study of in vitro pollen germination. 7. Observation of endosperm types.
IV	**ECOLOGY,** 1. Determination of the quantitative characters of a plant community by random quadrat method (abundance, density, dominance, species diversity, frequency) in grazing land, forests. 2. Estimation of above ground and below ground biomass in a grazing land employing minimum size of quadrat. 3. To determine soil moisture, porosity and water holding capacity of soil collected from varying depth at different locations. 4. Determination of pH of soil and water by universal indicator (or) pH meter. 5. Determination of dissolved oxygen. 6. Estimation of carbonate. 7. Estimation of bicarbonate.
V	**PHYTOGEOGRAPHY, CONSERVATION BIOLOGY & INTELLECTUAL PROPERTY RIGHTS** 1. Mapping of world vegetation 2. Mapping of Indian vegetation. 3. Remote sensing–Analyzing and interpretation of Satellite photographs-Vegetation/ weather. 4. Visit to remote sensing laboratory (at Anna University, Regional Meteorological Centre at Numgambakkam).

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

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

Recommended Text:

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

Reference books:

1. Aler Gingauz. 2001. Medicinal Chemistry. Oxford University Press & Wiley Publications.
2. Mann J. Davidson, R.S and J.B. Hobbs, D.V. Banthorpe, J.B. Harborne. 1994. *Natural Products*. Longman Scientific and Technical Essex.
3. Gopalan, C., B.V. Ramasastri and S.C. Balasubramanian. 1985. Nutritive Value of Indian Foods. National Institute of Nutrition, Hyderabad.
4. Harborne. J.B. 1998. Phytochemical methods. A guide to modern techniques of Plant Analysis, Chapman and Hall publication, London.
5. Traditional plant medicines as sources of new drugs. P.J Houghton in Pharmacognosy.Trease and Evan's.16 Ed .2009.
6. Sundara Rajan, S, 2003. Practical Manual of Plant Anatomy and Embryology 1st ed, Anmol Publications, ISBN-812610668.
7. Katherine Esau. 2006. Anatomy of Seed Plants. 2nd edition, John Wiley and Sons.

Web resources:

1. https://www.kobo.com/gr/en/ebook/phytochemistry-2
2. https://www.amazon.in/Textbook-Pharmacognosy-Phytochemistry-Kumar-Jayaveera-ebook/dp/B06XKSY76H
3. https://www.amazon.in/Computational-Phytochemistry-Satyajit-Dey-Sarker-ebook/dp/B07CV96NZJ.

Mapping with Programme Outcomes:

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

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

ELECTIVE-III MEDICINAL BOTANY

Title of the Course	**MEDICINAL BOTANY**						
Paper Number	**ELECTIVE III**						
Category	ELECTIVE	**Year**	I	**Credits**	3	**Course Code**	
		Semester	II				

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

Pre-requisite	Understanding the uses of medicinal plants and its conservation.
Learning Objectives	1. To understand the uses and effects of medicinal plants and herbal supplements.
	2. To gain knowledge about the historical and modern uses of plants in medicine.
	3. To gain insights into the perspectives of ethnobotanical research.
	4. To know the various methods of harvesting, drying and storage of medicinal herbs.
	5. To create new strategies to enhance growth and quality check of medicinal herbs.

UNIT	**CONTENTS**
I	**HISTORY AND TRADITIONAL SYSTEMS OF MEDICINE:** Historical Perspectives – European, African, American, Southeast Asian Practices. Scope and Importance of Medicinal Plants; Traditional systems of medicine - Definition and Scope. Classical health traditions - Naturopathy, Siddha, Ayurveda, Homeopathy, Unani and Materia Medica. Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in Ayurvedic treatments, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umoor-e-tabiya, tumors treatments/ therapy, polyherbal formulations.
II	**PHYTOCHEMISTRY AND PHARMACOGNOSY:** Phytochemistry, important phytoconstituents, their plant sources, medicinal properties. Histochemistry – definition, principles, staining methods. Biological stains – bright field dyes and flurochromes, detection and localization of phytochemicals. Raw drugs, authenticity, study through physical, microscopic and analytical methods. Different types of formulations. Adulteration and Admixtures.
III	**ACTIVE PRINCIPLE & DRUG DISCOVERY:** Brief description of selected plants, Active principles, biochemical properties and medicinal uses of Guggul (*Commiphora*) for hypercholesterolemia, *Boswellia* for inflammatory disorders, Arjuna (*Terminalia arjuna*) for cardio protection, turmeric (*Curcuma longa*) for wound healing, antioxidant and anticancer properties, Kutaki (*Picrorhiza kurroa*) for hepatoprotection, Opium Poppy for analgesic and antitussive, *Salix* for analgesic, *Cinchona* and *Artemisia* for Malaria, *Rauwolfia* as

	tranquilizer, *Belladona* as anticholinergic, *Digitalis* as cardiotonic, *Podophyllum* as antitumor, *Stevia rebaudiana* for antidiabetic, *Catharanthus roseus* for anticancer. Bioprospecting, drug discovery from plants with reference to diabetes and cancer. Product development and quality control.
IV	**CONSERVATION AND AUGMENTATION:** Significance of Cultivation, management, policies for conservation and sustainable use of medicinal plants. Conservation of endemic and endangered medicinal plants, Red list criteria; *In situ* conservation: Biosphere reserves, sacred groves, National Parks; *Ex situ* conservation: Botanic Gardens, Ethno medicinal plant Gardens. Propagation of Medicinal Plants: seeds, cuttings, layering, grafting and budding.
V	**ETHNO BOTANY AND FOLK MEDICINE:** Concepts and definition of Ethno botany and folk medicines. A brief history of ethnobotanical studies – globally & locally. Methods to study ethno botany; Applications of Ethno botany: Folk medicines of ethno botany, ethno medicine, ethno ecology, ethnic communities of India. Understanding the traditions of tribes in Tamil Nadu – Irulas and Kanis. Repository of Ethnobotanical data – Archeology, inventories, folklore and literature. Traditional Knowledge Sharing - Prior information consent, interviews, questionnaires and knowledge partners.Plants associated with culture, social, religious and medicinal purposes.Commercial use of traditional knowledge – ethics, IPR, biopiracy, equitable benefit sharing models.

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Recognize plants and relate to their medicinal uses	K1
CO2	Explain about the phytochemistry, pharmacognosy and bioprospecting of medicinal plant extracts.	K2
CO3	Apply techniques for conservation and propagation of medicinal plants.	K3
CO4	Analyze and decipher the significance of various methods of harvesting, drying and storage of medicinal herbs.	K4
CO5	Develop new strategies to enhance growth and quality check of medicinal herbs considering the practical issues pertinent to India.	K5 & K6

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

Recommended Text:

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

Reference Books:

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

Web resources:

1. https://www.amazon.in/Medical-Botany-Plants-Affecting-Health/dp/0471628824
2. https://www.amazon.in/Current-Trends-Medicinal-Botany-Muhammad/dp/9382332502
3. https://link.springer.com/book/10.1007/978-3-030-74779-4
4. https://www.elsevier.com/books/medicinal-plants/da/978-0-08-100085-4
5. https://www.pdfdrive.com/medicinal-plants-books.html

Mapping with Programme Outcomes:

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

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

Title of the Course	PHYTOCHEMISTRY						
Paper Number	ELECTIVE III						
Category	ELECTIVE	Year	I	Credits	3	Course Code	
		Semester	II				

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

Pre-requisite	Basic understanding of plant metabolites.
Learning Objectives	1. To comprehend the various classes of phytochemicals present in the plant kingdom**.**
	2. To understand the biosynthetic processes through which diverse phytochemicals are synthesized and to study their structural and functional characteristics**.**
	3. To learn about the isolation of different phytochemicals using the state-of-the art techniques**.**
	4. To learn about the application of different phytochemicals to cure diseases in human andanimals**.**
	5. To understand the information of the traditional system of medicine.

UNIT	CONTENTS
I	**SECONDARY METABOLITES AND CLASSIFICATION** Phytochemistry: Definition, history, principles. Secondary metabolites: definition, classification, occurrence and distribution in plants, functions, chemical constituents. Alkaloids, terpenoids, flavonoids, steroids, and coumarins.
II	**ISOLATION AND QUANTIFICATION OF PHYTOCHEMICALS** Techniques for isolation of medicinally important biomolecules: solvent extraction, chemical separations, steam distillation, soxhlet extraction. Purification, concentration, determination and quantification of compounds (TLC, Column, HPLC). Characterization of phytochemicals: spectroscopic methods.
III	**BIOSYNTHETIC PATHWAYS AND APPLICATION OF PHYTOCHEMICALS** Biosynthetic pathways of secondary compounds: Shikimic pathway; Mevalonic Acid Pathway; Pathways for commercially important phytochemicals: Taxol and *Vinca* alkaloids. Applications of phytochemicals in medicine, pharmaceuticals, food, flavour and cosmetic industries.
IV	**HERBALISM AND ETHNOBOTANY** Herbs and healing: Historical perspectives: local, national and global level; Herbal cultures: origin and development of human civilizations; Ethnobotany and Ethno medicine; Development of European, South and Central American, African, Indian,Chinese, and South East Asian Herbal Cultures.
	TRADITIONAL SYSTEM OF MEDICINE Classical health traditions: Systems of medicine: origin and development of biomedicine; Indian Systems of Medicine (Ayurveda, Siddha, Unani, Tibetan, Yoga

V	and Naturopathy) Ayurveda: Historical perspective, *Athuravritta* (disease management and treatment which involves eight specialties including Internal medicine and surgery); Fundamental principles of Ayurveda: Panchabhootha theory, Thridosha theory, Saptadhatu theory and *Mala* theory; Ayurvedic Pharmacology Ayurvedic Pharmacopoeia; *Vrikshayurveda.*

Course outcomes	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Understand the role of plants in the survival of human beings and other Organisms.	K1
CO2	Recognition of the contribution made by primitive people in exploration of plantknowledge to alleviate common diseases and development of systems of medicine.	K2
CO3	Gaining knowledge on different classes of phytochemicals present in higher andlower plants species.	K3
CO4	Demonstrate the various aspects of extraction, isolation and characterization of secondary metabolites.	K4 & K5
CO5	Know the methods of screening of secondary metabolites for various biological properties.	K6

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

Recommended Text:

1. Kokate, C.K., Purohit, A.P and Gokhale, S.B. 2010. Pharmacognosy. Vol. I & II. NiraliPrakashan, Pune.
2. Mohamed Ali. 2012. Textbook of Pharmacognosy. CBS Publishers & Distributors Pvt. Ltd., New Delhi.
3. Gokhale, S.B., Kokate, C.K. and Gokhale, A. 2016. Pharmacognosy of Traditional Drugs. NiraliPrakashan, 1st Edition. ISBN: 9351642062. 2.
4. Joshi, S.G. 2018. Medicinal Plants. Oxford & IBH Publishing C., Pvt., Ltd., New Delhi.
5. Kumar, N. 2018. A Textbook of Pharmacognosy. Aitbs Publishers, India.

Reference Books:

1. Shah, B.N. 2005. Textbook of Pharmacognosy and phytochemistry. Cbs Publishers & Distributors, New Delhi.
2. Harshal A and Pawar. 2018. Practical book of pharmacognosy and phytochemistry-Everest Publishing house.
3. Varsha Tiwari and Shamim Ahmad. 2018. A practical book of pharmacognosy and phytochemistry. Nirali prakashan advancement of knowledge.
4. Braithwaite, A and F.J. Smith. 1996. *Chromatographic Methods* (5^{th} Edition) Blackie Academic & Professional London.
5. Wilson, K and J. Walker (Eds). 1994. Principles and Techniques of Practical Biochemistry (4^{th}Edition) Cambridge University Press, Cambridge.

6. Harborne. J.B. 1998. Phytochemical methods. A guide to modern techniques of Plant Analysis, Chapman and Hall publication, London.

Web resources:

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

Mapping with Programme Outcomes:

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

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

ELECTIVE-III
RESEARCH METHODOLOGY, COMPUTER APPLICATIONS & BIOINFORMATICS

Title of the Course	**RESEARCH METHODOLOGY, COMPUTER APPLICATIONS & BIOINFORMATICS**						
Paper Number	**ELECTIVE III**						
Category	ELECTIVE	**Year**	I	**Credits**	3	**Course Code**	
		Semester	II				

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

Pre-requisite	To impart expertise about analysis and research.
Learning Objectives	1. To equip students to collect, analyze and evaluate data generated by their own inquiries in a scientific manner.
	2. To provide an overview on modern equipments that they would help students gain confidence to instantly commence research careers and/or start entrepreneurial ventures.
	3. To develop interdisciplinary skills in using computers in botany to learn about the biological database.
	4. Students aware with the most recent technologies for sequencing and bioinformatics analysis and is able to apply them to the structural and functional genomics of plants.
	5. Operate various software resources with advanced functions and its open office substitutes.

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

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

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

Recommended Text:

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

Reference Books:

1. Jayaraman, J. 2000. Laboratory manual of Biochemistry, Wiley Eastern Limited, New Delhi 110 002.
2. Pevsner,J.2015.Bioinformaticsandfunctionalgenomics.Hoboken,NJ:Wiley-Blackwell.
3. Arthur Conklin W.M and Greg White, 2016. Principles of computer security. TMH. McGraw-Hill Education; 4 edition.
4. Irfan Ali Khan and Attiya Khanum (eds.). 2004. Introductory Bioinformatics. Ukaaz Publications, Hyderabad.
5. Arthur Conklin W.M., and Greg White. 2016. Principles of computer security. TMH., McGraw-Hill Education; 4th edition
6. Mishra Shanthi Bhusan. 2015. Handbook of Research Methodology - A Compendium for Scholars & Researchers, Ebooks2go Inc.
7. Narayana, P.S.D. Varalakshmi, T. Pullaiah. 2016. Research Methodology in Plant Science, Scientific Publishers, Jaipur, Rajasthan.

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

Mapping with Programme Outcomes:

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

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

Title of the Course	BIOPESTICIDE TECHNOLOGY						
Paper Number	ELECTIVE III						
Category	ELECTIVE	Year	I	Credits	3	Course Code	
		Semester	II				

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

Pre-requisite	Prior knowledge on impact of chemical pesticides on environment andbiopesticides.
Learning Objectives	1. To understand the value and applications of biopesticides.
	2. To comprehend the various issues related to the use of chemical pesticides in horticulture, forestry, and agriculture.
	3. To gain knowledge about several biopesticides (bio-insecticides, bio-fungicides, bio-bactericides, bio-nematicides and bio-herbicides).
	4. To gain knowledge of the techniques for mass production of selected biopesticides.
	5. To be aware of the application strategies and weeds, nematodes, and disease targets.

UNIT	CONTENTS
I	**INTRODUCTION** Introduction of biopesticides. Biological control, History and concept of biopesticides. Importance, scope and potential of biopesticide. Advantages for the use of biopesticides.
II	**TYPES OF BIOPESTICIDES** Classification of biopesticides, botanical pesticides and biorationales. Mass production technology of bio-pesticides. Major classes-Properties and uses of Bioinsecticides, biofungicides, biobactericides, bionematicides and bioherbicides. Importance of neem in organic agriculture.
III	**IMPORTANT BIOINSECTICIDES** *Bacillus thuringiensis*, NPV, entomopathogenic fungi (*Beauveria, Metarhizium, Verticillium, Paecilomyces*). Biofungicides: *Trichoderma, Gliocladium,* non-pathogenic *Fusarium, Pseudomonas* spp., *Bacillus* spp. Biobactericides: *Agro bacterium radiobacter*. Bionematicides: *Paecilomyces, Trichoderma,* Bioherbicides: *Phytophthora, Colletotrichum*.
IV	**STANDARDIZATION OF BIOPESTICIDES** Target pests and crops of important biopesticides and their mechanisms of action. Testing of quality parameters and standardization of biopesticides.
V	**FORMULATION** Mass multiplication and formulation technology of biopesticides. Prospects and problems in commercialization and efficiacy of biopesticides. Commercial products of biopesticides.

Course outcomes	On completion of this course, the students will be able to:	Programme outcomes
CO1	Understand the issues in use of chemical pesticides and their harmful effects on life.	K1 & K2
CO2	Aware the significance of biopesticides and their beneficial role in controlling insect pests, diseases, nematodes and weeds.	K1 & K4
CO3	Knowledge on identification of promising biopesticides and their mechanisms of action against insect pests, diseases, nematodes and weeds.	K2 & K6
CO4	Learn the mass production and formulation technology of selected biopesticides.	K3 & K6
CO5	Knowledge on product development for commercialization of biopesticides.	K5

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

Recommended Text:

1. Johri, J. 2020. Recent Advances in Biopesticides: Biotechnological Applications. New India Publishing Agency (NIPA), New Delhi.
2. Kaushik, N. 2004. Biopesticides for sustainable agriculture: prospects and constraints. TERI Press, New Delhi.
3. Sahayaraj, K. 2014. Basic and Applied Aspects of Biopesticides. Springer India, New Delhi.
4. Tebeest, D.O. 2020. Microbial Control of Weeds. CBS Publishers and Distributors, New Delhi.
5. Joshi, S.R. 2020. Biopesticides: A Biotechnological Approach. New Age International (P) ltd. New Delhi.

Reference Books:

1. Ainsworth, G.C. 1971. A Dictionary of the Fungi. Commonwealth Mycological Institute, Kew, Surrey, England.
2. Carlile, M.J., Watkinson, S.C and Gooday, G.W. 2001. The Fungi. 2nd Edition. Academic Press, San Diego
3. Manoj Parihar, Anand Kumar. 2021. Biopesticides. Volume 2: Advances in Bio-inoculants. Elsevier.
4. Bailey, A., Chandler, D., Grant, W. P., Greaves, J., Prince, G., Tatchell, M. 2010. Biopesticides: pest management and regulation.Plumx.
5. Manoharachary, C., Singh, H.B., Varma, A. 2020. Trichoderma: Agricultural Applications and Beyond. Springer International Publishing, New York, USA.
6. Nollet, L.M.L and Rathore, H.S. 2019. Biopesticides Handbook. CRC Press, Florida, USA.
7. Anwer, M.A. 2021. Biopesticides and Bioagents: Novel Tools for Pest Management. Apple Academic Press, Florida, USA.

8. Awasthi, L.P. 2021. Biopesticides in Organic Farming: Recent Advances. CRC Press, Florida, USA.
9. Bailey, A., Chandler, D., Grant, W., Greaves, J., Prince, G., Tatchell, M., 2012. Biopesticides: Pest Management and Regulation. CABI, Surrey, UK.
10. Glare, T.R and Moran-Diez, M.E. 2016. Microbial-Based Biopesticides: Methods and Protocols. Humana Press, New Jersey, USA.
11. Gnanamanickam, S.S. 2019. Biological Control of Crop Diseases. CRC Press, Florida, USA.

Web resources:

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

Mapping with Programme Outcomes:

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

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

ELECTIVE-IV APPLIED BIOINFORMATICS

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

UNIT	CONTENTS
I	**BIOINFORMATICS AND INTERNET:** Internet Basics - File Transfer Protocol - The World Wide Web - Internet Resources –databases – types- Applications - NCBI Data Model - SEQ-Ids – Biosequences- Biosequence sets – Sequence annotation – Sequence description.
II	**GENBANK SEQUENCE DATABASE:** **Introduction**- Primary And Secondary Databases - Format Vs. Content - Genbank Flatfile- Submitting DNA Sequences to the Databases - DNA/RNA - Population, Phylogenetic, and Mutation Studies - Protein-Only Submissions - Consequences of DNA Model - EST/STS/GSS/HTG/SNP and Genome Centers - Contact points for submission of sequence data to DBJ/EMBL/Genbank.
III	**STRUCTURE DATABASES:** Introduction to Structures - Protein Data Bank (PDB) - Molecular Modeling Database at NCBI Structure File Formats - Visualizing Structural Information - Database Structure Viewers - Advanced Structure Modeling - Structure Similarity Searching.
IV	**SEQUENCE ALIGNMENT AND DATABASE SEARCHING:** Introduction - Evolutionary Basis of Sequence Alignment - Modular Nature of Proteins - Optimal Alignment Methods - Substitution Scores and Gap Penalties- Database Similarity Searching - FASTA – BLAST (BlastP, BlastN, etc.,) - Position Specific Scoring Matrices, Spliced Alignments.

V	**PREDICTIVE METHODS:** Using Protein Sequences Protein Identity Based on Composition - Physical Properties Based on Sequence - Motifs and Patterns - Secondary Structure and Folding Classes - Specialized Structures or Features - Tertiary Structure.

Course outcomes	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Familiarize with the tools of DNA sequence analysis.	K1 & K2
CO2	Use and explain the application of bioinformatics.	K2 & K3
CO3	Master the aspects of protein-protein interaction, BLAST and PSI-BLAST.	K3 & K4
CO4	Describe the features of local and multiple alignments.	K3 & K4
CO5	Interpret the characteristics of phylogenetic methods and bioinformatics applications.	K4 & K5

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

Recommended Text:

1. Baxevanis, A. D. & Ouellette, B. F. 2001. Bioinformatics: A practical guide to the analysis ofgenes and proteins. New York: Wiley-Interscience.
2. Bourne, P. E., & Gu, J. 2009. Structural bioinformatics. Hoboken, NJ: Wiley-Liss.
3. Lesk, A. M. 2002. Introduction to bioinformatics. Oxford: Oxford University Press.
4. Mount, D. W. 2001. Bioinformatics: Sequence and genome analysis. Cold Spring Harbor, NY:Cold Spring Harbor Laboratory Press.
5. Pevsner, J. 2015. Bioinformatics and functional genomics. Hoboken, NJ: Wiley-Blackwell.

Reference Books:

1. Campbell, A.M and Heyer, L.J. 2003. Discovering genomics, proteomics, and bioinformatics.San Francisco: Benjamin Cummings.
2. Green, M.R and Sambrook, J. 2012. Molecular cloning: A laboratory manual. Cold SpringHarbor, NY: Cold Spring Harbor Laboratory Press.
3. Liebler, D.C. 2002. Introduction to proteomics: Tools for the new biology. Totowa, NJ: HumanaPress.
4. Old, R.W., Primrose, S.B., and Twyman, R.M. 2001. Principles of gene manipulation: Anintroduction to genetic engineering. Oxford: Blackwell Scientific Publications.
5. Primrose, S.B., Twyman, R.M., Primrose, S.B., and Primrose, S.B. 2006. Principles of gene manipulation and genomics. Malden, MA: Blackwell Pub.

Web resources:

1. Bioinformatics: Algorithms & Applications by Prof. M. Michael Gromiha IIT-Madras. https://nptel.ac.in/courses/102/106/102106065/#.
2. Christopher Burge, David Gifford, and Ernest Fraenkel. *7.91*.J Foundations of Computational andSystems *Biology*. Spring 2014. Massachusetts Institute of Technology: MIT Open Course Ware, https://ocw.mit.edu.
3. https://link.springer.com/book/10.1007/978-3-540-72800-9.
4. https://www.amazon.in/Applied-Bioinformatics-Paul-Maria-Selzer-ebook/dp/B001AUOYY2.
5. https://books.google.co.in/books/about/Applied_Bioinformatics.html?id=PXZZDwAAQBAJ&redir_esc=y

Mapping with Programme Outcomes:

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

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

Title of the Course	**BIOSTATISTICS**						
Paper Number	**ELECTIVE IV**						
Category	ELECTIVE	**Year**	I	**Credits**	3	**Course Code**	
		Semester	II				

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

Pre-requisite	Fundamental knowledge on using in statistical tools and apply the tools to interpret the results.
Learning Objectives	1. To provide the student with a conceptual overview of statistical methods.
	2. To emphasis on usefulness of commonly used statistical software for analysis, research, and experimentation.
	3. To understand and evaluate critically the acquisition of data and its representation.
	4. To gain the knowledge about the probability and statistical inference are all topics that will be taught in order to obtain knowledge about the graphical representation of data.
	5. To learn more about how to organize, create, and carry out the distribution of scientific knowledge.

UNIT	**CONTENTS**
I	**INTRODUCTION TO STATISTICS** Introduction to biostatistics, basic principles, variables - Collection of data, sample collection and representation of Data - Primary and Secondary - Classification and tabulation of Data – Diagrams, Graphs and Presentation.
II	**DESCRIPTIVE STATISTICS** Mean median and mode for continuous and discontinuous variables. Measures of dispersion: Range of variation, standard deviation and standard error and coefficient variation.
III	**PROBABILITY** Basic principles - types - Rules of probability - addition and multiplication rules. **PROBABILITY DISTRIBUTION** Patterns of probability distribution; binomial - Poisson and normal.
IV	**HYPOTHESIS TESTING** Chi-square test for goodness of fit; Null hypothesis, level of Significance - Degrees of Freedom. Student‘t’ test – paired sample and mean differences ‘t’ tests. ANOVA. Basic introduction to Multivariate Analysis of Variance (MANOVA).
V	**CORRELATION AND REGRESSION** Correlation - types of correlation - methods of study of correlation - testing the significance of the coefficients of correlation. Regression and types. Sampling and experimental designs of research-Randomized block design and split plot design.

Course outcomes: CO	On completion of this course, the students will be able to:	Programme outcomes
CO1	Create and interpret visual representations of quantitative information, such as graphs or charts.	K5 & K6
CO2	Solve problems quantitatively using appropriate arithmetical, algebraic, or statistical methods	K3 & K5
CO3	Know the latest version using in statistical tools and apply the tools to interpret the results	K2
CO4	To develop their competence in hypothesis testing and interpretation.	K4
CO5	Understand why biologists need a background in statistics.	K1

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

Recommended Text:

1. Gurumani, N. 2005. Biostatistics, 2nd edn. MJP publications, India.
2. Datta, A.K. 2006. Basic Biostatistics and Its Applications. New Central Book Agency. ISBN 8173815038.
3. Pillai, R.S.N and Bagavathi, V.S. 2010. Statistics theory and practice. Chand & Co. Ltd, New Delhi.
4. Mahajan, B.K. 1984. Methods in Biostatistics for Medical students and Research works. Smt. Indu Mahajan, New Delhi.
5. Pillai, R.S.N and Bagavathi, V.S. 2010. Statistics theory and practice. Chand & Co. Ltd, New Delhi.
6. Khan, I.D and Khanum, A. 2004. Fundamentals of Biostatistics, Ukazsz Publications, Hyderabad, India.
7. Gupta, S.C. 2013. Fundamentals of statistics, Himalaya Publishers, Mumbai.
8. Kothari, C.R and Garg, G. 2014. Research methodology –Method and techniques. New Age International (P) Ltd. New Delhi.

Reference books:

1. Milton, J.S. 1992. Statistical method in Biological and Health Sciences. McGraw Hill Inc., New York.
2. Schefler, W.C. 1968. Statistics for biological sciences, Addision- Wesely Publication Co., London.
3. Spiegel, M.R. 1981. Theory and Problems of statistics, Schaum's Outline series McGraw-Hill International Book Co., Singapore.

4. Pillai, R.S.N and Bagawathi, V. 1987. Practical Statistics (For B.Com. and B.A., Students) S.Chand & Co. (Pvt.) Ltd., New York.
5. Sobl. R.R and Rohif, F.J. 1969. Biometry. The principles and Practice and Statistics in Biological Research. W.H. Freman and Co., San Francisco.
6. Zar, J.K. 2011. Biostatistical Analysis, Fourth Edition, Prantice-Hall International, New Jersey, USA.

Web resources:

1. nu.libguides.com/biostatistics
2. https://newonline courses.sciences.psu.edu/
3. https://bookauthority.org/books/beginner-biostatistics-ebooks
4. https://www.amazon.com/dp/1478638184?tag=uuid10-20
5. https://hastie.su.domains/ElemStatLearn/

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	2	1	3	3	3	3	1	3	1
CO 2	3	2	2	3	3	3	2	1	2	1
CO 3	3	1	2	3	3	3	3	2	2	2
CO 4	3	2	1	3	2	2	3	3	3	3
CO 5	3	2	3	3	3	3	3	1	3	1

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

ELECTIVE-IV INTELLECTUAL PROPERTY RIGHTS

Title of the Course	**INTELLECTUAL PROPERTY RIGHTS**						
Paper Number	**ELECTIVE IV**						
Category	ELECTIVE	**Year**	I	**Credits**	3	**Course Code**	
		Semester	II				

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

Pre-requisite	Intent to understand the legal systems governing the knowledge economy. Basic understanding of how laws are structured and interpreted.
Learning Objectives	1. Cater to the needs of the stakeholders of knowledge economy is designed for those interested in managers and similar individuals.
	2. Create awareness of current IPR and innovation trends.
	3. Disseminate information on patents, patent system in India and overseas and registration related issues.
	4. Pursue a career in IPR, which offers chances for IP consultants and Attorneys.
	5. Develop skill sets to enable you to comprehend and assess the methods used in knowledge based economy and innovation ecosystems.

UNIT	**CONTENTS**
I	**INTRODUCTION TO IPR** History and Development of IPR. Theories on concept of property: Tangible *vs* Intangible. Subject matters patentable in India. Non patentable subject matters in India. Patents: Criteria of Patentability, Patentable Inventions - Process and Product. Concept of Copyright. Historical Evolution of Copyright Ownership of copyright, Assignment and license of copyright.
II	**UNIT II OVERVIEW OF THE IPR REGIME AND DESIGN** International treaties signed by India. IPR and Constitution of India. World Intellectual Property Organization (WIPO): Functions of WIPO, Membership, GATT Agreement. Major Conventions on IP: Berne Convention, Paris Convention. TRIPS agreement. Industrial Designs – Subject matter of Design – Exclusion of Designs – Novelty and originality – Rights in Industrial Design.
III	**TRADE MARK, LEGISLATIONS AND PATENT ACT** History of Indian Patent Act 1970. Overview of IP laws in India. Major IP Laws in India. Patent Amendment Act 2005. WTO-TRIPS – Key effect on Indian Legislation. Organization of Patent System in India. Concept of Trademarks, Different kinds of marks, Criteria for registration, Non Registrable Trademarks, Registration of Trademarks. Infringement: Remedies and Penalties.
IV	**PRIOR ART SEARCH AND DRAFTING** Overview of Patent Search. Advantages of patent search. Open source and paid databases for Patent Search. International Patent classification system. Types of

	specifications: Drafting of Provisional specifications. Drafting of complete specifications. Drafting of claims.
V	**GI AND PATENT FILING PROCEDURES** Geographical Indications of Goods (Registration and Protection) Infringement – Offences and Penalties Remedies. Plant Variety and Farmers Right Act (PPVFR). Plant variety protection: Access and Benefit Sharing (ABS). Procedure for registration, effect of registration and term of protection. Role of NBA. Filing procedure for Ordinary application. Convention application. PCT National Phase application. Process of Obtaining a Patent. Infringement and Enforcement.

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Recall the history and foundation of Intellectual Property.	K1
CO2	Understand the differences of Property and Assets and Various Categories of Intellectual Creativity.	K2
CO3	Apply the methods to protect the Intellectual Property.	K3
CO4	Differentiate if the Said Intangible property be protected under law or protected by strategy.	K4
CO5	Create a recommendation document on the methods and procedures of protecting the said IP and search documents to substantiate them.	K5 & K6

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

Recommended Text:

1. Kalyan, C.K. 2010. Indian Patent Law and Practice, India, Oxford University Press.
2. Ahuja, V.K. 2017. Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.
3. Arthur Raphael Miller, Micheal Davis H. 2000. Intellectual Property: Patents, Trademarks and .Copyright in Nutshell, West Group Publishers.
4. Margreth, B. 2009. Intellectual Property, 3nd, New York Aspen publishers.
5. Nithyananda, K.V. 2019. Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
6. Venkataraman M. 2015. An introduction to Intellectual property rights. Create space Independent Pub.North Charleston, USA.

Reference Books

1. World Intellectual Property Organization. 2004. WIPO Intellectual property Handbook. Retrieved from https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf Journal of Intellectual Property Rights (JIPR): NISCAIR.
2. Anant Padmanabhan. 2012. Intellectual Property Rights: Infringement and Remedies

LexisNexis Butterworths Wadhwa.
3. Intellectual Property Law in the Asia Pacific Region. 2009. Kluwer Max Planck Series,
4. Pradeep, S. Mehta (ed.). 2005. Towards Functional Competition Policy for India, Academic Foundation, Related.
5. Ramakrishna B and Anil Kumar, H.S. 2017. Fundamentals of Intellectual Property Rights: For Students, Industrialist and Patent Lawyers, Notion Press, Chennai.
6. James Boyle, Jennifer Jenkins. 2018. Intellectual Property: Law & the Information Society—Cases and Materials, Create space Independent Pub. North Charleston, USA.
7. Damodar Reddy, S.V. 2019. Intellectual Property Rights -- Law and Practice, Asia Law House, Hyderabad.

Web resources:

1. http://cipam.gov.in/
2. https://www.wipo.int/about-ip/en/
3. http://www.ipindia.nic.in/
4. https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf.
5. https://swayam.gov.in/nd2_cec20_ge04/preview

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	3	3	3	3	2	3	2	3	2
CO 2	3	3	3	3	3	3	2	2	3	3
CO 3	3	2	3	2	2	3	3	3	2	1
CO 4	3	2	3	2	2	3	1	3	2	3
CO 5	3	2	1	3	2	3	2	3	2	3

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

ELECTIVE-IV NANOBIOTECHNOLOGY

Title of the Course	**NANOBIOTECHNOLOGY**						
Paper Number	**ELECTIVE IV**						
Category	ELECTIVE	**Year**	I	**Credits**	3	**Course Code**	
		Semester	II				

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

Pre-requisite	To provide an insight into the principles of nanotechnolgoy in biological and medical research.
Learning Objectives	1. To introduce the learners to the basic concepts in the emerging frontiers of nanotechnology.
	2. To give perspective to researchers and students who are interested in nanoscale physical and biological systems and their applications in medicine.
	3. To introduce the concepts in nanomaterials and their use with biocomponents to synthesize and interact with larger systems.
	4. To impart knowledge on the most recent molecular diagnostic and therapeutic tools used to treat various diseases.
	5.Incorporate sustainability in to account when you develop nanotechnology responsibly.

UNIT	**CONTENTS**
I	**BASIC CONCEPTS IN NANOBIOLOGY** History of Nanotechnology, Difference between Nanoscience and Nanotechnology, Green nanotechnology, Bottom up and top down approaches.
II	**UNIT II DIVERSITY IN NANOSYSTEMS** Carbon based nanostructures - fullerences, nanotubes, nanoshells, buckyballs – biomolecules and nanoparticles, nanosensors, nanomaterials - Classification based on dimensionality quantum dots, wells and wires – metal based nano materials (gold, silver and oxides) - Nanocomposites- Nanopolymers – Nanoglasses–Nano ceramics.
III	**METHODS OF NANOBIOTECHNOLOGY** Optical tools – Nanoforce and imaging – Surface methods – Mass spectrometry – Electrical Characterization and Dynamics of Transport – Microfludics: Concepts and applications to the Life Sciences.
IV	**NANOBIOTECHNOLOGY** Nanodevices and nanomachines based on biological nanostructures - Protein and DNA nanoarrays, tissue engineering, and luminescent quantum dots for biological labeling.
V	**APPLICATIONS OF NANOBIOTECHNOLOGY** Real Time PCR – Biosensors : From the glucose electrode to the Biochip – DNA Microarrays – Protein Microarrays – Cell Biochips – Lab on a chip – Polyelectrolyte multilayers – Biointegrating materials – Pharmaceutical applications of nanoparticles carriers.

Course outcomes: CO	On completion of this course, the students will be able to:	Programme outcomes
CO1	Recall the essential features of biology and nanotechnology that are converging to create the new area of bionanotechnology.	K1
CO2	Formulate procedures for the synthesis of nanoparticles which are of medical importance which could be used to treat specific diseases.	K2
CO3	Characterize the various types of nano particle synthesis and advocate promotes the use of nano materials and anno composites.	K3
CO4	Analyze and apply the important of nanoparticles in plant diversity.	K4
CO5	Construct various types of nanomaterial for application and evaluate the impact on environment.	K5 & K6
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper).	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved. (To be discussed during the Tutorial hour).	
Skills acquired from this course.	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill	

Recommended Text:

1. Dupas, C, Houdy, P., Lahmani, M. 2007. Nanoscience: ―Nanotechnologies and Nanophysics‖, Springer-Verlag Berlin Heidelberg.
2. Sharon, M and Sharon, M. 2012. Bio-Nanotechnology- Concepts and Applications, CRC Press.
3. Atkinson, W.I. 2011. Nanotechnology. Jaico Book House, New Delhi.
4. Nalwa, H.S. 2005. Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology. American Scientific Publ.
5. Lindsay, S.M. 2011. Introduction to Nanoscience, Oxford universal Press, First Edition.
6. Jain K.K. 2006. Nanobiotechnology molecular diagnostics: Current techniques and application (Horizon Bioscience).Taylor & Francis 1st edition.
7. Pradeep, T. 2012. Textbook of Nanoscience and Nanotechnology, McGraw Hill Education (India) Private Limited.
8. XiuMei Wang, Murugan Ramalingam, Xiangdong Kong and Lingyun Zhao. 2017. Nanobiomaterials: Classification, Fabrication and Biomedical Applications, Wiley-VCH Verlag GmbH & Co. KGaA.

Reference Books:

1. Claudio Nicolini. 2009. Nanotechnology Nanosciences, Pon Stanford Pub.Pvt.Ltd,
2. Robert, A and Ferias, Jr. 1999. Nanomedicine, Volume I: Basic capabilities, Landes Bioscience.
3. Barbara Panessa-Warren. 2006 Understanding cell-nanoparticle interactions making nanoparticles more biocompatible. Brookhaven National Laboratory.
4. European Commission, SCENIHR. 2006. Potential risks associated with engineered and adventitious products of nanotechnologies, European Union.

5. Gysell Mortimer, 2011. The interaction of synthetic nanoparticles with biological systems PhD Thesis, School of Biomedical Sciences, Univ.of Queensland.
6. Murty, B.S., Shankar, P., Raj, B., Rath, B.B., Murday, J. 2013. Textbook of Nanoscience and Nanotechnology. Spirnger Publication.
7. Prashant Kesharwani. 2019. Nanotechnology-Based Targeted Drug Delivery Systems for Lung Cancer. Academic Press. An imprint of Elsevier.

Web resources:

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

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	3	3	3	3	3	3	3	3	3
CO 2	3	3	3	3	3	3	2	1	2	3
CO 3	3	3	3	2	3	3	3	2	2	3
CO 4	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3

SKILL ENHANCEMENT COURSE (SE2)

AGRICULTURE AND FOOD MICROBIOLOGY

Title of the Course	**AGRICULTURE AND FOOD MICROBIOLOGY-II**						
Paper Number	**Skill Enhancement-II**						
Category	SKILL ENHANCEMENT	**Year**	I	**Credits**	2	**Course Code**	
		Semester	II				
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**		**Total**
		2	1		--		3
Pre-requisite	To understand the benefits of microbes in agriculture and food industry.						
Learning Objectives	1. To provide comprehensive knowledge about plant – microbe interactions.						
	2. To provide basic understanding about factors affecting growth of microbes						
	3. To appreciate the role of microbes in food preservation.						
	4. To understand about the benefits of microbes in agriculture and food industry.						
	5. To gain knowledge about practices involved in food industry.						

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

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

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

Recommended Text:

1. Pelczar M.J., Chan E.C.S. and Krieg N.R. 2003. Microbiology. 5th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi.
2. Subba Rao, N. S. 2000. Soil microbiology. 4th Edition, Oxford and IBH publishing Co. Pvt. Ltd., Calcutta, New Delhi, India.
3. Rangaswami, G. and Bagyaraj, D.J. 2006. Agricultural Microbiology. 2nd Unit 2nd Edition, PHI Learning, New Delhi, India.
4. Prescott, L.M., Harley J.P., Klein D. A. 2005. Microbiology, McGraw Hill, India. 6th edition.
5. Goldman, E. and Green, L.H. 2015. Practical Handbook of Microbiology (3rd Ed.). CRC Press.

Reference Books:

1. Adams, M.R. and Moss M. O. 2008. Food Microbiology, 3rd Edition, Royal Society of Chemistry, Cambridge, U.K.
2. Sylvia D.M. 2004. Principles and Applications of Soil Microbiology, 2nd Edition, Prentice Hall, USA.
3. Frazier, W.C. 1995. Food Microbiology, 4th Edition, Tata McGraw Hill Education, Noida, India.
4. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. 2001. Industrial Microbiology: An Introduction. 1st Edition, Blackwell Science, London, UK.
5. Das, S. and Saha, R. 2020. Microbiology Practical Manual. CBS Publishers and Distributors (P) Ltd., New Delhi, India.

Web resources:

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

Mapping with Programme Outcomes:

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

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

INTERNSHIP/INDUSTRIAL ACTIVITY

Title of the Course	**INTERNSHIP/ INDUSTRIAL ACTIVITY**						
Paper Number	**Skill Enhancement-II**						
Category	**SKILL ENHANCEMENT**	**Year**	**I**	**Credits**	**2**	**Course Code**	
		Semester	**II**				
Instructional Hours per week	**Lecture**		**Tutorial**		**Lab Practice**		**Total**
	2		**1**		**--**		**3**
Pre-requisite	The summer internship programme will give students the chance to experience real-world organisational situations, learn about processes and rules, and grasp the operations of the industry..						
Learning Objectives							
C1	The main goal of the internship programme is to give students exposure to industry and help them comprehend current management techniques by having them work for at least fifteen days in an industry/institution over the summer..						
C2	To comprehend how theoretical ideas are applied in many sectors and industries.						
C3	To create a foundation for industry-integrated education, as well as to give students better practical knowledge and hands-on experience, improve their leadership qualities, and sharpen their problem-solving and management skills.						
C4	The internship must focus on practice. The college will require the students to visit the offices of the research lab/industry/institution it has a memorandum of understanding (MOU) with in order to receive on-the-job training in the many different areas of those businesses' operations.						
C5	Internships provide students with practical experience in a variety of fields, including manufacturing, productivity, development, and quality analysis. These experiences prepare students for competitive hiring processes in reputable MNC industries.						
UNIT	**CONTENTS**						**No. of Hours**
I	**Guidelines for Internship Programme:** 1. To give students the opportunity to spend at least fifteen days on their own during the II Semester vocation in order to acquire exposure to research labs, industry, and respected institutions and comprehend contemporary research procedures. 2. Individual instruction is provided for the internship. The internship programme must be completed in order to receive a credential. 3. Students are required to indentify a research labs/industry/recognized institution for their Internship						

	Programme Coordinator in consultation with and approval of their faculty guide. The choice of the research labs/industry/recognized institution should be intimated to the Internship coordinator before commencement of the Internship. Simultaneously, students should also have identified a guide within the research labs/industry/recognized institution (industry guide) under whose supervision and guidance they would carry out their Internship Program. 4. Students are expected to learn about the history of the research labs, industry, and recognized institution during their time. They must also learn about its founders or shareholders, the nature of business, organizational structure, reporting relationships, and how the various management functions (such as finance, HR, marketing, sales, and operations) operate. This list is merely illustrative and not comprehensive. Students should collect and gather as much as possible of written materials, published data, and related matter. 5. Before leaving the research labs/industry/recognized institution, obtain the Internship Programme completion certificate on the letterhead of a research lab/industry/, or an accredited institution. 6. Maintain Internship Programme record with details on activities and personal learning during their project period. 7. The department head and the coordinator of the internship programme form a committee to ensure that the internship is followed. 8. At least two copies of the report must be prepared by the intern at the conclusion of the internship program—one for submission to the college and one copy for the student. If the organization, the guide, or both request additional copies, more copies may be made. The sources from which the information was gathered should be made crystal apparent in the report. Every page needs to have a number, which should be centred at the bottom of the page. All tables, figures, and appendices must be appropriately labeled and consecutively numbered or lettered. The report must be printed, bound (ideally with soft binding), and contain at least 25 pages. 9. The internship training report should be submitted to the department within a month from the date of commencement of third semester. 10. However, such submission shall not be accepted after the end of	

	third semester Examinations.	
II	**Evaluation of the Internship:** 1. The internship program will be assessed by the assigned Internship Programme Coordinator from the host institute. 2. Evaluation will be done by the Internship Programme Coordinator of the host institute and through seminar presentation/viva-voce. 3. The presentation should be specific, clear and well analyzed, and indicate the specific sources of information. 4. iv. According to the statement of the draft the evaluation of the interns will be done as per the sincerity and research output of the students. In addition the evaluation will also be assessed according to the activity of the log book, format of presentation, quality of the report made by the interns, uniqueness, skill sets and evaluation report of the internship coordinator.	
III	**College Guide Manual – Summer Internship Program** 1. The Internship Programme Coordinator should give proper procedures to the intern before and after the Internship. 2. The Internship Programme Coordinator should interact with the research labs/industry/recognized institution at least once before completion of the internship. 3. The weekly report submitted by the student should be reviewed and reported to the Internship Programme coordinator.	
IV	**Internal:** 100 marks Internship Programme Completion certificate - 30 marks Internship report - 30 marks Presentation - 20 marks Viva-voce - 20 marks	
V	**CONTENTS OF THE REPORT** Title page Page for supervisory committee Table of Acknowledgement Internship Certificate **Executive Summary** Introduction of the Report Overview of the Organization	

	What I have Learned Analyses Summary Recommendations and Conclusion References Appendices	

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	For students in those pertinent core areas, the internship is preparing them to become professionals after graduation.	K1
CO2	Compile data and familiarize yourself with techniques for planning an carrying out tests.	K2
CO3	Collect data and educate yourself on how to analy results of your scientific studies.	K3 & K5
CO4	This in-the-moment industrial exposure helps them become more knowledgeble and skilled in the latest technology.	K4
CO5	Improving communication skills and coming up with creative are crucial components of training that help someone become an entrepreneur.	K5 & K6

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

Recommended Text:

1. Dawson, C. 2002. Practical research methods. UBS Publishers, New Delhi.
2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. 1995. Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.

Mapping with Programme Outcomes:

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO 1	3	3	3	1	3	3	3	3	3	2
CO 2	3	3	3	3	3	3	2	1	3	3
CO 3	3	3	3	3	3	3	2	1	3	3
CO 4	3	2	3	3	3	3	3	2	3	3
CO 5	3	3	3	3	3	3	3	3	2	3

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

II YEAR

SEMESTER III

CORE VIII : CELL AND MOLECULAR BIOLOGY

Title of the Course	**CELL AND MOLECULAR BIOLOGY**						
Paper Number	CORE VIII						
Category	Core	**Year**	II	**Credits**	4	**CourseCode**	
		Semester	III				

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

Pre-requisite	To acquire knowledge on cell and expose the students a fundamental of the various techniques used in molecular studies.
Learning Objectives	1. Enable to learn various cell structures and functions of prokaryotes and eukaryotes and understand the salient features and functions of cellular organelles.
	2. To understand the cell division and it molecular mechanism so as to appreciate and manipulate normal and abnormal cell and tissue growth.
	3. To enlighten people of past molecular biology developments.
	4. To comprehend the molecular processes.
	5. A thorough examination of DNA structure, replication process, transcription process and translation processes.

UNIT	**CONTENTS**
I	The dynamic cells, Concept of prokaryote and Eukaryote. Structural organization of plant cell, specialized plant cell types chemical foundation. Cell wall- Structure and functions, Plasma membrane; structure, models and functions, site for ATPase, ion carriers channels and pumps, receptors. Plasmodesmata and its role in movement of molecule.
II	Chloroplast-structure and function, genome organization, gene expression, RNA editing, Mitochondria; structure, genome organization, biogenesis. Plant Vacuole - Tonoplast membrane, ATPases transporters as a storage organelle. Structure and function of other cell organelles- Golgi apparatus, lysosomes, endoplasmic reticulum and microbodies.
III	Nucleus: Structure and function, nuclear pore, Nucleosome organization, euchromatin and heterochromatin. Ribosome- Structure and functional significance. RNA and DNA Structure. A, B and Z Forms. Replication, transcription, translation in prokaryotes and eukaryotes. DNA damage and repair (Thymine dimer, photoreactivation, excision repair). Cell cycle and Apoptosis; Control mechanisms, role of cyclin dependent kinases. Retinoblastoma and E2F proteins, cytokinesis and cell plate formation, mechanisms of programmed cell death.

IV	DNA replication (prokaryotes and eukaryotes), enzymes involved in replication, DNA repair. DNA sequencing. Transcription, enzymes involved in transcription, post transcription changes, reverse transcription, Translation. Overlapping genes.
V	DNA/gene manipulating enzymes: endonuclease, ligase, polymerase, phosphatase, transcriptase, transferase, topoisomerase. Gene cloning: cloning vectors, molecular cloning and DNA libraries. Molecular genetic elements, insertion elements, transposons. Recombinant DNA. Direct and indirect gene transfer. Detection of recombinant molecule, production of gene products from cloned genes. Genome library, cDNA library.

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

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

Recommended Text:

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

Reference Books:

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

Web resources:

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

Mapping with Programme Outcomes:

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

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

CORE IX : GENETICS, PLANT BREEDING & BIOSTATISTICS

Title of the Course	**GENETICS, PLANT BREEDING & BIOSTATISTICS**						
Paper Number	**CORE IX**						
Category	Core	**Year**	II	**Credits**	4	**Course Code**	
		Semester	III				

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

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

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

IV	**PLANT BREEDING:** Objectives of plant breeding, characteristics improved by plant breeding, Genetic basis of breeding self and cross – Pollinated crops. Pure line theory, pure line selection and mass selection, clonal selection methods. Hybridization, Genetics and physiological basis of heterosis.
V	**BIOSTATISTICS:** Measures of central tendency (Mean , Median , Mode) and dispersal (Mean deviation , standard deviation) , standard errors ANOVA (One way). probability distributions (Binomial, Poisson andnormal); sampling distribution; difference between parametric and non-parametric statistics; confidence interval; errors; levels of significance; regression and correlation; t-test; analysis of variance; X2 test; basic introduction to Multivariate statistics, etc.

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

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

Recommended Text:

1. Benjamin, A. Pierce. 2012. Genetics- A conceptual Approach. W.H. Freeman and Company, New York, England.
2. Stansfield, W.D. 1969. Theory and problems of Genetics. McGraw-Hill
3. Sinnott, E.W.Dunn, L.E and Dobzhansky, T. 1973. Principles of Genetics. McGraw-Hill.New York.
4. Chaudhari, H.K.1984. Elementary Principles of Plant Breeding. Oxford & IBH Publishing Company.
5. Brown, T.A. 1992. Genetics a Molecular Approach, 2nd Ed. Chapman and Hall.
6. Chahal, G.S and Gosal, S.S. 2018. Principles and Procedures of Plant Breeding Biotechnological and Conventional Approaches, Narosa Publishing House, New Delhi.
7. Singh, B.D. 2013. Plant Breeding: Principles and Methods, Kalyani Publishers, New Delhi
8. Singh, P. 2017. Fundamentals of Plant Breeding, Kalyani Publishers.
9. Chaudhary, R.C. 2017. Introductory principles of plant breeding, Oxford IBH Publishers, New Delhi.

10. Gupta, P.K. 2009. Genetics. Rastogi publications, Meerut, New Delhi.
11. Gupta, S.C. 2013. Fundamentals of statistics, Himalaya Publishers, Mumbai.
12. Kothari, C.R and Garg, G. 2014. Research methodology –Method and techniques. New Age International (P) Ltd. New Delhi.
13. Gurumani, N. 2005. Biostatistics, 2nd edn. MJP publications, India.

Reference Books:

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

Web Resourses

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

Mapping with Programme Outcomes:

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

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

CORE X : RECOMBINANT DNA TECHNOLOGY AND INDUSTRIAL APPLICATIONS

Title of the Course	**RECOMBINANT DNA TECHNOLOGY AND INDUSTRIAL APPLICATIONS**						
Paper Number	**CORE X**						
Category	Core	**Year**	II	**Credits**	4	**Course Code**	
		Semester	III				

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

Pre-requisite	To understand the basis of genes and their interactions at population and evolutionary levels.
Learning Objectives	Students should be familiar with the basics of genetics and molecular biology.
	To develop critical understanding of chemical basis of genes and their interactions at population and evolutionary levels.
	To learn the applied aspects of molecular biology and recombination technology, gene insertion and production of recombined new plants.
	To impart knowledge that leads to comprehensive understanding of the principles, tools and practices of rDNA technology.
	To enable students to gain basic understanding of rDNA techniques and its applications.

UNIT	**CONTENTS**
I	Recombinant DNA (DNA insertion in to Plasmid). Transformation. Direct and indirect gene transfer. Detection of recombinant molecule, production of gene products from cloned genes. Genome library, cDNA library. Vitamins, antibiotics, enzymes, anticancer drugs, interferons, etc., are produced using this technology.
II	For the production of vitamins: Vitamins like B_{12} are produced by recombinant bacteria like *Paracoccus denitrificans*, *Propionibacterium shermanii*, *E.Coli* bacteria on a large scale by fermentation. Vitamin-C is produced on a large scale from *Saccharomyces cerevisiae* and *Zygosaccharomyces bailii* yeast and *Gluconobacter oxydans* bacteria.
III	Production of antibiotic medicines : Human Deoxyribonuclease I, Human Tissue Plasminogen Activator, β-Glucocerebrosidase, L-Asparaginase, Deoxycytidine kinase, Acid sphingomyelinase • Antibiotics are anti-bacterial molecules produced by other microbes. • Penicillins, aminoglycosides, tetracyclines like antibiotics are produced from fungi and bacteria. • However, these microbes produce them in small quantities. • Genetic engineering is used to produce these antibiotics on a large scale for human use. Further, different analogs of these antibiotics are obtained by gene manipulations.

IV	Recombinant hormones**:** Insulin (somatotrophin), Erythropoietin used in the treatment of anemia. For the production of vaccines Hepatitis B vaccine Interferons Interferon-alfa- hairy cell leukemia. Interferon-Beta-1b is used to treat relapsing multiple sclerosis, malignant glioma, and melanoma.
V	rDNA technology uses in animal husbandry and sericulture**.** Milk production in cattle, cheese ripening, and reduction of lactose levels. Fungal α-amylase silk production in sericulture. Uses in agriculture**.** rDNA technology can produce high yielding plants with the desired quality. Disease resistant crops like Bt-cotton, BT-brinjal, golden rice.

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Understand the basics of recombinant DNA technology.	K1
CO2	Demonstrate and to recollect the production of vitamins.	K2
CO3	Analyze the production of antibiotics.	K3
CO4	Compare and contrast the recombined organism and natural organisms.	K4
CO5	Create and develop skills for rDNA techniques and in producing hybrids varieties.	K5 & K6

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

Recommended Text:

1. Neal Stewart, Jr. 2008. Plant Biotechnology and Genetics: Principles, Techniques and Applications. JohnWiley&sons Inc.

2. Smith. J.K. 1996. Biotechnology – 3 rd Ed. Cambridge Univ. Press, Cambridge.

3. Khan. I.A. and A. Khanum .2004. Fundamentals of Biotechnology – Forensic Science Genetic Engineering. Ukaaz publication, Hyderabad.

4. Mba, C., Afza, R., Bado, S., and Jain, S.M. 2010. Plant Cell Culture: Essential Methods, John Wiley & Sons, UK.

5. Abdin, M.Z., Kiran, U., Kamaluddin, M., Ali, A. (Eds.). 2017. Plant Biotechnology: Principles and Applications, Springer publishers.

Reference books:

1. Watson, J.D. *et al.* 2003. Molecular Biology of the Gene. Fourth Edition. The Benjamin Cummings Pub. Co.

2. Lewin, B. 2003. Genes VIII. Oxford University Press.

3. Friefelder, D. 2005. Molecular Biology. Second Edition. NarosaPub.House.

4. Sobtir.C. and Gobe. 1991. Eukaryotic chromosomes. Narosa Publishinghouse.

5. Smith-Keary, P. 1991. Molecular Genetics. Macmillan Pub. Co. Ltd. London.

Web references

1.https://www.nature.com/scitable/topic/cell-biology

2.https://plato.stanford.edu/entries/molecular-biology/

3.https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/bioinformatics

4.https://onlinelibrary.wiley.com/doi/book/10.1002/9780470686522

5.https://books.google.co.in/books?id=oe_liIY_tVsC&printsec=frontcover#v=onepage&q&f=false

Mapping with Programme Outcomes:

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

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

LABORATORY COURSE-III (COVERING CORE PAPERS VIII, IX AND X)

Title of the Course	**LABORATORY COURSE- III (Covering Core Papers VIII, IX & X)**						
Paper Number							
Category	Core	**Year**	II	**Credits**	4	**Course Code**	
		Semester	III				

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

Pre-requisite	Practicals pertaining to above subjects is important to get knowledge on overall cell structure, cellular organelles and staining procedures and fundamental principles of genetics and plant breeding.
Learning Objectives	1. Observe the different stages of mitosis and chromosome behaviour and organization during various stages and to learn staining techniques of various plant tissues.
	2. Explain the principles of linkage, crossing over and the hereditary mechanisms.
	3. Expose the students to gain recent advances in molecular biology.
	4. Understand the principles of plant breeding to apply crop improvement programmes
	5. Understand the principles of rDNA techniques.

UNIT	**EXPERIMENTS**
I	**CELL AND MOLECULAR BIOLOGY** 1. Identification of different stages of mitosis from suitable plant material. (Onion root tips, garlic root tips). 2. Identification of meiosis from suitable plant material. (Onion /Tradeschantia floral buds). 3. Isolation of cell organelles : Mitochondria, Chloroplast, Nucleus, Lysosomes and there assay by succinate dehydrogenase activity (Mitochondria), acid phosphatase activity (Lysosome), acetocarmine staining (Nucleus) and microscopic observation (Chloroplast) 4. Study of mitotic index from suitable plant material. 5. Study of cyclosis in cells of suitable plant material. 6. To study plant vacuole in cells of onion leaf peel. 7. Restriction digestion of DNA samples using restriction endonucleases (RE). 8. To study the structure and organization of plant cell in various tissues of various plants (incl. leaf, stem and roots).
II	**GENETICS** 1. Problem solving on dihybrid phenotypic, genotypic and test cross ratios. 2. Incomplete dominance in plants. 3. Interactions of factors and modified dihybrid ratios. 4. Multiple alleles in plants, blood group inheritance in human. 5. Sex linked inheritance in Drosophila and plants.

	6. Quantitative inheritance in plants. 7. Tetrad analysis in Neurospora. 8. Complementation analysis to find out complementation groups in viruses. 9. Chromosome mapping from three point test cross data. Calculation of chiasmatic interference. 10. Calculate gene and genotypic frequency by Hardy- Weinberg equation.
III	**PLANT BREEDING** 1. Techniques in plant hybridization.
IV	**rDNA TECHNOLOGY** 1. Isolation of genomic DNA. 2. Electrophoresis of nucleic acid. 3. Preparation of competent E.coli cells. 4. Transformation and recovery of plasmid clones. 5. Isolation of plasmid DNA.
V	**rDNA TECHNOLOGY** 1. Southern blot. 2. Plasmid insertion techniques 3. Recombinant plasmids

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Recall or remember the various aspects of cell biology, genetics, molecular biology, plant breeding and tissue culture.	K1
CO2	Understand various concepts of cell biology, genetics, plant breeding and tissue culture.	K2
CO3	Apply the theory knowledge gained into practical mode in order to acquire applied knowledge by day-to-day hands-on experiences.	K3
CO4	Analyze or interpret the results achieved in practical session in the context of existing theory and knowledge.	K4
CO5	Evaluate the theory and practical skills gained during the course.	K5 &K6

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

Recommended Text:

1. George M Malacinski. 2015. Freifelders Essentials of Molecular Biology (4th ed.). Jones & Bartlett.

2. Gupta P.K. 2017. Cell and Molecular Biology (5th ed.), Rastogi Publications, Meerut.
3. Gupta, P.K. 2018. Cytogenetics, Rastogi Publications, Meerut.
4. Kumar, H.D. 2007. Molecular Biology and Biotechnology, Vikas Publishing House, New Delhi.
5. Bharadwaj, D.N. 2012. Breeding of field crops (pp. 1-23). Agrobios (India).
6. Singh, R.J. 2016. Plant Cytogenetics. CRC press, US.
7. Jackson, S.A., Kianian, S.F., Hossain, K.G and Walling, J.G. 2012. Practical laboratory exercises for plant molecular cytogenetics. In Plant Cytogenetics (pp. 323-333). Springer, New York.
8. Shivakumar, S. 2002. Molecular analysis: Laboratory Manual. University press, Palkalai nagar, Madurai, India.

Reference Books:

1. Gardener, J, Simmons, H.J and Snustad, D.P. 2006. Principle of Genetics, John Wiley & Sons, New York.
2. De Robertis E.D.P. and De Robertis E.M.P. 2017. Cell and Molecular Biology (8thed.) (South Asian Edition), Lea and Febiger, Philadelphia, USA.
3. Jackson, S.A., Kianian, S.F., Hossain, K.G., and Walling, J. G. 2012. Practical laboratory exercises for plant molecular cytogenetics. In Plant Cytogenetics (pp. 323-333). Springer, New York, NY.
4. Glick, B.R and J.E. Thompson. 1993. Methods in Plant Molecular Biology and Biotechnology. CRC Press, Boca Raton, Florida.
5. Glover, D.M and B.D. Hames (Eds). 1995. DNA cloning 1: A Practical Approach; Core Techniques, 2nd edition PAS, IRL press at Oxford University Press, Oxford.
6. Gunning, B.E.S and M. W. Steer. 1996. Plant Cell Biology: Structure and function. Jones and Bartlett Publishers, Boston, Massachusetts.
7. Hackett, P.B. and J.A. Fuchs, J.W. Messing. 1988. An Introduction to Recombinant DNA Techniques: Basic Experiments in Gene Manipulation. The Benjamin/ Cummings Publishing Co., Inc Menlo Park, California. 8. Hall, RD. (Ed).1999. Plant Cell Culture Protocols. Humana Press, New Jersey.
8. Harris, N and K.J. Oparka. 1994. Plant cell Biology: A Practical Approach. IRL Press, At Oxford University Press, Oxford, UK.

9. Gelvin, S.B., Schilperoort, R.A. (Eds.). 2000. Plant Molecualr Biology Manual.
10. Henry, RJ. 1997. Practical applications of plant molecular biology, Chapman & Hall, London.
11. Krebs, J.E., Goldstein E.S. and Kilpatrick S.T. 2017. Lewin's GENES XII (12thed.). Jones & Bartlett Learning.

Web sources:

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

Mapping with Programme Outcomes:

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

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

CORE X : INDUSTRY MODULE - INDUSTRIAL BOTANY

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

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	1	-	3	4

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

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

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

Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)

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

Course outcomes: CO	On completion of this course, the students will be able to:	Programme outcomes
CO1	Understand the basics of algae in industrial applications.	K1
CO2	Demonstrate and to recollect the uses in fungi in industries.	K2
CO3	Explain bacterial role in industries.	K3
CO4	Compare and contrast the use of plants in industries.	K4
CO5	Discuss and develop skills for working in industries specializing in biomolecules.	K5 & K6

Recommended Text:

1. Trivedi, P.C. 2001. Algal Biotechnology. Point publisher, Jaipur. India.
2. Dinabandhu, S and Kaushik. B.D. 2012. Algal Biotechnology and Environment. I.K. International, New Delhi.
3. Poonam Singh and Ashok Pandey. 2009. Biotechnology for agro-Industrial residues utilization. Springer.
4. Dilip K. Arora. 2003. Handbook of Fungal Biotechnology. CRC Press book.
5. Vardhana, R. 2009. Economic Botany. 1st ed. Sarup Book Publishers Pvt Ltd. New Delhi.
6. Dubey R.C. 2004. A text book of Biotechnology aspects of microbiology, British Sun Publication.
7. Pelzer, M.J., Chan, E.C.S and Krieg, N.R. 1983. Microbiology , Tata MaGraw Hill Publishing House, New Delhi.
8. Narayanaswamy, S. 1994. Plant Cell and Tissue Culture. Tata McGraw Hill Ltd. New Delhi

Reference books:

1. Becker. E.W. 1994. Micro algae Biotechnology and Microbiology.Cambridge University press.
2. Borowitzka, M.A. and borowizka, L.J. 1996. Microalgal Biotechnology. Cambridge University Press, Cambridge,
3. Sahoo, D. 2000. Farming the ocean: seaweed cultivation and utilization. Aravali International, New Delhi.
4. Mahendra Rai. 2009. Advances in Fungal Biotechnology. I.K. International Publishing House, New Delhi.
5. Street, H.E. 1978. Essay in Plant Taxonomy, Academic Press, London, UK.
6. Alexander N. Glazer and Hiroshi Nikaido. 1994. Microbial Biotechnology.
7. Pandey, B.P. 2005. College Botany I: Including Algae, Fungi, Lichens, Bacteria, Viruses, Plant Pathology, Industrial Microbiology and Bryophyta. S Chand & Company.
8. Chichister, U.K.J. 1999. Cultivation and Processing of Medicinal Plants, Wiley & Sons
9. William Charles Evans.1989. Pharmacognosy, 14th ed. Harcourt Brace & Company.
10. Kumar, H. D. 1999. Introductory Phycology.Affiliated East-West Press, Delhi.

11. Das, and SandSaha, R. 2020. Microbiology Practical Manual.CBS Publishers and Distributors (P) Ltd., New Delhi, India.
12. Willie, J and Sherwood, L. 2016. Prescott's Microbiology McGraw-Hill Education; 10th Edition, ISBN: 978-1259281594
13. Reinert, J. Bajaj. T.P.S. 1977. Applied and Fundamental Aspects of Plant cell, tissue and organ Culture. Springer – Verlaug.

Web resources:

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

Mapping with Programme Outcomes:

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

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

ELECTIVE V- SECONDARY PLANT PRODUCTS AND FERMENTATION BIOTECHNOLOGY

Title of the Course	**SECONDARY PLANT PRODUCTS AND FERMENTATION BIOTECHNOLOGY**						
Paper Number	**ELECTIVE V**						
Category	ELECTIVE	**Year**	I	**Credits**	3	**Course Code**	
		Semester	III				

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

Pre-requisite	To know about the microbial culture in the manufacture of value added products.
Learning Objectives	1. To familiar with the basics of biochemistry and fermentation.
	2. Understand secondary metabolites.
	3. To enhance the knowledge and skills needed for self-employment using the microbial derived products.
	4. Apply the microbial culture in the manufacturing of value added products.
	5. Critically analyze the types of bioreactors and the fermentation process.

UNIT	**CONTENTS**
I	**SECONDARY METABOLITES:** A brief account of acetate malonate, acetate mevalonate and shikimic acid pathways. Categories of phytochemicals – Phenols, alkaloids, flavonoids, terpenoids, steroids, glycosides, carbohydrates, proteins, amino acids, lipids, pigments, vitamins and other related compounds.
II	**MICROBIAL GROWTH:** Factors affecting microbial growth; Stoichiometry: Mass balances; Stoichiometry: energy balances; Growth kinetics; Measurement of growth.
III	**BIOREACTORS:** Introduction to bioreactors; Batch and Fed-batch bioreactors, Continuous bioreactors; Immobilized cells; Bioreactor operation; Sterilization; Aeration; Sensors; Instrumentation; Culture-specific design aspects: plant/mammalian cell culture reactors. Bioseparations: Biomass removal; Biomass disruption; Membrane-based techniques; Extraction; Adsorption and Chromatography Industrial Processes and Process economics: Description of industrial processes; Process flow sheeting; Process economics.
IV	**DOWNSTREAM PROCESSING:** Biomass removal and disruption; Centrifugation; sedimentation; Flocculation; Microfiltration; Sonication; Bead mills; Homogenizers; Chemical lysis; Enzymatic lysis; Membrane based purification: Ultrafiltration ; Reverse osmosis; Dialysis ; Diafiltration; Pervaporation; Perstraction; Adsorption and chromatography: size,

	charge, shape, hydrophobic interactions, Biological affinity; Process configurations (packed bed, expanded bed, simulated moving beds); Precipitation (Ammonium Sulfate, solvent); Electrophoresis(capillary); Crystallization; Extraction (solvent, aqueous two phase, super critical), Drying; Case studies.
V	**IMPORTANT PRODUCTS THROUGH FERMENTATION:** Organic acids citric acid acetic acid, enzymes – amylase, protease, lipase, antibiotics – penicillin, vitamins – B_{12}, amino acids – glycine, glutamic acid, organic solvenst – ethanol, butanol, acetone, alcoholic beverages – wine, beer, biomass – bakers yeast, biosurfactants, biopesticides, biopolymers.

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Critically analyze the types of bioreactors and the fermentation process.	K1
CO2	Evaluate the role of microorganisms in industry.	K2
CO3	Analyze the types of bioreactors.	K3
CO4	Create to understand the significance of intrinsic and extrinsic factors on growth of microorganism.	K4
CO5	Evaluate the concept of downstream processing.	K5 & K6
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper). Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)		
Skills acquired from this course: Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill		

Recommended Text:

1. Shuler, M. L and F. Kargi. 2002. *Bioprocess Engineering*, Prentice Hall Inc.
2. Doran, P.M. 1995. *Bioprocess Engineering Principles*, Elsevier.
3. Kaufman, P.B. L. J. Cseke, S. Warler, J. A. Duke, and H. L. Brielmann. 1999. *Natural Products from Plants*, CRC Press LLC.
4. Casia, J.R.L.E. 2009. Industrial Microbiology. New Age International (P) Ltd. Publisher, New Delhi.
5. Stanbury, P. F., Whitaker, A. and Hall, S.J. 1979. Principles of Fermentation Technology. Aditya Books (P) Ltd., New Delhi.
6. Potter, N. N. 2007. Food Science. CBS Publishers.

Reference books:

1. Rehm, H. J and G. Reed, *Biotechnology-A multi- Volume Comprehensive Treatise*, 2nd Ed, Vol 3, Wiley-VCH, 1993
2. Moo-Young, M. 2004. *Comprehensive Biotechnology,* Vol. 2, Pergamon Press,

3. Dicosmo, F and M. Missawa, 1996. *Plant Cell Culture Secondary Metabolism: Towards Industrial Application*. CRC LLC.
4. Frazier, W.C. and Weshoff, D.C. (2015). Food Microbiology (5th edition) McgrawHill.
5. Kumari, S. 2012. Basics of Food Biochemistry and Microbiology. Koros Press.
6. Whitaker. J.R. 2016. Handbook of Food Enzymology. CRC press
7. Shewfelt, R.L.2013. Introducing Food Science. CRC Press.
8. Smith, J.S and Hui, Y.H.2014. Food Processing. Wiley.
9. Varzakas, T and Tzia, C. 2016. Handbook of Food Processing. CRC Press.

Web resources:

1. https://link.springer.com/book/9783642673627
2. https://www.elsevier.com/books/secondary-plant-products/stumpf/978-0-12-675407-0
3. https://www.amazon.in/Secondary-Plant-Products-Comprehensive-Biochemistry-ebook/dp/B01E3II0E2
4. https://www.pdfdrive.com/principles-of-fermentation-technology-e40900163.html
5. https://link.springer.com/book/10.1007/978-3-030-16230-6

Mapping with Programme Outcomes:

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

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

ELECTIVE V - ENTREPRENEURIAL OPPORTUNITIES IN BOTANY

Title of the Course	**ENTREPRENEURIAL OPPORTUNITIES IN BOTANY**						
Paper Number	**ELECTIVE V**						
Category	ELECTIVE	**Year**	I	**Credits**	3	**Course Code**	
		Semester	III				

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

Pre-requisite	To understand the importance of floriculture and nursery management.
Learning Objectives	1. Understand the different classifications of horticultural crops, nursery management, and use of technology in horticulture.
	2. Develop their competency on pre and post-harvest technology in horticultural crops.
	3. Analyze the different methods of weed control and harvest treatments of horticultural crops.
	4. Examine the economic implications of cultivation of tropical and sub-tropical vegetable crops.
	5. Evaluate the importance of floriculture and contribution spices and condiments on economy.

UNIT	**CONTENTS**
I	Organic manures and fertilizers. Composition of fertilizer, NPK content of various fertilizers. Common organic manures bone meal, cow dung, poultry waste, oil cakes, organic mixtures and compost. Preparation of compost, aerobic and anaerobic – advantages. Vermicompost preparation, vermiwash. Panchakaviyam.
II	Common garden tools. Methods of plant propagation by seeds. Vegetative propagation, cutting, grafting, budding and layering. Use of growth regulators for rooting.
III	Gardening – types of garden, ornamental, indoor garden, kitchen garden, terrace garden, vegetable garden for marketing. Rockery and artificial ponds. Ornamental garden designing, garden components flower beds, borders, hedges, edges, drives, paths, garden adornments.
IV	Packaging of fruits, vegetables. Preservation techniques drying, heat treatment, low temperature storage and by chemicals. Preparation of wine, vinegar and dairy products.
V	Significance of mushrooms. Types of mushrooms (button mushroom, oyster mushroom). Spawn isolation and preparation. Cultivation. Value added products from mushroom – pickles, candies and dried mushrooms.

Course outcomes: CO	On completion of this course, the students will be able to:	Programme outcomes
CO1	Students can acquire knowledge about organic farming and their advantages	K1
CO2	Analyze both the theoretical and practical knowledge in understanding various horticultural techniques.	K2
CO3	To develop kitchen garden or terrace garden in their living area.	K3
CO4	Evaluate the horticultural techniques to students can develop self employment and economical improvement.	K4
CO5	Create and develop skills for mushroom cultivation.	K5 & K6

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

Recommended Text:

1. Chmielewski, J.G and Krayesky, D. 2013. General Botany laboratory Manual. Author House, Bloomington, USA.
2. Russell, T. 2012. Nature Guide: Trees: The world in your hands(Nature Guides). Mukherjee D. Gardening in India, Oxford IBH publishing co, New Delhi.
3. Kumar, N. 1997. Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
4. Webster, J and Weber, R. 2007. Introduction to Fungi, 3rd Ed. Cambridge UniversityPress, Cambridge.
5. Bendre, M. Ashok and Ashok Kumar, A. 2020. Text Book of Practical Botany 1 10th ed).Rastogi Publications, Meerut.
6. Singh, R and U.C. Singh 2020. Modern mushroom cultivation, 3d Edition Agrobios (India), Jodhpur.

Reference Books:

1. Adams, C.R. Banford, K.M. and Early, M.P. 1993. Principles of Horticulture.
2. Sathe, T.V. 2004. Vermiculture and Organic farming, Daya Publishers.
3. Peter, K.V. 2017. Basic Horticulture.
4. Hartman, H.T. and D.F. Kestler. 1976. Plant propagation principles and practice. Prentice Hall of India, New Delhi.
5. Jules Janick, 1982. Horticulture Science. Surjeet publications, New Delhi.
6. Ignacimuthu, S.1998. Plant Biotechnology. Tata Mc Graw Hill Ltd., New Delhi.
7. Gupta. P.K., 1998. Elements of Biotechnology. Rastogi publications, Meerut.
8. Edmond Musser and Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
9. Janick Jules. 1979. Horticultural Science.(3rd Ed.),W.H.Freeman and Co.,San Francisco, USA.

Web resources:
1. https://www.kobo.com/in/en/ebook/composting-process-organic-manures-through-eco-friendly-waste-management-practices 2. https://books.google.co.in/books/about/Plant_Propagation.html?id=K-gQh6OI7GcC&redir_esc=y 3. https://www.ebooks.com/en-us/subjects/gardening/ 4. https://www.amazon.in/Preservation-Techniques-Publishing-Technology-Nutrition-ebook/dp/B00RXCXB3Q 5. https://www.elsevier.com/books/food-preservation-techniques/zeuthen/978-1-85573-530-9

Mapping with Programme Outcomes:

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

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

ELECTIVE V

APPLIED PLANT CELL & TISSUE CULTURE

Title of the Course	**APPLIED PLANT CELL & TISSUE CULTURE**						
Paper Number	**ELECTIVE V**						
Category	ELECTIVE	**Year**	I	**Credits**	3	**Course Code**	
		Semester	III				

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

Pre-requisite	The course will equip students to either obtain employment in the field or start their own business there, depending on the needs of the industry.
Learning Objectives	1. To comprehend the basic principles and methodologies of plant tissue culture.
	2. To acquire knowledge on *in vitro* cultivation techniques to develop protocols targeted towards commercialization.
	3. To gain understanding of the various techniques of tissue culture for secondary metabolites production. .
	4. To recognize the worth of traditional germplasm and receive training in preserving and enhancing crop varieties to meet consumer demand and global legal policies.
	5. To impart practical information on plant tissue culture in order to produce labour suitable for the demands of the industry and research facilities

UNIT	**CONTENTS**
I	**BASIC PLANT TISSUE CULTURE:** Totipotency and concepts of plant tissue culture – Laboratory organization – Design of different laboratories and management - Aseptic techniques - Plant culture media – Inorganic nutrients – Macronutrients – Micronutrients - Carbon and energy sources – Organic supplements – Growth regulators – Solidifying agent – MS medium and B5 medium – Explant preparation - Methods of sterilization – Transfer and incubation of culture – Transplantation area.
II	**MICROPROPAGATION:** Micropropagation – Stages of micropropagation - Multiplication by axillary and apical shoots – Multiplication by adventitious shoots – Multiplication through callus culture – Organogenesis and somatic embryogenesis – Multiplication and Rooting - Hardening - Factors effecting micropropagation – Technical problems in micropropagation - Practical applications of micropropagation – Somaclonal & gametoclonal variation – synthetic seed technology - Shoot tip/Meristem culture for virus free plants.

III	**CELL AND PROTOPLAST CULTURES AND HAPLOID PRODUCTION:** Single cell and cell suspension culture – Applications - Production of haploids - Anther culture and pollen culture – Induction of haploids from un-pollinated ovaries and ovules – Role of haploids in Plant breeding - Protoplast culture: Protoplast isolation, purification – regeneration – culturing. Protoplast fusion techniques – somatic hybridization and cybridization - Applications of protoplast culture and hybridization.
IV	**METABOLIC ENGINEERING:** Application of cell culture systems in metabolic engineering - advantages of cell, tissue and organ culture as a source of secondary metabolites - Hairy root culture - Screening of high yielding cell lines - Procedures for extraction of high value industrial products – Alkaloids, food additives and insecticides in *in vitro* system.
V	**CRYOPRESERVATION AND BIOREACTORS:** Germplasm storage and conservation – Methods of in vitro conservation – Cryopreservation and steps involved in cryopreservation of plant materials - Types of bioreactors (Stirred tank and airlift) and their uses - Industrial scaling – Upstream and downstream processing - Manipulation in production profile by biotic and abiotic elicitation – Biotransformation – Food vaccines, bioplastics, plantibodies, plantigens - Applications of tissue culture in agriculture, Horticulture and forestry.

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Recall the principles and culture techniques of cells, callus, organs, pollen, anthers, embryos and protoplasts.	K1
CO2	Understand the techniques used in plant growth and regeneration under *in vitro* conditions.	K2
CO3	Apply the role plant tissue culture techniques in the production some secondary metabolites and planting stock in horticulture.	K3
CO4	Analyze the conditions that are suitable for direct and indirect plant regeneration.	K4
CO5	Evaluate the self-skills obtained during the course thorough internal and external assessment systems.	K5
CO6	Create idea to seek for suitable job in relevant industries/research centers or to become a potential entrepreneur based on knowledge achieved during the course.	K6
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper). Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour).		

Recommended Text:

1. Narayanaswamy, S. 1999. Plant cell and tissue culture. 8th edn. Tata McGraw Hill Publ. ISBN 0074602772.
2. Bhojwani, S.S and Razdan, M.K. 2004. Plant Tissue Culture, Read Elsevier India Pvt. Ltd. ISBN 818147 3256.
3. Trigiano, R.N and D.J. Gray (eds.). 2000. Plant tissue culture concepts and laboratory exercises. CRC Press. (Textbook). 2nd Edition.
4. Kyte, M and Kleyn, J. 1996. Plant from test tubes. Timber Press. Auge, R. et al., 1995. In vitro culture and its applications in horticulture. Science Publishers, Inc.
5. Auge, R. 1995. In vitro culture and its applications in horticulture. Science Publishers, Inc.
6. Gamborg, O.L. and G.C. Phillips (eds). 1995. Plant cell, tissue and organ culture. Springer Lab Manual.
7. Khasim, S.M. 2002. Botanical Microtechnique: Principles and Practice, Capital Publishing Company, New Delhi.
8. Srivastava, P.S. 1998. Plant Tissue Culture and Molecular Biology. N.R. Book Distributors, New Delhi.
9. Vinay Sharma and Afroz Alam. 2019. Plant Tissue Culture. Wiley.
10. Pullaiah, E., Rao, T., M.V. Subba, Sreedev. 2017. Plant Tissue Culture: Theory and Practicals. Scientific Publishers.
11. Chawla, H.S. 2009. Introduction to plant biotechnology, 3rd edition, Oxford and IBH publishing, New Delhi.
12. Gupta, S.D and Ibaraki, Y. 2006. Plant tissue culture engineering (Vol. 6). Springer Science & Business Media, Germany.
13. Razdan, M.K. 2015. Introduction to Plant Tissue Culture, 3rd edition. Oxford and IBH publishing, New Delhi.
14. Rober, H. Smith. 2013. Plant Tissue Culture: Techniques and Experiments, Academic Press, Elsevier.
15. Robert, N. Trigiano and Dennis, J and Gray (Eds.). 2011. Plant Tissue Culture, Development, and Biotechnology, CRC Press, Taylor & Francis Group.

Reference Books

1. Bhojwani, S. S and Dantu, P.K. 2013. Plant tissue culture: an introductory text (Vol. 318). New Delhi, India: Springer.
2. Vasil, I.K. and Thorpe, T.A. 1994. Plant Cell and Tissue Culture, Kluwer Academic Press, The Netherlands.
3. Loyola-Vargas, V.M. Ochoa-Alejo, N. 2016. Somatic embryogenesis: Fundamental aspects and applications, Springer international publishing, Switzerland.
4. Elhiti, M., Stasolla, C and Wang, A. 2013. Molecular regulation of plant somatic embryogenesis. In Vitro Cellular & Developmental Biology-Plant, 49(6), 631-642
5. Collins, H.A. and Edwards, S. 1998. Plant Cell Culture, Bios Scientific Publishers, Oxford, UK.
6. Hall, R.D. (Ed.). 1999. Plant Tissue Culture: Techniques and Experiments, Academic Press, New York.
7. Kartha, K.K. 1985. Cyropreservation of plant cells and organs. CRC Press, Boca Raton, Florida.
8. Rihan, H.Z., Kareem, F., El-Mahrouk, M.E., and Fuller, M.P. 2017. Artificial seeds (principle, aspects and applications). Agronomy, 7(4), 7.

9. Pullaiah, T. 2009. Plant Tissue Culture: Theory and Practicals, Scientific Publishers Journals Dept.Timir Baran Jha and Biswajit Ghosh. 2016. Plant Tissue Culture: Basic and Applied, Platinum Publishers; 2nd Edn.
10. Anis Mohammad and Ahmad Naseem. 2016. Plant Tissue Culture: Propagation, Conservation and Crop Improvement, Springer. Singapore.
11. Loyola-Vargas, V.M and Vázquez-Flota, F. 2006. Plant cell culture protocols (Vol. 318). USA: Humana Press, New Jersey.
12. Mba, C., Afza, R., Bado, S., and Jain, S.M. 2010. Plant Cell Culture: Essential Methods, John Wiley & Sons, UK.
13. Abdin, M.Z., Kiran, U., Kamaluddin, M., Ali, A. (Eds.). 2017. Plant Biotechnology: Principles and Applications, Springer publishers.
14. Fett-Neto, Arthur Germano (Ed.). 2016. Biotechnology of Plant Secondary Metabolism: Methods and Protocols, Springer publishers.
15. Smith, R.H. 2012. Plant tissue culture: techniques and experiments. Academic Press, UK.
16. Trigiano, R. N., and Gray, D. J. 2011. Plant tissue culture, development, and biotechnology. CRC Press, US.
17. Kartha, K.K. 1985. Cryopreservation of Plant Cells and Organs. CRC Press, Boca Raton, Florida, USA.

Web resources:

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

Mapping with Programme Outcomes:

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

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

ELECTIVE V - SILVICULTURE AND COMMERCIAL LANDSCAPING

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

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

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

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

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

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	To understand the importance and divisions of horticulture.	K1
CO2	Demonstrate the art of floriculture and landscape gardening.	K2
CO3	Explain plant propagation and fruit crop cultivation.	K3
CO4	Compare and contrast the vegetable cultivation and kitchen gardening.	K4
CO5	Discuss and develop skills for effective understanding on landscaping and components of gardens.	K5 & K6

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

Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved

(To be discussed during the Tutorial hour)

Skills acquired from this course.

Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

1. Edmond, J.B. 1977. Fundamentals of Horticulture. Tata McGraw Hill Publishers Co. Ltd., New Delhi.
2. Kumar, N. 2017. Introduction to Horticulture, Midtech Publisher.
3. Manibushan Rao, K. 1991. Textbook of Horticulture. Macmillan Publishing Co., New York.
4. Rao, K.M. 2000. Text book of Horticulture. Macmillan India Ltd, New Delhi.
5. George, A. 2002. Horticulture Principles and Practices. 2nd Edition. Pearson Education, Delhi.
6. Bohra, M.P.S. and Arora, 2017. Introduction to Horticulture, 2 nd Edition.
7. Singh, J. 2018. Fundamentals of Horticulture. Kalyani Publishers.
8. Acquaah, J. 2009. Horticulture – principles and practices, 4th edition, PHI learning Pvt. Ltd.

9. Rao Manibhushan K. 1991. Textbook of horticulture. MaC Millan India Ltd.
10. Gangulee H. C. and Kar A. K. 2004. College Botany Vol II, New Central Book Agency
11. Sharma V. K. 1999. Encyclopaedia of Practical Horticulture, Vol I –IV, Deep And Deep Publ. Pvt. Ltd.

Reference books:

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

Web Resources:

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

Mapping with Programme Outcomes:

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

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

Skill Enhancement (SE1)

Seminar paper (Open Choice)

Professional Communication Skill

Title of the Course	**Seminar paper** (or)**Professional Communication Skill**						
Paper Number	**ELECTIVE V**						
Category	ELECTIVE	**Year**	I	**Credits**	2	**Course Code**	
		Semester	III				
Instructional Hours per week		**Lecture**		**Tutorial**	**Lab Practice**	**Total**	
		3		-	--	5	

IV Semester

CORE 11 : PLANT PHYSIOLOGY AND PLANT METABOLISM

Title of the Course	**PLANT PHYSIOLOGY AND PLANT METABOLISM**						
Paper Number	**CORE XI**						
Category	Core	**Year**	II	**Credits**	4	**Course Code**	
		Semester	IV				

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

Pre-requisite	Basic knowledge on physiological processes in plants.
Learning Objectives	1. To acquire knowledge on the functional aspects of plants.
	2. To understand the biophysical and biochemical processes of plants.
	3. To study the metabolism of plants.
	4. To learn the plant growth regulations.
	5. To know the adaptive mechanisms of plants in adverse environmental conditions.

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

	Physiology and Biochemistry of nitrogen fixation State Integrated Board of Studies – Botany PG 40.
IV	Growth and development – Phases of plant growth – growth types- Growth substances - Auxins, gibberellins, cytokinins, abscisic acid, ethylene, brassinosteroids - physiological effect and mechanism of action in agricultural and horticultural crops – Photoperiodism – Classification of plants and mechanism of flowering – Phytochrome and their action on flowering – Vernalization- Mechanism and its practical application, biological rhythms and movements. Seed dormancy and causes and Seed germination and their biochemical changes.
V	Plant senescence –Types and Mechanism of senescence- Abscission: Morphological and biochemical changes – Significance. Fruit ripening- Biochemical, Physiological changes and control of fruit ripening. Plant response to environmental stress: Biotic and Abiotic stress – Water, temperature, light and salinity- Adaptive mechanism to various stresses (avoidance, escape, tolerance)–stress responsive proteins – anti-oxidative mechanism.

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

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

Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved
(To be discussed during the Tutorial hour).

Skills acquired from this course.

Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

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

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

Reference Books:

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

Web resources:

1. https://www.sciencedirect.com/topics/agriculture-and0biological-sciences/plant-physiology.
2. https://learn.careers360.com/biology/plant-physiology-chapter/
3. https://www.biologydiscussion.com/plants/plant-physiology/top-6-processes-of- plant- physiology/24154.
4. https://apan.net/meetings/apan45/files/17/17-01-01-01.pdf

5. https://basicbiology.net/plants/physiology
6. https://learn.careers360.com/biology/plant-physiology-chapter/4
7. https://swayam.gov.in/nd2_cec20_bt01/preview
8. https://www.nature.com/subjects/plant-physiology

Mapping with Programme Outcomes:

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

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

Core XII : BIOCHEMISTRY & APPLIED BIOTECHNOLOGY

Title of the Course	**BIOCHEMISTRY & APPLIED BIOTECHNOLOGY**						
Paper Number	**CORE XII**						
Category	Core	**Year**	II	**Credits**	4	**Course Code**	
		Semester	IV				

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

Pre-requisite	Basic knowledge on primary and secondary plant metabolites and enzymes. To empower students recognize and appreciate the basic principles that sustain biotechnology as an interdisciplinary domain of learning and research.
Learning Objectives	1. To study the fundamentals and significance of Plant Biochemistry.
	2. To know the structure and properties of plant biomolecules.
	3. To learn the fundamental and applications of Plant Biotechnology.
	4. To study the mechanism of enzyme action and inhibition.
	5. To expose the students on the fundaments of genetic transformation.

UNIT	**CONTENTS**
I	Atomic structure: chemical bonds - ionic bond, covalent bond, coordinate covalent bond, hydrogen bond, hydrogen ion concentration (pH), buffers. Thermodynamics principle, First Law of Thermodynamics a) energy (b) Enthalpy (ii) second law of thermodynamics (a) Spontaneity and disorder (b) entropy (c) free energy, redox potential, dissociation and association constant, activation energy, binding energy.
II	Photosynthesis: The physical nature of light – the absorption and fate of light energy – absorption and action spectra- photoreceptors- Ultra structure and biochemical compartmentation of Chloroplast; Biomolecules and Enzymes: Classification of carbohydrates; Structure and properties of monosaccharides, Oligosaccharides, Polysaccharides – Glycoproteins. Protein and Amino acids: Structure, Classification and properties; Peptides - Structure: Primary, secondary, Ramachandran plot, tertiary and quaternary structures. Classification of Lipids: Structure and properties of fatty acids, phospholipids, glycolipids, lipoproteins, cholesterol - structure and functions.
III	Enzymes- Classification and nomenclature chemical nature of enzymes – factors affecting enzyme action – Michaelis – Menton constant, MM equation, Lineweaver Burk plot, Enzyme inhibition, co enzymes- mechanism of enzyme action, isoenzymes. Secondary Metabolites: Structure, classification and properties of alkaloids, steroids, terpenoids, flavonoids. Glycosides - their chemical nature and role.

IV	Transgenic plants - pest resistance, herbicidal resistance, Disease resistant, abiotic and biotic stress tolerant, in improving crop yield, food quality- Golden rice, Edible vaccines, Virus and Bacteria based transient gene expression systems. Virus induced gene complementation, Virus State Integrated Board of Studies – Botany PG 42 induced gene silencing. Cytoplasmic male sterility and fertility restoration, terminator Seed technology, antisense technology for Delayed fruit ripening, Plants as factories for useful products and pharmaceuticals.
V	Screening of Biotransformants - Fermentation techniques- Types. Industrial Production of enzymes-amylase, protease & lipase and their applications. Immobilization for enzymes production. Antibiotic Penicillin production. Amino acid - Glutamic acid production. Production of Alcohol and Xanthan Gum. Bioreactors for culturing Plant cells and production of Secondary metabolites, Super bug and its role in biodegradation. Bioremediation - *In situ* and *Ex situ*.

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Knowledge on the fundamentals and significance of Plant Biochemistry	K1
CO2	Understanding on the structure and properties of plant biomolecules.	K2
CO3	Explain the role of enzymes in plants.	K3
CO4	Compare and contrast the methods of transgenic plants production and natural plants.	K4
CO5	Discuss and develop skills for effective utilization of microbial/plant enzymes and their role in biological cells.	K5 & K6

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

Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved

(To be discussed during the Tutorial hour).

Skills acquired from this course.

Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

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

8. Kumar, Pradeep. 2018. Advances in Microbial Biotechnology: Current Trends and Future Prospects. 10.1201/9781351248914.

Reference Books

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

Web sources:

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

Mapping with Programme Outcomes:

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

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

LABORATORY COURSE- IV COVERING CORE PAPERS XI & XII

Title of the Course	**LABORATORY COURSE- IV** Covering Core Papers XII & XIII						
Paper Number							
Category	Core	**Year**	II	**Credits**	4	**Course Code**	
		Semester	IV				

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

Pre-requisite	Practicals pertaining to above subjects is important to get knowledge on various physiological functions of plants.
Learning Objectives	1. Extract bimolecule of diverse nature from different sources so that they will be able to assess the metabolic profile of their source material.
	2. Recognize the role that water plays in several physiological processes in plants.
	3. To learn the fundamental and applications of Plant Biotechnology.
	4. Learn about chromatographic techniques.
	5. Expose the students to gain recent advances in molecular biology.

UNIT	**EXPERIMENTS**
I	**PLANT PHYSIOLOGY** 1. Determination of osmotic potential by plasmolytic method. 2. Determination of water potential using gravimetric method. 3. Determination of water potential using dye method (Chardakov's method). 4. Effect of Monochromatic light on apparent photosynthesis. 5. Effect of CO_2 concentration on apparent photosynthesis.
II	**PLANT PHYSIOLOGY** 1. Effect of temperature on protoplasmic membrane. 2. Separation of chloroplast pigments using paper chromatographic technique. 3. Estimation of chlorophyll content using Arnon's method. 4. Determination of rate of photosynthesis using O_2 electrode.
III	**BIOCHEMISTRY** 1. Rice coleoptile growth test for Indole Acetic Acid. 2. Effect of auxin on root initiation. 3. Experiments to show the heribicidal action of Auxin (2-4,D). 4. Effect of synthetic Cytokinin on the destruction of chlorophyll.
IV	**BIOCHEMISTRY** 1. Estimation of Carbohydrates, Protein, Lipid by standard methods.
V	**APPLIED BIOTECHNOLOGY** 1. Isolation of genomic DNA. 2. Electrophoresis of nucleic acid. 3. Preparation of competent *E.coli* cells. 4. Transformation and recovery of plasmid clones.

Course outcomes: CO	On completion of this course, the students will be able to:	Programme outcomes
CO1	Perform quantitative tests for all major macro molecules and file a report of chemical profile of a plant cell.	K1
CO2	Analyze the structure and properties of various enzymes.	K2
CO3	Understand the fundamentals of water and its relation to plants.	K1 & K3
CO4	Understand the role of pigment in photosynthetic mechanism and related events of plants.	K4
CO5	Evaluate the theory and practical skills gained during the course and create idea to seek for suitable job in relevant industries.	K5 & K6

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

Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour).

Skills acquired from this course.

Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

1. Plummer, D. 1988. An introduction to Practical Biochemistry, Tata McGraw–Hill Publishing Company Ltd., New Delhi.
2. Palanivelu, P. 2004. Laboratory Manual for analytical biochemistry and separation techniques, School of Biotechnology, Madurai Kamaraj University, Madurai.
3. Jayaraman.J.1981. Laboratory Manual in Biochemistry. Whiley Eastern Limited, New Delhi.
4. Bendre, A.M. and Ashok Kumar, 2009. A text book of practical Botany. Vol. I & II. Rastogi Publication. Meerut. 9th Edition.
5. Manju Bala, Sunita Gupta, Gupta NK. 2012. Practicals in Plant Physiology and Biochemistry. Scientific Publisher.
6. Joy, P.P., Surya, S and Aswathy, C. 2015. Laboratory Manual of Biochemistry, Agricultural University, Pineapple Research Station, Ernakulam, Kerala.
9. Poonam Sharma – Natu, Vijay Paul and P.S. Deshmukh. 2021. Laboratory manual Experimental Plant Physiology. Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi.
10. George M Malacinski. 2015. Freifelders Essentials of Molecular Biology (4th ed.) Jones

& Bartlett.

11. Gupta P.K. 2017. Cell and Molecular Biology (5th ed.), Rastogi Publications, Meerut.
12. Kumar, H.D. 2007. Molecular Biology and Biotechnology, Vikas Publishing House, New Delhi.
13. Shivakumar, S. 2002. Molecular analysis: Laboratory Manual. University press, Palkalai nagar, Madurai, India.

Reference books:

1. Bala, M., Gupta, S., Gupta, N.K and Sangha, M.K. 2013. Practicals in plant physiology and biochemistry. Scientific Publishers (India).
2. Wilson, K and J. Walker (Eds). 1994. Principles and Techniques of Practical Biochemistry (4th Edition) Cambridge University Press, Cambridge.
3. Bendre, A.M and Ashok Kumar. 2009. A text book of practical Botany. Vol. I & II. Rastogi Publication. Meerut. 9th Edition.
4. Manju Bala, Sunita Gupta, Gupta, N.K. 2012. Practicals in Plant Physiology and Biochemistry. Scientific Publisher.
5. Wilson, K and J. Walker. 2005. Principles and Techniques of Practical Biochemistry, 5th Edition. Cambridge University press, New York.
6. Rodney Boyer. 2000. Modern Experimental Biochemistry, 3rd Edition. Published by Addison Wesley Longman. Singapore.
7. Bala, M., Gupta, S., Gupta, N.K and Sangha, M.K. 2013. Practicals in plant physiology and biochemistry. Scientific Publishers (India).
8. Manju Bala, Sunita Gupta, Gupta, N.K. 2012. Practicals in Plant Physiology and Biochemistry. Scientific Publisher.
9. Wilson, K and J. Walker. 2005. Principles and Techniques of Practical Biochemistry, 5th Edition. Cambridge University press, New York.
12. Rodney Boyer. 2000. Modern Experimental Biochemistry, 3rd Edition. Published by Addison Wesley Longman. Singapore.Glick, B.R and J.E. Thompson. 1993. Methods in Plant Molecular Biology and Biotechnology. CRC Press, Boca Raton, Florida.
13. Glover, D.M and B.D. Hames (Eds). 1995. DNA cloning 1: A Practical Approach; Core

Techniques, 2nd edition PAS, IRL press at Oxford University Press, Oxford.

14. Hackett, P.B. and J.A. Fuchs, J.W. Messing. 1988. An Introduction to Recombinant DNA Techniques: Basic Experiments in Gene Manipulation. The Benjamin/ Cummings Publishing Co., Inc Menlo Park, California. 8. Hall, RD. (Ed).1999. Plant Cell Culture Protocols. Humana Press, New Jersey.
15. Gelvin, S.B., Schilperoort, R.A. (Eds.). 2000. Plant Molecualr Biology Manual.

Web resources:

1. file:///C:/Users/User/Downloads/2021%20Botany%20Syllabus%20after%20BoS%20formatted1%20(1).pdf
2. https://kau.in/document/laboratory-manual-biochemistry
3. https://www.amazon.in/Practical-Manual-on-Plant-Biochemistry/dp/6200539790
4. https://www.amazon.in/Laboratory-Manual-Physiology-Mukesh-Amaregouda/dp/6133993502
5. https://www.kopykitab.com/A-Laboratory-Manual-of-Plant-Physiology-Biochemistry-and-Ecology-by-Akhtar-Inam
6. https://www.kopykitab.com/Cell-And-Molecular-Biology-A-Lab-Manual-by-K-V-Chaitanya

Mapping with Programme Outcomes:

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

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

LECTIVE VI-ORGANIC FARMING

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

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

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

UNIT	**CONTENTS**
I	**AGRONOMY:** Organic farming- concept, characteristics, significance, organic ecosystem, scope of organic farming in India - Principles and types of organic farming. Choice of crops & varieties in organic farming - Initiative by Govt/NGOs/Other organizations for promotion of organic farming Operational structure of NPOP (National Programme for Organic Production) - Concept of dryland agronomy Organic nutrient resources & their fortification, restriction to nutrient use in organic farming - Organic production methods for cereals, vegetables and fruit crops
II	**SOIL SCIENCE:** Organic farming for sustainable agriculture; Manures- compost, methods of composting - Green manuring, vermicompost and biofertilizer. Harmful effect of non-judicious chemical fertilization - Organic farming practices for improving soil health. Quality parameters of organic manures and specifications - Soil fertility in organic farming systems. Manure preparation methodology - Soil improvement.
III	**FUNDAMENTAL OF ORGANIC FARM MANAGEMENT:** Land management in organic farming - Water management in organic farming. Organic insect disease management - Organic pest disease management. Preventive and cultural methods for insects and pest control - Identification of different fungal and bacterial biocontrol agents.

	Indigenous technical knowledge for insects-pest, disease - Weed and nutrient management in organic farming
IV	**POST HARVEST MANAGEMENT:** Processing, labeling of organic produce - Storage and transport of organic produce.
V	**ORGANIC QUALITY CONTROL STANDARDS:** Certification- types, process & procedure and agencies. Quality aspect and grading - Packaging and handling. Economic considerations and viability of organic products - Export of organic product and marketing

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

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

Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved

(To be discussed during the Tutorial hour).

Skills acquired from this course.

Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill.

Recommended Text:

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

Reference books:

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

Publishing.

Web resources:

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

Mapping with Programme Outcomes:

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

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

ELECTIVE VI- FORESTRY AND WOOD TECHNOLOGY

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

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

Pre-requisite	Prior knowledge on trees, forests and their importance.
Learning Objectives	1. To study various aspects of Forest Botany.
	2. To understand the importance and different forests and plants species.
	3. To know the ecological significance of forests.
	4. To enable the students to information on forests laws.
	5. To raise student awareness of the need to create a sustainable way of living and the current Global issues with forestry caused by human interference.

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

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

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Knowledge on various aspects of Forest Botany	K1
CO2	Understand the importance and of different forests.	K2
CO3	Analyze the ecological significance of forests	K3
CO4	To understand the dynamics of the forest.	K4
CO5	Understanding on various Indian forests laws and acts.	K5 &K6

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

Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour).

Skills acquired from this course.

Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill.

Recommended Text:

1. Manikandan, K and S. Prabhu. 2013. Indian forestry, a breakthrough approach to forest service. Jain Bros.
2. Roger Sands. 2013. Forestry in a global context, CAB international.
3. Balakathiresan. S.1986. Essentials of Forest Management. Natraj Publishers, Dehradun.
4. Agarwala, V.P. 1990. Forests in India, Environmental and Protection Frontiers. Oxford & IBH Publishing Co. New Delhi.
5. Chundawat, B.S. and Gautham, S.K. 1996. Text book of Agro forestry. Oxford and IBH publisher, New Delhi.
6. Singhi, G.B. 1987. Forest Ecology of India, Publisher: Rawat.
7. Ramprakash. 1986. Forest management. IBD Publishers, Debra Dun.
8. Tiwari, K.M. 1983. Social forestry in India. Nataraj Publishers, Dehra Dun.
9. WWF. 2007. Timber identification manual. TRAFFIC, New Delhi.
10. Dhiman, A.K. 2003. Sacred plants and their medicinal uses. Daya publishing house, New

Delhi.
11. Mehta, T. 1981. A handbook of forest utilization. Periodical Expert Book Agency, New Delhi.
12. Nair, N.C and Henry, A.N. 1983. Flora of Tamilnadu, India. Series: 1, Analysis, Vol.1. BSI, Coimbatore, India.

Reference Books:

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

Web resources:

1. http://wwwwds.worldbank.org/external/default/WDServer/WDSP/IB/2006/10/19/00 0112742_2006 1019150049/Rendered/PDF/367890Loggerheads0Report.pdf.
2. https://www.britannica.com/science/forestry
3. https://en.wikipedia.org/wiki/Forestry.
4. https://www.biologydiscussion.com/forest/essay-forest-importance.major-products-and-its- conservation/25119
5. https://academic.oop.com
6. https://www.sciencedirect.com/topics/agriculture-and-biological-science-forest-product.

Mapping with Programme Outcomes:

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

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

ELECTIVE VI- GENE CLONING AND GENE THERAPY

Title of the Course	**GENE CLONING AND GENE THERAPY**						
Paper Number	**ELECTIVE VI**						
Category	Elective	**Year**	II	**Credits**	3	**Course Code**	
		Semester	IV				

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

Pre-requisite	To know about the gene cloning and gene therapy.
Learning Objectives	1. To give a clear knowledge of genetic engineering, cloning vectors, enzymes involved in cloning.
	2. To understand the procedure involved in recombinant DNA technology and restriction mapping.
	3. To focus on the application of gene cloning in plants and animals.
	4. To enable the students to information on Gene Therapy.
	5. To raise student to create transgenic plants for hybrid seed production and molecular farming.

UNIT	**CONTENTS**
I	Definition of genetic engineering, gene cloning and recombinant DNA cloning vectors: Plasmids, bacteriophages, plant and animal vectors.
II	Gene cloning in prokaryotes and eukaryotes, Isolation of DNA to be cloned, insertion of DNA fragment into vector. Use of Restriction Linkers: use of Homopolyer tails, Transfer of recombinant DNA into Bacteria cell. Selection of clones.
III	Gene Therapy: Definition, Germ cell and Somatic cell. Amniocentesis in human; patient therapy, embryo therapy.
IV	Restriction mapping –. Random amplified polymorphic DNA using PCR. DNA finger printing; Gene Tagging. Physical methods of gene delivery. Gene transfer techniques.. Genetic counselling – Eugenics, Euthenics.
V	Transgenic plants with herbicide resistance, insect resistance, virus resistance andresistance against bacterial and fungal pathogens. Transgenic plants for hybrid seed production and molecular farming.

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Recollect the basic concepts of gene cloning.	K1
CO2	Demonstrate and to identify the selection of clones.	K2
CO3	Acquire knowledge on the gene therapy.	K3

CO4	Compare and understand the concept of gene therapy.	K4
CO5	Discuss and develop skills for hybrid seed production and molecular farming.	K5 &K6

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

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

Recommended Text:

1. Das, H.K. 2010. Textbook of Biotechnology (4th edition). Wiley India Pvt. Ltd. New Delhi
2. Gamborg, O.L and G.C. Phillips (eds). 1995. Plants, genes and agriculture. Jones and Bartlett Publishers.
3. Verma, P.S and Agarwal V.K. 2009. Genetic Engineering. S.Chand & Co. Ltd. New Delhi
4. Kreuzer, H and A. Massey. 1996. Recombinant DNA and biotechnology. A guide for teachers. ASM Press.
5. Ramavat, K.G. 2006. Plant Biotechnology. S. Chand and Co. Ltd., New Delhi.
6. Chawla, H.S. 2009. Introduction to Biotechnology. 2nd edn. Oxford IBH, ISBN: 978-81-204- 1732-8.
7. Halford, N. 2015. Plant Biotechnology: Current and Future Applications of Genetically Modified crops, John Wiley and Sons.
8. Kumar, Pradeep. 2018. Advances in Microbial Biotechnology: Current Trends and Future Prospects. 10.1201/9781351248914.
9. Thieman. 2014. Introduction to Biotechnology 3rd Edition. Pearson Education India.
10. Khan. I.A. and A. Khanum .2004. Fundamentals of Biotechnology – Forensic Science Genetic Engineering. Ukaaz publication, Hyderabad.
11. Gupta. P.K. 1998. Elements of Biotechnology. Rastogi publications, Meerut.

Reference books:

1. Smith. J.K. 1996. Biotechnology – 3rd Ed. Cambridge Univ. Press, Cambridge.
2. Slater, A. Scott, N and Fowler, M. 2008. Plant Biotechnology: The Genetic Manipulation of Plants. Oxford University Press Inc.
3. Reynolds, P.H.S. 1999. Inducible Gene Expression in Plants. CABI Publishing, U.K.
4. Chawla, H.S. 2009. Introduction to Biotechnology, 2nd edn. Oxford IBH, ISBN:978-81-204-1732-8.
5. Halford, N. 2015. Plant Biotechnology: Current and Future Applications of Genetically Modified Crops, John Wiley and Sons.
6. Brown T.A. 2001. Gene Cloning and DNA Analysis- An Introduction (4th edition). Blackwell Science. Oxford.
7. Clark, D.P and Pazdernik, N.J. 2009. Biotechnology- Applying the Genetic Revolution. Elsevier Academic Press. USA.
8. Glick B.R and J. J. Pasternak. 2009. Molecular Biotechnology, Panima Publication Co.
9. Harisha, S. 2007. Biotechnology Procedures and Experiments Handbook. Infinity Science Press Llc. Hingham. MA.

10. Mosier N.S and Ladisch M.R. 2009. Modern Biotechnology- Connecting Innovations in Microbiology and Biochemistry to Engineering Fundamentals. John Wiley & Sons Inc. New Jersey.
11. Primrose S., Twyman R. and Old B. 2001. Principles of Gene Manipulation (6th ed.). Blackwell Science. Oxford.
12. Ignacimuthu, S.1998. Applied Plant Biotechnology. Tata Mc Graw Hill, publishing company Ltd., New Delhi.
13. Neal Stewart, Jr. 2008. Plant Biotechnology and Genetics: Principles, Techniques and Applications. JohnWiley & sons Inc.

Web resources:

1. https://www.amazon.in/Gene-Cloning-Manipulation-Christopher-Howe-ebook/dp/B000SK4YLI
2. https://www.amazon.in/Gene-Cloning-Steve-Minchin-ebook/dp/B000SHTUT2
3. https://www.futuremedicine.com/doi/book/10.2217/9781780842134
4. https://www.researchgate.net/publication/51144570_Introduction_to_Gene_Therapy_A_Clinical_Aftermath
5. https://link.springer.com/book/10.1007/978-88-470-1643-9

Mapping with Programme Outcomes:

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

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

ELECTIVE VI- FARM SCIENCES: GREEN WEALTH

Title of the Course	**FARM SCIENCES- GREEN WEALTH**						
Paper Number	**ELECTIVE VI**						
Category	Elective	**Year**	II	**Credits**	3	**Course Code**	
		Semester	IV				

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

Pre-requisite	To understand the concept of fertilizers in crop production.
Learning Objectives	1. Understand the concept of agronomy and sustainable agriculture.
	2. Evaluate the importance of crop management technology.
	3. To develop their understanding on the concept of fertilizers.
	4. Develop the integrated management for better crop production by using fertilizers.
	5. Develop the skills for cultivation of plants and their value added processing/storage/quality control.

UNIT	**CONTENTS**
I	Agronomy and its scope, seeds and sowing, tillage and tilth, crop density and geometry, Crop nutrition, manures and fertilizers, nutrient use efficiency, water resources, soil plant water relationship, crop water requirement, water use efficiency, irrigation- scheduling criteria and methods, quality of irrigation water, water logging. Efficient utilization of water through soil and crop management practices. Management of crops in rain fed areas, Contingent crop planning for aberrant weather conditions, Concept, objective, principles and components of watershed management, factors affecting watershed management.
II	Weeds- Importance, classification, crop weed competition, concepts of weed management principles and methods, herbicides- classification, selectivity and resistance, allelopathy. Growth and development of crops, factors affecting growth and development, plant ideotypes, crop rotation and its principles, adaptation and distribution of crops, crop management technologies in problematic areas, harvesting and threshing of crops.
III	Identification of crops, seeds, fertilizers, pesticides and tillage implements, Effect of sowing depth on germination and seedling vigor, Identification of weeds in crops, Methods of herbicide and fertilizer application.
IV	Study of yield contributing characters and yield estimation, Seed germination and viability test, Numerical exercises on fertilizer requirement, plant population, herbicides and water requirement, Use of tillage implements- reversible plough, one way plough, harrow, leveler, seed drill, Study of soil moisture measuring devices, Measurement of field capacity, particle density, bulk density and infiltration rate, Measurement of irrigation water.

V	Harvesting, storage, physiological disorders of important vegetable crops like solanaceous fruit vegetables (brinjal, tomato &chilli), tuber crops (Potato), cucurbits (pumpkin, cucumber, watermelon & gourds), pod vegetables (pea & bean), cole crops (cabbage & cauliflower), bulb crops (onion, garlic), root crops (radish & carrot), common leafy vegetables, spices: turmeric and ginger, black pepper and cardamom.

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	To identify the importance of agronomy and its scope.	K1
CO2	Demonstrate both the theoretical and practical knowledge in weed management principles.	K2
CO3	Explain the methods of herbicide and fertilizer application.	K3
CO4	Compare and contrast the yield estimation and water management.	K4
CO5	Discuss and develop skills for effective conservation, harvesting and storage methods.	K5 & K6

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

Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)

Skills acquired from this course.

Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill.

Recommended Text:

1. Reddy, T.Y and G.H. Sankar Reddi. 2015. Principles of Agronomy. Kalyani Publishers.
2. Reddy, S.R. 2016. Principles of Agronomy. Kalyani Publishers.
3. Brady, N.C and Weil, R.R. 1996. The Nature and Properties of Soils - Weil, Prentice Hall Inc.
4. Craig, C. Sheaffer and Kristine, M. Moncada. 2012. Introduction to Agronomy-Food crops and Environment (Second Edition).
5. George Acquaah. 2004. Principles of Crop production: Theory, Techniques, and Technology. Pearson education.

References books:

1. Yawalkar, K.S. Agarwal, J. P and S. Bokde. 1967. Manures and fertilizers – AgriHorticultural Publication House.
2. Russell, J.E. 2002. Soil Conditions and Plants Growth - Daya Books.
3. Hansen, V. E. Israelsen, O.W and G. E. Stringham. 1980. Irrigation Principles and Practices -, New York Wiley.
4. Reddy, S.R. 2017. Principles of Agronomy. Kalyani Publishers
5. Sathe, T.V. 2004. Vermiculture and Organic Farming. Daya publishers.

Web resources:
1. https://www.amazon.in/Green-Wealth-Unusable-Moneymaking-Assets-ebook/dp/B004D2AYPW 2. https://www.kobo.com/us/en/ebook/green-wealth 3. https://nishat2013.files.wordpress.com/2013/11/agronomy-book.pdf 4. https://www.kobo.com/in/en/ebook/weed-2 5. https://www.amazon.in/Handbook-Fertilizers-Sources-Make-Up-Effects-ebook/dp/B00D45LHAK

Mapping with Programme Outcomes:

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

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

PROFESSIONAL COMPETENCY SKILL ENHANCEMENT

Title of the Course	**PROFESSIONAL COMPETENCY SKILL ENHANCEMENT**						
Paper Number	**SKILL ENHANCEMENT**						
Category	Skill Enhancment	**Year**	II	**Credits**	2	**Course Code**	
		Semester	IV				

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

Pre-requisite	To understand the concept of skill enhancement.
Learning Objectives	1. Understand the concept of agronomy and sustainable agriculture.
	2. To gain knowledge about the cell, organelles and physiology.
	3. To understand the biodiversity DNA recombination technology.
	4. Describe the basic signal transduction pathway and to recognize the overarching principles of prokaryotic and eukaryotic cellular communication.
	5.Understand the mechanism underling the shift from vegetative to reproductive phase.

UNIT	**CONTENTS**
I	**MOLECULES AND THEIR INTERACTION RELEVANT TO BIOLOGY** Structure of atoms, molecules, and chemical bonds. Composition, structure, and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids, and vitamins). Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.). Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties). Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers. Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes. Conformation of proteins (Ramachandran plot, secondary structure, domains, motif, and folds). Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA). Stability of proteins and nucleic acids. Metabolism of carbohydrates, lipids, amino acids nucleotides, and vitamins.
II	**CELLULAR ORGANIZATION** 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 the cytoskeleton and its role in

	motility). Organization of genes and chromosomes: Operon, unique and repetitive DNA, interrupted genes, gene families, the structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons). Cell division and the cell cycle: mitosis and meiosis, their regulation, steps in the cell cycle, regulation, and control of the cell cycle. Microbial Physiology: Growth yield and characteristics, strategies of cell division, stress response.
III	**FUNDAMENTAL PROCESSES** DNA replication, repair, and recombination: Unit of replication, enzymes involved, replication origin and replication fork, the fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination. RNA synthesis and processing: Transcription factors and machinery, a formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure, and function of different types of RNA, RNA transport). Protein synthesis and processing: Ribosome, the formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proofreading, translational inhibitors, Post-translational modification of proteins). Control of gene expression at transcription and translation level: Regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, the role of chromatin in gene expression and gene silencing).
IV	**CELL COMMUNICATION AND CELL SIGNALING:** **Host-parasite interaction**: Recognition and entry processes of different pathogens like bacteria, viruses into animal and plant host cells, alteration of host cell behavior by pathogens, virus-induced cell transformation, pathogen-induced diseases in animals and plants, cell-cell fusion in both normal and abnormal cells. **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. **Cancer:** Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer, and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth. **Innate and adaptive immune system:** Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity, and immunogenicity. B and T cell epitopes, structure, and function of antibody molecules. generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors,

	humoral and cell-mediated immune responses, primary and secondary immune modulation, the complement system, Toll-like receptors, cell-mediated effector functions, inflammation, hypersensitivity and autoimmunity, immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiencies, vaccines.
V	**DEVELOPMENTAL BIOLOGY** **Basic concepts of development:** Potency, commitment, specification, induction, competence, determination, and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in the analysis of the development. **Gametogenesis, fertilization, and early development:** Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination. **Morphogenesis and organogenesis in animals:** Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in Drosophila, amphibia, and chick; organogenesis – vulva formation in Caenorhabditis Elegans, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post-embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination. **Morphogenesis and organogenesis in plants:** 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 Programmed cell death, aging, and senescence.

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	To learn about the structure of atoms, molecules, and chemical bonds.	K1
CO2	Demonstrate both the theoretical and practical knowledge in cell biology and molecular biology.	K2
CO3	Explain the methods of recombinant technology.	K3
CO4	Compare and contrast the physiological functions and metabolism.	K4
CO5	Discuss and develop skills for effective comprehension and communication.	K5 & K6

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

Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)

Skills acquired from this course.

Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill.

Recommended Text:

1. Bhojwani, S.S. Bhatnagar, S.P and Dantu, P.K. 2015. The Embryology of Angiosperms (6th revised and enlarged edition). Vikas Publishing House, New Delhi.
2. Maheshwari, P. 1963. Recent Advances in Embryology of Angiosperms. Intl. Soc. Plant Morphologists, New Delhi.
3. Roy, S.C and Kumar, K.D.C. 1977. Cell Biology, New Central Book Agency, Calcutta.
4. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments.6th edition. John Wiley & Sons.
5. Ramavat, K.G. 2006. Plant Biotechnology. S. Chand and Co. Ltd., New Delhi.
6. Trivedi, P.C. 2000. Plant Biotechnology-Recent Advances. Panima Publication Corporation, New Delhi.
7. Chawla, H.S. 2009. Introduction to Biotechnology. 2nd edn. Oxford IBH, ISBN: 978-81-204- 1732-8.

Reference books:

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. Gupta. P.K. 2000. Cell and Molecular Biology, Rastogi Pub. Meerut.
3. Ignacimuthu, S. 2005. Basic Bioinformatics, Narosa publishing house.
4. Lesk, A.M. 2002. Introduction to Bioinformatics. Oxford University press.
5. Rastogi. 1996. Cell and molecular biology. New age international publishers.
6. Elliott, W.H. and Ellioff. 1997. Biochemistry and molecular biology. Oxford.
7. Freifelder D., 1987. Molecular Biology. Narosa publishing house.
8. Rastoji, S.C., Mendiratta,N., Rastogi, P. 2009. Bioinformatics : Methods and Applications, PHI, Third Edition.

Web resources:

1. https://www.nature.com/scitable/topic/cell-biology
2. https://plato.stanford.edu/entries/molecular-biology/
3. https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/bioinformatics
4. https://.britannica.com/technology/biotechnolog/
5. https://nptel.ac.in/courses/102/107/102107075/
6. https://plantae.org/plant-physiology-top-articles-of-2020-based-on- altmetric-scores/

Mapping with Programme Outcomes:

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

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

BOTANY FOR ADVANCED RESEARCH

BOTANY FOR ADVANCED STUDIES (4 HOURS)

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">BOTANY FOR ADVANCED STUDIES</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">Skill Enhancement</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Skill Enhancment</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>IV</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td colspan="2">2</td><td colspan="2">2</td><td>-</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">Students should to improve their career prospects, or pursuing a passion.</td></tr>
<tr><td colspan="2" rowspan="5">Learning Objectives</td><td colspan="8">1. To be familiar with the basic concepts and principles of plant systematics.</td></tr>
<tr><td colspan="8">2. Learn the importance of plant anatomy in plant production systems.</td></tr>
<tr><td colspan="8">3. To expose the students a fundamental of the various techniques used in molecular studies.</td></tr>
<tr><td colspan="8">4. To learn about the physiological processes that underlie plant metabolism.</td></tr>
<tr><td colspan="8">5. To know the energy production and its utilization in plants.</td></tr>
<tr><td>UNIT</td><td colspan="9">CONTENTS</td></tr>
<tr><td>I</td><td colspan="9">MOLECULAR GENETICS
Molecular Biology of gene expression:
Brief overview of the Central Dogma and Teminism. Transcription in prokaryotes and eukaryotes. Types and structure of RNA polymerase, Different types of RNA, Regulatory sequences and transcription factors involved. Mechanism: Initiation, elongation and termination. Split genes and RNA splicing in eukaryotes. Translation in prokaryotes and eukaryotes. Salient features, exceptions, tRNA-suppressor mutations. Mechanism of translation: Chain initiation, elongation and termination, proteins involved, factors affecting translation accuracy. Molecular mechanism of mutation, cancer biology, human cytogentics
Molecular mechanism of Gene Regulation:
Regulation in prokaryotes, Regulation in Eukaryotes, Epigenetic mechanisms: methylation and transcriptional inactivation, cosuppression through transcriptional silencing, genome imprinting. RNA processing->alternative splicing, RNA stability, RNA interference. Translational regulation: Gene amplification, mating type interconversion.
Genomics:
Structural genomics, Genetic and physical mapping (RFLP), microsatellite maps, cytogenetic maps, physical maps, positional cloning, chromosome walks and jumps, Genome sequencing, genome databases, human genome sequencing project. Functional genomics. Transcriptome, proteome and metabolome, Microarrays and gene-chips. Comparative genomics. Functional and evolutionary relationships</td></tr>
</table>

	prokaryotes, organelles and eukaryotes, orthologues and paralogues. Metabolomics: Identification and quantification of cellular metabolites in biological samples. Pharmacogenomics and drug designing.
II	**ADVANCED TRENDS IN SYSTEMATICS** **(i) Basic concepts of:** a. Morphology - History, general morphology, types of data, methods of gathering data, b. Anatomy - History, general anatomy, types of data, methods of gathering data, c. Embryology – History, types of data, methods of gathering data; d. Palynology: History, general palynological characters, types of data, methods of gathering data; e. Cytology and Cytogenetics: History, general cytological and cytogenetic characters, types of data, methods of gathering data; f. Ecology, History, general ecology, types of data, methods of gathering data (At least two examples from each section should be studied to substantiate the taxonomic significance) **(ii) Chemotaxonomy:** a. History, general chemical and chemotaxonomic characters, types of data, methods of gathering data. b. Identification of the major classes of the pharmaceutically important secondary metabolites from natural sources 8 (phenolics, steroids, terpenoids glycosides and alkaloids). c. Applications: Phytochemicals in cosmetics, aromatherapy, disease prevention, biotechnology in the production of phytochemicals. Phytochemical databases (**iii) Molecular trends in Biosystematics** a. Molecules and genomes in plant systematics, techniques used in molecular taxonomy, molecular systematics in crop evolution b. Serology in relation to plant taxonomy- Methods, role of serology in taxonomy. c. Cladistics and Phenetics **(iv) Molecular trends in Reproductive Biology:** (i) Apomixis – Types, cytogenetic basis and induction of apomixes, applications. (ii) Biochemistry and genetics of incompatibility, methods to overcome incompatibility, pollen viability tests, molecular basis of incompatibility (iii) Sterility – Male sterility, CMS, GMS, CGMS, temperature sensitive and photosensitive male sterility, transgenic male sterility, female sterility and zygotic sterility.
	PLANT PHYSIOLOGY (i) Modern concepts Photosynthesis – Environmental and agricultural relevance; Respiration – Biochemical control of respiration (ii) Photomorphogenesis Phytochrome genes and their expression, control of photo-morphogenic responses. Dose-response relations in photomorphogenesis, light induced chloroplast differentiation, effect of photoreceptors. (iii) Biological clock: Circadian rhythms, rhythm responses to environment, clock mechanism (iv) Photoperiodism General principles , florigen concept

III	(v) Plant growth and development Patterns of growth and differentiation; Gene expression and mutations regulating meristem function, embryogenesis, seedling, root, leaf and flower development. Homeotic genes, ABCD model in Arabidopsis flower, hormonal control of plant tissue development, effect of auxins on root and root formation, gibberellin promoted growth of plants, ethylene and triple response mutants, brassinosteroids and photomorphogenesis.
IV	**PLANT PHYSIOLOGY** Enzymes: General account: Importance and properties of enzymes in biological sciences, the classification and nomenclature of enzymes with examples, Mechanism of enzyme action role of enzyme in chemical action, various factors affecting the enzyme activity. Molecular genetics in plant physiology, Environmental plant physiology, Stress physiology .
V	**ECONOMC BOTANY** Economic importance of Cereals, Tuber Crops, Fibre yielding plants, Plantation Crops, Sugar yielding plants, Narcotics, Vegetables, Oil yielding plants, Pulses and Beverages

Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme Outcomes**
CO1	Understand of the basic principles of systematics, including identification, nomenclature, classification, and the inference of evolutionary patterns from data	K1, K2 & K5
CO2	Learn the structures, functions and roles of apical *vs* lateral meristems in monocot and dicot plant growth.	K1,K3 & K5
CO3	Understand the organization of nuclear genome	K3 & K5
CO4	Understand the various steps involved in the basic functioning of plant growth and the nutritive value of food.	K2, K3 & K5
CO5	Gain awareness about the various process involved in the energy production in plants and metabolic pathways.	K1, K5 & K6

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

Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour).

Skills acquired from this Course.

Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill.

Recommended Text:

1. Sharma, O.P. 2017. Plant Taxonomy. (II Edition).The McGraw Hill Companies.
2. Maheshwari, P. 1963. Recent Advances in Embryology of Angiosperms. Intl. Soc. Plant Morphologists, New Delhi.
3. Sharma, P.C. 2017. Text Book of Plant Anatomy. Arjun Publishing House, New Delhi.
4. Jain, V.K. 2017. Plant Physiology, S.Chand & Company Ltd. New Delhi.
5. Lincoln, T, Eduardo, Z, Ian Max, M, and Angus, M. 2018. Fundamentals of Plant Physiology. Sinauer Associates Inc., US.
6. Becker, W.M., Kleinsmith L.J. & Hardin J. 2005. The World of the Cell (6th edition).

Benjamin/Cummings Pub. Co. New York.
7. Brooker, R. J. 1999. Genetics Analysis and Principles. Addison Wesley Longman Inc., New York.
8. Bruce, A. et. al. 2002. Molecular Biology of the Cell. Garland Publishing. New York.

Reference books:

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

Web resources:

1. http:// www.ornl.gov.
2. http:// ash. gene. ncl. ac .nk..
3. http://tor. cshl. org. http:www. gdb. org.
4. http: //www. neg r. org.
5. http: // www. genetics. wustl. edu.
6. http: // genome. imb- jena. dc.

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	3	2	1	2	2	2	2
CO 2	3	3	2	2	3	3	2	3	2	3
CO 3	2	2	3	3	1	2	1	3	1	3
CO 4	3	3	3	3	2	2	3	2	3	1
CO 5	3	3	2	3	2	1	3	3	2	3

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

NAAN MUDHALVAN SCHEME

www.naanmudhalvan.tn.gov.in

COMPUTING SKILLS FOR INDUSTRY 4.0

Title of the Course		**COMPUTING SKILLS FOR INDUSTRY 4.0**					
Paper Number		**CORE I**					
Category	Core	**Year**	III	**Credits**	2	**Course Code**	
		Semester	VI				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		4	-	--	4		
Pre-requisite		Basic Knowledge on computer gained through higher secondary class.					

Learning Objectives		
C1	To learn about the basics and functions of computer, Study about internet and communication.	
C2	To facilitate students to learn about Microsoft Word and Excel.	
C3	To find out more about Microsoft PowerPoint, database management systems and MS Access.	
C4	To introduce AI and ML for Biology students.	
C5	To know about big data and data analytics.	
Course outcomes	**On completion of this course, students will be able to:**	
CO1	Learn how to use computer Internet, e-mail, Web browser, Web server, and Search engines.	K1
CO2	Create Documents, Tables and Spreadsheets.	K2
CO3	Know about creation and use of PowerPoint presentations, DBMS and MS Access.	K3
CO4	Acquire knowledge about AI and ML.	K4
CO5	Implement the knowledge in big data and data analytics.	K5
UNIT	**CONTENTS**	
I	**BASICS OF COMPUTER** Computer - Functions and Components of Computer – Operating System - Windows – Android – Intranet & Internet – www - Browser - Email - URL - Search engines - Websites & Web pages.	
II	**MICROSOFT OFFICE – I** Microsoft word: Creation of document – Formatting of page - Formatting of	

	paragraph -Formatting of text - Creation and formatting of table. Microsoft Power Point: Creation and Designing of slides – Animation options -Applications of MS Word and MS Power point.
III	**MICROSOFT OFFICE – II** **Microsoft** Excel: workbook – work sheet – Formatting of row, column and cell - Creation and formatting of table - Creation and formatting of charts Microsoft Access: Database Management System (DBMS) – Creation and designing of form – Management of data in table – Generation of report Applications of MS Excel and MS Access.
IV	**ARTIFICIAL INTELLIGENCE** Artificial Intelligence: Artificial Intelligence (AI) - What and Why? - Foundation of AI - The AIenvironment - Social Influence of AI - Applications and Future.
V	**BIG DATA AND DATA ANALYTICS** Big Data: Evolution - Data evolution - Big Data Definitions - Merits and Advantages of Big Data - Big Data Characteristics - Big Data Applications - Introduction to Data Analytics - Data Analysis Vs. Data Analytics - Types of Data Analytics - Application of Data Analytics.
	Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper). Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
	Skills acquired from this course Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Texts:

1	Rajaraman, V and N. Adabala, (6th Edition). 2015. Fundamentals of Computers, Prentice Hall of India Pvt. Ltd. New Delhi.
2	Anita Goel. 2010. Computer Fundamentals, Pearson Education.
3	Sinha, P.K. 2004. Computer Fundamentals, BPB Publications New Delhi 6th Edition.
4	Reema Thareja. 2014. Fundamentals of Computers, Oxford University Press.
5	Mooris mano. 1996. "Digital Design" Prentice Hall of India PVT Ltd., New Delhi.

References Books:

1	Forouzan, B. A. 2013. Data Communication and Networking, 5th Edition, TMH.
2	Balagurusamy, E. 2011. Fundamentals of computers, Tata Mc Grw-Hill, New Delhi.
3	Harley Hahn. The Internet-Complete Reference, Tata Mc Grw-Hill, New Delhi.
4	Kaliraj, P and Devi, T. 2020. Higher Education for Industry 4.0 and Transformation of Education 5.0.
5	Arthur Conklin W.M., and Greg White. 2016. Principles of computer security. TMH., McGraw-Hill Education; 4th edition

Web Resources:	
1	https://swayam.gov.in/nc_details/NPTEL
2	https://www.classcentral.com/report/swayam-moocs-course-list 4
3	https://swayam.gov.in/nd1_noc20_cs52/preview 6
4	https://www.classcentral.com/institution/npte
5	https://swayam.gov.in

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	2	3	3	3
CO 2	3	3	3	3	3	2	2	3	3	3
CO 3	3	3	3	3	3	3	2	3	3	3
CO 4	3	3	3	3	3	2	2	3	3	3
CO 5	3	3	3	3	3	3	2	3	1	3

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

PROJECT: INDIVIDUAL PROJECT

Title of the Course	**PROJECT: INDIVIDUAL PROJECT**						
Paper Number	**Skill Enhancement**						
Category	Skill Enhancment	**Year**	II	**Credits**	3	**Course Code**	
		Semester	IV				

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

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

UNIT	**CONTENTS**
I	1. Each student will be allotted a Project Guide from the faculty of the department concerned by lot method. 2. The topic of the dissertation shall be assigned to the candidate before the beginning of third semester. 3. After the completion of the project work, the student has to submit four copies of dissertation with report carrying his/her project report for evaluation by examiners. After evaluation, one copy is to be retained in the College Library. 4. Project work will be evaluated by both the external and the internal (Project Guide) examiners for the maximum of 100 marks in total on the scale of the maximum of 50 marks for the internal and the external each. 5. Viva-voce will be conducted by the panel comprising, External examiner and Internal Examiner for the maximum of 100 marks in total on the scale of the maximum of 50 marks for the internal and the external each.
	All the candidates of M.Sc (Botany) are required to undergo a major project and submit the following: 1. Dissertation/Thesis based on the work done by the student. 2. Soft copy of the project on CD/DVD. **PROJECT EVALUATION GUIDELINES:** **The project is evaluated on the basis of following heads:**

	For Viva-Voce maximum is 60 marks which will be conducted by both the internal and external examiners during end semester university practical examinations. **Internal:** 40 marks I Review – Selection of the field of study, topic and literature collection - 15 marks II Review – Research design and data collection - 10 marks III Review – Analysis and conclusion, preparation of rough draft - 15 marks **External:** 60 marks Thesis/ Dissertation - 30 marks Presentation - 15 marks Viva-voce - 15 marks	
III	**Suggested areas of work:** Algae, fungi, microbiology, biocontrol agents, plant tissue culture, plant physiology, phytochemistry, biochemistry, anatomy, plant taxonomy, Ethnobotany, ecology, sustainable agriculture, herbal formulations, cytogenetics, molecular biology, biotechnology, bioinformatics, nanotechnology and applied botany.	
IV	**Methodology:** **Each project should contain the following details:** 1. Brief introduction on the topic 2. Review of Literature 3. Materials and Methods 4. Results and Discussion – evidences in the form of figures, tables and photographs. 5. Summary 6. Bibliography	
Course outcomes: CO	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	For students in those pertinent core areas, the project is preparing them to become professionals after graduation.	K1
CO2	Compile data and familiarize yourself with techniques for planning and carrying out tests.	K2

CO3	Collect data and educate yourself on how to evaluate the analyzed results of your scientific studies.	K3 & K5
CO4	In-the-moment industrial exposure helps them become more knowledgeble and skilled in the latest technology.	K4
CO5 .	Improving communication skills and coming up with creative ideas are crucial components of training that help someone become an entrepreneur.	K5 & K6

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

Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)

Skills acquired from this course.

Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Texts:

i. Wilson, K and J. Walker (Eds). 1994. Principles and Techniques of Practical Biochemistry (4th Edition) Cambridge University Press, Cambridge.

ii. Bendre, A.M and Ashok Kumar. 2009. A text book of practical Botany. Vol. I & II. Rastogi Publication. Meerut. 9th Edition.

ii. Manju Bala, Sunita Gupta, Gupta, N.K. 2012. Practicals in Plant Physiology and Biochemistry. Scientific Publisher.

v. Wilson, K and J. Walker. 2005. Principles and Techniques of Practical Biochemistry, 5th Edition. Cambridge University press, New York.

v. Rodney Boyer. 2000. Modern Experimental Biochemistry, 3rd Edition. Published by Addison Wesley Longman. Singapore.

Reference Books:

1. Dawson, C. 2002. Practical research methods. UBS Publishers, New Delhi.
2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. 1995. Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.
3. Ruzin, S.E. 1999. Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A.
4. Wilson and Goulding. 1987. Principles of biochemical techniques, Oxford University Press.
5. Mukherji, S. and Ghosh, A.K. 2005. Plant Physiology. First Central Edition, New Central Book Agency (P) Ltd., Kolkata.
6. Taiz, L and Zeiger, E. 2010. Plant Physiology. 5th Edition. Sinauer Associates, USA.
7. Heldt, H.W and Piechulla, B. 2010. Plant Biochemistry, 4th Edition. Academic Press, NY.

Wilson, K and Walker, J. 2010. Principles and Techniques of Biochemistry and Molecular Biology, Seventh edition, Cambridge University Press, USA.

Web resources:

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

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	3	3	1	3	3	3	3	3	3
CO 2	3	3	3	3	3	3	2	1	3	2
CO 3	3	3	3	3	3	3	2	1	3	2
CO 4	3	2	3	3	3	3	3	2	3	3
CO 5	3	3	3	3	3	3	3	3	3	3

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