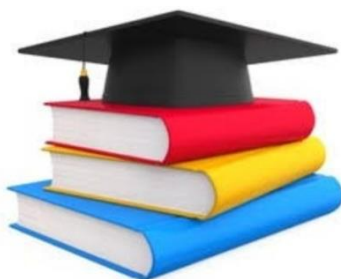




**MOTHER TERESA WOMEN'S UNIVERSITY  
KODAIKANAL-624 101**

**DEPARTMENT OF BIOTECHNOLOGY**

**M.Sc BOTANY  
Curriculum Framework, Syllabus, and Regulations  
(Based on TANSICHE Syllabus under choice Based Credit System–CBCS)**



**(For the candidates to be admitted from the Academic Year 2023-2024)**

## M.Sc. BOTANY

### 1. About the Programme:

M.Sc. Botany is a 2 year post graduate programme divided into 4 semesters that deals with all aspects of plant biology, their origin and their impact on the environment. The programme incorporates core courses, electives and practicals. The programme syllabus includes all the subjects associated with plants, microbes, plant cells, genetics and other related topics. Students can get both practical, outdoor tours and theoretical hands on the subject. There are a number of jobs and career options available after this programme in both the public and private sectors, the opportunities await in areas like academics, Botanical garden, national park, agriculture and forest department, tissue culture labs, food industries, oil industries, seed companies, agricultural and biotechnology firms etc.

### 2. Programme Educational Objectives (PEOs)

1. Build up the ability for the application of acquired knowledge in different field so life there by make our country self-sufficient
2. Make the students skilled in practical experiments, laboratory equipments and to interpret the data correctly
3. Widen the ability for the application of obtained knowledge in various field so life to make our country self-contained
4. Apply moral principles to biological science research, studies, and adopt recent pedagogical trends in education, including e-learning
5. Mold responsible citizen for nation-building and transforming the country towards future

### 3. Eligibility:

- A candidate who has passed Graduate in Botany and other Relevant Subject
- Candidate should have secured atleast 55% in the above subject from any recognized university.

### 4. General Guidelines for PG Programme

- i. **Duration:** The programme shall extend through a period of 4 consecutive semesters and the duration of a semester shall normally be 90 days or 450 hours. Examinations shall be conducted at the end of each semester for the respective subjects.
- ii. **Medium of Instruction:** English
- iii. **Evaluation:** Evaluation of the candidates shall be through Internal Assessment and External Examination.

- **Project Report**

A student should select a topic for the Project Work at the end of the third semester

itself and submit the Project Report at the end of the fourth semester. The Project Report shall not exceed 75 typed pages in Times New Roman font with 1.5 linespace.

- **Project Evaluation**

There is a Viva Voce Examination for Project Work. The Guide and an External Examiner shall evaluate and conduct the Viva Voce Examination. The Project Work carries 100 marks (Internal: 25 Marks; External (Viva): 75 Marks).

<b>Methods of Evaluation Theory</b>		
<b>Internal Evaluation</b>	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
<b>External Evaluation</b>	End Semester Examination	75 Marks
	<b>Total</b>	<b>100 Marks</b>
<b>Methods of Evaluation Practicals</b>		
	Continuous Internal Assessment Test	40 Marks
	Attendance and Class Participation	
<b>External Evaluation</b>	End Semester Examination	60 Marks
	Record	
	<b>Total</b>	<b>100 Marks</b>
<b>Methods of Assessment</b>		
<b>Recall (K1)</b>	Simple definitions, MCQ, Recall steps, Concept definitions	
<b>Understand/ Comprehend (K2)</b>	MCQ, True/False, Short essays, Concept explanations, Short summary or overview	
<b>Application (K3)</b>	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain	
<b>Analyze (K4)</b>	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge	
<b>Evaluate (K5)</b>	Longer essay/ Evaluation essay, Critique or justify with pros and cons	
<b>Create (K6)</b>	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

- Question paper pattern for External examination for Core and Elective papers:

**WRITTEN EXAMINATION QUESTION PAPER PATTERN**

**Theory Paper (Bloom’s Taxonomy based)**

<b>Intended Learning Skills</b>	<b>Maximum 75 Marks Passing Minimum: 50% Duration: Three Hours</b>
Memory Recall/Example/ Counter Example / Knowledge about the Concepts/Understanding	<b>Part–A (10x2=20Marks) Answer ALL questions Each Question carries 2 marks</b>
	Two questions from each Unit
	<b>Question 1 to Question 10</b>
Descriptions/Application (problems)	<b>Part–B (5x5=25Marks) Answer ALL questions Each question carries 5 Marks</b>
	<b>Either - or Type</b> Both parts of each question from the same Unit
	<b>Question 11 (a) or 11(b) to Question 15(a) or 15(b)</b>
Analysis/Synthesis / Evaluation	<b>Part-C (3x 10 = 30 Marks) Answer any THREE questions Each question carries 10 Marks</b>
	There shall be FIVE questions covering all the five units
	<b>Question 16 to Question 20</b>

**\*Minimum credits required to pass:91**

**5. Conversion of Marks to Grade Points and Letter Grade (Performance in a Course/Paper)**

Range of Marks	Grade Points	Letter Grade	Description
90 – 100	9.0 – 10.0	O	Outstanding

80-89	8.0 – 8.9	D+	Excellent
75-79	7.5 – 7.9	D	Distinction
70-74	7.0 – 7.4	A+	VeryGood
60-69	6.0 – 6.9	A	Good
50-59	5.0 – 5.9	B	Average
00-49	0.0	U	Re-appear
ABSENT	0.0	AAA	ABSENT

### 6.Attendance

Students must have earned 75% of attendance in each course for appearing for the examination. Students with 71% to 74% of attendance must apply for condonation in the Prescribed Form with prescribed fee. Students with 65% to 70% of attendance must apply for condonation in the Prescribed Form with the prescribed fee along with the Medical Certificate. Students with attendance less than 65% are not eligible to appear for the examination and they shall re-do the course with the prior permission of the Head of the Department, Principal and the Registrar of the University.

### 7. Maternity Leave

The student who avails maternity leave may be considered to appear for the examination with the approval of Staff/c, Head of the Department, Controller of Examination and the Registrar.

### 8. Any Other Information

In addition to the above mentioned regulations, any other common regulations pertaining to the PG Programmes are also applicable for this Programme.

### 9. PROGRAMME OUTCOMES (POs)

**On completion of M.Sc., Botany Programme, the students will be able to**

<b>PO1</b>	equip themselves with subject domain knowledge and technical skills pertaining to plants in a holistic manner
<b>PO2</b>	apply the knowledge of biology to make scientific queries and enhance the intellectual capacity
<b>PO3</b>	render beneficial contribution to the society through their knowledge acquired
<b>PO4</b>	build up the scientific analysis, interpretation of data and problem solving skills during experimentations and research projects.
<b>PO5</b>	inculcate the scientific temperament and execute it

<b>PO6</b>	apply contextual knowledge and modern tools of research for solving problems
<b>PO7</b>	enhance their capacity to obtain employment and higher studies in science
<b>PO8</b>	generate professional & ethical attitude, environmental consciousness, leadership quality, teamworkmanship with enormous responsibility in order to serve the society efficiently.

#### 10. PROGRAMME SPECIFIC OUTCOMES (PSOs)

**On completion of M.Sc., Botany Programme, the students will be able to**

<b>PSO1</b>	acquire knowledge about various plant groups from primitive to highly evolve
<b>PSO2</b>	implement the concept of science and technology with traditional and modern techniques for solving the complex problems in plant biology
<b>PSO3</b>	develop skills in laboratory practices as well as field based studies
<b>PSO4</b>	make experts in cultivation, conservation and sustainable utilization of biodiversity
<b>PSO5</b>	know about the advanced techniques in plant sciences like tissue culture, Phytoremediation, plant disease management, formulation of new herbal drugs, nursery maintenance, mushroom cultivation, biofertilizer production, fruit preservation and horticultural practices

**MOTHER TERESA WOMEN'S UNIVERSITY, KODAIKANAL**  
**B.Sc. BOTANY SYLLABUS**  
**2023-2024**

<b>SEMESTER-I</b>								
Course Code	Course Title	Hours			Credits	CIA	ESE	Total
		L	T	P				
P23BOT11	Plant Diversity – I: Algae, Fungi, Lichens and Bryophytes	4	3		5	25	75	100
P23BOT12	Plant Diversity –II: Pteridophytes, Gymnosperms and Paleobotany	4	3		5	25	75	100
P23BOP11	Laboratory Course-I Covering Theory Papers, I and II			6	4	25	75	100
P23BOE1A/ P23BOE1B/ P23BOE1C/ P23BOE1D	Elective-I: A. Microbiology, Immunology and Plant Pathology/ B. Conservation of Natural Resources and Policies/ C. Mushroom Cultivation/ D. Phytopharmacognosy	3	2		3	25	75	100
P23WSG11	Generic Course – I: Women Empowerment	3	2		3	25	75	100
<b>Total</b>		<b>30</b>			<b>20</b>	<b>-</b>	<b>-</b>	<b>500</b>
<b>SEMESTER-II</b>								
P23BOT23	Plant Taxonomy of Angiosperms and Economic Botany	3	3		5	25	75	100
P23BOT24	Plant Anatomy and Embryology of Angiosperms	3	3		5	25	75	100
P23BOP22	Laboratory Course-II Covering Papers, IV, V And VI			6	4	25	75	100
P23BOE2A/ P23BOE2B/ P23BOE2C/ P23BOE2D	A. Medicinal Botany/ B. Phytochemistry/ C. Research Methodology, Computer Applications & Bioinformatics/ D. Biopesticide Technology	2	2		3	25	75	100
P23CSG22	Generic Course-2: Cyber Security	2	2		2	25	75	100

P23BOS21	Skill Enhancement Course-1: NME - Nursery and Gardening	2	2		3	25	75	100
	<b>Total</b>	<b>30</b>			<b>22</b>	<b>-</b>	<b>-</b>	<b>600</b>



P23BOT11		<b>PLANT DIVERSITY – I: ALGAE, FUNGI, LICHENS AND BRYOPHYTES</b>					
<b>PaperNumber</b>		<b>COREI</b>					
<b>Category</b>	Core	<b>Year</b>	I	<b>Credits</b>	5	<b>Course Code</b>	P23BOCT11
		<b>Semester</b>	I				
<b>InstructionalHours perweek</b>		<b>Lecture</b>	<b>Tutorial</b>	<b>LabPractice</b>	<b>Total</b>		
		4	3	--	7		
<b>Pre-requisite</b>		Students should be familiar with the basics of algae, fungi, lichens and Bryophytes.					
<b>Learning Objectives</b>		<ol style="list-style-type: none"> <li>1. To learn about the classification, distinguishing traits, geographic distribution, and reproductive cycle of algae, fungi, lichens, and bryophytes.</li> <li>2. To gain knowledge about the ecological and economic importance of algae, fungi, lichens and bryophytes.</li> <li>3. To spark interest in the evolutionary roots of plant development.</li> <li>4. To study the biodiversity by describing and explaining the morphology and reproductive processes of algae, fungi, bryophytes and microorganisms.</li> <li>5. To expose the beneficial and harmful viewpoint.</li> </ol>					
<b>UNIT</b>	<b>CONTENTS</b>						
<b>I</b>	<b>ALGAE:</b> General account of algology, Contributions of Indian Phycologist (T.V.Desikachary, V.Krishnamurthy and V.S. Sundaralingam), Classification of algae by F.E. Fritsch (1935-45) & Silva (1982). Salient features of major classes: Cyanophyceae, Chlorophyceae, Xanthophyceae, Chrysophyceae, Cryptophyceae, Dinophyceae, Chloromonadineae, Euglenophyceae, Charophyceae, Bacillariophyceae, Phaeophyceae and Rhodophyceae. Range of thallus organization, algae of diverse habitats, reproduction (vegetative, asexual and sexual) and life cycles. Phylogeny and inter-relationships of algae, origin and evolution of sex in algae. Structure, reproduction and life histories of the following genera: <i>Oscillatoria</i> , <i>Scytonema</i> , <i>Ulva</i> , <i>Codium</i> , <i>Diatoms</i> , <i>Dictyota</i> and <i>Gelidium</i> .						
<b>II</b>	<b>FUNGI:</b> 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: <i>Plasmodiophora</i> ,						

	<i>Phytophthora, Rhizopus, Taphrina, Polyporus and Colletotrichum.</i>	
III	<b>LICHENS:</b> Introduction and Classification (Hale, 1969). Occurrence and inter-relationship of phycobionts and mycobionts, structure and reproduction in Ascolichens, Basidiolichens and Deuterolichens.	
IV	<b>BRYOPHYTES:</b> General characters and Classification of Bryophytes by Watson (1971). Distribution, Structural variations and evolution of gametophytes and sporophytes in Bryopsida, Anthoceroopsida 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: <i>Targionia, Lunularia, Porella</i> and <i>Polytrichum</i> .	
V	<b>ECONOMIC IMPORTANCE:</b> 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 <i>Pleurotus</i> . Lichen –economic importance and as indicator pollution. Bryophytes – Ecological and economic importance – industry, horticulture and medicine.	
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
<b>Recommended texts:</b>		
<ol style="list-style-type: none"> <li>1. Kumar, H.D. 1999. Introductory Phycology. Affiliated East-West Press, Delhi.</li> <li>2. Barsanti, L. and Guadtieri, P. 2014. Algae: Anatomy, Biochemistry and Biotechnology, 2<sup>nd</sup> Edition, CRC Press, ISBN: 1439867321.</li> <li>3. Sharma, O.P. 2011. Fungi and Allied Microorganisms, Mc Graw Hill, ISBN: 9780070700383, 0070700389</li> <li>4. Kevin K. 2018. Fungi biology and Application, 3rd Edition, Wiley Blackwell.</li> <li>5. Pandey, P.B. 2014. College Botany-1: Including Algae, Fungi, Lichens, Bacteria, Viruses, Plant Pathology, Industrial Microbiology and Bryophyta. Chand Publishing, New Delhi.</li> <li>6. Singh, Pandey and Jain. 2020. A text book of Botany, 5th Edition, Rastogi Publication, Meerut.</li> <li>7. Sharma, O.P. 2014. Bryophyta, Mcgraw Hill, ISBN: 9781259062872, 1259062872</li> </ol>		
<b>Reference Books:</b>		
<ol style="list-style-type: none"> <li>1. Sundaralingam, V. 1991. Marine algae. Bishen Singh and Mahendra Pal Singh Publishers, Dehradun.</li> </ol>		

2. Edwardlee,R. 2018. Phycology, 5<sup>th</sup>Ed., CambridgeUniversityPress, 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](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](https://www.youtube.com/watch?v=XQ_ZY57MY64)
8. <http://www-plb.ucdavis.edu/courses/bis/1c/text/Chapter22nf.pdf>

**MappingwithProgrammeOutcomes:**

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

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

<b>P23BOT12</b>		<b>PLANT DIVERSITY – II: PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY</b>					
<b>PaperNumber</b>		<b>COREII</b>					
<b>Category</b>	<b>Core</b>	<b>Year</b>	I	<b>Credits</b>	5	<b>Course Code</b>	P23BOCT12
		<b>Semester</b>	I				
<b>InstructionalHours perweek</b>		<b>Lecture</b>	<b>Tutorial</b>	<b>LabPractice</b>	<b>Total</b>		
		4	3	--	7		
<b>Pre-requisite</b>		Students should know about the fundamentals of Pteridophytes, Gymnosperms and fossil records.					
<b>Learning Objectives</b>		<ol style="list-style-type: none"> <li>To investigate the classification, distinctive traits, distribution and reproduction and life history of the various classes and major types of Pteridophytes and Gymnosperms.</li> <li>To identify and characterize diversity of lower vascular plants in order to comprehend the dynamics of diversity to realize the importance of diversity.</li> <li>To research the classification, phylogeny and economic importance of Pteridophytes and Gymnosperms.</li> <li>To study and understand the phylogeny and Paleontology of Pteridophytes and Gymnosperms.</li> <li>To learn about the concept of fossils and process of fossilization; distinctive characteristics of fossil records of Pteridophytes and Gymnosperms.</li> </ol>					
<b>UNIT</b>	<b>CONTENTS</b>						
<b>I</b>	<b>PTERIDOPHYTES:</b> General characteristics and classification (Reimer, 1954). Range of structure, reproduction and evolution of the gametophytes, Gametophyte types – sex organs. Apogamy and Apospory. Life cycles. Stellar evolution. Heterospory and seed habit, Telome theory, morphogenesis, Economic importance of Pteridophytes.						
<b>II</b>	<b>PTERIDOPHYTES:</b> Structure, anatomy, reproduction and life histories of the following genera: <i>Isoetes</i> , <i>Equisetum</i> , <i>Angiopteris</i> , <i>Osmunda</i> , <i>Pteris</i> and <i>Azolla</i> .						
<b>III</b>	<b>GYMNOSPERMS:</b> General characters - A general account of distribution of Gymnosperms. Morphology, anatomy, reproduction, phylogeny and classification (K.R.Sporne, 1965). Economic importance of Gymnosperms.						
<b>IV</b>	<b>GYMNOSPERMS:</b> Structure (Exomorphic and endomorphic), anatomy, reproduction and life histories of the following genera: <i>Thuja</i> , <i>Cupressus</i> , <i>Araucaria</i> , <i>Podocarpus</i> , <i>Gnetum</i> and <i>Ephedra</i> .						
	<b>PALEOBOTANY:</b> Geological Scale; Radiocarbon dating; Contribution of Birbal Sahni to						

<b>V</b>	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: <i>Rhynia</i> , <i>Lepidocarpon</i> , <i>Calamites</i> , <i>Cordaites</i> and <i>Lyginopteris</i> .	
<b>Course</b>		<b>Programme</b>
<b>Outcomes: On completion of this course the student will be able to</b>		<b>Outcomes</b>
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
<b>K1-Remember; K2-Understand; K3-Apply; K4-Analyze; K5 -Evaluate; K6 –Create.</b>		
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/other 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 Transferable Skill	
<b>Recommended Text:</b>		
<ol style="list-style-type: none"> <li>1. Vashishta, P.C. Sinha, A.K and Anil Kumar. 2016. Botany for Degree students. Gymnosperms. S. Chand and Company Ltd., New Delhi.</li> <li>2. Singh, V., Pande, P.C and Jain, D.K. 2021. A Text Book of Botany. Rastogi Publications, Meerut.</li> <li>3. Bhatnagar, S.P and Alok Moitra. 2020. Gymnosperms, New Age International (P) Ltd., Publishers, Bengaluru.</li> <li>4. Sharma, O.P. 2017. Pteridophyta, McGraw Hill Education, New York.</li> <li>5. Vashishta, P.C., A.K. Sinha and Anil Kumar. 2018. Botany for Degree students-Gymnosperms. S. Chand and Company Ltd., New Delhi.</li> <li>6. Johri, R.M, Lata, S, Tyagi, K. 2005. A text book of Gymnosperms, Dominant pub and Distributer, New Delhi.</li> </ol>		
<b>Reference books:</b>		
<ol style="list-style-type: none"> <li>1. Parihar, N.S. 2019. An Introduction to Embryophyta Pteridophytes. 5th Edition, Surjeet Publication, Delhi.</li> <li>2. Pandey, S.N and Trivedi, P.S. 2015. A Text Book of Botany Vol. II- 12 th edition (Paperback), Vikas Publishing.</li> </ol>		

3. Rashid, A. 2013. An introduction to Pteridophyta – Diversity, Development and differentiation (2<sup>nd</sup> 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, 2<sup>nd</sup> Edition, Academic Press.

**Web resources:**

1. <https://www.toppr.com/guides/biology/plant-kingdom/pteridophytes/>
2. [http://www.bsienvi.nic.in/Database/Pteridophytes-in-India\\_23432.aspx](http://www.bsienvi.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](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](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=HzYUAQAIAAJ>  
<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
CO2	3	3	3	3	3	3	3	3	3	3
CO3	2	3	3	3	3	1	3	3	3	3
CO4	3	3	2	3	3	3	3	2	3	2
CO5	3	2	2	2	2	2	2	1	2	1

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

<b>P23BOP11</b>	<b>CORE-III LABORATORY COURSE-I</b> 1. Algae, Fungi, Lichens and Bryophytes & 2. Pteridophytes, Gymnosperms and Paleobotany						
	CORE III						
<b>Category</b>	Core	<b>Year</b>	I	<b>Credits</b>	4	<b>CourseCode</b>	P23BOCP11
		<b>Semester</b>	I				
<b>InstructionalHours perweek</b>	<b>Lecture</b>			<b>Tutorial</b>		<b>LabPractice</b>	<b>Total</b>
				--		6	6
<b>Pre-requisite</b>	Students should be familiar with the fundamentals of algae, fungi, lichens, Bryophytes, Pteridophytes, Gymnosperms, Paleobotany and microbes in addition to essential laboratory techniques.						
<b>Learning Objectives</b>	1.To learn how to employ the use of instruments, technologies and methodologies related to thallophytes and non-flowering plant groups.						
	2.To enhance information on the identification of each taxonomical group by developing the skill-based detection of the morphology and microstructure of algae, and fungi.						
	3.To comprehend the fundamental concepts and methods used to identify Bryophytes, Pteridophytes and Gymnosperms through morphological changes and evolution, anatomy and reproduction.						
	4.To develop the technical abilities in staining, sectioning, sterilizing, and characterizing thallophytes, and other varieties of non-flowering plants.						
	5.To compare the structural diversity of fossil and extant plant species.						
<b>UNIT</b>	<b>EXPERIMENTS</b>						
<b>I</b>	<p><b>ALGAE</b> 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: <i>Oscillatoria</i>, <i>Scytonema</i>, <i>Ulva</i>, <i>Codium</i>, <i>Diatoms</i>, <i>Dictyota</i> and <i>Gelidium</i> (depending on availability of the specimen).</p> <p>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</p>						

	and blue green algae in the laboratory (Demonstration).
<b>II</b>	<p><b>FUNGI</b> Study of morphological and reproductive structures of the following living forms: <i>Plasmodiophora</i>, <i>Phytophthora</i>, <i>Rhizopus</i>, <i>Taphrina</i>, <i>Polyporus</i> and <i>Colletotrichum</i> (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).</p> <p><b>LICHENS</b> Study of morphological and reproductive structures of the genera <i>Parmelia</i>.</p>
<b>III</b>	<p><b>BRYOPHYTES</b> External morphology and internal anatomy of the vegetative and reproductive organs of the following living forms: <i>Targionia</i>, <i>Lunularia</i>, <i>Porella</i> and <i>Polytrichum</i> (depending on availability of the specimen).</p>
<b>IV</b>	<p><b>PTERIDOPHYTES</b> External morphology and internal anatomy of the vegetative and reproductive organs of the following living forms: <i>Isoetes</i>, <i>Equisetum</i>, <i>Angiopteris</i>, <i>Osmunda</i>, <i>Pteris</i> and <i>Azolla</i> (depending on availability of the specimen). Fossil slides observation: <i>Rhynia</i>, <i>Lepidocarpon</i>, <i>Calamites</i>.</p>
<b>V</b>	<p><b>GYMNOSPERMS</b> External morphology and internal anatomy of the vegetative and reproductive organs of the following living forms: <i>Thuja</i>, <i>Cupressus</i>, <i>Araucaria</i>, <i>Podocarpus</i>, <i>Gnetum</i> and <i>Ephedra</i> (depending on availability of the specimen). Fossil slides observation: <i>Cordaites</i> and <i>Lyginopteris</i>.</p>

**Course**

**outcomes:**

**CO** On completion of this course the student will be able to

CO1: Recall and applying the basic key to distinguish at species level identification of important plants and its structural organizations.

CO2: Demonstrate practical skills in thallophytes, Pteridophytes and Gymnosperms.

CO3: Describe the structure of algae, fungi, lichens, Bryophytes, Pteridophytes and Gymnosperms.



CO4: Determine the importance of structural diversity in the evolution of plant forms.	
CO5: Formulate techniques to isolate and culture of alga and fungi as well as to understand the diversity of plants.	
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 exams (CSIR/GATE/TNPSC/other) 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 Transferable Skills
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 exams (CSIR/GATE/TNPSC/other) 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 Transferable Skills

**Recommended Text:**

1. Kumar, H.D. 1999. Introductory Phycology. Affiliated East-West Press, Delhi.
2. Das, Sand 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 Kravesky, D. 2013. General Botany laboratory Manual. Author House, Bloomington, USA.
2. Webster, J and Weber, R. 2007. Introduction to Fungi, 3<sup>rd</sup> 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](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=gymnosperms&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)

<b>Title of the Course</b>	<b>P23BOE1A - MICROBIOLOGY, IMMUNOLOGY AND PLANT PATHOLOGY</b>						
<b>Paper Number</b>	ELECTIVE I						
<b>Category</b>	ELECTIVE	<b>Year</b>	I	<b>Credits</b>	3	<b>Course Code</b>	
		<b>Semester</b>	I				
<b>Instructional Hours per week</b>		<b>Lecture</b>		<b>Tutorial</b>		<b>Lab Practice</b>	
			3		2		--
<b>Pre-requisite</b>	1.The goal of the course is to provide students with basic understanding of microbiology, immunology, plant pathology and the etiology of specific plant diseases.						
<b>Learning Objectives</b>	2.To provide comprehensive knowledge about microbes and its effect on man and environment.						

	3.To provide comparative analysis of major groups of microbes.
	4.To study the principles of immune system, immunizing agents like antibodies and vaccines and gene therapy methods.
	5.To enhance the knowledge and skills needed for self-employment using the microbial derived products.
	6.To appreciate the role of immune system in conferring disease resistance.
UNIT	CONTENTS
I	<p><b>BACTERIA:</b></p> <p>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.</p>
II	<p><b>VIRUSES:</b></p> <p>General characters, Classification, Structure, Multiplication. Overview of Phycoviruses and Mycoviruses. Viruses of Eukaryotes – Animal &amp; 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.</p>
III	<p><b>FOOD MICROBIOLOGY:</b></p> <p>Beneficial role of microbes – yoghurt, Olives, Cheese, Bread, Wine, Tempeh, Miso &amp; Fermented green tea. Spoilage of fruits, vegetables, meats, poultry, eggs, bakery products, dairy products and canned foods. Microbial toxins - Exotoxin, Endotoxin &amp; Mycotoxin. Action of Enterotoxin, Cytotoxin&amp; Neurotoxin. Food Preservation – temperature, drying, radiation and chemicals. Soil Microbiology: Importance of Microbial flora of soil and factors affecting the microbial community in soil. Interaction among soil microbes (positive and negative interactions) &amp; with higher plants (rhizosphere &amp; 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.</p>

<p style="text-align: center;"><b>IV</b></p>	<p><b>IMMUNOLOGY:</b></p> <p>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.</p>	
<p style="text-align: center;"><b>V</b></p>	<p><b>PLANT PATHOLOGY:</b></p> <p><b>History and significance of plant pathology. Classification of plant diseases, Symptomology (important symptoms of plant pathogens).</b> 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 &amp; 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;</p> <p>Plant quarantine and legislation. Integrated Pest Management system. Diagnostic technique to detect pest/pathogen infection - Immunofluorescence (IF).</p>	
<p><b>Course outcomes:</b> <b>On completion of this course the student will be able to</b> <b>CO</b></p>		<p><b>Programme outcomes</b></p>
<p>CO1</p>	<p>Recognize the general characteristics of microbes, plant defense and immune cells.</p>	<p>K1</p>
<p>CO2</p>	<p>Explain about the stages in disease development and various defense mechanisms in plants and humans.</p>	<p>K2</p>
<p>CO3</p>	<p>Elucidate concepts of microbial interactions with plant and humans.</p>	<p>K3</p>
<p>CO4</p>	<p>Analyze the importance of harmful and beneficial microbes and immune system</p>	<p>K4</p>
<p>CO5</p>	<p>Determine and interpret the detection of pathogens and appreciate their adaptive strategies.</p>	<p>K5 &amp; K6</p>

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/other 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 Transferable Skill
<b>Recommended Text:</b>	
<ol style="list-style-type: none"> <li>1. Singh, R.S. 2018. Introduction to Principles of Plant Pathology, 4th Edition.</li> <li>2. Bilgrami, K.S and H.C. Dube. 2010 A text book of Modern Plant Pathology – Vikas Publishing House (P) Ltd., New Delhi</li> <li>3. Mehrotra, R.S. and Aggarwal, A. 2017. Plant Pathology. McGraw Hill Publisher.</li> <li>4. Dube, H.C. 2010. A text Book of Fungi, Bacteria and Viruses, 3rd Edition, Agrobios India, ISBN: 8188826383.</li> <li>5. Vaman Rao, C. 2006. Immunology. 2nd Edition. Narosa Publisher.</li> <li>6. Kenneth, M. 2017. Janeway’s Immunobiology. 9th Edition. Garland Publisher.</li> </ol>	
<b>Reference Books:</b>	
<ol style="list-style-type: none"> <li>1. Agrios, A.G. 2007. Plant Pathology, Elsevier. ISBN: 9780120445653.</li> <li>2. Jeffery, C., Pommerville. 2014. Alcamos Fundalmedals of Microbiology. 10th Edition. Johnsand Bartlett Learning.</li> <li>3. Pelczar, M. J. 2007. Microbiology. 35th Edition, Tata-McGraw Hill Publications, New York, ISBN: 0074623260.</li> <li>4. Ravi Chandra, N.G. 2013. Fundamentals of Plant Pathology, Phi Learning, ISBN:812034703X.</li> <li>5. Willie, J. and Sherwood, L. 2016. Prescott's Microbiology McGraw-Hill Education; 10th Edition, ISBN: 978-1259281594</li> <li>6. Chaube, H.S. and Singh, R. 2015. Introductory Plant Pathology CBS Publishers, ISBN: 978-8123926704.</li> <li>7. Rangasamy, G. 2006. Disease of crop plants in India (4th edition). Tata Mc Graw Hill New Delhi.</li> <li>8. Mishra, A., A. Bohra and A, Mishra. 2011. Plant Pathology-Disease and Management. Agro Bios, Jodhpur.</li> </ol>	
<b>Web resources:</b>	
<ol style="list-style-type: none"> <li>1. <a href="https://www.wileyindia.com/a-textbook-of-plant-pathology.html">https://www.wileyindia.com/a-textbook-of-plant-pathology.html</a></li> <li>2. <a href="https://www.britannica.com/science/plant-disease">https://www.britannica.com/science/plant-disease</a>.</li> <li>3. <a href="https://www.planetatural.com/pest-problem-solver/plant-disease/">https://www.planetatural.com/pest-problem-solver/plant-disease/</a></li> <li>4. <a href="https://www.elsevier.com/books/plant-pathology/agrios/978-0-08-047378-9">https://www.elsevier.com/books/plant-pathology/agrios/978-0-08-047378-9</a></li> <li>5. <a href="https://www.elsevier.com/life-sciences/immunology-and-microbiology/books">https://www.elsevier.com/life-sciences/immunology-and-microbiology/books</a></li> <li>6. <a href="https://www.amazon.in/INTRODUCTION-IMMUNOLOGY-RAFIA-IMRAN-ebook/dp/B09B66SD3J">https://www.amazon.in/INTRODUCTION-IMMUNOLOGY-RAFIA-IMRAN-ebook/dp/B09B66SD3J</a></li> </ol>	

**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**

<b>Title of the Course</b>	<b>P23BOE1B - CONSERVATION OF NATURAL RESOURCES AND POLICIES</b>									
<b>Paper Number</b>	<b>ELECTIVE I</b>									
<b>Category</b>	ELECTIVE		<b>Year</b>	I	<b>Credits</b>	3	<b>CourseCode</b>			
			<b>Semester</b>	I						
<b>InstructionalHours</b>	<b>Lecture</b>			<b>Tutorial</b>			<b>LabPractice</b>			<b>Total</b>

perweek	3	2	--	5
<b>Pre-requisite</b>	To create awareness of environmental problems and their consequences.			
<b>Learning Objectives</b>	1.Explain the term natural resources.			
	2.Describe the reasons for degradation of natural resources and suggest mea these.			
	3.List the various endangered species of animals and plants.			
	4.State the various environmental laws passed to conserve the natural resource			
	5.Explain sustainable development and justify its need; and describe the vari as well as non-conventional sources of energy.			

UNIT	CONTENTS
<b>I</b>	<b>NATURAL RESOURCES:</b> Definition – Importance – Classification – Human physiological socio-economic and cultural Human Population Explosion – Natural Resource Degradation – Concept of conservation – Equitable resource use for sustainable life system.
<b>II</b>	<b>FOREST RESOURCES:</b> Forest cover in India and the World – Importance – Desertification – Forest Wealth – Vanasamrakshna Samithi– Agroforestry – Social Forestry – Joint Forest Management Stra Conservation. <b>Wild Life:</b> Resources – Importance – Benefits – Wild life Extinction – Causes List of Endanger species in India and in the World – Ecological approach in wild life man Tourism – Wild Life projects in India – Sanctuaries and National Parks In India – Man Programme.
<b>III</b>	<b>LAND AND SOIL RESOURCES:</b> Soil, Complexity of soil nature, regional deposits, Land use and capability classification sys Planning models and their limitations. Impacts of natural and man-made activities on land cha land use planning– Soil Erosion – Loss of Soil Nutrients – Restoration of Soil Fertility – So Methods and Strategies in India. Wet Land Conservation and Management – Ecological Imp lands in India – Conservation Strategy and ecological Importance. Water Resources: Rivers and – Water Conservation and ground water level increase - WatershedProgramme.
<b>IV</b>	<b>MINERAL RESOURCES:</b> Use and exploitation – Environmental effects of extracting and using mineral resources – mining lands – Expansion of supplies by substitution and conservation. Food Resource Problems – Changes caused by agriculture – overgrazing effects of modern agriculture – Fer problems – Water Logging – Salinity – Sustainable agriculture, life stock breeding and farming
<b>V</b>	<b>ENVIRONMENTAL POLICY IN INDIA:</b> Need for policies- Public Policy – Economic policies – Relationship between economic de environment – Implementing Environmental Public Policy Strategies in pollution control – provisions in India regarding environment – Public Awareness and Participation in Management – National Land Use Policy 1988 – Industrial Policy 1991.

<b>Course</b>	
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<b>outcomes:On completion of this course the student will be able to</b>	
<b>CO</b>	
CO1	Understand the concept of different natural resources and their utilization.
CO2	Critically analyze the sustainable utilization land, water, forest and energy resources
CO3	Evaluate the management strategies of different natural Resources
CO4	Reflect upon the different national and international efforts in resource management and their conservation.
CO5	State the various environmental policy passed to conserve the natural resources.
ExtendedProfessionalComponent (is a part of internal component only,Not to be included in theExternalExamination questionpaper)	Questionsrelatedtotheabovetopics,fromvariouscompetitiveexaminationsUPSC/CSIR/GATE/TNPSC/otherstobesolved (TobediscussedduringtheTutorialhour)
Skillsacquiredfromthis course	Knowledge,ProblemSolving,Analyticalability,Professional Competency,ProfessionalCommunicationandTransferrableSkill
<b>RecommendedText:</b>	
<ol style="list-style-type: none"> <li>1. Trivedi R.K.1994. Environment and Natural Resources Conservation.</li> <li>2. Murthy J.V.S.1994. Watershed Management in India.</li> <li>3. Raymond, F Dasmann. 1984. Environmental Conservation, John Wiley.</li> <li>4. Nalini, K.S. 1993. Environmental Resources and Management, Anmol Publishers, New Delhi.</li> <li>5. Shyam Divan and Armin Rosencranz. 2001. Environmental Law and Policy in India, Oxford Uni.Press.</li> </ol>	
<b>Reference Books:</b>	
<ol style="list-style-type: none"> <li>1. Haue, R and Freed V.H. 1975. Environmental Dynamics of Pesticides, Menu Press, London</li> <li>2. Singh, B. 1992. Social Forestry for Rural Development, Anmol Publishers, New Delhi.</li> <li>3. Shafi. R. 1992. Forest Ecosystem of the World.</li> <li>4. Stacy Keach. 2016. Natural Resources Management. Syrawood Publishing House.</li> <li>5. Rathor B.S. 2013. Management of Natural Resource for Sustainable Development. Daya Publishing House, New Delhi.</li> </ol>	
<b>Web resources:</b>	
<ol style="list-style-type: none"> <li>1. <a href="https://www.amazon.in/conservation-natural-resources-Gifford-Pinchot-ebook/dp/B07HX76TVN">https://www.amazon.in/conservation-natural-resources-Gifford-Pinchot-ebook/dp/B07HX76TVN</a></li> <li>2. <a href="https://books.google.co.in/books/about/Natural_Resource_Conservation_and_Enviro.html?id=T2SRuhxpUW8C&amp;redir_esc=y">https://books.google.co.in/books/about/Natural_Resource_Conservation_and_Enviro.html?id=T2SRuhxpUW8C&amp;redir_esc=y</a></li> <li>3. <a href="https://www.kobo.com/ww/en/ebook/natural-resources-conservation-law">https://www.kobo.com/ww/en/ebook/natural-resources-conservation-law</a></li> <li>4. <a href="https://www.scribd.com/book/552185119/Natural-Resources-Conservation-and-Advances-for-Sustainability">https://www.scribd.com/book/552185119/Natural-Resources-Conservation-and-Advances-for-Sustainability</a></li> <li>5. <a href="https://www.scribd.com/document/354699536/Conservation-of-Natural-Resources">https://www.scribd.com/document/354699536/Conservation-of-Natural-Resources</a></li> </ol>	





**MappingwithProgrammeOutcomes:**

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

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

## ELECTIVE-I MUSHROOMCULTIVATION

<b>Titl e of the Co urs e</b>	<b>P23BOE1C -MUSHROOMCULTIVATION</b>					
<b>Pa per Nu mb er</b>	<b>ELECTIVE I</b>					
<b>Catego ry</b>	ELECTIVE	<b>Year</b>	I	<b>Credits</b>	3	<b>CourseCode</b>
		<b>Semest er</b>	I			
<b>InstructionalHours perweek</b>	<b>Lecture</b>	<b>Tutorial</b>	<b>LabPractice</b>	<b>Total</b>		
	3	2	--	5		
<b>Pre-requisite</b>	Basicknowledgeonstructureandfunction of various groupsof mushrooms.					
<b>Learning Objectives</b>	1.Toteachtheidentificationofmushrooms.					
	2.Todifferentiatetheediblemushrooms withtoxicand hallucinatingfungi.					
	3.Tostudythecultivation techniqueofmushrooms					
	4.Tolearntheeconomicimportanceofmushroominvariousfields.					
	5.Tostudy howto establishmushroom cultivation asbusiness enterprise.					
	6.Toteachtheidentificationofmushrooms.					
<b>UN IT</b>	<b>CONTENTS</b>					
<b>I</b>	<b>INTRODUCTION:</b>  Mushroom,EdibleMushroom,commercialproduction,medicinalvalueofmushrooms,nutraceuticals and dietary supplements					
<b>II</b>	<b>MORPHOLOGICAL AND MICROSCOPICAL IDENTIFICATION OF EDIBLE AND POISONOUS MUSHROOMS:</b>  Keysforidentificationofediblemushrooms: <i>Agaricusbisporus</i> , <i>Pleurotussajorcaju</i> , <i>Volvariellavolvcea</i> and <i>Calocybeindica</i> .Keyforidentifyinghallucinogenicmushroom( <i>Psilocybesp.</i> )MedicinalMushroom – <i>Cordyceps</i> , <i>Ganoderma lucidum</i> and <i>Lentinusedodes</i> .					

<b>III</b>	<b>CULTIVATION:</b> 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).	
<b>IV</b>	<b>POST-HARVEST MANAGEMENT:</b> Harvest, storage, quality assurance of mushrooms. Pest management.	
<b>V</b>	World production of 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.	
<b>Course</b>		<b>Programme outcomes</b>
<b>Outcomes: On completion of this course the student will be able to</b>		
<b>CO</b>		
CO1	Knowledge on identification of edible and toxic mushrooms belonging to Ascomycota 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 U PSC/TRB/NET/UGC–CSIR/GATE/TNPSC/other 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 Transferable Skill	
<b>Recommended Text:</b>		
<ol style="list-style-type: none"> <li>1. Cheung, P.C.K. 2008. Mushrooms as functional food. A John Wiley &amp; Sons, Inc., Publication.</li> <li>2. Dijksterhuis, J. and Samson, R.A. 2007. Food Mycology: A multifaceted approach in fungi and food. CRC press, New York.</li> <li>3. Hall, R.I., Stephenson, S.L., Buchanan, P.K., Yun, W. and Cole, A.L.J. 2003. Edible and poisonous</li> </ol>		

mushrooms of the world. Timber Press, Portland, Cambridge.

4. Ting, S. and Miles, P.G. 2004. Mushrooms: Cultivation, nutritional value, medicinal effect and nutritional environmental impact. CRC press, New York.
5. Verma, 2013. Mushroom: edible and medicinal: cultivation conservation, strain improvement with their marketing. Daya Publishing House.

**Reference books:**

1. Tiwari, S.C., Pandey K. 2018. Mushroom cultivation. Mittal publisher, New Delhi.
2. Philips, G., Miles, Chang, S-T. 2004. Mushrooms: Cultivation, nutritional value, medicinal effect and environmental effect. 2<sup>nd</sup> ed. CRC Press.
3. Diego, C.Z., Pando-Gimenez, A. 2017. Edible and medicinal mushrooms: Technology and Application. Wiley-Blackwell publishers.
4. Nita Bahl. 2002. Handbook on Mushroom 4<sup>th</sup> edition Vijayprimalani 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](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](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**

<b>Title of the Course</b>	<b>P23BOE1D - PHYTOPHARMACOGNOSY</b>						
<b>Paper Number</b>	<b>ELECTIVE I</b>						
<b>Category</b>	ELECTIVE	<b>Year</b>	I	<b>Credits</b>	3	<b>CourseCode</b>	
		<b>Semester</b>	I				
<b>Instructional Hours per week</b>		<b>Lecture</b>		<b>Tutorial</b>		<b>Lab Practice</b>	
			3		2		--
<b>Pre-requisite</b>	Students should be aware of traditional use of plant derived drugs in world.						
<b>Learning Objectives</b>	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.						
<b>UNIT</b>	<b>CONTENTS</b>						
<b>I</b>	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.						
<b>II</b>	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.).						
	Characterization of Therapeutic drugs: Extraction, separation, isolation (Chromatographic techniques) and characterization of secondary metabolites (Spectroscopic techniques). Quality control of plant drugs: Classical and						

<b>III</b>	modern approaches of drugs. Significance of Pharmacopoeial standards.
<b>IV</b>	Pharmacological action of Plant Drugs: Anti-cancer, Bitter tonic, Carminatives and G.I. regulators, Cardiotonics, CNS-Stimulant, Expectorant, Laxatives, Purgatives. Outline of pharmacogenomics functions.
<b>V</b>	Hallucinogenic, allergenic and other toxic plants, poisonous plants - biopesticides - biocides – biofungicides.

<b>Course outcomes:</b>		<b>Programme outcomes</b>
<b>On completion of this course the student will be able to</b>		
<b>CO</b>		
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 metabolites.	Knowledge on modern instrumentation on characterization of plant	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
<b>Recommended Text:</b>		
<ol style="list-style-type: none"> <li>Dewick P.M., 2002. Medicinal Natural Products: A biosynthetic approach, John Wiley &amp; Sons Ltd.</li> <li>Evans W.C., 2002, Trease and Evan's Pharmacognosy, W.B. Saunders.</li> <li>Harborne, J.B., 1998. Phytochemical Methods, Chapman and Hall.</li> <li>Harborne, J.B., 1998. Phytochemical Methods, Chapman and Hall.</li> <li>Vickery M.L. and B. Vickery, 1981. Secondary Plant Metabolism, The MacMillan Press Ltd.</li> </ol>		
<b>Reference books:</b>		
<ol style="list-style-type: none"> <li>Bruneton, J. 1999. Pharmacognosy, Phytochemistry, Medicinal Plants, Intercept Ltd., Paris.</li> <li>Evans W.C. 2002, Trease and Evan's Pharmacognosy, W.B. Saunders.</li> <li>Harborne, J.B. 1998. Phytochemical Methods, Chapman and Hall.</li> <li>Vickery M.L. and B. Vickery, 1981. Secondary Plant Metabolism, The MacMillan Press Ltd.</li> <li>Wagner H., S. Bladt and E.M. Zgainski (Translated by A. Scott) 1984, Plant Drug Analysis, Springer-Verlag.</li> </ol>		
<b>Web resources:</b>		
<ol style="list-style-type: none"> <li><a href="https://pharmabookbank.files.wordpress.com/2019/03/14.2.pharmacognosy-by-biren-shahavinash-seth-1.pdf">https://pharmabookbank.files.wordpress.com/2019/03/14.2.pharmacognosy-by-biren-shahavinash-seth-1.pdf</a></li> </ol>		

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>

**MappingwithProgrammeOutcomes:**

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)**



**CORE-IV TAXONOMY OF ANGIOSPERMS AND ECONOMIC BOTANY**

<b>Title of the Course</b>	<b>P23BOT23</b>					
	<b>PLANT TAXONOMY OF ANGIOSPERMS AND ECONOMIC BOTANY</b>					
<b>Paper Number</b>	<b>CORE IV</b>					
<b>Category</b>	Core	<b>Year</b>	I	<b>Credits</b>	5	<b>CourseCode</b>
		<b>Semester</b>	II			
<b>Instructional Hours per week</b>	<b>Lecture</b>		<b>Tutorial</b>		<b>Lab Practice</b>	<b>Total</b>
	3		3		--	6
<b>Pre-requisite</b>	Prior knowledge on morphological, anatomical characteristics and uses of plants					
<b>Learning Objectives</b>	1.To be familiar with the basic concepts and principles of plant systematics.					
	2.To develop a suitable method for correct characterization and identification					
	3.To understand the importance of taxonomic relationships in research of plants					
	4.To provide information on various classification systems					
	5.To know about the economic importance of plants.					
<b>UNIT</b>	<b>CONTENTS</b>					
<b>I</b>	<b>TAXONOMY AND SYSTEMATICS</b> Botanical exploration and contribution with special reference to India by William Roxburgh, Robert Wright, Nathaniel Wallich and Gamble, J.S. Principles of classification as proposed by Linnaeus, Natural – Bentham and Hooker, Phylogenetic system - Hutchinson, Modern – The use of botanical gardens and herbaria of world, preparation and maintenance of Herbarium, Botanical societies, their organization and role.					
<b>II</b>	<b>MODERN TRENDS IN TAXONOMY</b> Modern trends in taxonomy, chemotaxonomy, numerical taxonomy, biosystematics. ICBN rules, nomenclature, binomial nomenclature, importance and principle. Important articles, typification, publication, effective and valid publication, author citation, recommendations and amendments of code of nomenclature, dictionaries, Taxonomic literature (Index Kewensis)					
<b>III</b>	<b>SYSTEMATIC ANALYSIS OF PLANTS-I</b> Polypetalae – Nymphaeaceae, Sterculiaceae, Portulacaceae, Rhamnaceae, Vitaceae, Sapindaceae, Turneraceae.					
	<b>SYSTEMATIC ANALYSIS OF PLANTS-II</b> Gamopetalae – Sapotaceae, Oleaceae, Boraginaceae, Scrophulariaceae, Bignoniaceae, Acanthaceae, Verbenaceae.					

<b>IV</b>	Monochlamydeae – Nyctaginaceae, Aristolochiaceae, Casuarinaceae. Monocots – Orchidaceae, Liliaceae, Commelinaceae, Cyperaceae.	
<b>V</b>	<p><b>ECONOMIC BOTANY</b>                      General account on utilization of selected crop plants: (i) Cereals (rice and wheat) – (ii) Pulses (black gram), (iii) Drug yielding plants (<i>Withania somnifera</i> and <i>Coleus aromaticus</i>) (iv) (Groundnut, sunflower).*</p> <p>(v) Sugar yielding plants (sugarcane and sugar beet), (vi) Spices and condiments (cardamom), (vii) Commercial crops - fibre (jute), (viii) Timber (Teak and red cedar), (ix) Resins and gums (Asafoetida and gum arabic) – (x) Essential oils (lemon grass), (xi) Beverages (tea, coffee), (xii) Plants used as avenue trees for shade, pollution control and aesthetic plantation - uses of <i>Casuarina</i>.</p>	
<b>Course</b>		
<b>outcomes: On completion of this course, the students will be able to:</b>		
<b>CO</b>		
CO1	Recollect the basic concepts of morphology of leaves, flowers. Identify the types of compound leaves, inflorescence and fruits. Describe their characteristic features	
CO2	Explain the principles of taxonomy. Summarize the taxonomic hierarchy. Define Binomial nomenclature. Group Activity – Construct key preparation	
CO3	Explain the various types of classification. Distinguish its advantages and disadvantages. Construction of floral formula and floral diagram.	
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.	
CO5	Illustrate and explain the characteristic features and list out the economic importance of the families.	
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 UPS, CSIR/GATE/TNPSC/other 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 Transferable Skill	
<b>Recommended Text:</b>		
<ol style="list-style-type: none"> <li>1. Pandey, B.P. 2013. Taxonomy of Angiosperms, S. Chand Publishing, New Delhi.</li> <li>2. Sharma, O.P. 2017. Plant Taxonomy. (II Edition). The McGraw Hill Companies.</li> <li>3. Singh, G. 2007. Plant systematics theory and practices. Oxford and IBH Publishing Co.</li> <li>4. Jain, S.K and Rao R.R. 1993. A handbook of field and herbarium methods. Today and Tomorrow Publ.</li> </ol>		

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:**

- <https://www.ipni.org/>  
<http://www.theplantlist.org/>  
 3. <https://www.amazon.in/PLANT-TAXONOMY-Sharma/dp/0070141592>  
<https://www.tropicos.org/home>  
<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**

<b>Title of the Course</b>	<b>P23BOT24 -PLANT ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS</b>
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Paper Number	CORE V					
Category	Core	Year	I	Credits	5	CourseCode
		Semester	II			
InstructionalHours perweek		Lecture	Tutorial	LabPractice	Total	
		3	3			
Pre-requisite	To acquire knowledge on the anatomical structure and reproductive phase of					
Learning Objectives	1.Learn the importance of plant anatomy in plant production systems.					
	2.Classify meristems and identify their structures, functions and roles in plants growth and secondary growth of woody plants.					
	3.Understand the mechanism underling the shift from vegetative to reproductive					
	4.Trace the development of male and female gametophyte.					
	5.Understand the recent advances in palynology.					
UNIT	CONTENTS					
I	<p><b>CELL WALL:</b> Morphological and physico-chemical changes; Plasmodesmata- types of pits – growth of cell intercellular spaces; Meristems: Classifications: Theories of shoot and root apices, Cytological apex. Vascular Cambium: Composition and organization – multiplicative and additive divisions and secondary xylem – tracheary elements and vessels – vesselless dicots – xylem rays and angiosperm wood; Dendrochronology – grain, texture and figure in wood; reaction wood; ring porous wood. Phloem: Ultra structure and ontogeny of sieve tube elements and companion tracheary elements.</p>					
II	<p><b>PERIDERM:</b> Structure, organization and activity of phellogen. Polyderm and Rhytiderm – wound periderm thickening in Dicots; Anomalous secondary growth in Dicots (Amaranthaceae, Aristolochia Piperaceae, Nyctaginaceae) and arborescent Monocots. Primary thickening in palms; Ontogeny and types of Stomata; Leaf abscission; Major nodal types; Kranz anatomy and its significance. Principle of killing and fixation, dehydration and rehydration of botanical specimens. Stains: staining (fast-green and light green) of free hand sections; Protocol for serial sectioning impregnated specimens; Mounting and mounting media.</p>					
III	<p><b>MICROSPORANGIUM AND MALE GAMETOPHYTE:</b> Structure and development of Anther; Ultrastructure and physiology of anther tapetum; Palynology: Morphology and ultrastructure of pollen wall, pollen kitt, pollen analysis, pollen sterility and pollen physiology.</p>					

<b>IV</b>	<p><b>MEGASPORANGIUM AND FEMALE GAMETOPHYTE:</b></p> <p>Structure and development of Megasporangium; Types of ovules, Endothelium, obtuse Megasporogenesis: Female gametophyte: Structure, types, haustorial behavior and Nutrition. Fertilization: Double fertilization and triple fusion; Endosperm: Development of endosperm, efficiency of endosperm haustoria and functions; Ruminant endosperm. Embryogeny: Development of (Grass) and dicot (Crucifer) embryos.</p>
<b>V</b>	<p><b>POLYEMBRYONY:</b></p> <p>Causes of Polyembryony, classification, induction and practical application. Apomixis and its importance and Fruit development and role of growth substances. Parthenocarpy and its importance.</p>

<b>Course outcomes:</b>	<b>On completion of this course, the students will be able to:</b>
<b>CO</b>	
CO1	Learn the structures, functions and roles of apical vs lateral meristems in monocot and dicot plant growth.
CO2	Study the function and organization of woody stems derived from secondary growth in dicot and monocot plants.
CO3	Apply their idea on sectioning and dissection of plants to demonstrate various stages of plant development.
CO4	Understand the various concepts of plant development and reproduction.
CO5	Profitably manipulate the process of reproduction in plants with a professional and entrepreneurial mindset.
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 UPS, CSIR/GATE/TNPSC/other 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 Transferable Skill

<p><b>Recommended Text:</b></p> <ol style="list-style-type: none"> <li>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.</li> <li>2. Maheshwari, P. 1963. Recent Advances in Embryology of Angiosperms. Intl. Soc. Plant Morphologists, New Delhi.</li> <li>3. Sharma, P.C. 2017. Text Book of Plant Anatomy. Arjun Publishing House, New Delhi.</li> <li>4. Pandey, S.N and Ajanta Chandha. 2006. Plant Anatomy and Embryology. Vikas Publishing House Pvt. Ltd, New Delhi.</li> <li>5. Narayanaswamy, S. 1994. Plant Cell and Tissue Culture. Tata McGraw Hill Ltd. New Delhi.</li> </ol>
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<b>Reference Books:</b>										
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.										
<b>Web resources:</b>										
1. <a href="https://www.ipni.org/">https://www.ipni.org/</a>										
2. <a href="http://www.theplantlist.org/">http://www.theplantlist.org/</a>										
3. <a href="https://faculty.etsu.edu/liuc/plant_anatomy_sites.htm">https://faculty.etsu.edu/liuc/plant_anatomy_sites.htm</a>										
4. <a href="http://aryacollegeludhiana.in/E_BOOK/Botany/plant_anatomy.pdf">http://aryacollegeludhiana.in/E_BOOK/Botany/plant_anatomy.pdf</a>										
5. <a href="https://www.uou.ac.in/sites/default/files/slm/BSCBO-202.pdf">https://www.uou.ac.in/sites/default/files/slm/BSCBO-202.pdf</a>										
6. <a href="http://greenlab.cirad.fr/GLUVED/html/P1_Prelim/Bota/Bota_typo_014.html">http://greenlab.cirad.fr/GLUVED/html/P1_Prelim/Bota/Bota_typo_014.html</a>										
7. <a href="https://www.askiitians.com/">https://www.askiitians.com/</a>										

**MappingwithProgrammeOutcomes:**

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)

**ELECTIVE-II MEDICINAL BOTANY**

<b>Title of the Course</b>	<b>P23BOE2A</b>									
	<b>MEDICINAL BOTANY</b>									
<b>Paper Number</b>	<b>ELECTIVE II</b>									
<b>Category</b>	ELECTIVE	<b>Year</b>	I	<b>Credits</b>	3	<b>CourseCode</b>				
		<b>Semester</b>	II							
<b>InstructionalHours perweek</b>	<b>Lecture</b>		<b>Tutorial</b>		<b>LabPractice</b>		<b>Total</b>			
	2		2		--		4			

<b>Pre-requisite</b>	Understanding the uses of medicinal plants and its conservation.
<b>Learning Objectives</b>	1.To understand the uses and effects of medicinal plants and herbal supplement 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 plants 5.To create new strategies to enhance growth and quality check of medicinal plants
<b>UNIT</b>	<b>CONTENTS</b>
<b>I</b>	<b>HISTORY AND TRADITIONAL SYSTEMS OF MEDICINE:</b>  Historical Perspectives – European, African, American, Southeast Asian Practices. Scope and Importance of Medicinal Plants; Traditional systems of medicine - Definition and Scope. Classical systems of medicine: Naturopathy, Siddha, Ayurveda, Homeopathy, Unani and MateriaMedica. Ayurveda: panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in Ayurvedic treatment. Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicinal systems. Concept: Umoor-e-tabiya, tumors treatments/ therapy, polyherbal formulations.
<b>II</b>	<b>PHYTOCHEMISTRY AND PHARMACOGNOSY:</b>  Phytochemistry, important phytoconstituents, their plant sources, medicinal properties. Definition, principles, staining methods. Biological stains – bright field dyes and fluorescence. Localization of phytochemicals. Raw drugs, authenticity, study through physical, microscopic and instrumental methods. Different types of formulations. Adulteration and Admixtures.
<b>III</b>	<b>ACTIVE PRINCIPLE &amp; DRUG DISCOVERY:</b>  Brief description of selected plants, Active principles, biochemical properties and medicinal uses. <i>Commiphora</i> for hypercholesterolemia, <i>Boswellia</i> for inflammatory disorders, Arjuna ( <i>Terminalia arjuna</i> ) for cardio protection, turmeric ( <i>Curcuma longa</i> ) for wound healing, antioxidant and anticancer activity, <i>Picrorhizakurroa</i> for hepatoprotection, Opium Poppy for analgesic and antitussive, <i>Sassafras</i> , <i>Cinchona</i> and <i>Artemisia</i> for Malaria, <i>Rauwolfia</i> as tranquilizer, <i>Belladonna</i> as anticholinergic, <i>Adonis</i> as cardiotonic, <i>Podophyllum</i> as antitumor, <i>Stevia rebaudiana</i> for antidiabetic, <i>Catharanthus roseus</i> for anticancer. Bioprospecting, drug discovery from plants with reference to diabetes and cancer. Product development and quality control.
<b>IV</b>	<b>CONSERVATION AND AUGMENTATION:</b>  Significance of Cultivation, management, policies for conservation and sustainable use of medicinal plants. Conservation of endemic and endangered medicinal plants, Red list criteria; <i>In situ</i> conservation: reserves, sacred groves, National Parks; <i>Ex situ</i> conservation: Botanic Gardens, Ethno medicinal gardens. Propagation of Medicinal Plants: seeds, cuttings, layering, grafting and budding.

V	<p><b>ETHNO BOTANY AND FOLK MEDICINE:</b></p> <p>Concepts and definition of Ethno botany and folk medicines. A brief history of ethnobotanical &amp; locally. Methods to study ethno botany; Applications of Ethno botany: Folk medicines of et medicine, ethno ecology, ethnic communities of India. Understanding the traditions of tribes Irulas and Kanis. Repository of Ethnobotanical data – Archeology, inventories, folklo Traditional Knowledge Sharing - Prior information consent, interviews, questionnaires partners.Plants associated with culture, social, religious and medicinal purposes.Commercial knowledge – ethics, IPR, biopiracy, equitable benefit sharing models.</p>
<p><b>Course</b></p> <p><b>outcomes:On completion of this course, the students will be able to:</b></p> <p><b>CO</b></p>	
CO1	Recognize plants and relate to their medicinal uses
CO2	Explain about the phytochemistry, pharmacognosy and bioprospecting of medicinal plant extracts.
CO3	Apply techniques for conservation and propagation of medicinal plants.
CO4	Analyze and decipher the significance of various methods of harvesting, drying and storage of medicinal herbs.
CO5	Develop new strategies to enhance growth and quality check of medicinal herbs considering the practical issues pertinent to India.
ExtendedProfessionalComponent (is a part of internal component only,Not to be included in theExternalExamination questionpaper)	Questionsrelatedtotheabovetopics,fromvariouscompetitiveexaminationsUPSC CSIR/GATE/TNPSC/otherstobesolved (TobediscussedduringtheTutorialhour)
Skillsacquiredfromthis course	Knowledge,ProblemSolving,Analyticalability,Professional Competency,ProfessionalCommunicationandTransferrableSkill
<p><b>RecommendedText:</b></p> <ol style="list-style-type: none"> <li>1. AYUSH (www.indianmedicine.nic.in). 2014. <i>About the systems—An overview of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy</i>. New Delhi: Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (AYUSH), Ministry and Family Welfare, Government of India.</li> <li>2. Bhat, S.V., Nagasampagi, B.A., &amp; Meenakshi, S. 2009. <i>Natural Products – Chemistry and Applications</i>. Narosa Publishing House, India Ltd.</li> <li>3. CSIR- Central Institute of Medicinal and Aromatic Plants, Lucknow. 2016. <i>AushGyanya: Handbook of Medicinal and Aromatic Plant Cultivation</i>.</li> <li>4. Kapoor, L. D. 2001. <i>Handbook of Ayurvedic medicinal plants</i>. Boca Raton, FL: CRC Press.</li> <li>5. Saroya, A.S. 2017. <i>Ethno botany</i>. ICAR publication.</li> </ol>	



<p>6. Sharma, R. 2003. Medicinal Plants of India-An Encyclopedia. Delhi: Daya Publishing House.</p> <p>7. Sharma, R. 2013. Agro Techniques of Medicinal Plants. Daya Publishing House, Delhi.</p> <p>8. Thakur, R. S., H. S. Puri, and Husain, A. 1989. <i>Major medicinal plants of India</i>. Central Institute of Medicinal and Aromatic Plants, Lucknow, India.</p>
<p><b>Reference Books:</b></p> <p>1. Akerele, O., Heywood, V and Synge, H. 1991. The Conservation of Medicinal Plants. Cambridge University Press.</p> <p>2. Evans, W.C. 2009. Trease and Evans Pharmacognosy, 16th edn. Philadelphia, PA: Elsevier Saunders Ltd.</p> <p>3. Jain, S.K. and Jain, Vartika. (eds.). 2017. Methods and Approaches in Ethnobotany: Concepts, Practices and Prospects. Deep Publications, Delhi</p> <p>4. Amruth. 1996. The Medicinal plants Magazine (All volumes) Medicinal plant Conservatory Society, Bangalore.</p> <p>5. Bhattacharjee, S.K. 2004. Hand Book of Medicinal plants. Pointer Publishers, Jaipur.</p> <p>6. Handa, S.S and V.K. Kapoor. 1993. Pharmacognosy. VallabhPrakashan, New Delhi.</p>
<p><b>Web resources:</b></p> <p>1. <a href="https://www.amazon.in/Medical-Botany-Plants-Affecting-Health/dp/0471628824">https://www.amazon.in/Medical-Botany-Plants-Affecting-Health/dp/0471628824</a></p> <p>2. <a href="https://www.amazon.in/Current-Trends-Medicinal-Botany-Muhammad/dp/9382332502">https://www.amazon.in/Current-Trends-Medicinal-Botany-Muhammad/dp/9382332502</a></p> <p>3. <a href="https://link.springer.com/book/10.1007/978-3-030-74779-4">https://link.springer.com/book/10.1007/978-3-030-74779-4</a></p> <p>4. <a href="https://www.elsevier.com/books/medicinal-plants/da/978-0-08-100085-4">https://www.elsevier.com/books/medicinal-plants/da/978-0-08-100085-4</a></p> <p>5. <a href="https://www.pdfdrive.com/medicinal-plants-books.html">https://www.pdfdrive.com/medicinal-plants-books.html</a></p>

**MappingwithProgrammeOutcomes:**

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)**

<b>Title of the Course</b>			
<b>Paper Number</b>			
<b>Category</b>	ELECTIVE	<b>Year</b>	I
		<b>Semester</b>	II
<b>Instructional Hours per week</b>		<b>Lecture</b>	<b>Tutorial</b>
		2	2
<b>Pre-requisite</b>	Basic understanding of plant metabolites.		
<b>Learning Objectives</b>	1. To comprehend the various classes of phytochemicals present in plants.		
	2. To understand the biosynthetic processes through which diverse phytochemicals are synthesized.		
	3. To learn about the isolation of different phytochemicals using different techniques.		
	4. To learn about the application of different phytochemicals in various fields.		
	5. To understand the information of the traditional system of medicine.		
<b>UNIT</b>			
<b>I</b>	<p align="center"><b>SECONDARY METABOLITES AND CLASSIFICATION</b></p> Phytochemistry: Definition, history, principles. Secondary metabolites: definition, classification, occurrence.		
<b>II</b>	<p align="center"><b>ISOLATION AND QUANTIFICATION OF PHYTOCHEMICALS</b></p> Techniques for isolation of medicinally important biomolecules: solvent extraction, chemical separations, chromatography.		
<b>III</b>	<p align="center"><b>BIOSYNTHETIC PATHWAYS AND APPLICATION OF PHYTOCHEMICALS</b></p> Biosynthetic pathways of secondary compounds: Shikimic pathway; Mevalonic Acid Pathway; Pathway of alkaloids.		
<b>IV</b>	<p align="center"><b>HERBALISM AND ETHNOBOTANY</b></p> Herbs and healing: Historical perspectives: local, national and global level; Herbal cultures: origin and development.		

<b>V</b>	<p><b>TRADITIONAL SYSTEM OF MEDICINE</b>                  Classical health traditions: Systems of medicine: origin and development of biomedicine; Indian Systems of medicine: Fundamental principles of Ayurveda: Panchabhootha theory, Tridosha theory, Saptadhatu theory and <i>Mala</i></p>	
<b>Course</b>		
<b>outcomes:</b>	<b>On completion of this course, the students will be able to:</b>	
<b>CO</b>		
CO1	Understand the role of plants in the survival of human beings and other Organisms.	
CO2	Recognition of the contribution made by primitive people in exploration of plant knowledge to alleviate common diseases and development of systems of medicine.	
CO3	Gaining knowledge on different classes of phytochemicals present in higher and lower plants species.	
CO4	Demonstrate the various aspects of extraction, isolation and characterization of secondary metabolites.	
CO5	Know the methods of screening of secondary metabolites for various biological properties.	
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 exams (To be discussed during the Tutorial hour)	
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferable Skills	
<b>Recommended Text:</b>		
<ol style="list-style-type: none"> <li>1. Kokate, C.K., Purohit, A.P and Gokhale, S.B. 2010. Pharmacognosy. Vol. I &amp; II. Nirali Prakashan, Pune.</li> <li>2. Mohamed Ali. 2012. Textbook of Pharmacognosy. CBS Publishers &amp; Distributors Pvt. Ltd., New Delhi.</li> <li>3. Gokhale, S.B., Kokate, C.K. and Gokhale, A. 2016. Pharmacognosy of Traditional Drugs. Nirali Prakashan, 1st Edition. ISBN: 9351642062. 2.</li> <li>4. Joshi, S.G. 2018. Medicinal Plants. Oxford &amp; IBH Publishing C., Pvt., Ltd., New Delhi.</li> <li>5. Kumar, N. 2018. A Textbook of Pharmacognosy. Aitbs Publishers, India.</li> </ol>		
<b>Reference Books:</b>		
<ol style="list-style-type: none"> <li>1. Shah, B.N. 2005. Textbook of Pharmacognosy and phytochemistry. Cbs Publishers &amp; Distributors, New Delhi.</li> <li>2. Harshal A and Pawar. 2018. Practical book of pharmacognosy and phytochemistry- Everest Publishing house.</li> </ol>		

<ol style="list-style-type: none"> <li>3. Varsha Tiwari and Shamim Ahmad. 2018. A practical book of pharmacognosy and phytochemistry. Nirali Prakashan advancement of knowledge.</li> <li>4. Braithwaite, A and F.J. Smith. 1996. <i>Chromatographic Methods</i> (5<sup>th</sup> Edition) Blackie Academic &amp; Professional London.</li> <li>5. Wilson, K and J. Walker (Eds). 1994. <i>Principles and Techniques of Practical Biochemistry</i> (4<sup>th</sup> Edition) Cambridge University Press, Cambridge.</li> <li>6. Harborne. J.B. 1998. <i>Phytochemical methods. A guide to modern techniques of Plant Analysis</i>, Chapman and Hall publication, London.</li> </ol>
<b>Web resources:</b>
<ol style="list-style-type: none"> <li>1. <a href="https://www.kobo.com/gr/en/ebook/phytochemistry-2">https://www.kobo.com/gr/en/ebook/phytochemistry-2</a></li> <li>2. <a href="https://www.amazon.in/Textbook-Pharmacognosy-Phytochemistry-Kumar-Jayaveera-ebook/dp/B06XKSY76H">https://www.amazon.in/Textbook-Pharmacognosy-Phytochemistry-Kumar-Jayaveera-ebook/dp/B06XKSY76H</a></li> <li>3. <a href="https://www.amazon.in/Computational-Phytochemistry-Satyajit-Dey-Sarker-ebook/dp/B07CV96NZJ">https://www.amazon.in/Computational-Phytochemistry-Satyajit-Dey-Sarker-ebook/dp/B07CV96NZJ</a></li> <li>4. <a href="https://studyfrnd.com/pharmacognosy-and-phytochemistry-book/">https://studyfrnd.com/pharmacognosy-and-phytochemistry-book/</a></li> <li>5. <a href="https://www.worldcat.org/title/textbook-of-pharmacognosy-and-phytochemistry/oclc/802053616">https://www.worldcat.org/title/textbook-of-pharmacognosy-and-phytochemistry/oclc/802053616</a></li> <li>6. <a href="https://www.worldcat.org/title/phytochemistry/oclc/621430002">https://www.worldcat.org/title/phytochemistry/oclc/621430002</a></li> </ol>

**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-II RESEARCH METHODOLOGY, COMPUTER APPLICATIONS & BIOINFORMATICS**

<b>Title of the Course</b>	<b>P23BOE2C</b>						
	<b>RESEARCH METHODOLOGY, COMPUTER APPLICATIONS &amp; BIOINFORMATICS</b>						
<b>Paper Number</b>	<b>ELECTIVE II</b>						
<b>Category</b>	ELECTIVE	<b>Year</b>	I	<b>Credits</b>	3	<b>CourseCode</b>	
		<b>Semester</b>	II				
<b>Instructional Hours per week</b>	<b>Lecture</b>		<b>Tutorial</b>		<b>Lab Practice</b>		<b>Total</b>
	2		2		--		4
<b>Pre-requisite</b>	To impart expertise about analysis and research.						
<b>Learning Objectives</b>	1.To equip students to collect, analyze and evaluate data generated by their scientific manner.						
	2.To provide an overview on modern equipments that they would help students to instantly commence research careers and/or start entrepreneurial ventures.						
	3.To develop interdisciplinary skills in using computers in botany to learn a database.						
	4.Students aware with the most recent technologies for sequencing and bioinformatics 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 applications.						
<b>UNIT</b>	<b>CONTENTS</b>						
<b>I</b>	Literature collection and citation: bibliography —bibliometrics (scientometrics): definition-lit. bibliography - *biblioscape – plagiarism - project proposal writing - dissertation writing – presentation (oral/poster) - E-learning tools- monograph - introduction and writing-Standard operating procedure introduction and preparation — Research Institutions - National and International.						
<b>II</b>	Basic principles and applications of pH meter, UV-visible spectrophotometer, centrifugation, chromatography- TLC, Gas chromatography with mass spectrum (GC/MS), and HPLC-Scanning electron microscopy-Agarose gel Electrophoresis — Polyacrylamide Gel Electrophoresis –Polymerase chain reaction						
<b>III</b>	Introduction to computers and Bioinformatics. Types of hardware and software operating systems. Fundamentals of networking, operation of networks, telnet, ftp, www, Internet. Biological Research using search engines, finding scientific articles.						
<b>IV</b>	Public biological databases, searching biological databases. Use of nucleic acid and protein databases.						

<b>V</b>	NCBI, EMBL, DDBJ, SWISSPORT, Protein prediction and Gene finding tools. Techniques i BLAST, FASTA, Multiple Sequence Analysis.
<b>Course</b>	
<b>outcomes:On completion of this course, the students will be able to:</b>	
<b>CO</b>	
CO1 Research	Realize the need of centrifuges and chromatography and their uses in
CO2	Learn the principles and applications of electrophoresis.
CO3	Construct the phylogenetic trees for similar characteristic feature of plant genomes and study <i>de novo</i> drug design through synthetic biology.
CO4	Understand the concept of pairwise alignment of DNA sequences using algorithms.
CO5	Interpret the features of local and multiple alignments.
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 CSIR/GATE/TNPSC/other 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 Transferable Skill
<b>Recommended Text:</b>	
<ol style="list-style-type: none"> <li>1. Veerakumari, L. 2017. Bioinstrumentation. MJP Publisher, India. p578.</li> <li>2. Sree Ramulu, V.S. 1988. Thesis Writing, Oxford &amp; IBH Pub. New Delhi.</li> <li>3. Kothekar, V and T. Nandi. 2009. An introduction to Bioinformatics. Panima publishing crop, New Delhi.</li> <li>4. Mani, K and N. Vijayaraj. 2004. Bioinformatics – A Practical Approach. 1st Edn. Aparna publication, Coimbatore.</li> <li>5. Gurumani, N. 2019. Research Methodology: For Biological Sciences, MP. Publishers.</li> </ol>	
<b>Reference Books:</b>	
<ol style="list-style-type: none"> <li>1. Jayaraman, J. 2000. Laboratory manual of Biochemistry, Wiley Eastern Limited, New Delhi 110 002.</li> <li>2. Pevsner, J. 2015. Bioinformatics and functional genomics. Hoboken, NJ: Wiley-Blackwell.</li> <li>3. Arthur Conklin W.M and Greg White, 2016. Principles of computer security. TMH. McGraw-Hill Education; 4 edition.</li> <li>4. Irfan Ali Khan and Attiya Khanum (eds.). 2004. Introductory Bioinformatics. Ukaaz Publications, Hyderabad.</li> <li>5. Arthur Conklin W.M., and Greg White. 2016. Principles of computer security. TMH., McGraw-Hill Education; 4<sup>th</sup> edition</li> </ol>	

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

**MappingwithProgrammeOutcomes:**

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

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

Title of the Course	<b>P23BOE2D</b> <b>BIOPESTICIDE TECHNOLOGY</b>							
Paper Number	<b>ELECTIVE II</b>							
Category	ELECTIVE	Year	I	Credits	3	CourseCode		
		Semester	II					
Instructional Hours per week	Lecture	2	Tutorial	2	Lab Practice	--	Total	4
	Pre-requisite		Prior knowledge on impact of chemical pesticides on environment and biopesticides					
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 forestry, and agriculture.						
		3. To gain knowledge about several biopesticides (bio-insecticides, bio-fungicides, 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 diseases.						
UNIT	CONTENTS							
<b>I</b>	<b>INTRODUCTION</b> Introduction of biopesticides. Biological control, History and concept of biopesticides. Importance and potential of biopesticide. Advantages for the use of biopesticides.							
<b>II</b>	<b>TYPES OF BIOPESTICIDES</b> Classification of biopesticides, botanical pesticides and biorationals. Mass production technologies for pesticides. Major classes-Properties and uses of Bioinsecticides, biofungicides, biobactericides and bioherbicides. Importance of neem in organic agriculture.							
<b>III</b>	<b>IMPORTANT BIOINSECTICIDES</b> <i>Bacillus thuringiensis</i> , NPV, entomopathogenic fungi ( <i>Beauveria</i> , <i>Metarhizium</i> , <i>Verticillium</i> ) Biofungicides: <i>Trichoderma</i> , <i>Gliocladium</i> , non-pathogenic <i>Fusarium</i> , <i>Pseudomonas</i> spp. Biobactericides: <i>Agrobacterium radiobacter</i> . Bio-nematicides: <i>Paecilomyces</i> , <i>Trichoderma</i> <i>Phytophthora</i> , <i>Colletotrichum</i> .							
<b>IV</b>	<b>STANDARDIZATION OF BIOPESTICIDES</b> Target pests and crops of important biopesticides and their mechanisms of action. Testing of efficacy and standardization of biopesticides.							
<b>V</b>	<b>FORMULATION</b> Mass multiplication and formulation technology of biopesticides. Prospects and problems in production and efficiency of biopesticides. Commercial products of biopesticides.							



<b>Course outcomes:</b> <b>CO</b>	<b>On completion of this course, the students will be able to:</b>
CO1	Understand the issues in use of chemical pesticides and their harmful effects on life.
CO2	Aware of the significance of biopesticides and their beneficial role in controlling insect pests, diseases, nematodes and weeds.
CO3	Knowledge on identification of promising biopesticides and their mechanisms of action against insect pests, diseases, nematodes and weeds.
CO4	Learn the mass production and formulation technology of selected biopesticides.
CO5	Knowledge on product development for commercialization of biopesticides.
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/CSIR/GATE/TNPSC/other 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 Transferable Skill
<b>Recommended Text:</b>	
<ol style="list-style-type: none"> <li>1. Johri, J. 2020. Recent Advances in Biopesticides: Biotechnological Applications. New India Publishing Agency (NIPA), New Delhi.</li> <li>2. Kaushik, N. 2004. Biopesticides for sustainable agriculture: prospects and constraints. TERIPress, New Delhi.</li> <li>3. Sahayaraj, K. 2014. Basic and Applied Aspects of Biopesticides. Springer India, New Delhi.</li> <li>4. Tebeest, D.O. 2020. Microbial Control of Weeds. CBS Publishers and Distributors, New Delhi.</li> <li>5. Joshi, S.R. 2020. Biopesticides: A Biotechnological Approach. New Age International (P) Ltd. New Delhi.</li> </ol>	
<b>Reference Books:</b>	
<ol style="list-style-type: none"> <li>1. Ainsworth, G.C. 1971. A Dictionary of the Fungi. Commonwealth Mycological Institute, Kew, Surrey, England.</li> <li>2. Carlile, M.J., Watkinson, S.C and Gooday, G.W. 2001. The Fungi. 2nd Edition. Academic Press, San Diego</li> <li>3. Manoj Parihar, Anand Kumar. 2021. Biopesticides. Volume 2: Advances in Bioinoculants. Elsevier.</li> <li>4. <a href="#">Bailey, A.</a>, <a href="#">Chandler, D.</a>, <a href="#">Grant, W. P.</a>, <a href="#">Greaves, J.</a>, <a href="#">Prince, G.</a>, <a href="#">Tatchell, M.</a> 2010. Biopesticides: pest management and regulation. Plumx.</li> <li>5. Manoharachary, C., Singh, H.B., Varma, A. 2020. Trichoderma: Agricultural Applications and Beyond. Springer International Publishing, New York, USA.</li> <li>6. Nolle, L.M.L and Rathore, H.S. 2019. Biopesticides Handbook. CRC Press, Florida, USA.</li> <li>7. Anwer, M.A. 2021. Biopesticides and Bioagents: Novel Tools for Pest Management.</li> </ol>	

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)**

**SKILL ENHANCEMENT (SE1)**

<b>Title of the Course</b>	<b>P23BOS21 (NME) NURSERY AND GARDENING</b>
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	<b>SKILL ENHANCEMENT</b>							
<b>Paper Number</b>								
<b>Category</b>	Skill Enhancement	<b>Year</b>	I	<b>Credits</b>	2	<b>CourseCode</b>		
		<b>Semester</b>	II					
<b>InstructionalHours perweek</b>		<b>Lecture</b>		<b>Tutorial</b>		<b>LabPractice</b>		<b>Total</b>
		2		2		--		4
<b>Pre-requisite</b>		Students should know nursery and gardening practices.						
<b>Learning Objectives</b>		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.						
<b>UNIT</b>	<b>CONTENTS</b>							
<b>I</b>	<b>NURSERY:</b> Definition, objectives and scope and building up of infrastructure for nursery, planning and se Planting - direct seeding and transplants.							
<b>II</b>	<b>SEED:</b> Structure and types - Seed dormancy; causes and methods of breaking dormancy - Seed sto factors affecting seed viability, genetic erosion - Seed production technology - seed testing and							
<b>III</b>	<b>VEGETATIVE PROPAGATION:</b> Air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting mediu cuttings - Hardening of plants - green house - mist chamber, shed root, shade house and glassho							
<b>IV</b>	<b>GARDENING:</b> definition, objectives and scope - different types of gardening - landscape and home gardeni components - plant materials and design - computer applications in landscaping.							
<b>V</b>	<b>GARDENING OPERATIONS:</b> Soil laying, manuring, watering, management of pests and diseases and harvesting. Sowing/ra seedlings: Transplanting of seedlings - Study of cultivation of different vegetables: cabbag finger, onion, garlic, tomatoes, and carrots - Storage and marketing procedures.							
<b>Course</b>								
<b>outcomes: CO</b>	<b>On completion of this course, the students will be able to:</b>							

CO1	Recognize the basic process required for growing and maintaining plants in nurseries.
CO2	Explain the different methods of plant propagation and various gardening styles.
CO3	Apply techniques for effective hardening of plants and computer applications for creative gardening.
CO4	Compare and contrast cultivation of different vegetables and growth of plants in nursery and gardening.
CO5	Develop new strategies to enhance growth and quality of nursery plants.
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/CSIR/GATE/TNPSC/other 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
<b>Recommended Text:</b>	
<ol style="list-style-type: none"> <li>1. Bose T.K and Mukherjee, D. 1972. Gardening in India, Oxford &amp; IBH Publishing Co., New Delhi.</li> <li>2. Sandhu, M.K. 1989. Plant Propagation, Wile Eastern Ltd., Bengaluru.</li> <li>3. Kumar, N. 1997. Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.</li> <li>4. Edmond Musser and Andres. 1957. Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.</li> <li>5. Agrawal, P.K. 1993. Hand Book of Seed Technology, Dept. of Agriculture and Cooperation, National Seed Corporation Ltd., New Delhi.</li> </ol>	
<b>Reference Books:</b>	
<ol style="list-style-type: none"> <li>1. N.L. Patel, S.L. Chawla, T.R. Ahlawat: Commercial Horticulture I, 2016, ASPEE College of Horticulture, Navsari Agricultural University, Navsari 396 450, Gujarat,</li> <li>2. Prasad S &amp; Kumar U. 2005. Greenhouse Management for Horticultural Crops. 2nd Ed. Agrobios.</li> <li>3. George Acquah, 2002, Horticulture-principles and practices. Prentice-Hall of India pvt. Ltd., New Delhi.</li> <li>4. Abraham, A and Vatsala, P. 1981. Introduction to Orchids. Trop. Bot. Garden, Trivandrum.</li> <li>5. Hartman, H.T and Kester, D.E. 1989. Plant propagation. Printice Hall Ltd., New Delhi.</li> </ol>	
<b>Web resources:</b>	
<ol style="list-style-type: none"> <li>1. <a href="https://www.kopykitab.com/Nursery-And-Gardening-SEC-by-Prof-C-D-Patil-Dr-G-M-Rane-Dr-S-A-Patil">https://www.kopykitab.com/Nursery-And-Gardening-SEC-by-Prof-C-D-Patil-Dr-G-M-Rane-Dr-S-A-Patil</a></li> <li>2. <a href="https://www.wonderslate.com/nursery-and-gardening-management/ebook-details?siteName=books&amp;bookId=38078&amp;preview=true">https://www.wonderslate.com/nursery-and-gardening-management/ebook-details?siteName=books&amp;bookId=38078&amp;preview=true</a></li> <li>3. <a href="https://books.google.co.in/books/about/Nursery_Hindi_Book_Bonsai_Plants_Nursery.htm?id=-nfDDwAAQBAJ&amp;redir_esc=y">https://books.google.co.in/books/about/Nursery_Hindi_Book_Bonsai_Plants_Nursery.htm?id=-nfDDwAAQBAJ&amp;redir_esc=y</a></li> <li>4. <a href="https://www.amazon.in/Gardening-Books/b?ie=UTF8&amp;node=1318122031">https://www.amazon.in/Gardening-Books/b?ie=UTF8&amp;node=1318122031</a></li> <li>5. <a href="https://www.worldcat.org/title/handbook-of-horticulture/oclc/688653648">https://www.worldcat.org/title/handbook-of-horticulture/oclc/688653648</a></li> </ol>	

**MappingwithProgrammeOutcomes:**

<b>COs</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>
<b>CO1</b>	3	3	1	3	2	1	2	2	3	2
<b>CO2</b>	3	3	2	2	3	3	2	3	2	3
<b>CO3</b>	2	2	3	3	1	2	1	3	3	1
<b>CO4</b>	3	3	3	3	3	2	3	3	3	1
<b>CO5</b>	3	3	2	3	2	3	1	2	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		P23BOP22: LABORATORY COURSE-II					
Paper Number		CORE VII					
Category	Core	Year	I	Credits	4	CourseCode	
		Semester	II				
InstructionalHours perweek		Lecture	Tutorial	LabPractice	Total		
		2	-	4	6		
Pre-requisite		Theoretical understanding of plant taxonomy, ecology and phytogeography, embryology as well as basic laboratory skills for the relevant core course.					
Learning Objectives		1.Understand and develop skill sets in plant morphological, floral character key preparation.					
		2.Expedite skilled workers to carry out research in frontier areas of plant scienc					
		3.Classify meristems and identify their structures, functions and roles in 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	<b>TAXONOMY AND ECONOMIC BOTANY OF ANGIOSPERMS</b>						
	Preparation of artificial keys. Description of a species, based on virtual herbarium and live specimens of the families theory. Study the products of plants mentioned in the syllabus of economic botany with special refer morphology, botanical name and family. Solving nomenclature problems. <b>Field trip:</b> A field trip at least 3-4 days to a floristically rich area to study plants in nature and field rep not less than 20 herbarium sheets representing the families studied.						

<p style="text-align: center;"><b>II</b></p>	<p><b>ANATOMY</b></p> <ol style="list-style-type: none"> <li>1. Study of shoot apex of <i>Hydrilla</i></li> <li>2. Observation of cambial types.</li> <li>3. Sectioning and observation of nodal types.</li> <li>4. Study of anomalous secondary growth of the following: STEM- <i>Nyctanthus</i>, <i>Bouerhavia</i>, <i>Aristolochia</i>, <i>Bignonia</i>, <i>Piper</i> petal and <i>Mirabilis</i>. ROOT: <i>Acyranthus</i></li> <li>5. Observation of stomatal types by epidermal peeling.</li> <li>6. Maceration of wood and observation of the components of xylem.</li> <li>7. Double staining technique to study the stem anomali.</li> </ol>
<p style="text-align: center;"><b>III</b></p>	<p><b>EMBRYOLOGY</b></p> <ol style="list-style-type: none"> <li>1. Observation of T.S. of anther.</li> <li>2. Observation of ovule types.</li> <li>3. Observation of mature embryo sacs.</li> <li>4. Dissection and observation of embryos (globular and cordate embryos).</li> <li>5. Study of pollen morphology</li> <li>6. Study of in vitro pollen germination.</li> <li>7. Observation of endosperm types.</li> </ol>
<p style="text-align: center;"><b>IV</b></p>	<p><b>ECOLOGY,</b></p> <ol style="list-style-type: none"> <li>1. Determination of the quantitative characters of a plant community by random (abundance, density, dominance, species diversity, frequency) in grazing land, forests.</li> <li>2. Estimation of above ground and below ground biomass in a grazing land employing quadrat.</li> <li>3. To determine soil moisture, porosity and water holding capacity of soil collected from different locations.</li> <li>4. Determination of pH of soil and water by universal indicator (or) pH meter.</li> <li>5. Determination of dissolved oxygen.</li> <li>6. Estimation of carbonate.</li> <li>7. Estimation of bicarbonate.</li> </ol>
<p style="text-align: center;"><b>V</b></p>	<p><b>PHYTOGEOGRAPHY, CONSERVATION BIOLOGY &amp; INTELLECTUAL PROPERTY</b></p> <ol style="list-style-type: none"> <li>1. Mapping of world vegetation</li> <li>2. Mapping of Indian vegetation.</li> <li>3. Remote sensing – Analyzing and interpretation of Satellite photographs- Vegetation/ v</li> <li>4. Visit to remote sensing laboratory (at Anna University, Regional Meteorological Centre at Numgambakkam).</li> </ol>
<p><b>Course outcomes: On completion of this course, the students will be able to:</b> <b>CO</b></p>	
<p><b>CO1 characteristics.</b></p>	<p>To gain recent advances in plant morphological and floral</p>

CO2	Understand about different floral characteristics and artificial key preparation which employed for plant identification and conservation.
CO3	Recall or remember the information including basic and advanced in relation with plant anatomy and embryology.
CO4	Apply their idea on sectioning and dissection of plants to demonstrate various stages of plant development.
CO5	Know about different vegetation sampling methods.
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/CSIR/GATE/TNPSC/other 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
<b>Recommended Text:</b>	
<ol style="list-style-type: none"> <li>1. Subramaniam, N.S. 1996. Laboratory Manual of Plant Taxonomy. Vikas Publishing House Pvt. Ltd., New Delhi.</li> <li>2. Gokhale, S.B., Kokate, C.K. and Gokhale, A. 2016. Pharmacognosy of Traditional Drugs. Nirali Prakashan, 1st Edition. ISBN: 9351642062.</li> <li>3. Joshi, S.G. 2018. Medicinal Plants. Oxford &amp; IBH Publishing C., Pvt., Ltd., New Delhi. ISBN: 9788120414143.</li> <li>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.</li> <li>5. Sundara, R. S. 2000. Practical manual of plant anatomy and embryology. Anmol Publ. PVT LTD, New Delhi.</li> <li>6. Panshin, A.J and C. de Zeeuw. 1980. Textbook of wood technology. Structure, identification and uses of the commercial woods of the United States and Canada. Fourth Edition. New York: McGraw-Hill Book Company.</li> <li>7. Sharma, H.P. 2009. Plant Embryology: Classical and Experimental, Bombay Popular Prakashan, ISBN-8173199698, 9788173199691.</li> </ol>	
<b>Reference books:</b>	
<ol style="list-style-type: none"> <li>1. Aler Gingauz. 2001. Medicinal Chemistry. Oxford University Press &amp; Wiley Publications.</li> <li>2. Mann J. Davidson, R. Sand J. B. Hobbs, D. V. Banthorpe, J. B. Harborne. 1994. <i>Natural Products</i>. Longman Scientific and Technical Essex.</li> <li>3. Gopalan, C., B. V. Ramasastri and S. C. Balasubramanian. 1985. Nutritive Value of Indian Foods. National Institute of Nutrition, Hyderabad.</li> <li>4. Harborne. J.B. 1998. Phytochemical methods. A guide to modern techniques of Plant Analysis, Chapman and Hall publication, London.</li> <li>5. Traditional plant medicines as sources of new drugs. P. J. Houghton in Pharmacognosy. Trease and Evan's. 16 Ed. 2009.</li> <li>6. Sundara Rajan, S, 2003. Practical Manual of Plant Anatomy and Embryology 1st ed, Anmol Publications, ISBN-812610668.</li> <li>7. Katherine Esau. 2006. Anatomy of Seed Plants. 2nd edition, John Wiley and Sons.</li> </ol>	



**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
<b>CO1</b>	3	3	3	3	3	3	3	S	3	3
<b>CO2</b>	3	3	2	3	3	2	1	2	3	2
<b>CO3</b>	3	3	3	3	3	3	3	3	3	3
<b>CO4</b>	3	3	3	3	3	3	3	1	2	3
<b>CO5</b>	3	2	2	3	3	3	3	2	3	3

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