**ANNAMALAI UNIVERSITY**

**(Affiliated Colleges)**

**405 - M.Sc. Botany**

Programme Structure and Scheme of Examination (under CBCS)

(Applicable to the candidates admitted from the academic year 2023 -2024 onwards)

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| **Part** | **Course Code** | **Study Components & Course Title** | **Credit** | **Hours/ Week** | **Maximum Marks** |
| **CIA** | **ESE** | **Total** |
|  |  | **SEMESTER – I** |  |  |  |  |  |
| Part A | 23PBOTC11 | Core - I: Plant Diversity - I: Algae, Fungi, Lichens and Bryophytes. | 5 | 7 | 25 | 75 | 100 |
| 23PBOTC12 | Core - II: PlantDiversity - II: Pteridophytes, Gymnosperms and Paleobotany. | 5 | 7 | 25 | 75 | 100 |
| 23PBOTP13 | Core - III: Practical – ICovering Core Papers - I and II | 4 | 6 | 25 | 75 | 100 |
|  | Elective – I  | 3 | 5 | 25 | 75 | 100 |
| 23PBOTE14-1 | Microbiology, immunology and plant pathology / |  |  |  |  |  |
| 23PBOTE14-2 | Conservation of natural resources and policies / |  |  |  |  |  |
| 23PBOTE14-3 | Mushroom cultivation |  |  |  |  |  |
|  | Elective-II  | 3 | 5 | 25 | 75 | 100 |
| 23PBOTE15-1 | Horticulture / |  |  |  |  |  |
| 23PBOTE15-2 | Ethnobotany, naturopathy and Traditional Healthcare / |  |  |  |  |  |
| 23PBOTE15-3 | Algal Technology  |  |  |  |  |  |
|  |  | **Total** | **20** | **30** |  |  | **500** |
|  |  | **SEMESTER – II** |  |  |  |  |  |
| Part A | 23PBOTC21 | Core - IV: Plant Anatomy and Embryology of angiosperms | 5 | 6 | 25 | 75 | 100 |
| 23PBOTC22 | Core - V: Taxonomy of Angiosperms and Economic Botany | 5 | 6 | 25 | 75 | 100 |
| 23PBOTP23 | Core - VI: Practical - IICovering Core Papers - IV and V | 4 | 6 | 25 | 75 | 100 |
|  | Elective – III | 3 | 4 | 25 | 75 | 100 |
| 23PBOTE24-1 | Medicinal Botany / |  |  |  |  |  |
| 23PBOTE24-2 | Research methodology, computer applications & bioinformatics / |  |  |  |  |  |
| 23PBOTE24-3 | Biopesticide Technology |  |  |  |  |  |
|  | Elective – IV | 3 | 4 | 25 | 75 | 100 |
| 23PBOTE25-1 | Applied bioinformatics / |  |  |  |  |  |
| 23PBOTE25-2 | Biostatistics / |  |  |  |  |  |
|  | 23PBOTE25-3 | Intellectual Property Rights |  |  |  |  |  |
| Part B | 23PBOTS26 | Skill Enhancement Course (SEC-I): Floriculture and Medicinal Plant Cultivation | 2 | 4 | 25 | 75 | 100 |
|  |  | **Total** | **22** | **30** |  |  | **600** |

**Department Elective Courses**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Semester** | **Course Code** | **Course Title** | **C** | **H/W** | **CIA** | **ESE** | **Total** |
| **I** | **23PBOTE14-1** |  Microbiology, immunology and plant pathology  | 3 | 5 | 25 | 75 | 100 |
| **23PBOTE14-2** | Conservation of natural resources and policies  | 3 | 5 | 25 | 75 | 100 |
| **23PBOTE14-3** | Mushroom cultivation | 3 | 5 | 25 | 75 | 100 |
| **I** | **23PBOTE15-1** | Horticulture | 3 | 5 | 25 | 75 | 100 |
| **23PBOTE15-2** | Ethnobotany, naturopathy and Traditional Healthcare  | 3 | 5 | 25 | 75 | 100 |
| **23PBOTE15-3** | Algal Technology  | 3 | 5 | 25 | 75 | 100 |
| **II** | **23PBOTE24-1** | .Medicinal Botany | 3 | 4 | 25 | 75 | 100 |
| **23PBOTE24-2** | Research methodology, computer applications & bioinformatics | 3 | 4 | 25 | 75 | 100 |
| **23PBOTE24-3** | Biopesticide Technology | 3 | 4 | 25 | 75 | 100 |
| **II** | **23PBOTE25-1** | Applied bioinformatics  | 3 | 4 | 25 | 75 | 100 |
| **23PBOTE25-2** | Biostatistics | 3 | 4 | 25 | 75 | 100 |
| **23PBOTE25-3** | Intellectual Property Rights | 3 | 4 | 25 | 75 | 100 |

**(Department is offering the following NME to OTHER DEPARTMENTS )**

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **Semester** | **Course Code** | **Course Title** | **C** | **H/W** | **CIA** | **ESE** | **Total** |
| **II** | **23PBOTN26-1** |  Horticulture | 2 | 4 | 25 | 75 | 100 |
| **23PBOTN26-2** | Research Methodology, Computer Applications and Bioinformatics | 2 | 4 | 25 | 75 | 100 |

Preamble

# StructureofCourse

1. LearningandTeachingActivities

# TutorialActivities

1. LaboratoryActivities

# Field StudyActivities

1. AssessmentActivities

# Assessmentprinciples

* 1. AssessmentDetails

# Teachingmethodologies

1. FacultyCourseFile

# TemplateforPGProgrammein Botany

1. TemplateforSemester

# InstructionsforCourseTransaction

1. TestingPattern

# DifferentTypesofCourses

1. ElectiveCourses(EDfromotherDepartmentExperts)

# SkillDevelopmentCourses

1. Institution-Industry-Interaction

# Syllabus

**CBCS - COURSE PATTERN AND SYLLABUS**

**M.Sc.BOTANY CURRICULUM**

(Forthestudentsadmittedduringtheacademicyear2023–2024onwards)

|  |  |  |  |
| --- | --- | --- | --- |
| **Semester** | **23PBOTC11: CORE COURSE - I** **CORE COURSE-I- PLANT DIVERSITY - I****ALGAE ,FUNGI, LICHENS AND BRYOPHYTES** | **H/W** | **C** |
| **I** | **7** | **5** |

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| **Pre-requisite** | Students should be familiar with the basics of algae,fungi,lichens and Bryophytes. |
| **Learning Objectives** | 1. To learn about the classification, distinguishing traits, geographic distribution, and reproductive cycle of algae, fungi, lichens, and bryophytes.
2. To gain knowledge about the ecological and economic importance of algae, fungi, lichens and bryophytes.
3. To spark interest in the evolutionary roots of plant development.
4. To understand the biodiversity by describing and explaining the morphology and reproductive processes of algae, fungi, bryophytes and microorganisms.
5. Toexposethebeneficialandharmfulviewpoint.
 |
| **UNIT** | **CONTENTS** |
| **I** | **ALGAE:** General account of algology, Contributions of Indian Phycologist (T.V.Desikachary, V.Krishnamurthy and V.S. Sundaralingam), Classification of algae by F.E. Fritsch (1935-45) & Silva (1982). Salient features of major classes: Cyanophyceae, Chlorophyceae, Xanthophyceae, Chrysophyceae, Cryptophyceae, Dinophyceae, Chloromonadineae, Euglenophyceae, Charophyceae, Bacillariophyceae, Phaeophyceae and Rhodophyceae. Range of thallus organization, algae of diverse habitats, reproduction (vegetative, asexual and sexual) and life cycles. Phylogeny and inter-relationships of algae, origin and evolution of sex in algae.Structure, reproduction and life histories of the following genera: *Oscillatoria*, *Scytonema, Ulva, Codium, Diatoms, Dictyota* and *Gelidium.* |
| **II** | **FUNGI:** General Characteristics, occurrence and distribution. Mode of nutrition in fungi. Contributions of Indian Mycologists (C.V.Subramanian), Classification of Fungi by Alexopoulos and Mims (1979) & Recent trends in the classification of fungi - Phylogeny and inter-relationships of major groups of fungi. General characters of major classes: Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina. Heterothallism in fungi, sexuality in fungi, Para sexuality, sex hormones in fungi. Structure, reproduction and life histories of the following genera: *Plasmodiophora, Phytophthora, Rhizopus, Taphrina, Polyporus* and Colletotrichum. |
| **III** | **LICHENS:** Introduction and Classification (Hale, 1969). Occurrence and inter-relationship of phycobionts and mycobionts, structure and reproduction in Ascolichens, Basiodiolichens and Deuterolichens.  |
| **IV** | **BRYOPHYTES:** General characters and Classification of Bryophytes by Watson (1971). Distribution, Structural variations and evolution of gametophytes and sporophytes in Bryopsida, Anthoceropsida and Mosses. General characters of major groups - Marchantiales, Jungermaniales, Anthocerotales, Sphagnales, Funariales and Polytrichales. Reproduction - Vegetative and sexual, spore dispersal mechanisms in bryophytes, spore germination patterns in bryophytes. Structure, reproduction and life histories of the following genera: *Targionia, Lunularia, Porella* and *Polytrichum.* |
| **V** | **ECONOMIC IMPORTANCE:**Algae - Economic importance in Food and feed - Single cell protein, Industrial products (Agar-Agar, Carrageenan, Alginic acid, Iodine, biofertilizers, Vitamins and biofuel), Medicinal value and Diatomaceous earth. Fungi – Economic importance in food, industries and medicine. Culturing and cultivation of mushrooms *Pleurotus.* Lichen –economic importance and as indicator pollution. Bryophytes – Ecological and economic importance – industry, horticulture and medicine.  |
| **Course outcomes:** On completion of this course, the students will be able to: **CO**  | **Programme outcomes** |
| 1. Relate to the structural organizations of algae, fungi, lichens and Bryophytes.
 | K1 |
| 1. Demonstrate both the theoretical and practical knowledge in understanding the diversity of basic life forms and their importance.
 | K2 |
| 1. Explain life cycle patterns in algae, fungi, lichens and Bryophytes.
 | K3 |
| 1. Compare and contrast the mode of reproduction in diverse groups of basic plant forms.
 | K4 |
| 1. Discuss and develop skills for effective conservation and utilization of lower plant forms.
 | K5 &K6 |

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| 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, ProfessionalCompetency, Professional Communication and Transferrable Skill |
| **Recommended texts:** |
| 1. Kumar, H.D.1999. Introductory Phycology. Affiliated East-West Press, Delhi.
2. Barsanti, L. and Guadtieri, P. 2014. Algae: Anatomy, Biochemistry and Biotechnology, 2ndEdition, CRC Press, ISBN: 1439867321.
3. Sharma, O.P. 2011. Fungi and Allied Microorganisms, Mc Graw Hill, ISBN:9780070700383, 0070700389
4. Kevin K. 2018. Fungi biology and Application, 3rd Edition, Wiley Blackwell.
5. Pandey, P.B. 2014. College Botany-1: Including Algae, Fungi, Lichens, Bacteria, Viruses, Plant Pathology, Industrial Microbiology and Bryophyta. Chand Publishing, New Delhi.
6. Singh, Pandey and Jain. 2020. A text book of Botany, 5th Edition, Rastogi Publication, Meerut.
7. Sharma, O.P. 2014. Bryophyta, Mcgraw Hill, ISBN: 9781259062872, 1259062872
 |
| **Reference Books:** |
| 1. Sundaralingam, V. 1991. Marine algae. Bishen Singh and Mahendra Pal Singh Publishers, Dehradun.
2. Edwardlee,R. 2018. Phycology, 5thEd., Cambridge UniversityPress, London.
3. Nash, T.H. 2008. Lichen Biology, Cambridge University press.
4. Johri, R.M., Lata, S. and Tyagi, K. 2012. A Textbook of Bryophyta. Dominant Publishers & Distributors Pvt., Ltd., New Delhi. ISBN: 9789384207335.
5. Alexopoulos, C.J. and Mims, M. 2007. Introductory Mycology. 4th Edition, Wiley Publishers, ISBN: 9780471522294
 |
| **Web resources:** |
| 1. https://[www.britannica.com/science/algae](http://www.britannica.com/science/algae)2. https://en.wikipedia.org/wiki/Bryophyte3. https://[www.britannica.com/plant/bryophyte/Ecology-and-habits](http://www.britannica.com/plant/bryophyte/Ecology-and-habits)4. https://[www.livescience.com/53618-fungus.html.](http://www.livescience.com/53618-fungus.html)5. <http://www.uobabylon.edu.iq/eprints/paper_11_20160_754.pdf>6. <https://www.youtube.com/watch?v=vcYPI6y-Udo>7. https://www.youtube.com/watch?v=XQ\_ZY57MY64 8. http://www-plb.ucdavis.edu/courses/bis/1c/text/Chapter22nf.pdf  |

**MappingwithProgrammeOutcomes:**

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| **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)**

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| **Semester** | **23PBOTC12 :**  **CORE COURSE-II- PLANT DIVERSITY - II****PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY** | **H/W** | **C** |
| **I** | **7** | **5** |

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| **Pre-requisite** | Studentsshouldknowaboutthefundamentsof Pteridophytes,Gymnospermsand fossil records. |
| **Learning Objectives** | 1. Toinvestigatetheclassification,distinctive traits,distributionandreproductionandlifehistoryofthevariousclassesand majortypes ofPteridophytesand Gymnosperms.
2. To identify and characterize diversity of lower vascular plants in order to comprehend the dynamics of diversity to realize the importance of diversity.
3. To research the classification, phylogeny and economic importance of Pteridophytes and Gymnosperms.
4. Tostudyandunderstandthephylogenyand PaleontologyofPteridophytesand Gymnosperms.
5. To learn about the conceptoffossilsandprocessoffossilization;distinctive characteristics offossilrecords of Pteridophytes and Gymnosperms.
 |
| **UNIT** | **CONTENTS** |
| **I** | **PTERIDOPHYTES:** General characteristics and classification (Reimer, 1954). Range of structure, reproduction and evolution of the gametophytes, Gametophyte types – sex organs. Apogamy and Apospory. Life cycles. Stellar evolution. Heterospory and seed habit, Telome theory, morphogenesis, Economic importance of Pteridophytes. |
| **II** | **PTERIDOPHYTES:** Structure, anatomy, reproduction and life histories of the following genera: *Isoetes, Equisetum Angiopteris, Osmunda, Pteris* and *Azolla.* |
| **III** | **GYMNOSPERMS:** General characters - A general account of distribution of Gymnosperms. Morphology, anatomy, reproduction, phylogeny and classification (K.R.Sporne, 1965). Economic importance of Gymnosperms. |
| **IV** | **GYMNOSPERMS:** Structure (Exomorphic and endomorphic), anatomy, reproduction and life histories of the following genera: *Thuja,Cupressus, Araucaria, Podocarpus, Gnetum* and *Ephedra*. |

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| **V** | **PALEOBOTANY:** Geological Scale; Radiocarbon dating; Contribution of Birbal Sahni to Paleobotany. Gondwana flora of India. Study of fossils in understanding evolution. Fossilization and fossil types. Economic importance of fossils – fossil fuels and industrial raw materials and uses. Study of organ genera: *Rhynia, Lepidocarpon, Calamites,Cordaites*and *Lyginopteris.* |
| **CourseOutcomes:**On successful completion of this course the student will be able to |
| 1. Recallonclassification,recenttrendsinphylogeneticrelationship,generalcharacters ofPteridophytesand Gymnosperms.
 | K1 &K3 |
| 1. Learnthemorphological/anatomicalorganization,lifehistory ofmajortypes ofPteridophytesand Gymnosperms.
 | K3 & K4 |
| 1. ComprehendtheeconomicimportanceofPteridophytes, Gymnosperms, and fossils.
 | K3 & K5 |
| 1. UnderstandingtheevolutionaryrelationshipofPteridophytesand Gymnosperms.
 | K2  |
| 1. Awarenessonfossiltypes,fossilizationandfossilrecordsofPteridophytesand Gymnosperms.
 | K1 & K3 |
| **K1**-Remember; **K2**-Understand; **K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** –Create. |
| ExtendedProfessionalComponent (is a part ofinternal component only,Not to be included in theExternalExaminationquestionpaper) | Questionsrelatedtotheabovetopics,fromvariouscompetitiveexaminationsUPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/otherstobesolved(TobediscussedduringtheTutorialhour) |
| Skillsacquiredfromthiscourse | Knowledge,ProblemSolving,Analyticalability,ProfessionalCompetency,ProfessionalCommunicationandTransferrableSkill |

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

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| **Reference books:** |
| 1. Parihar, N.S. 2019. An Introduction to Embryophyta Pteridophytes. 5th Edition, Surjeet Publication, Delhi.
2. Pandey, S.N and Trivedi, P.S. 2015. A Text Book of Botany Vol. II- 12 th edition (Paper back), Vikas Publishing.
3. Rashid, A. 2013. An introduction to Pteridophyta – Diversity, Development and differentiation (2nd edition), Vikas Publications.
4. ArnoldA.C.2005.An IntroductiontoPaleobotany.Agrobios(India).Jodhpur.
5. Sporne, K.R. 2017. The morphology of Pteridophytes (The structure of Ferns and Allied Plants) (Paper back), Andesite Press.
6. Sporne, K.R. 1967. The Morphology of Gymnosperms. Hutchinson & Co., London.
7. Taylor, E, Taylor, T, Krings, M. 2008. Paleobotany: The Biology and Evolution of FossilPlants,2nd Edition, AcademicPress.
 |
| **Web resources:** |
| 1. <https://www.toppr.com/guides/biology/plant-kingdom/pteridophytes/>
2. <http://www.bsienvis.nic.in/Database/Pteridophytes-in-India_23432.aspx>
3. https://books.google.co.in/books?hl=en&lr=&id=Pn7CAAAQBAJ&oi=fnd&pg=PA1&dq=Introduction+to+Gymnosperms&ots=sfYSzCL02&sig=ysX1KRvetV0bAza4Sq6RWau4XU8&redir\_esc=y#v=onepage&q=Introduction%20to%20Gymnosperms&f=false
4. <https://books.google.co.in/books/about/Botany_for_Degree_Gymnosperm_Multicolor.html?id=HTdFYFNxnWQC&redir_esc=y>
5. <https://books.google.co.in/books/about/Gymnosperms.html?id=4dvyNckni8wC>
6. <https://arboretum.harvard.edu/wp-content/uploads/2013-70-4-beyond-pine-cones-an-introduction-to-gymnosperms.pdf>
7. <https://www.palaeontologyonline.com/>
8. <https://books.google.co.in/books/about/Paleobotany.html?id=HzYUAQAAIAAJ>

<https://trove.nla.gov.au/work/11471742?q&versionId=46695996> |

**MappingwithProgrammeOutcomes:**

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| **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)**

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| **Semester** | **23PBOTP13 : CORE -III- LABORATORY / PRACTICAL COURSE-I****COVERING THEORY PAPERS I AND II** | **H/W** | **C** |
| **I** | **6** | **4** |

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| **Pre-requisite** | Studentsshould be familiar with the fundamentals of algae, fungi, lichens, Bryophytes, Pteridophytes, Gymnospersms, Paleobotany andmicrobes in addition to essential laboratory techniques. |
| **Learning Objectives** | 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. |
| **UNIT** | **EXPERIMENTS** |
| **I** | **ALGAE**Study of algae in the field and laboratory of the genera included in theory. External morphology and internal anatomy of the vegetative and reproductive structures of the following living forms: *Oscillatoria*, *Scytonema, Ulva, Codium, Diatoms, Dictyota*and *Gelidium* (depending onavailability of the specimen).To record the local algal flora–Study of their morphology and structure.Identification of algae to species level (at least One).Preparation of culture media and culture of green algae and blue green algae in the laboratory (Demonstration).  |
| **II** | **FUNGI**Study of morphological and reproductive structures of the following living forms: *Plasmodiophora, Phytophthora, Rhizopus, Taphrina, Polyporus* and Colletotrichum (depending onavailability of thespecimen).Isolation and identification of fungi from soil, air, and Baiting method. Preparation of culture media.Cultivation of mushroom in the laboratory (Demonstration). **LICHENS**Study of morphological and reproductive structures of the genera *Parmelia.* |
| **III** | **BRYOPHYTES**External morphology and internal anatomy of the vegetative and reproductive organs of thefollowinglivingforms: *Targionia, Lunularia, Porella* and *Polytrichum* (depending onavailability of thespecimen). |
| **IV** | **PTERIDOPHYTES**External morphology and internal anatomy of the vegetative and reproductive organs of thefollowinglivingforms: *Isoetes, Equisetum Angiopteris, Osmunda, Pteris* and *Azolla* (depending onavailability of thespecimen). *Fossilslidesobservation:Rhynia, Lepidocarpon, Calamites.* |
| **V** | **GYMNOSPERMS** External morphology and internal anatomy of the vegetative and reproductive organs of the following living forms: *Thuja, Cupressus, Araucaria, Podocarpus, Gnetum* and *Ephedra* (depending onavailability of thespecimen). Fossilslidesobservation*: Cordaites* and *Lyginopteris.* |
| **Course outcomes:** On completion of this course, the students will be able to: **CO**  | **Programme outcomes** |
| 1. Recallandapplyingthebasickeystodistinguishatspecieslevelidentificationofimportantalgaeandfungithrough itsstructuralorganizations.
 | K1 & K4 |
| 1. Demonstrate practical skills in thallophytes, Pteridophytes and Gymnosperms.
 | K2 |
| 1. Describe the structure of algae, fungi, lichens, Bryophytes, Pteridophytes and Gymnosperms.
 | K3 |
| 1. Determine the importance of structural diversity in the evolution of plant forms.
 | K5 |
| 1. Formulate techniques to isolate and culture of alga and fungi as well as to understand the diversity of plant forms.
 | K5 & K6 |
| ExtendedProfessionalComponent (is a part ofinternal component only,Not to be included in theExternalExaminationquestionpaper) | Questionsrelatedtotheabovetopics,fromvariouscompetitiveexaminationsUPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/otherstobesolved(TobediscussedduringtheTutorialhour) |

|  |  |
| --- | --- |
| Skillsacquiredfromthiscourse | Knowledge,ProblemSolving,Analyticalability,ProfessionalCompetency,ProfessionalCommunicationandTransferrableSkill |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examinationquestion 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 thiscourse | Knowledge, Problem Solving, Analytical ability, ProfessionalCompetency, Professional Communication and Transferrable Skill |

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| **RecommendedText:** |
| 1. Kumar,H.D.1999. IntroductoryPhycology.Affiliated East-WestPress,Delhi.
2. Das,SandSaha,R.2020.MicrobiologyPracticalManual.CBSPublishersandDistributors(P) Ltd., New Delhi,India.
3. Sharma,O.P.2012. Pteridophyta,Tata McGraw-Hills Ltd,NewDelhi.
4. SharmaO.P and S, Dixit.2002.Gymnosperms.PragatiPrakashan.
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 andKrayesky,D. 2013.GeneralBotany laboratory Manual.AuthorHouse,Bloomington, USA.
2. Webster,J andWeber,R.2007.IntroductiontoFungi,3rdEd.CambridgeUniversityPress,Cambridge.
3. Sharma,O.P.2017. Bryophyta,MacMillanIndia Ltd,NewDelhi.
4. Ashok, M. Bendre and Kumar. 2010. A text book of Practical Botany, Algae, Fungi, Lichen, Bryophyta, Pteridophyta, Gymnosperms and Palaeobotany. Revised edition. Published by Rakesh Kumar Rastogi publication.
5. Gangulee, H.C and A.K. Kar. 2013. College Botany. Vth Edition. S. Chand.
 |
| **Web resources:** |
| 1. <https://www.frontiersin.org/articles/10.3389/fmicb.2017.00923/full>
2. <https://microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175e.pdf>
3. <http://www.cuteri.eu/microbiologia/manuale_microbiologia_pratica.pdf>
4. <https://www.amazon.in/Manual-Practical-Bryophyta-Suresh-Kumar/dp/B0072GNFX4>
5. https://www.amazon.in/Practical-Manual-Pteridophyta-Rajan-Sundara/dp/8126106883
6. <https://www.google.co.in/books/edition/Gymnosperms/3YrT5E3Erm8C?hl=en&gbpv=1&dq=gymnosperms&printsec=frontcover>
7. <https://www.amazon.in/Paleobotany-Biology-Evolution-Fossil-Plants/dp/0123739721>
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**Mapping with Programme Outcomes:**

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| **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)**

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| **Semester** | **23PBOTE14-1:( Generic / Discipline centric)** **ELECTIVE–I****MICROBIOLOGY, IMMUNOLOGY AND PLANT PATHOLOGY** | **H/W** | **C** |
| **I** | **5** | **3** |

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| **Pre-requisite** | 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. |
| **Learning Objectives** | 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** | **BACTERIA:**Types of microorganisms. General characteristic of bacteria – Outline classification of Bergey’s manual of 9th edition. Classification of bacteria based on Morphological, cultural, physiological and molecular characteristics. Bacterial growth – batch culture and continuous culture. Growth Curve. Factors affecting growth. Determination of bacterial growth – Direct method: Haemocytometer, Viable plate count; Indirect method: Turbidity. Nutritional types.Reproduction - Fission and sporulation. Genetic recombination- Transformation, Transduction and Conjugation. Isolation and cultivation of bacteria. Maintenance of bacterial culture.  |
| **II** | **VIRUSES:** General characters, Classification, Structure, Multiplication. Overview of Phycoviruses and Mycoviruses. Viruses of Eukaryotes – Animal & Plant viruses. Cultivation of viruses – in embryonated egg and in plants. Control of viral infections. Bacteriophages- classification, replication of DNA and RNA phages -Lytic and Lysogenic cycle. Viroids and prions. Mycoplasma: Structure and classification. |

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| **III** | **FOOD MICROBIOLOGY:** Beneficial role of microbes – yoghurt, Olives, Cheese, Bread, Wine, Tempeh, Miso & Fermented green tea. Spoilage of fruits, vegetables, meats, poultry, eggs, bakery products, dairy products and canned foods. Microbial toxins - Exotoxin, Endotoxin & Mycotoxin. Action of Enterotoxin, Cytotoxin& Neurotoxin. Food Preservation – temperature, drying, radiation and chemicals. Soil Microbiology: Importance of Microbial flora of soil and factors affecting the microbial community in soil. Interaction among soil microbes (positive and negative interactions) & with higher plants (rhizosphere &phyllosphere). Microorganisms in organic matter decomposition. Environmental Microbiology: Microbiology of water and air. Water borne diseases - diphtheria, chicken pox. Air borne diseases - Swine flu and **Measles**. Microbial degradation of chemical pesticides and hydrocarbon. |
| **IV** | **IMMUNOLOGY:** Introduction; Immune System; Types of Immunity - Innate and Acquired.Immune Cells - Hematopoiesis, B and T lymphocytes - Maturation, NK cells. Introduction to inflammation, Adaptive immune system, Innate Immune system. Antigen: Definition, Properties and types. Antibody – Structure, types and function. Generation of antibody diversity.Antigen - Antibody interactions: definition, types- Precipitation, Agglutination, Complement fixation. Immune Response – Humoral and Cell Mediated. Vaccines – history, types and recombinant vaccines. Immunodiagnosis –Blood Grouping, Widal test, Enzyme-Linked Immunosorbent Assay (ELISA), Immunoelectrophoresis and Immunodiffusion. |
| **V** | **PLANT PATHOLOGY:** **History and significance of plant pathology. Classification of plant diseases, Symptomology (important symptoms of**plant pathogens). Principles of plant infection –Inoculum, inoculum potential, Pathogenicity. Disease triangle. Host parasite interrelationship and interaction. Causal agents of plant diseases - biotic causes (fungi, bacteria virus, mycoplasma, nematodes, parasitic algae, angiospermic parasites - Abiotic causes (Physiological, deficiency of nutrients & minerals and pollution).Mechanism of penetration- Disease development of pathogen (colonization) and dissemination of pathogens. Role of enzymes and toxins in disease development. Defence mechanism of host – structural and biochemical defences. Important diseases of crop plants in India - Sheath blight of rice, Late blight of potato, Little leaf of Brinjal and Red rust of tea.Principles of disease management – Cultural practices, physical, chemical and biological methods, disease controlled by immunization. Biocontrol - merits and demerits; Plant quarantine and legislation. Integrated Pest Management system. Diagnostic technique to detect pest/pathogen infection - Immunofluorescence (IF). |
| **Course outcomes:** On completion of this course, the students will be able to: **CO**  | **Programme outcomes** |
| 1. Recognize the general characteristics of microbes, plant defense and immune cells.
 | K1 |
| 1. Explain about the stages in disease development and various defense mechanisms in plants and humans.
 | K2 |
| 1. Elucidate concepts of microbial interactions with plant and humans.
 | K3 |
| 1. Analyze the importance of harmful and beneficial microbes and immune system
 | K4 |
| 1. Determine and interpret the detection of pathogens and appreciate their adaptive strategies.
 | K5 & K6 |
| ExtendedProfessionalComponent (is a part ofinternal component only,Not to be included in theExternalExaminationquestionpaper) | Questionsrelatedtotheabovetopics,fromvariouscompetitiveexaminationsUPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/otherstobesolved(TobediscussedduringtheTutorialhour) |
| SkillsacquiredfromthisCourse | Knowledge,ProblemSolving,Analyticalability,ProfessionalCompetency,ProfessionalCommunicationandTransferrableSkill |

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| **RecommendedText:** |
| 1. Singh, R.S. 2018. Introduction to Principles of Plant Pathology, 4th Edition.
2. Bilgrami, K.S and H.C. Dube. 2010 A text book of Modern Plant Pathology – Vikas Publishing House (P) Ltd., New Delhi
3. Mehrotra, R.S. and Aggarwal, A. 2017. Plant Pathology. McGraw Hill Publisher.
4. Dube, H.C. 2010. A text Book of Fungi, Bacteria and Viruses, 3rd Edition, Agrobios India,

ISBN: 8188826383.1. Vaman Rao, C. 2006. Immunology. 2nd Edition. Narosa Publisher.
2. Kenneth, M. 2017. Janeway’s Immunobiology. 9th Edition. Garland Publisher.
 |
| **Reference Books:** |
| 1. Agrios, A.G. 2007. Plant Pathology, Elsevier. ISBN: 9780120445653.
2. Jeffery, C., Pommerville. 2014. Alcamos Fundalmedals of Microbiology. 10th Edition. Johnsand Bartlett Learning.
3. Pelczar, M. J. 2007. Microbiology. 35th Edition, Tata-McGraw Hill Publications, New York, ISBN: 0074623260.
4. Ravi Chandra, N.G. 2013. Fundamentals of Plant Pathology, Phi Learning, ISBN:812034703X.
5. Willie, J. and Sherwood, L. 2016. Prescott's Microbiology McGraw-Hill Education; 10th

Edition, ISBN: 978-12592815941. Chaube, H.S. and Singh, R. 2015. Introductory Plant Pathology CBS Publishers, ISBN: 978-8123926704.
2. Rangasamy, G. 2006. Disease of crop plants in India (4th edition). Tata Mc Graw Hill New Delhi.
3. Mishra, A., A. Bohra and A, Mishra. 2011. Plant Pathology-Disease and Management. Agro Bios, Jodhpur.
 |
| **Web resources:** |
| 1. https://www.wileyindia.com/a-textbook-of-plant-pathology.html
2. https://www.britannica.com/science/plant-disease.
3. https://www.planetatural.com/pest-problem-solver/plant-disease/
4. <https://www.elsevier.com/books/plant-pathology/agrios/978-0-08-047378-9>
5. <https://www.elsevier.com/life-sciences/immunology-and-microbiology/books>
6. <https://www.amazon.in/INTRODUCTION-IMMUNOLOGY-RAFIA-IMRAN-ebook/dp/B09B66SD3J>
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**Mapping with Programme Outcomes:**

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| **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)**

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| **Semester** | **23PBOTE14-2:( Generic / Discipline centric)** **ELECTIVE–I****CONSERVATION OF NATURAL RESOURCES AND POLICIES** | **H/W** | **C** |
| **I** | **5** | **3** |

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| **Pre-requisite** | To create awareness of environmental problems and their consequences. |
| **Learning Objectives** | 1.Explain the term natural resources.  |
|  | 2.Describe the reasons for degradation of natural resources and suggest measures to prevent these.  |
|  | 3.List the various endangered species of animals and plants. |
|  | 4.State the various environmental laws passed to conserve the natural resources. |
|  | 5.Explain sustainable development and justify its need; and describe the various conventional as well as non-conventional sources of energy. |
| **UNIT** | **CONTENTS** |
| **I** | **NATURAL RESOURCES:** Definition – Importance – Classification – Human physiological socio-economic and cultural development – Human Population Explosion – Natural Resource Degradation – Concept of conservation – Value system – Equitable resource use for sustainable life system.  |
| **II** | **FOREST RESOURCES:**Forest cover in India and the World – Importance – Desertification – Forest Wealth – Afforestation – Vanasamrakshna Samithi– Agroforestry – Social Forestry – Joint Forest Management Strategy for Forest Conservation. **Wild Life:** Resources – Importance – Benefits – Wild life Extinction – Causes for Extinction – List of Endanger species in India and in the World – Ecological approach in wild life management – Eco Tourism – Wild Life projects in India – Sanctuaries and National Parks In India – Man and Bio sphere Programme. |
| **III** | **III FOOD MICROBIOLOGY:** **LAND AND SOIL RESOURCES:** Soil, Complexity of soil nature, regional deposits, Land use and capability classification systems, Land use Planning models and their limitations. Impacts of natural and man-made activities on land characteristics and land use planning– Soil Erosion – Loss of Soil Nutrients – Restoration of Soil Fertility – Soil Conservation Methods and Strategies in India. Wet Land Conservation and Management – Ecological Importance of wet lands in India – Conservation Strategy and ecological Importance. Water Resources: Rivers and Lakes In India – Water Conservation and ground water level increase - Watershed Programme.  |
| **IV** | **MINERAL RESOURCES:**Use and exploitation – Environmental effects of extracting and using mineral resources – Restoration of mining lands – Expansion of supplies by substitution and conservation. Food Resources: World Food Problems – Changes caused by agriculture – overgrazing effects of modern agriculture – Fertilizer-Pesticide problems – Water Logging – Salinity – Sustainable agriculture, life stock breeding and farming. |
| **V** | **ENVIRONMENTAL POLICY IN INDIA:**Need for policies- Public Policy – Economic policies – Relationship between economic development and environment – Implementing Environmental Public Policy Strategies in pollution control – Constitutional provisions in India regarding environment – Public Awareness and Participation in Environmental Management – National Land Use Policy 1988 – Industrial Policy 1991. |
| **Course outcomes:** On completion of this course, the students will be able to: **CO**  | **Programme outcomes** |
| 1. Understand the concept of different natural resources and their utilization.
 | K1 |
| 1. Critically analyze the sustainable utilization land, water, forest and energy resources
 | K2 & K6 |
| 1. Evaluate the management strategies of different natural resources
 | K3 |
| 1. Reflect upon the different national and international efforts in resource management and their conservation.
 | K4 |
| 1. State the various environmental policy passed to conserve the natural resources.
 | K5 |
| ExtendedProfessionalComponent (is a part ofinternal component only,Not to be included in theExternalExaminationquestionpaper) | Questionsrelatedtotheabovetopics,fromvariouscompetitiveexaminationsUPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/otherstobesolved(TobediscussedduringtheTutorialhour) |
| Skillsacquiredfromthis course | Knowledge,ProblemSolving,Analyticalability,ProfessionalCompetency,ProfessionalCommunicationandTransferrableSkill |

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| **RecommendedText:** |
| 1. Trivedi R.K.1994. Environment and Natural Resources Conservation. 2. Murthy J.V.S.1994. Watershed Management in India. 3. Raymond, F Dasmann. 1984. Environmental Conservation, John Wiley. 4. Nalini, K.S. 1993. Environmental Resources and Management, Anmol Publishers, New Delhi. 5. Shyam Divan and Armin Rosencranz. 2001. Environmental Law and Policy in India, Oxford  Uni.Press. |
| **Reference Books:** |
| 1. Haue, R and Freed V.H. 1975. Environmental Dynamics of Pesticides, Menum Press, London 2. Singh, B. 1992. Social Forestry for Rural Development, Anmol Publishers, New Delhi. 3. Shafi. R. 1992. Forest Ecosystem of the World. 4. Stacy Keach. 2016. Natural Resources Management. Syrawood Publishing House. 5. Rathor B.S. 2013. Management of Natural Resource for Sustainable Development. Daya Publishing House, New Delhi. |
| **Web resources:** |
| 1. <https://www.amazon.in/conservation-natural-resources-Gifford-Pinchot-ebook/dp/B07HX76TVN>
2. <https://books.google.co.in/books/about/Natural_Resource_Conservation_and_Enviro.html?id=T2SRuhxpUW8C&redir_esc=y>
3. <https://www.kobo.com/ww/en/ebook/natural-resources-conservation-law>
4. <https://www.scribd.com/book/552185119/Natural-Resources-Conservation-and-Advances-for-Sustainability>
5. https://www.scribd.com/document/354699536/Conservation-of-Natural-Resources
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**Mapping with Programme Outcomes:**

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

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

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| **Semester** | **23PBOTE14-3:( Generic / Discipline centric)** **ELECTIVE–I****MUSHROOM CULTIVATION** | **H/W** | **C** |
| **I** | **5** | **3** |

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| **Pre-requisite** | Basicknowledgeonstructureandfunction ofvarious groupsof mushrooms. |
| **Learning Objectives** | 1.Toteachtheidentificationofmushrooms. |
|  | 2.Todifferentiatetheediblemushrooms withtoxicand hallucinatingfungi. |
|  | 3.Tostudythecultivation techniqueofmushrooms |
|  | 4.Tolearntheeconomicimportanceofmushroominvariousfields. |
|  | 5.Tostudy howto establishmushroom cultivation asbusiness enterprise. |
|  | 6.Toteachtheidentificationofmushrooms. |
| **UNIT** | **CONTENTS** |
| **I** | **INTRODUCTION:**Mushroom,EdibleMushroom,commercialproduction,medicinalvalueofmushrooms,nutraceuticals and dietary supplements |
| **II** | **MORPHOLOGICAL AND MICROSCOPICAL IDENTIFICATION OF EDIBLE AND POISONOUS MUSHROOMS**:Keysforidentificationofediblemushrooms:*Agaricusbisporus*,*Pleurotussajorcaju*,*Volvariellavolvcea*and*Calocybeindica.*Keyforidentifyinghallucinogenicmushroom(*Psilocybe*sp.)MedicinalMushroom –*Cordyceps,Ganoderma lucidum*and*Lentinusedodes.* |
| **III** | **CULTIVATION:**Substratesterilization,bedpreparation,croppingroomandmaintenance,raising of pure culture and spawn preparation, factors effecting button mushroom production(Temp,pH, airandwatermanagement, competitor mouldsand otherdisease). |
| **IV** | **POST-HARVESTMANAGEMENT:**Harvest,storage,qualityassuranceofmushrooms.Pestmanagement. |
| **V** | Worldproductionediblemushroom,Legalandregulatoryissuesofintroducingthemedicinalmushrooms in different countries. Developing small scale industry and Government schemes.MushroomResearch Centres–Internationaland National levels. |
| **Course outcomes:** On completion of this course, the students will be able to: **CO**  | **Programme outcomes** |
| 1.KnowledgeonidentificationofedibleandtoxicmushroomsbelongingtoAscomycotaand Basidiomycota. | K1,K3 |
| 2.Outlinethenutraceutical propertiesof ediblemushrooms. | K2,K4 |
| 3.Knowledgeon cultivationtechniques ofedible and medicinal mushrooms. | K3,K6 |
| 4.Understandtheharvestand post-harvesttechniquesofmushroomcrops. | K4 |
| 5.Knowledgeonthe productionand marketingstrategies formushrooms. | K5 |
| ExtendedProfessionalComponent (is a part ofinternal component only,Not to be included in theExternalExaminationquestionpaper) | Questionsrelatedtotheabovetopics,fromvariouscompetitiveexaminationsUPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/otherstobesolved(TobediscussedduringtheTutorialhour) |
| Skillsacquiredfromthiscourse | Knowledge,ProblemSolving,Analyticalability,ProfessionalCompetency,ProfessionalCommunicationandTransferrableSkill |

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| **RecommendedText:** |
| 1. Cheung,P.C.K.2008. Mushroomsasfunctionalfood.AJohnWiley&Sons, Inc.,Publication.
2. Dijksterhuis, J. and Samson, R.A. 2007. Food Mycology: A multifaceted approach in fungiandfood. CRC press, Newyork.
3. Hall.,R.I.,Stepheson,S.L.,Buchanan,P.K.,Yun,W.andCole,A.L.J.2003.Edibleandpoisonousmushrooms of theworld. TimberPress,Portland, Cambridge.
4. Ting,S.andMiles,P.G.2004.Mushrooms:Cultivation,nutritionalvalue,medicinaleffectandnutritional environmental impact. CRC press, Newyork.
5. Verma, 2013. Mushroom: edible and medicinal: cultivation conservation, strain improvement with their marketing.DayaPublishingHouse.
 |
| **Referencebooks:** |
| 1. Tiwari.,SC.,PandeyK. 2018.Mushroomcultivation.Mittalpublisher,NewDelhi.
2. Philips,G.,Miles,Chang,S-T. 2004.Mushrooms:Cultivation, nutritionalvalue, medicinaleffectand environmentaleffect. 2nded. CRCPress.
3. Diego,C.Z.,Pando-Gimenez,A.2017.Edibleandmedicinalmushrooms:TechnologyandApplication.Wiley-Blackwell publishers.
4. Nita Bahl. 2002. Handbook on Mushroom 4th edition Vijayprimlani for oxford & IBH publishing co., Pvt., Ltd., New Delhi. Dr.C. Sebastian Rajesekaran Reader in Botany Bishop Heber College, Trichy – 17.

5. Suman. 2005. Mushroom Cultivation Processing and Uses, M/s. IBD Publishers and Distributors, New Delhi. |
| **Web resources:** |
| 1. <https://www.amazon.in/Mushroom-Cultivation-India-B-C/dp/817035479X>
2. <http://nrcmushroom.org/book-cultivation-merged.pdf>
3. <http://agricoop.nic.in/sites/default/files/ICAR_8.pdf>
4. <http://www.agrimoon.com/mushroom-culture-horticulture-icar-pdf-book/>

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

**Mapping with Programme Outcomes:**

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| **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)**

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| **Semester** | **23PBOTE15- 1:( Generic / Discipline centric)** **ELECTIVE–II****HORTICULTURE** | **H/W** | **C** |
| **I** | **5** | **3** |

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| **Pre-requisite** | Students should know fundamental knowledge on horticulture applications. |
| **Learning Objectives** | 1.Know about the brief history, divisions, classification and structure of horticultural plants.  |
|  | 2.Acquire knowledge on plant growth processes and stages of plant growth.  |
|  | 3.Understand the plant growth environment in relation to soil, nutrients, fertilizers, and bio inoculants.  |
|  | 4.Study the sexual and vegetative propagation methods including propagation through specialized vegetative structures. |
|  | 5.Develop practical skills in micro propagation techniques and soil-less production of horticultural crops. |
| **UNIT** | **CONTENTS** |
| **I** | **INTRODUCTION TO HORTICULTURE** Definition; Brief History, Divisions of Horticulture, Classification of horticultural plants, Structure of Horticultural Plants –Cell and Tissue systems, Anatomy of stem root and leaf, Morphological structures, Plant growth processes-A brief account of Photosynthesis, Respiration, Transpiration and Translocation, Stages of plant growth.  |
| **II** | **FACTORS AFFECTING PLANT GROWTH** Plant Growth Environment: Abiotic factors, Soil –Profile structure, Primary and Secondary nutrients and their functions, Organic matter, Fertilizers –organic, Inorganic and Potting Media, Bio inoculants, Methods of fertilizer application, Directing Plant growth-Training -Pruning and thinning.  |
| **III** | **PLANT PROPAGATION** Plant propagation: Seeds –Advantages, Viability, Mechanism of Dormancy and Dormancy Breaking: Methods of Direct and Indirect Seedling Production in Nurseries and Transplantation; Propagation through specialized underground structures –Corm, Tuber, Sucker, Bulb, Bulbil, Rhizome; Vegetative Propagation –Cutting, Layering, Grafting and Budding.  |
| **IV** | **MICROPROPAGATION TECHNIQUES** Stages, multiplication by shoot tip, Nodal culture and Callus culture-Application and Limitations, Somatic embryogenesis, Synthetic seeds –Preparation and Potential uses of artificial seeds, Embryo Rescue, Soil-less Production of Horticultural crops –Hydroponics, sand culture, gravel culture.  |
| **V** | **AESTHETICS OF HORTICULTURE** Design: Elements and Principles of Design, Flower Arrangement, Terrarium Culture, Bonsai, Growing Plants Indoors, Turf Production, Landscaping-Principles, Types of Parks, Xeriscaping. Postharvest handling of Horticultural Products –Harvesting, Storage, Processing, Elements of Marketing. Robotics in Horticulture. |

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| **Course outcomes:** On completion of this course, the students will be able to: **CO**  | **Programme outcomes** |
| 1. Identify and categorize various horticultural plants and the conditions that affect their growth and productivity.
 | K1 |
| 1. Explain the various structures and growth processes of horticultural plants.
 | K2  |
| 1. Demonstrate the propagation, growth, and maintenance of plants in horticulture systems.
 | K3 |
| 1. Correlate the soil characteristics and fertility to good plant growth.
 | K4 |
| 1. Utilize the role plant tissue culture techniques in the production of quality planting stock in horticulture.
 | K5 |
| 1. Apply horticultural skills and knowledge to explore career opportunities in horticulture industry.
 | K6 |
| ExtendedProfessionalComponent (is a part ofinternal component only,Not to be included in theExternalExaminationquestionpaper) | Questionsrelatedtotheabovetopics,fromvariouscompetitiveexaminationsUPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/otherstobesolved(TobediscussedduringtheTutorialhour) |
| Skillsacquiredfromthiscourse | Knowledge,ProblemSolving,Analyticalability,ProfessionalCompetency,ProfessionalCommunicationandTransferrableSkill |

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| **RecommendedText:** |
| 1. Acquaah, G. 2011.Horticulture: Principles and Practices. (4th ed), Pearson Education, London, UK.
2. Janik, J. 1972. Horticultural Science. W.H. Freeman & Company, San Francisco.
3. Kumar, N. 1994. Introduction to Horticulture, Rajalakshmi Publication, India.
4. Manibhushan Rao, K. 2005. Text Book of Horticulture. (2nd ed), Macmillan India Ltd., New Delhi.
5. Schilletter, J. C. and Richey, H. W. 2005. Text Book of general Horticulture. 2nd ed. Biotech Books, Delhi.
6. Sharma, R.R. 2016. Propagation of horticultural crops. Kalyani Publishers, New Delhi.
7. Subba Rao, N.S. 1997. Biofertilizers in Agriculture and Forestry. India Book House Limited, Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.
 |
| **Reference Books:** |
| 1. Acquaah, G. 2002. Horticulture Principles and Practices. 2nd ed. Pearson Education (Singapore) Pvt. Ltd.
2. Ashman, M.A. and Puri, G. 2002. Essential soil science-A clear and concise introduction to soil science. Blackwell scientific publishers, London.
3. Denisen, E.L. 1979. Principles of Horticulture. MacMillan Publishing co, Inc. New York.
4. Dirr, M. and Heuser, C.W. 2009. The Reference Manual of Woody Plant Propagation: From Seed to Tissue Culture. Timber Press, Oregon, USA.
5. Thomson, L.M. and Troen, F.R. 1975. Soils and soil fertility Tata, McGraw Hill Publication Co. Ltd. New Delhi.
6. Tolanus, S. 2006. Soil fertility, Fertilizer and Integrated Nutrient management. CBS Publication, Delhi, India.
 |
| **Web resources:** |
| 1. <https://www.kobo.com/in/en/ebooks/horticulture>
2. <https://www.gale.com/gardening-and-horticulture>
3. <https://www.iaritoppers.com/p/horticulture-icar-ecourse-pdf-books.html>
4. <https://www.amazon.in/Introduction-Horticulture-N-Kumar-ebook/dp/B08M4289M6>
5. https:/[/www.rese](http://www.researchgate.net/publication/316438576_Polyembryony_in_Horticulture_and_)a[rchgate.net/publication/316438576\_Polyembryony\_in\_Horticulture\_and\_](http://www.researchgate.net/publication/316438576_Polyembryony_in_Horticulture_and_) its\_significance
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**Mapping with Programme Outcomes:**

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

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

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| **Semester** | **23PBOTE15- 2:( Generic / Discipline centric)** **ELECTIVE–II****ETHNOBOTANY, NATUROPATHY AND TRADITIONAL HEALTHCARE** | **H/W** | **C** |
| **I** | **5** | **3** |

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| **Pre-requisite** | The training imparts the knowledge and abilities required to conduct field studies on how humans use plants. |
| **Learning Objectives** | 1.Understand the concept of ethnobotany and the life style and traditional practices of plants by Indian tribals.  |
|  | 2.Emphasize the importance of non-timber forest products for Indian tribal people livelihoods. |
|  | 3.Evaluate the various research techniques to gather tribal knowledge of ethnobotany. |
|  | 4.Use strategies to turn ethno botanical knowledge into goods with value additions. |
|  | 5.To save and document ethno botanicalsin order to use plant resources sustainably. |
| **UNIT** | **CONTENTS** |
| **I** | **ETHNOBOTANY:**Concept, important landmarks in the development, scope, sub disciplines of ethno botany. Interdisciplinary approaches. Knowledge of following sociological and anthropological terms: culture, values and norms, institutions, culture diffusion and ethnocentrism. History of ethnobotany: A brief history of ethno botanical studies in the world and in India. |
| **II** | **PLANTS USED BY TRIBALS OF INDIA:**Distribution of tribes in India. Basic knowledge of following tribes of Tamil Nadu: Irulas, Kanis, Paliyars Badagas, Kurumbres, Thodas and Malayalis. Plants used by tribals of Tamil Nadu. |
| **III** | **SOURCES OF ETHNOBOTANICAL DATA:** Primary - archeological sources and inventories, Secondary - travelogues, folklore and literary sources, herbaria, medicinal texts and official records. Methods in ethnobotanical research. Prior Informed Consent, PRA techniques, interviews and questionnaire methods, choice of resource persons. Folk taxonomy – plants associated with culture and socio- religious activities. Non – timber forest products (NTFP) and livelihood – Sustainable harvest and value addition. |
| **IV** | **NATUROPATHIC MEDICINE:**Role of plants in naturopathy- Importance and relevance of medicinal drugs in India. Indian Systems of Medicine (Ayurveda, Siddha, Allopathy, Homeopathy, Unani, Tibetan, Yoga and Naturopathy). Disease diagnosis, treatment, and cure using natural therapies including dietetics, botanical medicine, homeopathy, fasting, exercise, lifestyle counseling, detoxification, and chelation, clinical nutrition, hydrotherapy, naturopathic manipulation, spiritual healing, environmental assessment,**TRADITIONAL HEALTH CARE:**Health practices, approaches, knowledge and beliefs incorporating plant, animal and mineral based medicines, spiritual therapies, manual techniques and exercises, applied singularly or in combination to treat, diagnose and prevent illnesses or maintain well-being. |
| **V** | **BIOPROSPECTING AND VALUE ADDITION:**Bioprospecting of drug molecules derived from Indian traditional plants; Methods for bioprospecting of natural resources; From folk Taxonomy to species confirmation - evidences based on phylogenetic and metabolomic analyses; Ethno botanical databases and Traditional knowledge Digital Library (TKDL). |
| **Course outcomes:** On completion of this course, the students will be able to: **CO**  | **Programme outcomes** |
| 1. Recall or remember concept of ethnobotany.
 | K1 |
| 1. Understand the life style and traditional practices of plants by Indian tribals.
 | K2 & K6 |
| 1. Highlight the role of Non-Timber Forest products for livelihood of tribal people of India
 | K3 |
| 1. Assess the methods to transform ethnobotanical knowledge into value added products.
 | K4 |
| 1. Build idea to make digitization of ethnobotanical knowledge.
 | K5 |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examinationquestion 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 thiscourse | Knowledge, Problem Solving, Analytical ability, ProfessionalCompetency, Professional Communication and Transferrable Skill |

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| **RecommendedText:** |
| 1. Subramaniam, S.V and V.R. Madhavan (Eds,). 1983. Heritage of the Tamil Siddha Medicine. International Institute of Tamil Studies. Madras.
2. Jain, A. and Jain, S.K. 2016. Indian Ethno botany - Bibliography of 21st Century   Scientific Publishers (India).
3. Gokhale, S.B., Kokate, C.K and Gokhale, A. 2016. Pharmacognosy of Traditional Drugs. 1st ed. NiraliPrakashan, Pune.
4. Gringauz. 2012. Introduction to Medicinal Chemistry: How Drugs Act & Why? Wiley India Pvt Ltd. Noida.
5. Joshi, S.G. 2018. Medicinal Plants. Oxford & IBH Publishing C., Pvt., Ltd., New Delhi.
 |
| **Reference Books:** |
| 1. CSIR. 1940-1976. Wealth of India. A Dictionary of Raw Materials and Industrial Products - Raw Materials. Vol.1-11. CSIR Publication & Information Directorate. New Delhi.
2. Gokhale, S.B., Kokate, C.K and Gokhale, A. 2016. Pharmacognosy of Traditional Drugs. 1st ed. Nirali Prakashan, Pune.
3. Laird, S.A. 2002. Biodiversity and Traditional knowledge equitable partnerships in Practice. Earthscan Publications Ltd., London.
4. Ministry of Environment and Forests. 1994. Ethno biology in India. A Status Report. All India Coordinated Research Project on Ethno biology. Ministry of Environment and Forests. New Delhi.
5. Kumar, N. 2018. A Textbook of Pharmacognosy. Aitbs Publishers, India.
6. Premendra Singh. 2013. Medicinal Plants: Conservation, Cultivation and Utilization. Daya Publishing House, New Delhi.
7. Albuquerque, U.P., Ramos, M.A., Júnior, W.S.F., and De Medeiros, P.M. 2017. Ethnobotany.
 |
| **Web resources:** |
| 1. file:///C:/Users/HP/Downloads/8-Vol.-5-Issue-3-March-2014-IJPSR-1178-A-Paper-81.pdf 2
2. http://www.plantsjournal.com/archives/2017/vol5issue3/PartB/5-3-8-217.pdf 3
3. https://shodhganga.inflibnet.ac.in/bitstream/10603/116454/7/07\_chapter%201.pdf 4
4. https://www.cell.com/action/showPdf?pii=S1360-1385%2817%2930001-8 5
5. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3465383/pdf/pnas.201202242.pdf 6
6. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4151377/pdf/1746-4269-10-48.pdf 7 Jain, S. K. 1994. http://www.worldcat.org/identities/lccn-n85-4353/
7. http://www.frlht.org/
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**Mapping with Programme Outcomes:**

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

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

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| **Semester** | **23PBOTE15- 3:( Generic / Discipline centric)** **ELECTIVE–II****ALGAL TECHNOLOGY** | **H/W** | **C** |
| **I** | **5** | **3** |

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| **Pre-requisite** | Students should be familiar with thebasicandappliedknowledgeonalgal biotechnology. |
| **Learning Objectives** | 1.To provide a basic overview of algae cultivation techniques and resource potentials.  |
|  | 2.To educate people about the widespread commercial uses of algae. |
|  | 3.To educate people about the therapeutic usesof algae. |
|  | 4.Toenrichthecurrentknowledgeof how algae are used inbasicresearchandtechnologicalapplications. |
|  | 5.To spread awareness of the value of algae biotechnology and its applications in diverse industries. |
| **UNIT** | **CONTENTS** |
| **I** | **SCOPE OF ALGAL TECHNOLOGY** Scope of algal technology – Commercial potential and utility of algae. Algae as sources for food, feed, pigments, Pharmaceuticals and neutraceuticals, fine chemicals, fuel, biofertilizers and hormones. Economic importance of algae in India. |
| **II** | **ALGAL PRODUCTS**Industrial application of algae - fuel, algal lipids - transesterification to ester fuel - substitutes for petroleum derived fuel. Algal products - Spirulina mass cultivation and its applications. Mass cultivation of micro-algae as source of protein and as feed. Liquid seaweed fertilizers - method of preparation, applications and its advantages over inorganic fertilizers. |
| **III** | **ALGAL PRODUCTION AND UTILIZATION**Algal production systems; Strain selection; Algal growth curve; Culture media; cultivation methods – small scale and Large-scale cultivation of algae. Harvesting and packing. Therapeutic uses - antioxidant, anti-ulcerogenic, antifungal, antibiotics, antitumor and antiviral compounds. Production of pigments and their utilization.  |
| **IV** | **IMMOBILIZATION AND RDNA TECHNOLOGY IN ALGAE** Algal immobilization and its applications - culturing for metabolite production and natural compounds. Methods of immobilization - alginate beads-extraction of compounds. Recombinant DNA technology in algae - Transformation systems in algae. Isolation of protoplasts, regeneration of fusion of macro algae. Role of algae in nanobiotechnology. |
| **V** | **ROLE OF ALGAE IN ENVIRONMENT MANAGEMENT** Role of algae in environmental health - Sewage treatment, treating industrial effluent, Phytoremediation- heavy metal removal, algae as indicators in assessing water quality and pollution; Saprobic index; Monitoring, assessment, restoration and management of coastal and marine ecosystem environment. Algal culture collection centers in India and abroad and their importance. |
| **Course outcomes:** On completion of this course, the students will be able to: **CO**  | **Programme outcomes** |
| 1. Understand the applied facet of botany and acquire a complete knowledge about the cultivation methods in algae.
 | K1& K3 |
| 1. Realization of the commercial potential of algal products.
 | K5 |
| 1. Analyze emerging areas of algal biotechnology for identifying therapeutic importance of algal products and their uses.
 | K2 & K4 |
| 1. Gain more information about algae genetics.
 | K4 |
| 1. Translate various algal technologies for the benefit of the ecosystem.
 | K3 & K6 |
| ExtendedProfessionalComponent (is a part ofinternal component only,Not to be included in theExternalExaminationquestionpaper) | Questionsrelatedtotheabovetopics,fromvariouscompetitiveexaminationsUPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/otherstobesolved(TobediscussedduringtheTutorialhour) |
| Skillsacquiredfromthiscourse | Knowledge,ProblemSolving,Analyticalability,ProfessionalCompetency,ProfessionalCommunicationandTransferrableSkill |

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| **RecommendedText:** |
| 1. Trivedi, P.C. 2001. Algal Biotechnology. Point publisher, Jaipur. India.
2. Bold, H.C and Wynne, M.J. 1978. Introduction to the Algae: Structure and Function. Prantice Hall of India New Delhi.
3. Sahoo, D. 2000. Farming the ocean: seaweed cultivation and utilization. Aravali International, New Delhi.
4. Bast, F. 2014. An Illustrated Review on Cultivation and Life History of Agronomically Important Sea plants. In Seaweed: Mineral Composition, Nutritional and Antioxidant Benefits and Agricultural Uses, Eds. Vitor Hugo Pomin, 39-70. Nova Publishers, New York. ISBN: 978-1-63117-571-8**.**
5. Rapouso, M.F.J., Morais, R.M.S.C., Morais, A.M.M.B. 2013. Bioactivity and applications of sulphated polysaccharides from marine microalgae. Marine Drugs, 11, 233-252.
6. Bajpai, Rakesh, K., Prokop,Ales,Zappi,Mark,E.2014.AlgalBiorefineriesVolume1:
 |
| **Reference Books:** |
| 1. Kumar H.D and H.N. Singh.1982. A text Book on Algae. Affiliated East- West Press Pvt. Ltd
2. Suganya, T and Renganathan, S. 2015. Biodiesel production using algal technology. Academic Press. ISBN: 0128009713.
3. Bajpai, Rakesh K., Prokop, Ales, Zappi, Mark E. 2014. Algal Biorefineries Volume 1: Cultivation of Cells and Products. Springer. ISBN: 9400774931.
4. Hojnacka, K., Wieczorek, P.P., Schroeder, G., Michalak, I. (Eds.). 2018. Algae Biomass: Characteristics and Applications. Developments in Applied Phycology.
5. Aziz, Farhad and Rasheed, Rezan. 2019. A Course Book of Algae. Publisher: University of Sulaimani. ISBN: 978-9922-20-391-1.
6. Dinabandhu, S and Kaushik. B.D. 2012. Algal Biotechnology and Environment. I.K. International, New Delhi.
7. Trivedi, P.C. 2001. Algal Biotechnology. Point publisher, Jaipur. India.
8. Becker. E.W. 1994. Micro algae Biotechnology and Microbiology. Cambridge University press.
9. Borowitzka, M.A. and borowizka, L.J. 1996. Microalgal Biotechnology. Cambridge University Press, Cambridge,
10. Bast, F. 2014. Seaweeds: Ancestors of land plants with rich diversity. Resonance, 19(2) 1032-1043 *ISSN*: 0971-8044.
11. Faizal, Band Yusuf, C. 2016.Algal biotechnology: Products and processes. Springer.
12. Gouveia, L. 2011. Microalgae as a feedstock for biofuels. Springer Briefs in Microbiology, London.
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| **Web resources:** |
| 1. <https://www.springer.com/gp/book/9783319123332>
2. <https://www.researchgate.net/publication/318449035_Algae_Biotechnology>
3. <https://www.energy.gov/sites/prod/files/2015/04/f21/algae_marrone_132100.pdf>
4. <https://www.amazon.in/Prospects-Challenges-Algal-Biotechnology-Tripathi-ebook/dp/B0779BF366>
5. <https://www.degruyter.com/view/product/177050>
6. <https://www.amazon.in/Algal-Biotechnology-Mihir-Kumar-Das/dp/B0072I61LA>
7. <https://www.elsevier.com/books/algal-biotechnology/ahmad/978-0-323-90476-6>
8. <https://www.appleacademicpress.com/phycobiotechnology-biodiversity-and-biotechnology-of-algae-and-algal-products-for-food-feed-and-fuel/9781771888967>
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**Mapping with Programme Outcomes:**

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

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

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| **Semester** | **CORE-IV - 23PBOTC21 :****PLANT ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS** | **H/W** | **C** |
| **II** | **6** | **5** |

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| **Pre-requisite** | To acquire knowledge on the anatomical structure and reproductive phase of angiosperms. |
| **Learning Objectives** | 1.Learn the importance of plant anatomy in plant production systems. |
|  | 2.Classify meristems and identify their structures, functions and roles in monocot and dicot plants growth and secondary growth of woody plants. |
|  | 3.Understand the mechanism underling the shift from vegetative to reproductive phase. |
|  | 4.Trace the development of male and female gametophyte. |
|  | 5.Understand the recent advances in palynology. |
| **UNIT** | **CONTENTS** |
| **I** | **CELL WALL:**Morphological and physico-chemical changes; Plasmodesmata- types of pits – growth of cell wall – formation of intercellular spaces; Meristems: Classifications: Theories of shoot and root apices, Cytological zonation in shoot apex. Vascular Cambium: Composition and organization – multiplicative and additive divisions. Xylem: Primary and secondary xylem – tracheary elements and vessels – vesselless dicots – xylem rays and axial parenchyma of angiosperm wood; Dendrochronology – grain, texture and figure in wood; reaction wood; ring porous and diffuse porous wood. Phloem: Ultra structure and ontogeny of sieve tube elements and companion cell. Evolution of tracheary elements.  |
| **II** | **PERIDERM:** Structure, organization and activity of phellogen. Polyderm and Rhytiderm – wound periderm. Normal secondary thickening in Dicots; Anomalous secondary growth in Dicots (Amaranthaceae, Aristolochiaceae, Bignoniaceae, Piperaceae, Nyctaginaceae) and arborescent Monocots. Primary thickening in palms; Ontogeny of leaf, Structure and types of Stomata; Leaf abscission; Major nodal types; Kranz anatomy and its significance. Microtechnique: Principle of killing and fixation, dehydration and rehydration of botanical specimens. Stains: Principle of double staining (fast-green and light green) of free hand sections; Protocol for serial sectioning of paraffin wax impregnated specimens; Mounting and mounting media.  |
| **III** | **MICROSPORANGIUM AND MALE GAMETOPHYTE:**Structure and development of Anther; Ultrastructure and physiology of anther tapetum; Male gametophyte; Palynology: Morphology and ultrastructure of pollen wall, pollen kitt, pollen analysis, pollen storage, pollen sterility and pollen physiology.  |
| **IV** | **MEGASPORANGIUM AND FEMALE GAMETOPHYTE:**Structure and development of Megasporangium; Types of ovules, Endothelium, obturator and nucellus. Megasporogenesis: Female gametophyte: Structure, types, haustorialbehavior and Nutrition of embryo sacs. Fertilization: Double fertilization and triple fusion; Endosperm: Development of endosperm, types, physiological efficiency of endosperm haustoria and functions; Ruminate endosperm. Embryogeny: Development of monocot (Grass) and dicot (Crucifer) embryos.  |
| **V** | **POLYEMBRYONY:**Causes of Polyembryony, classification, induction and practical application. Apomixis and its significance. Seed and Fruit development and role of growth substances. Parthenocarpy and its importance.  |
| **Course outcomes:** On completion of this course, the students will be able to: **CO**  | **Programme outcomes** |
| 1. Learn the structures, functions and roles of apical *vs* lateral meristems in monocot and dicot plant growth.  | K1& K2 |
| 2. Study the function and organization of woody stems derived from secondary growth in dicot and monocot plants. | K1&K4 |
| 3. Apply their idea on sectioning and dissection of plants to demonstrate various stages of plant development. | K2& K6 |
| 4. Understand the various concepts of plant development and reproduction. | K3& K6 |
| 5. Profitably manipulate the process of reproduction in plants with a professional and entrepreneurial mindset. | K5 |
| ExtendedProfessionalComponent (is a part ofinternal component only,Not to be included in theExternalExaminationquestionpaper) | Questionsrelatedtotheabovetopics,fromvariouscompetitiveexaminationsUPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/otherstobesolved(TobediscussedduringtheTutorialhour) |
| Skillsacquiredfromthiscourse | Knowledge,ProblemSolving,Analyticalability,ProfessionalCompetency,ProfessionalCommunicationandTransferrableSkill |

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| **RecommendedText:** |
| 1. Bhojwani, S.S. Bhatnagar, S.P and Dantu, P.K. 2015. The Embryology of Angiosperms (6th revised and enlarged edition). Vikas Publishing House, New Delhi.
2. Maheshwari, P. 1963. Recent Advances in Embryology of Angiosperms. Intl. Soc. Plant Morphologists, New Delhi.
3. Sharma, P.C. 2017. Text Book of Plant Anatomy. Arjun Publishing House, New Delhi.
4. Pandey.S.N and Ajanta Chandha. 2006. Plant Anatomy and Embryology. Vikas Publishinf House Pvt. Ltd, New Delhi.
5. Narayanaswamy, S. 1994. Plant Cell and Tissue Culture. Tata McGraw Hill Ltd. New Delhi.
 |
| **Reference Books:** |
| 1. Krishnamurthy, K.V. 1988. Methods in Plant Histochemistry. S. Viswanathan & Co., Madras.2. Swamy, B.G.L and Krishnamurthy. K.V 1990. From flower to fruits, Tata – McGraw Hill publishing Co Ltd, New Delhi.3. Pullaiah, T., Lakshiminarayana, K and Hanumantha Rao, B. 2006. Text book of Embryology of Angiosperms. Regency Publications, New Delhi. 4. Bierhorst, D.W. 1971. Morphology of Vascular Plants. Macmillan publishers, New York. 1. Crang, R., Lyons-Sobaski, S and Wise, R. 2018. Plant Anatomy: A Concept-Based Approach to the Structure of Seed Plants. Springer International Publishing.
2. Cutler, D. F., Botha, T and Stevenson, D.W. 2008. Plant Anatomy: An Applied Approach. Blackwell Publishing, Malden, USA.
3. Eames, A.J and Mac Daniels, L.H. 2013. Introduction to Plant Anatomy, 3rd Edition. McGraw-Hill Inc., US.
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| **Web resources:** |
| 1. https://[www.ipni.org/](http://www.ipni.org/)
2. http://www.theplantlist.org/
3. https://faculty.etsu.edu/liuc/plant\_anatomy\_sites.htm
4. <http://aryacollegeludhiana.in/E_BOOK/Botany/plant_anatomy.pdf>
5. https://[www.uou.ac.in/sites/default/files/slm/BSCBO-202.pdf](http://www.uou.ac.in/sites/default/files/slm/BSCBO-202.pdf)
6. <http://greenlab.cirad.fr/GLUVED/html/P1_Prelim/Bota/Bota_typo_014.html>
7. <https://www.askiitians.com/>
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**Mapping with Programme Outcomes:**

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| **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)**

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| **Semester** | **CORE-V - 23PBOTC22 :****TAXONOMY OF ANGIOSPERMS AND** **ECONOMIC BOTANY** | **H/W** | **C** |
| **II** | **6** | **5** |

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| **Pre-requisite** | Prior knowledge on morphological, anatomical characteristics and uses of plants. |
| **Learning Objectives** | 1.To be familiar with the basic concepts and principles of plant systematics.  |
|  | 2.To develop a suitable method for correct characterization and identification of plants.  |
|  | 3.To understand the importance of taxonomic relationships in research of plant systematics.  |
|  | 4.To provide information on various classification systems |
|  | 5.To know about the economic importance of plants. |
| **UNIT** | **CONTENTS** |
| **I** | **TAXONOMY AND SYSTEMATICS**Botanical exploration and contribution with special reference to India by William Roxburgh, J.D. Hooker, Robert Wright, Nathanial Wallich and Gamble, J.S. Principles of classification as proposed – Artificial – Linnaeus, Natural – Bentham and Hooker, Phylogenetic system - Hutchinson, Modern – Takhtajan. Botanical gardens and herbaria of world, preparation and maintenance of Herbarium, Botanical survey of India – its organization and role. |
| **II** | **MODERN TRENDS IN TAXONOMY**Modern trends in taxonomy, chemotaxonomy, numerical taxonomy, biosystemics. ICBN uninominal systems- genesis binomial nomenclature, importance and principle. Important articles, typification, principles of priority, effective and valid publication, author citation, recommendations and amendents of code. Glossories and dictionaries, Taxonomic literature (Index Kewensis) |
| **III** | **SYSTEMATIC ANALYSIS OF PLANTS-I**Polypetalae – Nympheaceae, Sterculiaceae, Portulaceae, Rhamnaceae, Vitaceae, Sapindaceae, Combretaceae, Turneraceae. |
| **IV** | **SYSTEMATIC ANALYSIS OF PLANTS-II**Gamopetalae – Sapotaceae, Oleaceae, Boraginaceae, Scrophulariaceae, Bignoniaceae, Convolvulaceae, Acanthaceae, Verbenaceae.Monochlamydeae – Nyctaginaceae, Aristolochiaceae, Casuarinaceae. Monocots – Orchidaceae, Amarylidaceae, Lilliaceae, Commelinaceae, Cyperaceae. |

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| **V** | **ECONOMIC BOTANY**General account on utilization of selected crop plants: (i) Cereals (rice and wheat) – (ii) Pulses (red gram and black gram), (iii) Drug yielding plants (*Withaniasomnifera*and *Coleus aromaticus)* (iv) Oil yielding plants (Groundnut, sunflower).(v) Sugar yielding plants (sugarcane and sugar beet), (vi) Spices and condiments (cardamom, cinnamon). (vii) Commercial crops - fibre (jute), (viii) Timber (Teak and red sanders wood), (ix) Resins and gums (Asafoetida and gum arabic) – (x) Essential oils (lemon grass and menthol), (xi) Beverages (tea, coffee), (xii) Plants used as avenue trees for shade, pollution control and aesthetics (xiii) Energy plantation - uses of *Casuarina.* |
| **Course outcomes:** On completion of this course, the students will be able to: **CO**  | **Programme outcomes** |
| 1. Recollect the basic concepts of morphology of leaves, flowers. Identify the types of compound leaves , inflorescence and fruits Describe their characteristic features  | K1, K2K3 |
| 2. Explain the principles of taxonomy. Summarize the taxonomic hierarchy. Define Binomial nomenclature. Group Activity -Construct key preparation | K1, K2K5, K6 |
| 3. Explain the various types of classification. Distinguish its advantages and disadvantages Construction of floral formula anf floral diagram. | K1, K2K3, K4 |
| 4. Illustrate and explain the characteristic features and list out the economic importance of the families Field trip to local botanical garden and regional botanical garden. | K1, K2K3, K4 |
| 5. Illustrate and explain the characteristic featuresand list out the economic importance of the families.  | K1, K2K3, K5 |
| ExtendedProfessionalComponent (is a part ofinternal component only,Not to be included in theExternalExaminationquestionpaper) | Questionsrelatedtotheabovetopics,fromvariouscompetitiveexaminationsUPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/otherstobesolved(TobediscussedduringtheTutorialhour) |
| Skillsacquiredfromthiscourse | Knowledge,ProblemSolving,Analyticalability,ProfessionalCompetency,ProfessionalCommunicationandTransferrableSkill |

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| **RecommendedText:** |
| 1. Pandey, B.P. 2013. Taxonomy of Angiosperms, S. Chand Publishing, New Delhi.
2. Sharma, O.P. 2017. Plant Taxonomy. (II Edition).The McGraw Hill Companies.
3. Singh, G. 2007. Plant systematics theory and practices. Oxford and IBH Publishing Co.
4. Jain, S.K and Rao R.R. 1993. A handbook of field and herbarium methods. Today and Tomorrow Publ.
5. Pandurangan, A.G., Vrinda, K.B and Mathew Dan. 2013. Frontiers in plant taxonomy. JNTBGRI, Thiruvananthapuram, Kerala.
6. Vardhana, R. 2009. Economic Botany. 1st ed. Sarup Book Publishers Pvt Ltd. New Delhi.
7. Subramaniam, N.S. 1997. Modern plant taxonomy. Vikas Publishing House, New Delhi.
 |
| **Reference Books:** |
| 1. Wallis, T.E. 1999. Text book of Pharmacognosy. CBS Publishers and Distributors, New Delhi.
2. Kumaresan, V and Annie Regland. 2004. Taxonomy of Angiosperms systematic Botany, Economic Botany, Botany & Ethnobotany.
3. Anonymous, 2004. Cultivation of Selected Medicinal Plants. National Medicinal Plants Board, Govt. of India, New Delhi.
4. Vallabh. 2000. Practical Pharmacognosy, Kolkata. New Delhi.
5. Acharya Vipul Rao. 2000. Herbal cure for common diseases. Diamond books, Pvt. Ltd.
6. Dey, A.C. 1998. Indian medicinal plants used in Ayurvedic preparations, Bishen Singh Mahendra Pal Singh.
7. Sathya, S., Jaiganesh, K.P and Sudha, T. 2019. Current Trends in Herbal Drug Technology. Pharmacy Council of India New Delhi.
8. Mohamad Ali. 2009. Pharmacognosy and Phytochemistry. CBS Publications& Distribution, New Delhi, Volume.1.
9. Lewis, W.H and M.P.F. Elwin Lewis. 1976. Medical Botany. Plants affecting Man’s Health. A Wiley Inter Science Publication. John Wiley and Sons, New York.
 |
| **Web resources:** |
| 1.https://[www.ipni.org/](http://www.ipni.org/)2.<http://www.theplantlist.org/>3.<https://www.amazon.in/PLANT-TAXONOMY-Sharma/dp/0070141592>5.https://www.tropicos.org/home6.http://apps.kew.org/herbcat/gotoHerbariumGrowthPage.do7.https://www.absbooksindia.com/shop/science/botany/textbook-of-economic-botany |

**Mapping with Programme Outcomes:**

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| **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)**

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| **Semester** | **CORE-VI - 23PBOTP23 :****LABORATORY/ PRACTICAL COURSE-II- COVERING CORE PAPERS, IV AND V** | **H/W** | **C** |
| **II** | **6** | **4** |

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| **Pre-requisite** | Theoretical understanding of plant taxonomy, ecology and phytogeography, plant anatomy and embryology as well as basic laboratory skills for the relevant core course. |
| **Learning Objectives** | 1.Understand and develop skill sets in plant morphological, floral characteristics and artificial key preparation. |
|  | 2.Expedite skilled workers to carry out research in frontier areas of plant science. |
|  | 3.Classify meristems and identify their structures, functions and roles in monocot and dicot plants growth and secondary growth of woody plants |
|  | 4.Learn the importance of plant anatomy in plant production systems. |
|  | 5Know about different vegetation sampling methods. |
| **UNIT** | **EXPERIMENTS** |
| **I** | **TAXONOMY AND ECONOMIC BOTANY OF ANGIOSPERMS**Preparation of artificial keys.Description of a species, based on virtual herbarium and live specimens of the families mentioned in the theory.Study the products of plants mentioned in the syllabus of economic botany with special reference to the morphology, botanical name and family.Solving nomenclature problems. **Field trip:**A field trip at least 3-4 days to a floristically rich area to study plants in nature and field report submission of not less than 20 herbarium sheets representing the families studied. |
| **II** | **ANATOMY** 1. Study of shoot apex of *Hydrilla* 2. Observation of cambial types. 3. Sectioning and observation of nodal types. 4. Study of anomalous secondary growth of the following: STEM- *Nyctanthus, Bouerhhavia, Aristolochia, Bignonia, Piper* petal and *Mirabilis*. ROOT: *Acyranthus*5. Observation of stomatal types by epidermal peeling. 6. Maceration of wood and observation of the components of xylem. 7. Double staining technique to study the stem anomali.  |
| **III** | **EMBRYOLOGY**1. Observation of T.S. of anther. 2. Observation of ovule types. 3. Observation of mature embryo sacs. 4. Dissection and observation of embryos (globular and cordate embryos). 5. Study of pollen morphology 6. Study of in vitro pollen germination. 7. Observation of endosperm types.  |
| **IV** | **ECOLOGY,** 1. Determination of the quantitative characters of a plant community by random quadrat method (abundance, density, dominance, species diversity, frequency) in grazing land, forests.
2. Estimation of above ground and below ground biomass in a grazing land employing minimum size of quadrat.
3. To determine soil moisture, porosity and water holding capacity of soil collected from varying depth at different locations.
4. Determination of pH of soil and water by universal indicator (or) pH meter.
5. Determination of dissolvedoxygen.
6. Estimation of carbonate.
7. Estimation of bicarbonate.
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| **V** | **PHYTOGEOGRAPHY, CONSERVATION BIOLOGY & INTELLECTUAL PROPERTY RIGHTS**1. Mapping of world vegetation
2. Mapping of Indian vegetation.
3. Remote sensing – Analyzing and interpretation of Satellite photographs- Vegetation/ weather.

 4. Visit to remote sensing laboratory (at Anna University, Regional  Meteorological Centre at Numgambakkam). |

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| **Course outcomes:** On completion of this course, the students will be able to: **CO**  | **Programme outcomes** |
| 1. To gain recent advances in plant morphological and floral characteristics.
 | K1 |
| 1. Understand about different floral characteristics and artificial key preparation which employed for plant identification and conservation.
 | K2 |
| 1. Recall or remember the information including basic and advanced in relation with plant anatomy and embryology.
 | K4 &K5 |
| 1. Apply their idea on sectioning and dissection of plants to demonstrate various stages of plant development.
 | K3 |
| 1. Know about different vegetation sampling methods.
 | K3 |
| ExtendedProfessionalComponent (is a part ofinternal component only,Not to be included in theExternalExaminationquestionpaper) | Questionsrelatedtotheabovetopics,fromvariouscompetitiveexaminationsUPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/otherstobesolved(TobediscussedduringtheTutorialhour) |
| Skillsacquiredfromthiscourse | Knowledge,ProblemSolving,Analyticalability,ProfessionalCompetency,ProfessionalCommunicationandTransferrableSkill |

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

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| **Reference books:** |
| 1. Aler Gingauz.2001. MedicinalChemistry.OxfordUniversityPress&WileyPublications.
2. MannJ.Davidson,R.SandJ.B.Hobbs,D.V.Banthorpe,J.B.Harborne.1994.*NaturalProducts*.Longman Scientificand TechnicalEssex.
3. Gopalan,C., B.V.RamasastriandS.C.Balasubramanian.1985.NutritiveValueofIndianFoods. NationalInstituteofNutrition,Hyderabad.
4. Harborne. J.B. 1998. Phytochemical methods. A guide to modern techniques of Plant Analysis, Chapman and Hall publication, London.
5. Traditionalplantmedicinesassourcesofnewdrugs.P.JHoughtoninPharmacognosy.Treaseand Evan's.16Ed.2009.
6. Sundara Rajan, S, 2003. Practical Manual of Plant Anatomy and Embryology 1st ed, Anmol Publications, ISBN-812610668.
7. Katherine Esau. 2006. Anatomy of Seed Plants. 2nd edition, John Wiley and Sons.
 |
| **Web resources:** |
| 1. <https://www.kobo.com/gr/en/ebook/phytochemistry-2>
2. <https://www.amazon.in/Textbook-Pharmacognosy-Phytochemistry-Kumar-Jayaveera-ebook/dp/B06XKSY76H>
3. <https://www.amazon.in/Computational-Phytochemistry-Satyajit-Dey-Sarker-ebook/dp/B07CV96NZJ>
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>
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 **MappingwithProgrammeOutcomes:**

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

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

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| **Semester** | **ELECTIVE –III: GENERIC/ DISCIPLINE CENTRIC 23PBOTE24-1 :****MEDICINAL BOTANY** | **H/W** | **C** |
| **II** | **4** | **3** |

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| **Pre-requisite** | Understanding the uses of medicinal plants and its conservation. |
| **Learning Objectives** | 1.To understand the uses and effects of medicinal plants and herbal supplements. |
|  | 2.To gain knowledge about the historical and modern uses of plants in medicine. |
|  | 3.To gain insights into the perspectives of ethnobotanical research. |
|  | 4.To know the various methods of harvesting, drying and storage of medicinal herbs. |
|  | 5.To create new strategies to enhance growth and quality check of medicinal herbs. |
| **UNIT** | **CONTENTS** |
| **I** | **HISTORY AND TRADITIONAL SYSTEMS OF MEDICINE:**Historical Perspectives – European, African, American, Southeast Asian Practices. Scope and Importance of Medicinal Plants; Traditional systems of medicine - Definition and Scope. Classical health traditions - Naturopathy, Siddha, Ayurveda, Homeopathy, Unani and MateriaMedica. Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in Ayurvedic treatments, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umoor-e-tabiya, tumors treatments/ therapy, polyherbal formulations. |
| **II** | **PHYTOCHEMISTRY AND PHARMACOGNOSY:**Phytochemistry, important phytoconstituents, their plant sources, medicinal properties. Histochemistry – definition, principles, staining methods. Biological stains – bright field dyes and flurochromes, detection and localization of phytochemicals. Raw drugs, authenticity, study through physical, microscopic and analytical methods. Different types of formulations. Adulteration and Admixtures.  |
| **III** | **ACTIVE PRINCIPLE &DRUG DISCOVERY:** Brief description of selected plants, Active principles, biochemical properties and medicinal uses of Guggul (*Commiphora*) for hypercholesterolemia, *Boswellia*for inflammatory disorders, Arjuna (*Terminalia arjuna*) for cardio protection, turmeric (*Curcuma longa*) for wound healing, antioxidant and anticancer properties, Kutaki (*Picrorhiza kurroa*) for hepatoprotection, Opium Poppy for analgesic and antitussive, *Salix* for analgesic, *Cinchona* and *Artemisia* for Malaria, *Rauwolfia*as tranquilizer, *Belladona* as anticholinergic, *Digitalis* as cardiotonic, *Podophyllum* as antitumor, *Stevia rebaudiana* for antidiabetic, *Catharanthus roseus* for anticancer. Bioprospecting, drug discovery from plants with reference to diabetes and cancer. Product development and quality control. |
| **IV** | **CONSERVATION AND AUGMENTATION:**Significance of Cultivation, management, policies for conservation and sustainable use of medicinal plants. Conservation of endemic and endangered medicinal plants, Red list criteria; *In situ* conservation: Biosphere reserves, sacred groves, National Parks; *Ex situ* conservation: Botanic Gardens, Ethno medicinal plant Gardens. Propagation of Medicinal Plants: seeds, cuttings, layering, grafting and budding. |
| **V** | **ETHNO BOTANY AND FOLK MEDICINE:**Concepts and definition of Ethno botany and folk medicines. A brief history of ethnobotanical studies – globally & locally. Methods to study ethno botany; Applications of Ethno botany: Folk medicines of ethno botany, ethno medicine, ethno ecology, ethnic communities of India. Understanding the traditions of tribes in Tamil Nadu – Irulas and Kanis. Repository of Ethnobotanical data – Archeology, inventories, folklore and literature. Traditional Knowledge Sharing - Prior information consent, interviews, questionnaires and knowledge partners.Plants associated with culture, social, religious and medicinal purposes.Commercial use of traditional knowledge – ethics, IPR, biopiracy, equitable benefit sharing models. |

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| **Course outcomes:** On completion of this course, the students will be able to: **CO**  | **Programme outcomes** |
|  1. Recognize plants and relate to their medicinal uses | K1 |
| 1. Explain about the phytochemistry, pharmacognosy and bioprospecting of medicinal plant extracts.
 | K2 |
| 1. Apply techniques for conservation and propagation of medicinal plants.
 | K3 |
| 1. Analyze and decipher the significance of various methods of harvesting, drying and storage of medicinal herbs.
 | K4 |
| 1. Develop new strategies to enhance growth and quality check of medicinal herbs considering the practical issues pertinent to India.
 | K5 & K6 |
| ExtendedProfessionalComponent (is a part ofinternal component only,Not to be included in theExternalExaminationquestionpaper) | Questionsrelatedtotheabovetopics,fromvariouscompetitiveexaminationsUPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/otherstobesolved(TobediscussedduringtheTutorialhour) |
| Skillsacquiredfromthiscourse | Knowledge,ProblemSolving,Analyticalability,ProfessionalCompetency,ProfessionalCommunicationandTransferrableSkill |

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| **RecommendedText:** |
| 1. AYUSH (www.indianmedicine.nic.in). 2014. *About the systems*—*An overview of Ayurveda*, *Yoga and Naturopathy*, *Unani*, *Siddha and Homeopathy.* New Delhi: Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (AYUSH), Ministry and Family Welfare, Government of India.
2. Bhat, S.V., Nagasampagi, B.A., & Meenakshi, S. 2009. Natural Products – Chemistry and Applications. Narosa Publishing House, India Ltd.
3. CSIR- Central Institute of Medicinal and Aromatic Plants, Lucknow. 2016. *AushGyanya*: Handbook of Medicinal and Aromatic Plant Cultivation.
4. Kapoor, L. D. 2001. Handbook of Ayurvedic medicinal plants*.* Boca Raton, FL: CRC Press.
5. Saroya, A.S. 2017. Ethno botany. ICAR publication.
6. Sharma, R. 2003. Medicinal Plants of India-An Encyclopedia. Delhi: Daya Publishing House.
7. Sharma, R. 2013. Agro Techniques of Medicinal Plants. Daya Publishing House, Delhi.
8. Thakur, R. S., H. S. Puri, and Husain, A. 1989. *Major medicinal plants of India*. Central Institute of Medicinal and Aromatic Plants, Lucknow, India.
 |
| **Reference Books:** |
| 1. Akerele, O., Heywood, V and Synge, H. 1991. The Conservation of Medicinal Plants. Cambridge University Press.
2. Evans, W.C. 2009. Trease and Evans Pharmacognosy, 16th edn. Philadelphia, PA: Elsevier Saunders Ltd.
3. Jain, S.K. and Jain, Vartika. (eds.). 2017. Methods and Approaches in Ethnobotany: Concepts, Practices and Prospects. Deep Publications, Delhi
4. Amruth. 1996. The Medicinal plants Magazine (All volumes) Medicinal plant Conservatory Society, Bangalore.
5. Bhattacharjee, S.K. 2004. Hand Book of Medicinal plants. Pointer Publishers, Jaipur.
6. Handa, S.S and V.K. Kapoor. 1993. Pharmacognosy. VallabhPrakashan, New Delhi.
 |
| **Web resources:** |
| 1. https://www.amazon.in/Medical-Botany-Plants-Affecting-Health/dp/0471628824
2. https://www.amazon.in/Current-Trends-Medicinal-Botany-Muhammad/dp/9382332502
3. https://link.springer.com/book/10.1007/978-3-030-74779-4
4. https://www.elsevier.com/books/medicinal-plants/da/978-0-08-100085-4
5. https://www.pdfdrive.com/medicinal-plants-books.html
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**Mapping with Programme Outcomes:**

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| **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)**

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| **Semester** | **ELECTIVE –III: GENERIC/ DISCIPLINE CENTRIC 23PBOTE24-2 :****RESEARCH METHODOLOGY, COMPUTER APPLICATIONS & BIOINFORMATICS** | **H/W** | **C** |
| **II** | **4** | **3** |

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| **Pre-requisite** | To impart expertise about analysis and research. |
| **Learning Objectives** | 1.To equip students to collect, analyze and evaluate data generated by their own inquiries in a scientific manner. |
|  | 2.To provide an overview on modern equipments that they would help students gain confidence to instantly commence research careers and/or start entrepreneurial ventures. |
|  | 3.To develop interdisciplinary skills in using computers in botany to learn about the biological database.  |
|  | 4.Students aware with the most recent technologies for sequencing and bioinformatics analysis and is able to apply them to the structural and functional genomics of plants. |
|  | 5.Operate various software resources with advanced functions and its open office substitutes. |
| **UNIT** | **CONTENTS** |
| **I** | Literature collection and citation: bibliography —bibliometrics (scientometrics): definition-laws — citations and bibliography - \*biblioscape— plagiarism— project proposal writing — dissertation writing – paper presentation (oral/poster) - E-learning tools- monograph — introduction and writing-Standard operating procedure (SOP) – introduction and preparation — Research Institutions - National and International.  |
| **II** | Basic principles and applications of pH meter, UV-visible spectrophotometer, centrifuge, lyophilizer, chromatography- TLC, Gas chromatography with mass spectrum (GC/MS), and HPLC-Scanning electron microscopy-Agarose gel Electrophoresis — Polyacrylamide GelElectrophoresis –Polymerase chain reaction  |
| **III** | Introduction to computers and Bioinformatics. Types of hardware and software operating systems. Fundamentals of networking, operation of networks, telnet, ftp, www, Internet. Biological Research on the web: Using search engines, finding scientific articles. |
| **IV** | Public biological databases, searching biological databases. Use of nucleic acid and protein data banks. |
| **V** | NCBI, EMBL, DDBJ, SWISSPORT, Protein prediction and Gene finding tools. Techniques in Bioinformatics- BLAST, FASTA, Multiple Sequence Analysis **.** |

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| **Course outcomes:** On completion of this course, the students will be able to: **CO**  | **Programme outcomes** |
| 1. Realize the need of centrifuges and chromatography and their uses in research
 | K1 &K2 |
| 1. Learn the principles and applications of electrophoresis.
 | K2 &K3 |
| 1. Construct the phylogenetic trees for similar characteristic feature of plant genomes and study *de novo* drug design through synthetic biology.
 | K5 &K6 |
| 4 Understand the concept of pairwise alignment of DNA sequences using algorithms. | K3 &K4 |
|  5. Interpretthefeatures oflocaland multiplealignments.  | K4 &K5 |
| ExtendedProfessionalComponent (is a part ofinternal component only,Not to be included in theExternalExaminationquestionpaper) | Questionsrelatedtotheabovetopics,fromvariouscompetitiveexaminationsUPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/otherstobesolved(TobediscussedduringtheTutorialhour) |
| Skillsacquiredfromthiscourse | Knowledge,ProblemSolving,Analyticalability,ProfessionalCompetency,ProfessionalCommunicationandTransferrableSkill |

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| **RecommendedText:** |
| 1. Veerakumari, L. 2017. Bioinstrumentation. MJP Publisher, India. p578.
2. SreeRamulu, V.S.1988. Thesis Writing, Oxford& IBH Pub. New Delhi.
3. Kothekar, V and T.Nandi. 2009. An introduction to Bioinformatics. Panima publishing crop, New Delhi.
4. Mani, K and N. Vijayaraj. 2004. Bioinformatics – A Practical Approach.1st Edn. Aparna publication, Coimbatore.
5. Gurumani, N. 2019. Research Methodology: For Biological Sciences, MP. Publishers.
 |
| **Reference Books:** |
| 1. Jayaraman, J. 2000. Laboratory manual of Biochemistry, Wiley Eastern Limited, New Delhi 110 002.
2. Pevsner,J.2015.Bioinformaticsandfunctionalgenomics.Hoboken,NJ:Wiley-Blackwell.
3. Arthur Conklin W.M and Greg White, 2016. Principles of computer security. TMH. McGraw-Hill Education; 4 edition.
4. Irfan Ali Khan and Attiya Khanum (eds.). 2004. Introductory Bioinformatics. Ukaaz Publications, Hyderabad.
5. Arthur Conklin W.M., and Greg White. 2016. Principles of computer security. TMH., McGraw-Hill Education; 4th edition
6. Mishra Shanthi Bhusan. 2015. Handbook of Research Methodology - A Compendium for Scholars & Researchers, Ebooks2go Inc.
7. Narayana, P.S.D. Varalakshmi, T. Pullaiah. 2016. Research Methodology in Plant Science, Scientific Publishers, Jaipur, Rajasthan.
 |
| **Web resources:** |
| <https://www.kobo.com/in/en/ebook/bioinstrumentation-1><https://www.worldcat.org/title/bioinstrumentation/oclc/74848857><https://www.amazon.in/Bioinstrumentation-M-H-Fulekar-Bhawana-Pandey-ebook/dp/B01JP3M9TW>https://en.wikipdia.org/wiki/bioinstrumentationhttps://www.britannica.com/science/chromatography<https://en.wikipedia.org/wiki/electrophoresis> |

**Mapping with Programme Outcomes:**

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

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

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| **Semester** | **ELECTIVE –III: GENERIC/ DISCIPLINE CENTRIC 23PBOTE24-3 :****BIOPESTICIDE TECHNOLOGY** | **H/W** | **C** |
| **II** | **4** | **3** |

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| **Pre-requisite** | Priorknowledgeonimpactofchemicalpesticidesonenvironmentandbiopesticides. |
| **Learning Objectives** | 1.To understand the value and applications of biopesticides. |
|  | 2.To comprehend the various issues related to the use of chemical pesticides in horticulture, forestry, and agriculture. |
|  | 3.To gain knowledge about several biopesticides (bio-insecticides, bio-fungicides, bio-bactericides, bio-nematicides and bio-herbicides). |
|  | 4.To gain knowledge of the techniques for mass production of selected biopesticides. |
|  | 5.To be aware of the application strategies and weeds, nematodes, and disease targets. |
| **UNIT** | **CONTENTS** |
| **I** | **INTRODUCTION**Introduction of biopesticides. Biological control, History and concept of biopesticides. Importance, scope and potential of biopesticide. Advantages for the use of biopesticides. |
| **II** | **TYPES OF BIOPESTICIDES**Classification of biopesticides, botanical pesticides and biorationales. Mass production technology of bio-pesticides. Major classes-Properties and uses of Bioinsecticides, biofungicides, biobactericides, bionematicides and bioherbicides. Importance of neem in organic agriculture. |
| **III** | **IMPORTANT BIOINSECTICIDES***Bacillus thuringiensis*, NPV, entomopathogenic fungi (*Beauveria, Metarhizium, Verticillium, Paecilomyces*). Biofungicides: *Trichoderma, Gliocladium,* non-pathogenic *Fusarium, Pseudomonas* spp., *Bacillus* spp. Biobactericides: *Agro bacterium radiobacter*. Bionematicides: *Paecilomyces*, *Trichoderma*, Bioherbicides: *Phytophthora, Colletotrichum*.  |
| **IV** | **STANDARDIZATION OF BIOPESTICIDES**Target pests and crops of important biopesticides and their mechanisms of action. Testing of quality parameters and standardization of biopesticides. |
| **V** | **FORMULATION**Mass multiplication and formulation technology of biopesticides. Prospects and problems in commercialization and efficiacy of biopesticides. Commercial products of biopesticides. |

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| **Course outcomes:** On completion of this course, the students will be able to: **CO**  | **Programme outcomes** |
| 1. Understandthe issuesinuse of chemicalpesticidesandtheir harmfuleffects onlife.
 | K1& K2 |
| 1. Awarethesignificanceofbiopesticidesandtheirbeneficialroleincontrolling insectpests,diseases,nematodesandweeds.
 | K1&K4 |
| 1. Knowledge on identification of promising biopesticides and their mechanisms of action against insect pests, diseases, nematodes and weeds.
 | K2& K6 |
| 1. Learnthemass productionandformulation technologyofselected biopesticides.
 | K3& K6 |
| 1. Knowledge on product development for commercialization of biopesticides.
 | K5 |
| ExtendedProfessionalComponent (is a part ofinternal component only,Not to be included in theExternalExaminationquestionpaper) | Questionsrelatedtotheabovetopics,fromvariouscompetitiveexaminationsUPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/otherstobesolved(TobediscussedduringtheTutorialhour) |
| Skillsacquiredfromthiscourse | Knowledge,ProblemSolving,Analyticalability,ProfessionalCompetency,ProfessionalCommunicationandTransferrableSkill |

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| **RecommendedText:** |
| 1. Johri,J.2020.RecentAdvancesinBiopesticides:BiotechnologicalApplications.NewIndiaPublishingAgency (NIPA), NewDelhi.
2. Kaushik,N.2004.Biopesticidesforsustainableagriculture:prospectsandconstraints.TERIPress,New Delhi.
3. Sahayaraj,K.2014.BasicandAppliedAspectsofBiopesticides.SpringerIndia,NewDelhi.
4. Tebeest,D.O.2020.MicrobialControlofWeeds.CBSPublishersandDistributors,New Delhi.
5. Joshi, S.R. 2020. Biopesticides: A Biotechnological Approach. New Age International (P) ltd. New Delhi.
 |
| **Reference Books:** |
| 1. Ainsworth, G.C. 1971. A Dictionary of the Fungi. Commonwealth Mycological Institute, Kew, Surrey, England.
2. Carlile, M.J., Watkinson, S.C and Gooday, G.W. 2001. The Fungi. 2nd Edition. Academic Press, San Diego
3. Manoj Parihar, Anand Kumar. 2021. Biopesticides. Volume 2: Advances in Bio- inoculants. Elsevier.
4. [Bailey, A.](https://www.cabi.org/cabebooks/search/?q=ed%3a%22Bailey%2c+A.%22), [Chandler, D.](https://www.cabi.org/cabebooks/search/?q=ed%3a%22Chandler%2c+D.%22), [Grant, W. P.](https://www.cabi.org/cabebooks/search/?q=ed%3a%22Grant%2c+W.+P.%22), [Greaves, J.](https://www.cabi.org/cabebooks/search/?q=ed%3a%22Greaves%2c+J.%22), [Prince, G.](https://www.cabi.org/cabebooks/search/?q=ed%3a%22Prince%2c+G.%22), [Tatchell, M.](https://www.cabi.org/cabebooks/search/?q=ed%3a%22Tatchell%2c+M.%22) 2010. Biopesticides: pest management and regulation.Plumx.
5. Manoharachary, C., Singh, H.B., Varma, A. 2020. Trichoderma: Agricultural Applications and Beyond. Springer International Publishing, New York, USA.
6. Nollet, L.M.L and Rathore, H.S. 2019. Biopesticides Handbook. CRC Press, Florida, USA.
7. Anwer, M.A. 2021. Biopesticides and Bioagents: Novel Tools for Pest Management. Apple Academic Press, Florida, USA.
8. Awasthi, L.P. 2021. Biopesticides in Organic Farming: Recent Advances. CRC Press, Florida, USA.
9. Bailey, A., Chandler, D., Grant, W., Greaves, J., Prince, G., Tatchell, M., 2012. Biopesticides: Pest Management and Regulation. CABI, Surrey, UK.
10. Glare, T.R and Moran-Diez, M.E. 2016. Microbial-Based Biopesticides: Methods and Protocols. Humana Press, New Jersey, USA.
11. Gnanamanickam,S.S.2019.BiologicalControlofCropDiseases.CRCPress,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>
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**MappingwithProgrammeOutcomes:**

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| **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)**

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| **Semester** | **ELECTIVE –IV: GENERIC/ DISCIPLINE CENTRIC 23PBOTE25-1 :****APPLIED BIOINFORMATICS** | **H/W** | **C** |
| **II** | **4** | **3** |

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| **Pre-requisite** | Basicknowledgeinmolecularbiology.FamiliaritywithoperationsofcomputersandMS officetools. |
| **Learning Objectives** | 1.Tolearnaboutthebioinformaticsdatabases,databanks,dataformatanddataretrievalfromtheonlinesources. |
|  | 2.Toexplaintheessentialfeaturesoftheinterdisciplinaryfieldofscience forbetterunderstandingbiologicaldata. |
|  | 3.Tooutlinethetypes ofbiologicaldatabases. |
|  | 4.Todemonstratedifferent onlinebioinformaticstools. |
|  | 5.Tosummarizethestrong foundationforperformingfurtherresearch inbioinformatics. |
| **UNIT** | **CONTENTS** |
| **I** | **BIOINFORMATICSANDINTERNET:**InternetBasics-FileTransferProtocol-TheWorldWideWeb-InternetResources–databases–types-Applications-NCBI DataModel-SEQ-Ids–Biosequences-Biosequencesets–Sequence annotation–Sequencedescription. |
| **II** | **GENBANK SEQUENCE DATABASE:****Introduction**- Primary And Secondary Databases - Format Vs.Content-GenbankFlatﬁle-SubmittingDNASequencestotheDatabases - DNA/RNA-Population,Phylogenetic, and Mutation Studies - Protein-Only Submissions - Consequences of DNA Model -EST/STS/GSS/HTG/SNP and Genome Centers -Contact points for submission of sequence data toDBJ/EMBL/Genbank. |
| **III** | **STRUCTURE DATABASES:** Introduction to Structures- Protein Data Bank (PDB) - MolecularModeling Database at NCBI Structure File Formats - Visualizing Structural Information -DatabaseStructureViewers -AdvancedStructureModeling-StructureSimilarity Searching. |
| **IV** | **SEQUENCEALIGNMENTANDDATABASESEARCHING:**Introduction-EvolutionaryBasisofSequenceAlignment-ModularNatureofProteins-OptimalAlignmentMethods-SubstitutionScoresandGap Penalties-DatabaseSimilaritySearching-FASTA–BLAST(BlastP,BlastN,etc.,)-PositionSpeciﬁcScoringMatrices, Spliced Alignments. |
| **V** | **PREDICTIVE METHODS:** Using Protein Sequences Protein Identity Based on Composition - PhysicalProperties Based on Sequence - Motifs and Patterns - Secondary Structure and Folding Classes -SpecializedStructures orFeatures-Tertiary Structure. |

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| **Course outcomes:** On completion of this course, the students will be able to: **CO**  | **Programme outcomes** |
| 1. FamiliarizewiththetoolsofDNAsequence analysis. | K1&K2 |
| 2. Useandexplainthe applicationofbioinformatics. | K2&K3 |
| 3. Mastertheaspectsofprotein-proteininteraction,BLASTandPSI-BLAST. | K3&K4 |
| 4. Describethefeatures oflocaland multiplealignments. | K3&K4 |
| 5. Interpretthecharacteristicsofphylogeneticmethodsandbioinformaticsapplications. | K4&K5 |
| ExtendedProfessionalComponent (is a part ofinternal component only,Not to be included in theExternalExaminationquestionpaper) | Questionsrelatedtotheabovetopics,fromvariouscompetitiveexaminationsUPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/otherstobesolved(TobediscussedduringtheTutorialhour) |
| Skillsacquiredfromthiscourse | Knowledge,ProblemSolving,Analyticalability,ProfessionalCompetency,ProfessionalCommunicationandTransferrableSkill |

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| **RecommendedText:** |
| 1. Baxevanis,A.D.&Ouellette,B.F.2001.Bioinformatics:Apracticalguidetotheanalysisofgenesand proteins. NewYork: Wiley-Interscience.
2. Bourne,P.E.,&Gu,J.2009. Structuralbioinformatics.Hoboken, NJ:Wiley-Liss.
3. Lesk,A.M.2002. Introductiontobioinformatics.Oxford: Oxford UniversityPress.
4. Mount,D.W.2001.Bioinformatics:Sequenceandgenomeanalysis.ColdSpringHarbor,NY:ColdSpring HarborLaboratory Press.
5. Pevsner,J.2015.Bioinformaticsandfunctionalgenomics.Hoboken,NJ:Wiley-Blackwell.
 |
| **ReferenceBooks:** |
| 1. Campbell,A.MandHeyer,L.J.2003.Discoveringgenomics,proteomics,andbioinformatics.SanFrancisco: Benjamin Cummings.
2. Green,M.RandSambrook,J.2012.Molecularcloning:Alaboratorymanual.ColdSpringHarbor,NY: Cold Spring HarborLaboratory Press.
3. Liebler,D.C.2002.Introductiontoproteomics:Toolsforthenewbiology.Totowa,NJ:HumanaPress.
4. Old,R.W.,Primrose,S.B.,andTwyman,R.M.2001.Principlesofgenemanipulation:Anintroductionto geneticengineering. Oxford:Blackwell ScientificPublications.
5. Primrose,S.B.,Twyman,R.M.,Primrose,S.B.,andPrimrose,S.B.2006.Principlesofgene manipulationandgenomics.Malden,MA:BlackwellPub.
 |
| **Web resources:** |
| 1. Bioinformatics:Algorithms&ApplicationsbyProf.M.MichaelGromihaIIT-Madras.

[https://nptel.ac.in/courses/102/106/102106065/#.](https://nptel.ac.in/courses/102/106/102106065/)1. ChristopherBurge,DavidGifford,andErnestFraenkel. *7.91.*JFoundationsofComputationalandSystems*Biology.* Spring2014.MassachusettsInstituteofTechnology:MITOpenCourseWare,[https://ocw.mit.edu.](https://ocw.mit.edu/courses/biology/7-91j-foundations-of-computational-and-systems-biology-spring-2014)
2. <https://link.springer.com/book/10.1007/978-3-540-72800-9>.
3. <https://www.amazon.in/Applied-Bioinformatics-Paul-Maria-Selzer-ebook/dp/B001AUOYY2>.
4. https://books.google.co.in/books/about/Applied\_Bioinformatics.html?id=PXZZDwAAQBAJ&redir\_esc=y
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**MappingwithProgrammeOutcomes:**

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

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

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| **Semester** | **ELECTIVE –IV: GENERIC/ DISCIPLINE CENTRIC 23PBOTE25-2 :****BIOSTATISTICS** | **H/W** | **C** |
| **II** | **4** | **3** |

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| **Pre-requisite** | Fundamental knowledge on using in statistical tools and apply the tools to interpret the results. |
| **Learning Objectives** | 1.To provide the student with a conceptual overview of statistical methods. |
|  | 2.To emphasis on usefulness of commonly used statistical software for analysis, research, and experimentation.  |
|  | 3.To understand and evaluate critically the acquisition of data and its representation.  |
|  | 4.To gain the knowledge about the probability and statistical inference are all topics that will be taught in order to obtain knowledge about the graphical representation of data. |
|  | 5.To learn more about how to organize, create, and carry out the distribution of scientific knowledge. |
| **UNIT** | **CONTENTS** |
| **I** | **INTRODUCTION TOSTATISTICS**Introduction to biostatistics, basic principles, variables - Collection of data, sample collection and representation of Data - Primary and Secondary - Classification and tabulation of Data – Diagrams, graphs and presentation. |
| **II** | **DESCRIPTIVE STATISTICS**Mean, median and mode for continuous and discontinuous variables. Measures of dispersion: Range of variation, standard deviation and standard error and coefficient variation. |
| **III** | **PROBABILITY** Basic principles - types - Rules of probability - addition and multiplication rules. **PROBABILITY DISTRIBUTION**Patterns of probability distribution; binomial - Poisson and normal. |
| **IV** | **HYPOTHESIS TESTING**Chi-square test for goodness of fit; Null hypothesis, level of Significance - Degrees of Freedom. Student ‘t’ test – paired sample and mean differences ‘t’ tests. ANOVA. Basic introduction to Multivariate Analysis of Variance (MANOVA). |
| **V** | **CORRELATION AND REGRESSION** Correlation - types of correlation - methods of study of correlation - testing the significance of the coefficients of correlation. Regression and types. Sampling and experimental designs of research-Randomized block design and split plot design. |

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| **Course outcomes:** On completion of this course, the students will be able to: **CO**  | **Programme outcomes** |
| 1. Create and interpret visual representations of quantitative information, such as graphs or charts.
 | K5 & K6 |
| 1. Solve problems quantitatively using appropriate arithmetical, algebraic, or statistical methods
 | K3 & K5 |
| 1. Know the latest version using in statistical tools and apply the tools to interpret the results
 | K2 |
| 1. To developtheircompetenceinhypothesistestingandinterpretation.
 | K4 |
| 1. Understand why biologists need a background in statistics.
 |  K1 |
| ExtendedProfessionalComponent (is a part ofinternal component only,Not to be included in theExternalExaminationquestionpaper) | Questionsrelatedtotheabovetopics,fromvariouscompetitiveexaminationsUPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/otherstobesolved(TobediscussedduringtheTutorialhour) |
| SkillsacquiredfromthisCourse | Knowledge,ProblemSolving,Analyticalability,ProfessionalCompetency,ProfessionalCommunicationandTransferrableSkill |

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| **RecommendedText:** |
| 1. Gurumani, N. 2005. Biostatistics, 2nd edn. MJP publications, India.
2. Datta, A.K. 2006. Basic Biostatistics and Its Applications. New Central Book Agency. ISBN 8173815038.
3. Pillai, R.S.N and Bagavathi, V.S. 2010. Statistics theory and practice. Chand & Co. Ltd, New Delhi.
4. Mahajan, B.K. 1984. Methods in Biostatistics for Medical students and Research works. Smt. Indu Mahajan, New Delhi.
5. Pillai, R.S.N and Bagavathi, V.S. 2010. Statistics theory and practice. Chand & Co. Ltd, New Delhi.
6. Khan, I.D and Khanum, A. 2004. Fundamentals of Biostatistics, Ukazsz Publications, Hyderabad, India.
7. Gupta, S.C. 2013. Fundamentals of statistics, Himalaya Publishers, Mumbai.
8. Kothari, C.R and Garg, G. 2014. Research methodology –Method and techniques. New Age International (P) Ltd. New Delhi.
 |
| **Reference books:** |
| 1. Milton, J.S. 1992. Statistical method in Biological and Health Sciences. McGraw Hill Inc., New York.
2. Schefler, W.C. 1968. Statistics for biological sciences, Addision- Wesely Publication Co., London.
3. Spiegel, M.R. 1981. Theory and Problems of statistics, Schaum’s Outline series McGraw-Hill International Book Co., Singapore.
4. Pillai, R.S.N and Bagawathi, V. 1987. Practical Statistics (For B.Com. and B.A., Students) S.Chand & Co. (Pvt.) Ltd., New York.
5. Sobl. R.R and Rohif, F.J. 1969. Biometry. The principles and Practice and Statistics in Biological Research. W.H. Freman and Co., San Francisco.
6. Zar, J.K. 2011. Biostatistical Analysis, Fourth Edition, Prantice-Hall International, New Jersey, USA.
 |
| **Web resources:** |
| 1. nu.libguides.com/biostatistics
2. https://newonline courses.sciences.psu.edu/
3. <https://bookauthority.org/books/beginner-biostatistics-ebooks>
4. <https://www.amazon.com/dp/1478638184?tag=uuid10-20>
5. https://hastie.su.domains/ElemStatLearn/
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**MappingwithProgrammeOutcomes:**

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

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

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| **Semester** | **ELECTIVE –IV: GENERIC/ DISCIPLINE CENTRIC 23PBOTE25-3 :****INTELLECTUAL PROPERTY RIGHTS** | **H/W** | **C** |
| **II** | **4** | **3** |

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| **Pre-requisite** | Intent to understand the legal systems governing the knowledge economy. Basic understanding of how laws are structured and interpreted. |
| **Learning Objectives** | 1.Cater to the needs of the stakeholders of knowledge economy is designed for those interested in managers and similar individuals.  |
|  | 2.Create awareness of current IPR and innovation trends. |
|  | 3.Disseminate information on patents, patent system in India and overseas and registration related issues. |
|  | 4.Pursue a career in IPR, which offers chances for IP consultants and Attorneys.  |
|  | 5.Develop skill sets to enable you to comprehend and assess the methods used in knowledge based economy and innovation ecosystems. |
| **UNIT** | **CONTENTS** |
| **I** | **INTRODUCTION TO IPR** History and Development of IPR. Theories on concept of property: Tangible *vs* Intangible. Subject matters patentable in India. Non patentable subject matters in India. Patents: Criteria of Patentability, Patentable Inventions - Process and Product. Concept of Copyright. Historical Evolution of Copyright Ownership of copyright, Assignment and license of copyright. |
| **II** | **UNIT II OVERVIEW OF THE IPR REGIME AND DESIGN** International treaties signed by India. IPR and Constitution of India. World Intellectual Property Organization (WIPO): Functions of WIPO, Membership, GATT Agreement. Major Conventions on IP: Berne Convention, Paris Convention. TRIPS agreement. Industrial Designs – Subject matter of Design – Exclusion of Designs – Novelty and originality – Rights in Industrial Design. |
| **III** | **TRADE MARK, LEGISLATIONS AND PATENT ACT** History of Indian Patent Act 1970. Overview of IP laws in India. Major IP Laws in India. Patent Amendment Act 2005. WTO-TRIPS – Key effect on Indian Legislation. Organization of Patent System in India. Concept of Trademarks, Different kinds of marks, Criteria for registration, Non Registrable Trademarks, Registration of Trademarks. Infringement: Remedies and Penalties. |
| **IV** | **PRIOR ART SEARCH AND DRAFTING** Overview of Patent Search. Advantages of patent search. Open source and paid databases for Patent Search. International Patent classification system. Types of specifications: Drafting of Provisional specifications. Drafting of complete specifications. Drafting of claims. |
| **V** | **GI AND PATENT FILING PROCEDURES** Geographical Indications of Goods (Registration and Protection) Infringement – Offences and Penalties Remedies. Plant Variety and Farmers Right Act (PPVFR). Plant variety protection: Access and Benefit Sharing (ABS). Procedure for registration, effect of registration and term of protection. Role of NBA. Filing procedure for Ordinary application. Convention application. PCT National Phase application. Process of Obtaining a Patent. Infringement and Enforcement. |

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| **Course outcomes:** On completion of this course, the students will be able to: **CO**  | **Programme outcomes** |
| 1. Recall the history and foundation of Intellectual Property.
 | K1 |
| 1. Understand the differences of Property and Assets and Various Categories of Intellectual Creativity.
 | K2 |
| 1. Apply the methods to protect the Intellectual Property.
 | K3 |
| 1. Differentiate if the Said Intangible property be protected under law or protected by strategy.
 | K4  |
| 1. Create a recommendation document on the methods and procedures of protecting the said IP and search documents to substantiate them.
 | K5 & K6 |
| ExtendedProfessionalComponent (is a part ofinternal component only,Not to be included in theExternalExaminationquestionpaper) | Questionsrelatedtotheabovetopics,fromvariouscompetitiveexaminationsUPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/otherstobesolved(TobediscussedduringtheTutorialhour) |
| Skillsacquiredfromthiscourse | Knowledge,ProblemSolving,Analyticalability,ProfessionalCompetency,ProfessionalCommunicationandTransferrableSkill |

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| **RecommendedText:** |
| 1. Kalyan, C.K. 2010. Indian Patent Law and Practice, India, Oxford University Press.
2. Ahuja, V.K. 2017. Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.
3. Arthur Raphael Miller, Micheal Davis H. 2000. Intellectual Property: Patents, Trademarks and .Copyright in a Nutshell, West Group Publishers.
4. Margreth, B. 2009. Intellectual Property, 3nd, New York Aspen publishers.
5. Nithyananda, K.V. 2019. Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
6. Venkataraman M. 2015. An introduction to Intellectual property rights. Create space Independent Pub.North Charleston, USA.
 |
| **ReferenceBooks** |
| 1. World Intellectual Property Organization. 2004. WIPO Intellectual property Handbook. Retrieved from https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo\_pub \_489.pdf Journal of Intellectual Property Rights (JIPR): NISCAIR.
2. Anant Padmanabhan. 2012. Intellectual Property Rights: Infringement and Remedies LexisNexis Butterworths Wadhwa.
3. Intellectual Property Law in the Asia Pacific Region. 2009. Kluwer Max Planck Series,
4. Pradeep, S. Mehta (ed.). 2005. Towards Functional Competition Policy for India, Academic Foundation, Related.
5. Ramakrishna B and Anil Kumar, H.S. 2017. Fundamentals of Intellectual Property Rights: For Students, Industrialist and Patent Lawyers, Notion Press, Chennai.
6. James Boyle, Jennifer Jenkins. 2018. Intellectual Property: Law & the Information Society—Cases and Materials, Create space Independent Pub. North Charleston, USA.
7. Damodar Reddy, S.V. 2019. Intellectual Property Rights -- Law and Practice, Asia Law House, Hyderabad.
 |
| **Web resources:** |
| 1. <http://cipam.gov.in/>
2. <https://www.wipo.int/about-ip/en/>
3. <http://www.ipindia.nic.in/>
4. https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo\_pub\_489.pdf.
5. <https://swayam.gov.in/nd2_cec20_ge04/preview>
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**MappingwithProgrammeOutcomes:**

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

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

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| **Semester** | **Skill Enhancement : GENERIC/**  **Discipline specific 23PBOTS26 :****Floriculture and Medicinal Plant Cultivation** | **H/W** | **C** |
| **II** | **4** | **2** |

**UNIT I**

 Nursery Management and Routine Garden Operations. Sexual and vegetative methods of propagation. Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Wintering; Mulching; Topiary. Role of plant growth regulators. Flowering annuals; Herbaceous perennials; Divine vines; Shade and ornamental trees. Ornamental bulbous and foliage plants; Cacti and succulents; Palms and Cycads; Ferns and Selaginellas.

**UNIT II**

 Cultivation of plants in pots; Indoor gardening; Bonsai. Principles of Garden Designs: English, Italian, French, Persian, Mughal and Japanese Gardens. Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Shrubbery, Borders, Water garden. Some Famous gardens of India)

**UNIT III**

 Landscaping Places of Public Importance: Landscaping highways and Educational institutions. Techniques of Commercial Floriculture. Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life. Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolous.

**UNIT IV**

 History, Scope and Importance of Medicinal Plants. Indigenous Medicinal Sciences. Definition and Scope-Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in ayurvedic treatments, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umoor-e- tabiya, tumors treatments/ therapy, polyherbal formulations.

**UNIT V**

 Conservation of endangered and endemic medicinal plants. Definition: endemic and endangered medicinal plants, Red list criteria. In situ conservation: Biosphere reserves, sacred groves, National Parks; Ex situ conservation: Botanic Gardens and Ethnomedicinal plant Gardens. Propagation of Medicinal Plants: Objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of green house for nursery production, propagation through cuttings, layering, grafting and budding.

**Suggested Readings :**

1. S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
2. S.K. Jain (ed.) Glimpses of Indian. Ethnobotany, Oxford and I B H, New Delhi – 1981
3. S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.
4. S.K. Jain, 1990. Contributions of Indian ethnobotany.Scientific publishers, Jodhpur.
5. Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons – Chichester
6. Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India.Botanical Survey of India. Howrah.
7. Rajiv K. Sinha – Ethnobotany The Renaissance of Traditional Herbal Medicine – INA –SHREE Publishers, Jaipur-1969.
8. Faulks, P.J. 1958.An introduction to Ethnobotany, Moredale pub. Ltd. Men.
9. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
10. Trivedi P C, 2006. Medicinal Plants: Ethnobotanical Approach, Agrobios, India.
11. Purohit and Vyas, 2008. Medicinal Plant Cultivation: A Scientific Approach, 2nd edn. Agrobios, India.